ENCYCLOPÆDIA BRITANNICA

1768

The Encyclopædia Britannica is published with the editorial advice and consultation of the faculties of the University of Chicago

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"LET KNOWLEDGE GROW FROM MORE TO MORE
AND THUS BE HUMAN LIFE ENRICHED."

ENCYCLOPÆDIA BRITANNICA

A New Survey of Universal Knowledge

Volume 14

LIBIDO to MARY, DUCHESS OF BURGUNDY

THE UNIVERSITY OF CHICAGO

ENCYCLOPÆDIA BRITANNICA, INC.

CHICAGO · LONDON · TORONTO

PRINTED IN THE U.S.A.

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FOUNDED A.D. 1768

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LIBIDO to MARY, DUCHESS OF BURGUNDY

LIBIDO (li-bīd'o), defined by Freud as "the energy of those instincts which have to do with all that may be comprised under the word 'Love.'" Jung enlarged the concept so that for him it describes the energy resident in all instincts. Libido is usually considered to be synonymous with other such vague concepts as *élan vital* and psychophysiological energy. It is claimed that the energy of intellectual processes is measured by intelligence tests in terms of clearness and speed; but the measurement of the conative energy of a "wish" is more difficult, because the wish, which may be considered to be the inner feeling of need together with motor sets appropriate to its appeasement, may fail to find expression in measurable overt conduct on account of opposing repressive (unconscious) and suppressive (conscious) forces.

LIBITINA, Roman goddess of funerals. She had a sanctuary in a sacred grove (perhaps on the Esquiline), where, by an ordinance of Servius Tullius, a piece of money was deposited whenever a death took place. Here the undertakers (*libitinarii*), who carried out all funeral arrangements by contract, had their offices, and everything necessary was kept for sale or hire; here all deaths were registered for statistical purposes. By antiquarians Libitina was sometimes identified with Persephone, but more commonly (partly or completely) with Venus Lubentia or Lubentina, a mere confusion. Libitina may have been an earth goddess connected with luxuriant nature and the enjoyments of life (*cf. lub-et, lib-ido*); then, all such deities being connected with the underworld, she also became the goddess of death, and that side of her character predominated in the later conceptions.

LIBON, a Greek architect, born at Elis, who was employed to build the great temple of Zeus at Olympia (*q.v.*) about 460 B.C. (Pausanias v. 10. 3).

LIBOURNE, a town of southwestern France, capital of an arrondissement of the department of Gironde, at the confluence of the Isle with the Dordogne, 22 mi. E.N.E. of Bordeaux on the railway to Angoulême. Pop. (1936) 16,261. The river is tidal and vessels drawing 14 ft. can reach the town at the highest tides. Libourne stands on an ancient site. Under the Romans *Condate* stood a mile to the south of the present Libourne; it was destroyed in the 5th century. Resuscitated by Charlemagne, it was rebuilt in 1269, under its present name and on the site and plan it still retains, by Roger de Leybourne (of Leybourne in Kent), seneschal of Guienne, acting under the authority of King Edward I of England. It suffered considerably in the struggles of the French and English in the 14th century. The church of St. Jean, restored 15th-century Gothic, has a stone spire 232 ft. high. On the quay a 14th-century clock tower survives from the old ramparts, and the hôtel-de-ville is a quaint relic of the 16th century. Libourne is the seat of a sub-prefecture and of tribunals of first instance and of commerce. Trade is in local wines and brandies. Printing and cooperage are carried on.

LIBRA (The Balance), in astronomy, the 7th sign of the zodiac, denoted by the symbol ♎, resembling a pair of scales, probably to suggest that when the sun enters this part of the ecliptic, at the autumnal equinox, the days and nights are equal.

LIBRARIES. A library (from Lat. *liber*, book) is a collection of printed or written literature. The earliest libraries of the world were probably temples. The earliest collections of which we know anything were collections of archives.

Assyria.—In the course of his excavations at Nineveh in 1850, Layard came upon tablets of clay, covered with cuneiform characters. These varied in size from 1 to 12 in. square. It is estimated that this library consisted of some 10,000 distinct works and documents. The tablets appear to have been methodically arranged and catalogued, and the library seems to have been public. (*See* BABYLONIA AND ASSYRIA and NIPPUR.)

Ancient Egyptian Libraries.—At an early date Heliopolis was a literary centre of great importance, with culture akin to the Babylonian. Attached to every temple were professional scribes. We possess a record relating to "the land of the collected works (library) of Khufu," a monarch of the 4th dynasty, and a similar inscription relating to the library of Khafra, the builder of the second pyramid. At Edfu the library was a small chamber in the temple, on the wall of which is a list of books (Brugsch, *History of Egypt*, 1881, i, 240). The exact position of Ikhnaton's library (or archives) of clay tablets is known. A library of charred books has been found at Mendes (Egypt Expl. Fund, *Two Hieroglyphic Papyri*), and we have references to temple libraries in the Silsileh "Nile" stelae and, perhaps, in the Harris papyri. The most famous of the Egyptian libraries, that of King Osymandyas (Rameses II, 1300–1236 B.C.), described by Diodorus Siculus, was probably in the Ramessæum at Western Thebes. Papyri from the palace, of a later date, have been discovered by Sir W. Flinders Petrie. According to Eustathius there was a great collection at Memphis. At the Persian invasion many books were carried away by the conquerors.

Greece.—Amongst known collectors of books were Pisistratus, Polycrates of Samos, Euclid the Athenian, Nicocrates of Cyprus, Euripides and Aristotle (Athenaeus i. 41). At Cnidus there is said to have been a special collection of works upon medicine. Pisistratus is reported to have been the first of the Greeks who collected books on a large scale. Plato is known to have been a collector; and Xenophon tells us of the library of Euthydemus. The library of Aristotle was bequeathed by him to his disciple, Theophrastus, and by Theophrastus to Neleus, who carried it to Scepsis, where it is said to have been concealed underground to avoid the literary cupidity of the kings of Pergamum. It is certain that the libraries of Alexandria were the most important, as they were the most celebrated, of the ancient world.

Alexandria.—Ptolemy Soter had, it seems, already begun to collect books, but it was in the reign of Ptolemy Philadelphus that the libraries were properly established in separate buildings. There were two libraries at Alexandria; the larger, in the Brucheum quarter, was in connection with the museum, a sort of academy, while the smaller was in the Serapeum. The number of volumes was very large, although it is difficult to attain any certainty amongst varying accounts, such as those of Tzetzes (42,800 in the Serapeum and 490,000 in the Brucheum), Aulus Gellius (700,000) and Seneca (400,000). It should be observed that, as the ancient roll or volume usually contained less matter than a modern book, these numbers must be discounted for comparison with modern collections. The first five librarians appear to have been Zenodotus, Callimachus, Eratosthenes, Apollonius and Aristophanes; they cover about a century. Some of the first experiments in bibliography were the catalogues of the Alexandrian libraries. Amongst other lists, two were prepared by order of Ptolemy Philadelphus, one of tragedies, the other of comedies. The πίνακες of Callimachus formed a catalogue of all the principal books, arranged in 120 classes. After the time of Aurelian, the Serapeum became the principal library. The usual statement that the libraries continued to flourish until they were destroyed in A.D. 640 can hardly be supported.

The Pergamum.—German researches in the acropolis of Pergamum (1878–86) revealed four library rooms (Al. Conze, *Die pergamen. Bibliothek.* 1884). Despite the embargo placed by the Ptolemies upon the export of papyrus, the library, when it was transported to Egypt, numbered 200,000 volumes. We learn from Suidas that in 221 B.C. Antiochus the Great summoned the poet and grammarian, Euphorion of Chalcis, to be his librarian.

Rome.—It is not until the last century of the republic that we hear of libraries in Rome, with the exception of the writings of Mago upon agriculture. The first considerable collections of which we hear in Rome were brought there as the spoils of war. The library of Perseus was all that Aemilius Paulus reserved from the prizes of victory (167 B.C.) for himself and his sons. Next came the library of Apellicon the Teian, brought from Athens by Sulla (86 B.C.). The zeal of Cicero and Atticus in adding to their collections is well known. Tyrannion is said to have had 30,000 vols. of his own, and Cicero wrote to M. Terentius Varro: "Si hortum in bibliotheca habes, nihil deerit." The honour of being the first actually to dedicate a library to the public is said by Pliny and Ovid to have fallen to G. Asinius Pollio, who erected a library in the Atrium Libertatis on Mount Aventine. Augustus erected two libraries, the Octavian and the Palatine. The former was founded (33 B.C.) in honour of his sister, the charge of the books being committed to C. Melissus. The Octavian and Palatine libraries perished by fire; the story that the Palatine was destroyed by order of Pope Gregory the Great in the 6th century is now generally rejected. Tiberius, the immediate successor of Augustus, established on the Palatine what Gellius refers to as the "Tiberian library." Vespasian established a library in the Temple of Peace erected after the burning of the city under Nero. Domitian restored the libraries then destroyed, and he, or Hadrian, founded the Capitoline library. The most famous and important of the imperial libraries was that created by Ulpius Trajanus, known as the Ulpian library, afterwards removed to the baths of Diocletian. The library of Domitian, which had been destroyed by fire in the reign of Commodus, was restored by Gordian, who added to it the 62,000 books bequeathed to him by Serenus Sammonicus. In the 4th century there are said to have been 28 public libraries in Rome.

Roman Provincial Libraries.—The library which the younger Pliny gave to Comum cost a million sesterces; Hadrian established one at Athens, described by Pausanias, and recently identified with the Stoa of Hadrian. At Ephesus and at Timgad in Algeria, the structural plan of the library buildings is clear (R. Cagnat, "Les Bibliothèques municipales dans l'Empire Romain," 1906, *Mém. de l'Acad. des Insc.*, tom. xxxviii. pt. 1). A private library discovered at Herculaneum contained 1,756 rolls on shelves round the room, to a height of about 6 ft., with a central press. The Christian libraries closely followed the classical prototypes.

The names of several librarians (generally slaves or freedmen) are preserved to us in inscriptions, including that of C. Hymenaeus, physician and librarian to Augustus.

Constantinople.—When the seat of empire was removed by Constantine to his new capital upon the Bosporus, the emperor established a collection there. Constantine's library, which contained 6,900 vols., was perhaps mainly intended as a repository of Christian literature; it was greatly enlarged by Julian and Theodosius, at whose death it is said to have increased to 100,000 volumes. Julian not only augmented the library at Constantinople, but founded others.

As Christian literature grew, libraries became part of the ecclesiastical organization, and it became the rule to attach one to every church. The largest of these libraries, that founded by Pamphilus (d. A.D. 309) at Caesarea, and said to have been increased by Eusebius to 30,000 vols., is frequently mentioned by St. Jerome. St. Augustine bequeathed his collection to the library of the church at Hippo, which was fortunate enough to escape destruction at the hands of the Vandals. Even the hermit communities of the Egyptian deserts, out of which developed the later monastic orders, accumulated books.

With the removal of the capital to Byzantium the libraries of Rome ceased to collect the writings of the Greeks, while the Greek libraries had never cared much to collect Latin literature. The church became increasingly hostile to pagan letters. The repeated irruptions of the barbarians soon swept the old learning and libraries alike from the soil of Italy. With the close of the Western empire in 476 the ancient history of libraries may be said to cease.

MEDIAEVAL PERIOD

Gaul.—During the first few centuries after the fall of the Western empire, in the West, as in the East, few cared for learning. Sidonius Apollinaris tells us of the libraries of several private collectors in Gaul.

During the 6th and 7th centuries in the Irish monasteries there appear to have been many books. The library of York, which was founded by Archbishop Egbert, was almost more famous than that of Canterbury, and was described in verse by Alcuin. The inroads of the Northmen in the 9th and 10th centuries had been fatal to monastic libraries. The correspondence of Lupus Servatus, a pupil of Hrabanus Maurus at Fulda, and afterwards abbot of Ferrières, illustrates the paucity and dearness of books, the declining care for learning, and the increasing troubles of the time. Charlemagne collected a number of choice books for his private use. Although these collections were dispersed at his death, his son, Louis, formed a library which continued to exist under Charles the Bald. But the greatest private collector of the middle ages was doubtless Gerbert, Pope Sylvester II.

St. Benedict.—For the next four or five centuries the collecting and multiplication of books were almost entirely confined to the monasteries. In each newly-founded monastery there was to be a library, *et velut curia quaedam illustrium auctorum,* that is of religious writers. Monte Cassino became the starting point of a long tradition. Of the reformed Benedictine orders the Carthusians and the Cistercians were those most devoted to literary pursuits. The abbeys of Fleury, of Melk and of St. Gall were remarkable for the splendour of their libraries. The Augustinians and the Dominicans rank next to the Benedictines. The libraries of Ste. Geneviève and St. Victor, belonging to the former order, were amongst the largest of the monastic collections. Richard of Bury praises them for their diligence in collecting books. Sir Richard Whittington built a large library for the Grey Friars in London, and they possessed considerable libraries at Oxford.

Monastic Libraries.—In Italy, the earliest and most famous was Monte Cassino, which fell a prey to the Saracens and to fire in the 9th century. The library of Bobbio was famous for its palimpsests; the collection was mainly transferred to the Ambrosian library at Milan.

Of the monastic libraries of France the principal were those of Fleury, of Cluny, of St. Riquier and of Corbie. The library of St. Riquier, in the time of Louis the Pious, contained 256 mss., with over 500 works. Of the collection at Corbie in Picardy we have also catalogues dating from the 12th and from the 17th centuries. In 1638, 400 of its choicest manuscripts were removed to St. Germain-des-Prés. The remainder were removed after 1794, partly to the national library at Paris, partly to the town library of Amiens.

The chief monastic libraries of Germany were at Fulda, Corvey, Reichenau and Sponheim. The library of Corvey on the Weser, after being despoiled in the Reformation, was presented to the University of Marburg in 1811. The library of Reichenau fell a prey to the Thirty Years' War. The library at St. Gall, formed as early as 816 by its second abbot, still exists.

England.—In England, the principal collections were those of Canterbury, York, Wearmouth, Jarrow, Whitby, Glastonbury, Crowland, Peterborough and Durham. The library of Christchurch, Canterbury, originally founded by Augustine and Theodore, contained, in the 13th or 14th century, about 5,000 works. It was destroyed by the Danes about 867. Of Whitby there is a catalogue of the 12th century. The catalogue of Glastonbury has been printed by Hearne in his edition of John of Glastonbury. The library of Crowland perished by fire in 1091; Peterborough was rich; from a catalogue of about the end of the 14th century, it had 344 vols., with nearly 1,700 titles. The catalogues of Durham have been printed by the Surtees Society. (The oldest catalogue of a Western library is that of the monastery of Fontanelle in Normandy [8th century].) Many catalogues may be found in the collections of D'Achery, Martene and Durand, and Pez, in the bibliographical periodicals of Naumann and Petzholdt and the *Zentralblatt f. Bibliothekswesen.* The Rev. Joseph Hunter has collected some particulars as to the contents of the English monastic libraries; E. Edwards has printed a list of the catalogues (*Libraries and Founders of Libraries,* 1865, pp. 448–454. *See* also G. Becker, *Catalogi Bibliothecarum Antiqui,* [1885].) In the 14th century the Franciscans compiled a general catalogue of the mss. in 160 English libraries, and about 1400, John Boston, a Benedictine monk of Bury, catalogued the libraries of 195 religious houses in England and part of Scotland (Tanner, *Bibl. Brit. Hibern.,* 1748). Leland's list of the books he found during his visitation of the houses in 1539–45 is printed in his *Collectanea.* The identification of the early provenance of mediaeval mss. has been greatly advanced of late years, especially by the works of M. R. James, both by catalogues of existing collections and publications of surviving monastic catalogues, *e.g.,* those of Canterbury and Dover (1909). (*See,* generally, J. W. Clark, *The Care of Books* [1909], and E. A. Savage, *Old English Libraries,* 1911.) These catalogues, with many others, afford abundant evidence of the limited size and character of the monkish collections.

The Development of Library Arrangements.—Modern library methods began with the rule of St. Benedict, early in the 6th century. In the 48th chapter the monks were ordered to borrow a book apiece and to read it straight through. In many houses the treasury or spendiment contained two classes of books —one for the monks generally, one more closely guarded. A press near the infirmary contained books used by the reader in the refectory. By the end of the 15th century the larger monasteries found the necessity of a separate library apartment. Libraries were specially built at Canterbury, Durham, Citeaux, Clairvaux and elsewhere, and there grew up increased liberality in the use of books. By the 15th century, collegiate and monastic libraries were on the same plan, the books being laid on desks or lecterns, and chained to a horizontal bar. As the books increased the accommodation was augmented by one or two shelves erected above the desks. The library at Cesana is still in its original condition. The Laurentian library at Florence was designed by Michelangelo on the monastic model. There were no chains in the library of the Escorial, erected in 1584, which showed, for the first time, bookcases placed against the walls. Chains continued to be used in England in church libraries down to the early part of the 18th century, as at Wimborne. Triple desks and revolving lecterns, raised by a wooden screw, formed part of the library furniture. The English cathedral libraries were fashioned after the same principle. By the end of the 17th century the type of the public library developed from collegiate and monastic prototypes became fixed throughout Europe. The library of St. John's college, Cambridge (16th century), and the Bodleian at Oxford, are slightly developed from the mediaeval type. In that of Trinity college, Cambridge, the walls are covered with books and the windows are raised. (H. R. Tedder, "Evolution of the Public Library," in *Trans. of 2nd Int. Library Conference,* 1897, 1898.)

Arabians.—Greek manuscripts were eagerly sought for and translated into Arabic, and colleges and libraries everywhere arose, notably at Baghdad, Cordova, Cairo and Tripoli. The royal library of the Fatimites in Africa, and that collected by the Omayyads of Spain are reported, perhaps with exaggeration, to have contained 100,000 and 600,000 mss. It is said that there were no less than 70 libraries opened in the cities of Andalusia.

Renaissance.—In the 9th century, under Leo the Philosopher and Constantine Porphyrogenitus, the libraries of Constantinople awoke into renewed life. Meanwhile, in the West we find arising outside the monasteries a taste for collecting books. Charles V. of France formed a considerable library of 910 vols., including much newer literature, and had a catalogue of them prepared in 1373. Guy, earl of Warwick, formed a collection of French romances, which he bequeathed to Bordesley abbey in 1315. Richard of Bury, the doubtful author of the *Philobiblon,* amassed a noble collection. The taste for secular literature and for the classics gave a fresh direction to collectors, and a disposition to encourage literature began to show itself. Cosimo de' Medici formed a library at Venice while living there in exile in 1433, and on his return to Florence laid the foundation of the great Medicean library. Niccolo Niccoli had already, in 1436, left his library of over 800 volumes for the use of the public. Frederick, duke of Urbino, and Poggio Bracciolini, were among the chief collectors of the Latin mss. buried in monastic libraries. Beyond the Alps, Matthias Corvinus, king of Hungary, amassed a great collection of splendid manuscripts. With printing, the modern history of libraries may be said to begin.

MODERN BRITISH LIBRARIES

State Libraries, British Museum.—The British Museum ranks in importance before all the great libraries of the world, except the National Library of France, and excels in the arrangement and accessibility of its contents. The library consists of about 3,200,000 printed vols. and 56,000 mss.; the shelves measure about 55 miles. This extraordinary opulence is principally due to the enlightened energy of Sir Anthony Panizzi (*q.v.*).

The foundation of the British Museum dates from 1753, when effect was given to the bequest (in exchange for £20,000 to be paid to his executors) by Sir Hans Sloane, of his books, manuscripts, curiosities, etc., to be held by trustees for the use of the nation. A bill was passed through parliament for the purchase of the Sloane collections and of the Harleian mss., costing

£10,000. To these, with the Cottonian mss., acquired by the country in 1700, was added by George II., in 1757, the royal library of the former kings of England, coupled with the privilege of obtaining a copy of every publication entered at Stationers' Hall. A lottery having been authorized to defray the expenses of purchases, as well as for providing suitable accommodation, the museum and library were established in Montague House, and opened to the public Jan. 15, 1759. In 1763 George III. presented the Thomason collection (in 2,220 vols.) of Civil War and Commonwealth tracts. The Rev. C. M. Cracherode bequeathed his collection of choice books in 1799, and Sir Joseph Banks his library (16,000 vols.) of natural history and travels, in 1820. Of other libraries since then incorporated in the museum, the most valuable are George III.'s collection, 15,000 volumes of tracts and 65,259 vols. of printed books, which was transferred (for a pecuniary consideration) by George IV. in 1823, and that of the Right Hon. Thomas Grenville (20,240 vols. of rare books, bequeathed in 1846). The Cracherode, Banksian, King's and Grenville libraries are still preserved as separate collections.

The collections of newspapers, starting with those in the Thomason and Burney collections, are unique; provincial newspapers have, since 1906, been stored at a repository at Hendon. Of newspapers published in the United Kingdom 3,126 are annually filed and bound.

The department of mss. is equal in importance to that of the printed books. The collection of *European* mss. contains 54,000 vols., over 80,000 rolls, a rich series of charters, etc., and a vast quantity of papers, ranging from the 3rd century B.C. down to our own times, and includes the *Codex Alexandrinus* of the Bible, the old historical chronicles of England, the charters of the Anglo-Saxon kings, the Arthurian romances, and also unprinted works by English writers. The famous collections of mss. made by Sir Robert Cotton and Robert Harley, earl of Oxford, have already been mentioned, and from these and other sources the museum has become rich in early Anglo-Saxon and Latin codices, such as Beowulf, the charters of King Edgar and Henry I. to Hyde abbey, which are written in gold letters; or the Lindisfarne gospels (A.D. 700), containing the earliest extant Anglo-Saxon version of the Latin gospels. The museum can boast of an early copy of the *Iliad,* and one of the earliest known codices of the *Odyssey.* Among the unrivalled collection of Greek papyri are the unique mss. of several works of ancient literature, such as Aristotle, *On the Constitution of Athens,* the *Mimes* of Herodas, and the *Odes* of Bacchylides. Irish, French and Italian mss. are well represented. For illuminated mss. special reference may be made to the Lindisfarne Gospels, the Bedford Hours, the Sforza Book of Hours, and Queen Mary's Psalter. The collections of local and family history, of maps, and of music are very rich. Oriental printed books (116,000), and mss. (16,200) form, since 1892, a separate department. The collection includes the library formed by Mr. Rich (consul at Baghdad in the early part of the 19th century); the Chambers collection of Sanskrit mss.; and a library of Hebrew mss., including that of the great scholar, Michaelis, and codices of great age, brought from Yemen. The collection of Syriac mss. is important.

The building in which the library is housed was opened in 1857. The reading room is surrounded by book stores placed in iron stacks, the origin of the more modern steel stacks; in these are fitted hanging and rolling auxiliary bookcases. The presses inside the reading-room contain upwards of 60,000 vols.; to those on the ground floor (20,000), readers have direct access. The Natural History Museum, South Kensington, a department of the British Museum under separate management, has a library of books on the natural sciences numbering over 100,000 volumes.

Patent Office and other State Libraries.—The finest technical library in the country is that of the Patent Office in Southampton buildings, London. The library contains 220,000 volumes.

Another special library is the National Art Library, transferred to South Kensington in 1856. It contains about 150,000 vols. and 250,000 photographs. For science there is the library of the Science Museum, South Kensington, which was founded in 1857 (170,000 vols.). It is devoted to pure and applied science; it maintains, besides its own subject catalogue, an index to scientific books and periodicals.

The only other State libraries which are open to the public are those of the Board of Education (50,000 vols.), the Ministry of Agriculture, the Imperial Institute and the Imperial War Museum.

Among the other State libraries in London may be briefly noted as follows:—Admiralty (1700) 100,000 vols.; House of Commons (1818), *c.* 60,000 vols.; House of Lords (1834) 80,000 vols.; India Office (1800) 130,000 printed books and 15,000 mss. and xylographs; Kew, Royal Botanic Gardens (1853), 40,000 volumes.

Outside London the most important State libraries are the national libraries of Scotland, Wales and Ireland. Sir George Mackenzie, of Rosehaugh, may be regarded as the founder of the National Library of Scotland. In 1684 the first librarian was appointed, and in 1686 the books and furniture were valued at upwards of £11,000, exclusive of donations. The library retains the copyright privilege conferred upon it in 1709. Of the special collections the most important are the Astorga (Spanish), purchased in 1824; the Thorkelin collection, relating chiefly to the history and antiquities of the northern nations; the Dietrich collection of German pamphlets and dissertations, and the Barnbougle Scottish collection, presented in 1928 by Lord Rosebery.

Manuscripts number well over 3,000. There are 13 monastic chartularies which escaped the destruction of the religious houses to which they belonged. The mss. relating to Scottish church history include the collections of Spottiswoode, Wodrow and Calderwood. Sir James Balfour's collection and the Balcarres papers consist largely of original State papers of James V., Queen Mary and James VI. The Sibbald papers are largely topographical. The Riddel notebooks illustrate Scottish genealogy. The Magnusson Icelandic mss., purchased in 1825, and some Persian and Sanskrit, with a few classical, manuscripts may be noted. The most important mss. of old poetry are the Bannatyne ms., written by George Bannatyne in 1568, and the Auchinleck ms.

In 1922, the Faculty, finding the maintenance of the general library increasingly onerous, offered it to the Government as a national library of Scotland. The Government accepted the offer in 1923, when an institution towards which movements had been made in Scotland since 1870 received a gift of £100,000 from Sir Alexander Grant, and the necessary act was passed and the library transferred in 1925. The library now contains over 750,000 volumes. The advocates retain the law section.

The National Library of Wales at Aberystwyth, founded in 1907, was opened in 1915. It enjoys the copyright privilege, and now contains nearly 500,000 volumes, classified by the Library of Congress scheme. It is very rich in Welsh manuscripts, including the collection of Sir John Williams, and Wynn of the Gwydyr, Peniarth, Crosswood and Carreglwyd papers. Francis Bourdillon's Romances, and C. Thomas-Stanford's Euclids are among special collections of printed books. The National Library of Ireland, Dublin, was founded in 1877, and incorporates the library of the Royal Dublin Society. It contains about 300,000 volumes, classified on the decimal system, and catalogued in various forms.

University and Collegiate Libraries.—The earliest library of the University of Oxford was in existence in 1337; the second was founded by Humphrey, duke of Gloucester (d. 1447); these perished, and the Bodleian library was founded in 1598 and endowed in 1611 by Sir Thomas Bodley (*q.v.*). He opened the library in 1603 with upwards of 2,000 volumes. In 1610 he obtained a grant from the Stationers' company of a copy of every work printed in the country, a privilege still enjoyed under the Copyright Acts. Other chief benefactors have been Archbishop Laud, John Selden, Richard Gough, Francis Douce, Lord Sunderlin (brother of Edmund Malone) and Richard Rawlinson. The library now contains almost 1,250,000 printed volumes, and about 40,000 manuscripts (other than charters, rolls, etc.). In oriental manuscripts it is, perhaps, superior to any other European library; and it is exceedingly rich in other manuscripts, especially in English literary and local history, and in early printing.

The Radcliffe library of natural science, founded by Dr. John Radcliffe (d. 1714) and opened, in 1749, in the domed building known as the "Radcliffe Camera," was transferred to the new University museum and laboratories in 1860, when the trustees offered the use of the Camera to the curators of the Bodleian; the building was transferred absolutely in 1927. In the Camera are the modern books, and it also serves as a reading-room, especially for undergraduates and in the evening. Departmental libraries forming part of the Bodleian are the Indian institute, the Law library, Maitland library (social and legal history), and Rhodes house (Colonial history).

The Bodleian library is open by right to all graduate members of the university, and to other recommended students. The ordinary expenditure is about £10,000. A large repository has been arranged for book storage underground. A new building with capacity for 5,000,000 volumes has been approved (May, 1936), designed by Sir Gilbert Scott (*q.v.*).

The Taylor institution for modern languages is due to the benefaction of Sir Robert Taylor, an architect (d. 1788). The Finch collection (bequeathed in 1830), is kept with it.

The libraries of the several colleges vary considerably. That of All Souls was established in 1443 by Archbishop Chichele, and possesses 40,000 printed volumes and 300 mss., and is rich in law. The library of Christ Church is rich in divinity and topography. Corpus possesses a fine collection of Aldines, with about 400 mss. Exeter college has classical dissertations and English theological and political tracts. Jesus college has the bequest of Sir Leoline Jenkins and also Welsh mss. Keble college has the mss. of many of Keble's works. Magdalen college has about 22,500 volumes and 250 mss. with scientific and topographical collections. The old library of Merton college (*see* above) now specializes in modern foreign history and philosophy. New college has about 17,000 printed volumes and about 350 mss., including several presented by its founder, William of Wykeham. Oriel college has a special collection on comparative philology and mythology. Queen's college is strong in theology, in modern history, and in English county histories. St. John's college library is largely composed of theology and law before 1750, and medical books of the 16th and 17th centuries. Wadham college has the botanical books bequeathed by Richard Warner (1775) and Benjamin Wiffen's collection on the Spanish Reformers, Worcester college has of late specially devoted itself to classical archaeology. It is also rich in old English drama and poetry, and drawings by Inigo Jones.

The University library at Cambridge dates from the earlier part of the 15th century. Two early catalogues are preserved, the first embracing 52 vols. and dating from about 1425, the second a shelf-list, apparently of 330 vols., made in 1473. The library, which contains about 1,000,000 vols. and 19 miles of shelves, has the copyright privilege. It includes a fine series of *editiones principes* of the classics and of the early productions of English and Netherlandish presses. The mss. number over 10,000, in which are included a considerable number of adversaria or printed books with ms. notes, which form a leading feature in the collection. The most famous of the mss. is the *Codex Bezae* of the four gospels and the Acts, which was presented to the university by Beza himself.

There is a library attached to the Fitzwilliam museum, bequeathed to the university in 1816. It contains printed and ms. music, and a collection of illuminated mss., chiefly French and Flemish. Catalogues and reprints have been published.

Trinity College Library.—The library of Trinity college has over 100,000 printed and nearly 2,000 ms. volumes. Amongst special collections are the Capell collection of early dramatic and especially Shakespearian literature, German theology and philosophy, and the Grylls bequest in 1863 of 9,600 vols., including many early printed books. There are printed catalogues of the Sanskrit and other oriental mss. by Aufrecht and Palmer, of the incunabula by Robert Sinker, and of the Capell collection by W. W. Greg, 1903.

Clare college library includes George Ruggle's early Italian and Spanish plays. The library of Corpus Christi college is famous for the bequest made by Archbishop Parker in 1575. The printed books are less than 5,000 in number; the ancient mss. attract scholars from all parts of Europe. Gonville and Caius college library is of early foundation. The printed books of King's college include the bequest by Jacob Bryant (1804). The mss. are almost wholly oriental. Magdalene college is remarkable for popular literature and for naval mss., the greater portion of which is in the Pepysian library. (*See* PEPYS, SAMUEL.) The library of Peterhouse, the oldest in Cambridge, possesses a catalogue of some 600 or 700 books dating from 1418. It has a unique collection of ms. music. Queen's college library contains about 30,000 vols., and is rich in Semitic literature. The library of St. John's college is rich in early printed books and English history.

The library of the University of London, founded in 1837, now at South Kensington, has over 300,000 vols., and includes the Goldsmiths' Economic (60,000 vols.), and a musical library. Other collections are De Morgan's collection of mathematical books, Grote's classical library, etc.

University college library, Gower street, established in 1829, has 286,000 vols., including Jeremy Bentham's library, Morrison's Chinese library, Barlow's Dante library, collections of law, medicine (including medical history), mathematical, Icelandic, theological, art, oriental and other books.

King's college library, founded in 1828, has over 70,000 volumes. In close association with the University of London is the London School of Economics and Political Science (1896), in which is housed the British Library of Political Science, with 250,000 books and 500,000 pamphlets and official reports. The School of Oriental Studies was established in 1916 in the building of the London institution. The library of Sion college (1635) is rich in liturgies, Port-Royal authors, etc., and contains about 200,000 vols. classified on a modification of the decimal system. The copyright privilege was commuted in 1835.

English Provinces.—The Rothamsted Experimental Station has an agricultural library of 20,000 volumes. The other English universities and colleges have libraries; the chief are: Manchester (205,000 vols.); Birmingham (120,000 vols.); Liverpool (100,000 vols.); Leeds (98,000 vols.); Sheffield (83,000 vols.); Bristol (70,000 vols.), absorbing in 1924 the library of the Bristol Medical Chirurgical Society (1831); Durham (39,000 vols.) has many incunabula. That of Exeter is combined with the City library. The Association of University Teachers established in 1925, at Birmingham, an enquiry bureau for the University libraries, to act as a centre for mutual lending; this it is intended to transfer when possible to the central library for students. The University libraries share in the grants made by the Government's Universities Grants committee. A few of the libraries of theological colleges and public schools are important and have historical collections, incunabula, etc., such as Oscott college (1838), 36,000 vols.; Stonyhurst college (1794), *c.* 40,000 vols.; Shrewsbury school, 7,000 vols., etc.

Scotland.—The University library of Edinburgh originated in a bequest of books made to the town in 1580 by Clement Little, advocate. In 1831 the books were removed to the present building. Modern accessions have been the Halliwell-Phillips (Shakespeare), the Laing (Scottish mss.), the Baillie (oriental mss.) and the Hodgson (political economy). The library now consists of about 350,000 vols. of printed books, with over 8,000 mss.

All schools and colleges in Scotland are well equipped with libraries. The oldest University Library, St. Andrews (1456) contains well over a quarter of a million volumes. Glasgow (15th Cent.) has 255,000 volumes; Aberdeen (1500) 260,000 volumes. Among others are New College, Edinburgh (1843), 50,000 volumes, and Royal Technical College, Glasgow, 16,000 volumes.

Ireland.—In 1601 the English army, to commemorate their victory at Kinsale, subscribed £1,800 to establish a library in the University of Dublin. Later bequests and gifts have been Sir Jerome Alexander's (law books and mss.), 1674; Palliser, 1726; Gilbert, 1736; and Quin (classical and Italian), 1805. In 1802 the collection of 20,000 vols. formed by the pensionary Fagel, was acquired. The library enjoys the copyright privilege. After the recognition of the Irish Free State the right was confirmed. The library now contains 386,000 vols. and over 2,000 mss. There is no permanent endowment. There is a printed catalogue of the mss. (1900) and incunabula (1890).

Queen's college, Belfast (1849), has about 101,000 vols.; Queen's college, Cork (1849), 100,000; University college, Dublin, 65,000; and St. Patrick's college, Maynooth (1795) about 55,000. (*See* L. Newcombe, *The University and College Libraries of Great Britain and Ireland*, 1927.)

Cathedral and Church Libraries.—With one or two exceptions, libraries are attached to the cathedrals. Intended for the cathedral or diocesan clergy, they are in most cases open to persons suitably introduced. Many have valuable mss., but most were ravaged in the Civil War, and the printed collections are the work of antiquarian deans of the 18th century. That of St. Paul's cathedral was founded in very early times, and now numbers some 22,000 vols. and pamphlets, with a good collection of early Bibles and Testaments, Paul's Cross sermons, and works connected with the cathedral (catalogue 1893).

For the library of Christ Church, Oxford, which belongs alike to the college and the cathedral, *see* above. That of Durham, 20,000 vols., dates from monastic times, and possesses many of the books which belonged to the monastery. The collection is fairly general, and is kept up to date. It is especially rich in very early mss., written at Durham. The library at York is open to the public, has many valuable mss. and early printed books. It includes Edward Hailstone's topographical library (catalogue of pr. bks., 1896). The foundation of the library at Canterbury dates probably from the time of Augustine, but nothing of the pre-Conquest library survives. Many of the mss. originally here were transferred by Archbishop Parker to Corpus Christi college, Cambridge (catalogue 1743 and 1802, of mss. 1911). The present building was erected in 1867. The Lincoln cathedral library (catalogue 1859, of incunabula 1925, of mss. 1927) was refounded by Dean Honeywood, at the Restoration, in a building by Wren. Chichester dates from the Restoration only; Ely is rich in the non-jurors. Exeter possesses many Saxon mss., including the "Exeter Book" of Old English poetry, the gift of Leofric, the first bishop. At Lichfield the existing library is post-Restoration, but includes the famous Evangeliary of St. Chad. The collection at Norwich is chiefly modern. The earlier library at Peterborough being almost destroyed in the Civil War, Bishop White Kennett refounded it, but many of his books have been lost. Salisbury is rich in incunabula (catalogue 1880). Winchester cathedral library is mainly the bequest of Bishop Morley (17th century). The library at Bristol was burnt and pillaged in the riots of 1831. At Chester, in 1691, Dean Arderne bequeathed his books and part of his estate "as the beginning of a public library for the clergy and city." The library of Hereford (catalogue of mss., 1927) is a good specimen of an old monastic chained library; Worcester has fine mss. (catalogue, 1906, and of incunabula, 1910). The four Welsh cathedrals were supplied with libraries by a deed of settlement in 1709. All are small; the largest, St. Asaph, has about 1,750 volumes. That founded by Archbishop Leighton in 1684 in Dunblane cathedral (2,000 vols.), is the only cathedral library in Scotland of any historic interest. The public library established about 1694 in St. Patrick's cathedral, Dublin, by Archbishop Marsh, was incorporated in 1707, and endowed by its founder at his death in 1713. The books are chiefly theological and include the libraries of Bishop Stillingfleet and of Elias Bouhereau, the first librarian. In 1849 Beriah Botfield published *Notes on the Cathedral Libraries of England.*

The best Catholic libraries in London are those of Brompton Oratory (1849—35,000 vols., 3,000 pamph.) and Westminster cathedral (22,000 vols. and valuable archives). The archiepiscopal library at Lambeth palace (41,000 printed books and 1,300 mss.) has been enriched by the gifts of Laud, Tenison, Manners Sutton, and others of his successors. It is rich in theology and Church history. Of the illuminated mss., and early printed books, catalogues have been issued by S. R. Maitland (1792–1866). The mss. are described in H. J. Todd's catalogue, 1812, and the older volumes by M. R. James, 1900.

Endowed Libraries.—In London the Bishopsgate institute (1891), founded out of City charities, contains about 50,000 vols., and a fine collection of prints, drawings and maps of London. The Cripplegate institute (1896) in Golden lane, also founded out of charity monies, has three branches—St. Bride institute; the Queen street, Cheapside, branch; and St. Luke's institute. The St. Bride Foundation Technical Reference Library (1895) is a very complete collection of about 30,000 vols. on printing and allied arts. Dr. Williams's library (over 75,000 vols.), founded in 1716 by the will of Dr. Daniel Williams, is primarily theological, and has been enlarged to include philosophy, history and literature, with collections of theosophy and of the works of Boehme, Law, and other mystics. The mss. include the original minutes of the Westminster Assembly, letters and treatises of Richard Baxter and the journals of Crabbe Robinson.

The most notable of the English provincial endowed libraries are those of Manchester. That founded by Humphrey Chetham in 1653 is still housed in its old collegiate buildings (100,000 vols. and mss.). More important is the John Rylands. In 1928 the John Rylands had 310,000 vols. and 10,000 mss., including the 6,000 Crawford mss. from Haigh Hall, bought in 1901, and 20,000 French Revolution broadsides, etc., presented by the earl of Crawford in 1924. Other considerable endowed libraries are the William Salt, Stafford (20,000 vols. of Staffordshire history) opened 1874; the Solon Ceramic library, Stoke-on-Trent (5,500 vols. and 100 current periodicals); St. Deiniol's (1894), Hawarden, founded by W. E. Gladstone; and the Shakespeare Memorial (1879), Stratford-upon-Avon.

The oldest endowed library in Scotland is the Innerpeffray, Perthshire (1680), founded by David Drummond, 3rd Lord Madertie. The most important is the Mitchell in Glasgow, founded by Stephen Mitchell (1874), opened in 1877. It contains valuable collections of Scottish poetry, Burns' works, Glasgow printing, and art. It contains over 250,000 vols., and is the reference library for the Glasgow public library system. Glasgow also has Stirling's and Glasgow Public Library (1791), which was amalgamated with an existing subscription library (60,000 vols.) and Baillie's Institution Free Reference library (24,000 vols.) established under the bequest of George Baillie (1863), but not opened till 1887. The public library of Armagh, Ireland, was founded in 1770.

Libraries of Societies and Learned Bodies.—Full particulars of most will be found in R. A. Rye's *Libraries of London: a Guide for Students* (3rd ed., 1927), and a more summary guide, covering the whole country, in the *Aslib Directory*, 1928.

Of the law libraries, that at Lincoln's Inn, London, is the oldest and the largest (72,000 vols.). That of the Middle Temple contains 70,000 vols. The library of the Inner Temple is known to have existed in 1540. Its chief collections are William Petyt's mss., received in 1708, John Adolphus's historical pamphlets, and the Crawford collection on crime. There are about 62,000 vols. Gray's Inn library (30,000 vols.) was established before 1555. The Law Society (1828) has 62,000 volumes. The Royal Institution of Great Britain (1803), possessing a general reference subscription library of about 150,000 vols., was closed in 1916, its oriental section remaining to help found the London University School of Oriental Studies, while its Western books went to the university and college libraries.

The best library of archaeology is the Society of Antiquaries', Burlington House, 60,000 vols., many mss. and early printed books. For natural sciences there are the libraries of the Royal Society (1667), in Burlington House, which contains over 100,000 vols., mainly publications of scientific bodies (the celebrated Arundel bequest, dating from the society's infancy, has been dispersed), Geological Society (1807), 40,000 vols. and maps; the Linnean Society (1788), 50,000 vols.; the Zoological Society (1829), about 36,000 vols. The Royal Society of Medicine (1907), incorporating a number of medical societies, 120,000 vols.; the Royal College of Physicians (1525), 40,000 vols.; the British Medical Association, 20,000 vols.; the Royal College of Surgeons (1800), 60,000 vols.; the Medical Society (1773), largely historical, 20,000 vols.; the Chemical Society (1841), over 30,000 vols. Other important London society libraries are the Royal Geographical Society (1830), 80,000 vols., and numerous maps, open to the public for reference; the Royal Colonial Institute (1868), 184,000 vols. of British colonial literature; the Royal United Service institution, Whitehall (1831), 32,000 vols., belles-lettres, politics and history. The Gladstone library (31,000 vols. and pamph.) of the National Liberal Club may be used occasionally by non-members; the Garrick (a small dramatic collection), and the (Senior) United Service Club (Dugald Stewart's library) may be mentioned. Very few club libraries are supervised by trained librarians. Libraries are owned by the British and Foreign Bible Society (catalogue of Bibles, 1903–11), the Institution of Civil Engineers (53,000 vols.), the Institution of Electrical Engineers (25,000 vols.), the Royal Academy (10,500 valuable vols.), the Royal Institute of British Architects (23,000 vols.), and many others.

The library of the Writers to the Signet (1722), now contains about 150,000 vols., with early prints and other rare books, especially in British topography.

The library of the Royal Irish Academy at Dublin (1785, 50,000 vols. and over 2,000 Irish mss.), is partly supported by a Government grant and is freely open.

Among subscription libraries, the London library (300,000) stands first in order of importance. It was founded in 1841 as a lending library for the use of scholars, largely at the instance of Carlyle. Author and subject catalogues have been printed, the latter of great value.

The first circulating library in Birmingham was opened in 1757, and was followed by Liverpool Lyceum (1758) and Warrington's (1760), both merged in the museum, and by Leeds (1768).

Other proprietary libraries have been established at Leicester, Liverpool (Athenaeum, 1798), Manchester, Newcastle, Belfast (the Linen Hall library), Nottingham and elsewhere. In Scotland the first subscription library was started by Allan Ramsay, the poet, at Edinburgh in 1725. Commercial subscription libraries have increased greatly, Mudie's (1841), W. H. Smith's, and *The Times* Book Club being typical modern examples.

Many of the principal clubs possess libraries; that of the Athenaeum (London) is by far the most important. It now numbers about 75,000 vols. of choice books. The pamphlets (of which also there is a complete printed catalogue), include those collected by Gibbon and Mackintosh. Next comes the Reform club, with about 60,000 vols.

Public Libraries.—The first act of parliament authorizing the establishment of public libraries in England was obtained by William Ewart, M.P., in 1850. In 1853 the act of 1850 was extended to Ireland and Scotland.

The Public Libraries Amendment Act of 1919, besides establishing the county as a library unit, removed the rate-limit in England and Wales. The American library in 1928 was spending roughly four to five times as much per head as the average British library.

British Library Legislation.—The main points in British library legislation are as follows:—(*a*) The acts are permissive and not compulsory. (*b*) Municipal libraries are managed by committees appointed by the local authorities, who may delegate to them all their powers and duties. Glasgow has contracted them out by a special act. In Ireland, committees are appointed much as in England. (*c*) Power is given to provide libraries, museums, schools for science, art galleries and schools for art. (*d*) The regulation and management of public libraries are entrusted to the library authority, which may either be the local authority or a committee with a full or partial delegation of powers.

The London Government Act, 1899, by uniting various vestries or boards, extinguished about 23 library areas. The Metropolitan County of London in 1928 comprised 27 library areas, or, counting also the City, 28.

From 1887 progress has been rapid. An immense stimulus was given from about 1900, when Andrew Carnegie (*q.v.*) began to present library buildings to towns in England as well as to Scotland and the United States. In 1926, 57 out of 62 counties, 81 out of 82 country boroughs, all metropolitan boroughs, 232 out of 249 municipal boroughs, 732 out of 792 urban districts, and 12,660 out of 12,841 are, by adoption or inclusion, library areas under the acts. But 49 urban areas, with a population of 580,000, had then no library service, nor in 1925 had half the rural population of the country.

Building Developments and Equipment.—The Carnegie Trust, in 1917, ceased to make grants, and in 1925 decided to consider no further applications. The total sum expended by the trust on public library buildings in 1914–26 was £295,600. In every case "open access" was adopted, and stress was laid upon accommodation for children. Good specimens may be seen at Manchester and Croydon. Great improvements were effected in design. Card catalogue and subject-lists have almost entirely taken the place of printed catalogues. Library policy has, also, become far more liberal than it was before the World War. Of the greatest importance to business men has been the establishment in great city libraries, since 1919, of commercial and technical departments, notably those of Birmingham, Manchester, Liverpool and Glasgow.

There is one important municipal library which is not rate-supported under the Public Libraries Acts. This is the Guildhall reference library of the Corporation of the City of London. A library was established for London by Sir Richard Whittington between 1421–26. But it did not remain without accident; about 1549 the Lord Protector Somerset carried off three cart-loads of books, and during the great fire of 1666 the remainder together with the buildings were destroyed. Nothing was done to repair the loss until 1824; a new library was opened in 1828.

The library (nearly 200,000 printed vols. and nearly 15,000 mss. in 1928) includes a special collection of books, prints and drawings about London, the Solomons Hebrew and rabbinical library, the National Dickens library, etc., and the libraries of the Clockmakers' and Gardeners' companies and of the Old Dutch church in Austin Friars.

British Library Administration.—A brief statement of the work and methods of public libraries in the United Kingdom will help to give some idea of the extent of their activities. In 1909 60 million vols. were circulated every year for home-reading, 54% representing fiction, including juvenile literature. The reference libraries issued over 11 million vols., exclusive of books consulted at open shelves, and to the reading-rooms, 85 million visits are made per annum. It is evident, moreover, that a complete revolution in library practice has been effected since 1882. Very little had been accomplished in the way of scientific classification schemes, although the decimal method of Melvil Dewey had been applied in the United States. Dewey's system is now in use in 180 public libraries, J. D. Brown's "subject" classification in 59; the later but important library of Congress system in about five.

A complete catalogue of a general popular library contains no addition to bibliography, is costly and is out of date the moment it is printed. Modern libraries therefore compile complete catalogues only in manuscript form, and issue cheap class-lists, supplemented by lists of recent accessions.

The idea of using separate clips or cards for cataloguing books, in order to obtain complete powers of arrangement and revision, is not new, having been applied during the French revolutionary period. The card system is perhaps the most generally used, but many improvements in the adjustable binders, called by librarians the "sheaf system," already begin to make this latter form a serious rival. The card method consists of a series of cards, each bearing one entry, kept on edge in trays or drawers, to which projecting guides are added in order to facilitate reference. The sheaf method provides for slips of a uniform size being kept in book form in volumes capable of being opened by means of a screw or other fastening, for the purpose of adding or withdrawing slips. Both sides of a slip may be used, while a number of entries may be made on one slip. For great research libraries, however, the catalogue in volumes, though expensive to keep up to date, is the easiest to use.

In the United States, practically every library has its open shelf collection. On the continent of Europe, however, this method is rare. The first "safeguarded" open access municipal lending library was opened at Clerkenwell (now Finsbury), London, in 1893. Every year several municipal systems are reorganized in this way, and nothing but local lack of funds prevents the universal adoption of the system.

In America losses are sometimes enormous, one library having confessed to a loss of 35,000 volumes in a single year. The precautions of the British plan are automatic locking wickets for entrance and exit, and registration of borrowers. The great majority of British and American libraries use cards for "charging" or registering books lent to borrowers.

Various Activities of Libraries.—Other activities of modern libraries which are common to both Britain and America are courses of lectures, drawing attention to the books in the library, book exhibitions, work with children, provision of books for the blind and for foreign residents, travelling libraries and the education of library assistants. In some districts (*e.g.*, Leicester) the libraries keep public elementary schools supplied with books, over which the teachers are able to exercise supervision. Under the Law of Property Amendment Act, 1924, all manorial documents were placed under the charge of the master of the rolls, who could order their deposit in authorized repositories. Many public libraries and some of local societies were so designated, and the care of archives received a great stimulus; their study had, since 1919, been included in the curriculum of the School of Librarianship, and was added in 1927 to that of the Library Association.

Excellent work has been accomplished within recent years by the Library Association and the University of London School of Librarianship in the training of librarians.

The report of the departmental committee on public libraries, 1927, is the best survey of the field since that of 1849. The committee aimed at stimulating backward authorities by showing what is done in more favoured places. They were opposed to putting the libraries under the education authorities. The effect of the report was to outline a co-ordinated national system of public libraries, consisting of the urban libraries and the county libraries, with their village and small town branches, all these working together in regional schemes of co-operation, and beyond them the Central Library for Students acting as a reserve for out-of-the-way books, and acting as the centre for mutual loans between a large circle of special libraries, and the public libraries. The report obtained general approval, notably that of the Library Association. In the same year the Scottish Library Association appealed to the secretary of State for Scotland to appoint (and the minister of finance in Northern Ireland appointed) similar committees to make enquiry and report on the library service in those countries.

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COUNTY LIBRARIES

Whilst the library movement made notable headway during the last quarter of the 19th century, largely through the generous financial encouragement of Andrew Carnegie, the 28 years that followed have witnessed a greater, and, since 1918, a much more rapid advance. Before this date the service was severely handicapped by two restrictions: the one penny rate limit, which, except in the largest cities, precluded anything like adequate expenditure on books and salaries, and the almost total impossibility of applying the Public Libraries Acts in the smaller centres of population. An admirable statistical report, setting forth in detail the anomalies and difficulties of the situation, was prepared by Prof. W. G. S. Adams and published by the Carnegie United Kingdom Trust in 1915. From this it was manifest that the position in the towns could not be remedied without the removal of the rate limit, and the only hope for the rural areas was in some broad scheme of co-operation. The Library Association had persistently agitated for new legislation, with the former object as the most urgent item. Pending action by the Government, the Carnegie Trustees now set up a number of circulating systems on a regional basis, as an experiment and an object lesson to show how the rural problem should be solved.

Legislation.—The position of these rural systems was regularized in Scotland by the Education (Scotland) Act of 1918, empowering county education authorities to make book provision for children and young persons attending schools or classes, and for adults. The subject was also dealt with in an interim report by the adult education committee of the Ministry of Reconstruction; and, almost immediately, the Public Libraries Act of 1919 was passed, authorizing county councils to adopt the acts, to levy a rate, and provide a library service through their education committees. Similar powers were granted in Northern Ireland by the Public Libraries Act of 1924, and in the Irish Free State by the Local Government Act of 1925.

Success of the County Library System.—Hitherto, such rural library systems as had been established, were financed by the Carnegie Trustees, who continued to offer to defray the capital expenditure of county councils which were willing to adopt the acts. During the period 1915–27, the grants made by the trustees for this purpose in Great Britain totalled £263,785, with some supplementary grants for the period ending in 1930. Further sums are being allocated to Irish county libraries, and grants are made from time to time for special objects. In their report issued in March 1928, the trustees show that 22 English, three Welsh and six Scottish counties are now independent of their assistance, and will henceforth rely entirely on public funds. Thus it is obvious that the progress of the system has been extremely rapid, only five counties, by the end of 1926, not as yet adopted the Public Libraries Acts, one of these being London, where there is no area not already provided for by previous adoption of the acts, and the other Westmorland, which has a scheme based on the Kendal public library. The rate of this expansion is indicated by the figures given in the report of the Public Libraries Committee set up by C. P. Trevelyan, then president of the Board of Education, in 1924, which completed its proceedings in 1927. In 1911 the population in England and Wales resident in library areas amounted to 62·5% of the total. The percentage rose to 68·8 by 1921, to 90·4 by 1924, and by 1926 to 96·3. Of this last figure, the urban library service accounts for 64·1%, and the county systems for 32·2%. Thus only 3·7% of the population now reside in areas for which there is as yet no provision and none even contemplated. The committee therefore propose that the remaining county councils should be constituted library authorities for their areas; and, further, that those councils which have excluded certain populous areas, covered by towns or urban districts, should be constituted library authorities for the whole. The result would be to bring in a further population of 1,332,000. The report pointed out, however, that a library area does not necessarily imply a library service, and that, so far as they were able to ascertain, in 1925 only about one-half of the 12 millions dwelling in county library areas were actually enjoying a library service.

The system began with the periodical supply of boxes of books to village centres, usually in schools, and the boxes were sent by railway or other carriers. An increasing number of counties now have their own motor-vans, which are fitted with shelves and form small travelling libraries, affording the local volunteer librarian some opportunity of choosing books on the spot. Here and there, local interest or the philanthropy of some well-wisher has resulted in the formation of small stocks of reference books, and even the opening of a village reading-room. Special provision is usually made, so far as resources permit, for adult classes, and special collections are formed for teachers. The problem of the community of 10 to 20 million inhabitants embraced by a county area is gradually being solved by the method of differential rating, small libraries of the municipal type being established in such places. Middlesex is an excellent example of the policy of co-ordinating the municipal library and the rural system. Two other experiments that will be watched with attention are being carried out in Cornwall and Northern Ireland. In Cornwall, seven borough and two urban district libraries have been brought into a co-operative scheme for the whole county. The Belfast library has been encouraged by a liberal grant from the Carnegie Trustees to become the centre of a regional scheme of co-operation for the whole of Northern Ireland. Merely fractional rates, as low as one-tenth to one-fourth of a penny were raised by the county authorities in the first instance. In some places these have risen to a half-penny, or even more. But it is admitted that the county services are seriously under-financed, and that as the public realizes the benefits and opportunities within their scope a much more liberal provision will be demanded.

Post-war Developments.—In both county and town, progress since the act of 1919 would have been far greater but for the general anxiety to keep down the rates. That act abolished the rate limit in England and Wales, and next year the limit in Scotland was raised to threepence, and in Ireland the same, with an extension to sixpence in county boroughs. (In Northern Ireland the penny rate limit was re-established in county council areas, with a possible differential rating for urban districts, to a maximum of threepence, with Government consent.) Most of the municipal libraries proceeded to levy rates in proportion to their necessities. But, with the increase in the prices of books, other expenses, and the persistent demand for retrenchment, it has been difficult to maintain efficiency in municipal libraries at the high level desired, and the pay of the assistant is still inconsistent with the idea that he is entering a learned profession. The public libraries committee offer various recommendations for the general improvement of the service, particularly by schemes of co-operation; but they were not of opinion that the urban libraries should be transferred to the education committees, or that the numerous library districts in the metropolis should be unified under the London County Council. Only one member pressed for the latter reform.

The Central Library for Students.—Most important among these schemes for general or local co-operation was the plan for developing the Central Library for Students, as a national library forming a special department of the British Museum, to be a supplemental supply to the municipal and county libraries throughout England and Wales (Scotland and Ireland being supplied from the depôts at Dunfermline and Dublin), and to undertake such other urgent duties as the preparation of a union catalogue, the organization of an information bureau, and the issue of periodical book-lists. This library was started in 1917, largely to provide books for adult classes; but has grown from a collection of 3,000 books to a collection of 37,560, a large proportion of them costly works, supplying, in 1927, no less than 465 libraries with books they were unable to afford. The Central Library is mainly financed by an annual subsidy of £3,000 from the Carnegie Trustees. By a mutual arrangement with a large number of outlier libraries, comprising various public libraries, and such important research libraries as the Science library at South Kensington, those of the London School of Economics, the Linnaean, Folk-Lore, and Royal Asiatic Societies, the Society of Antiquaries, the Royal Colonial and Royal Anthropological Institutes, and the Royal Irish Academy, it is able to satisfy the needs, not only of students, but also of advanced research in all parts of the country. The public libraries committee outline a system of co-operation in which public libraries would be grouped round regional centres, usually the great urban libraries, with a federation of special libraries pooling their resources, and a central library acting as centre of the whole system. They recommend that an interim grant of £5,000 a year should be made by the Government to the Central library to establish it on a sound basis, and that the Science library should have an additional £3,500 a year to enable it to act in co-operation as the central supply for research students in science. The aggregate cost to the national exchequer of their proposals for the development of the Central library and of the Science library, and of the agency for central cataloguing, would not exceed £12,000 a year; and the benefit to scholarship, research, industry and commerce would be incalculable.

Co-operation with Special Libraries.—The growth in numbers and extent of special libraries of all kinds has been remarkable during the period reviewed. The valuable work of the Association of Special Libraries and Information Bureaux, established in 1925, has been a main factor in promoting this; and the publication of their Directory, "Aslib" (1928), another work financed by the Carnegie Trustees, is an immense benefit to librarians and users of libraries, since it is the first systematic survey of the special library resources of the nation. Similarly, the work of the joint standing committee on (university) library co-operation is doing much to facilitate the mobilization of the resources of university and other learned libraries, and the publication of the *World List of Scientific Periodicals* has materially contributed to the same object.

Librarianship.—The Library Association, which for many years had striven to raise the educational status of workers in libraries, and had held lectures, correspondence classes and examinations, with that purpose, appealed in 1917 for the establishment of a day school within the University of London, for the regular training of librarians. With the support of the Carnegie Trustees, who undertook to provide £1,500 a year for the first quinquennium, the School of Librarianship was opened at University college, London. A reduced grant was made for the second quinquennium, the balance required being made up by the university senate. According to the latest report, 549 students have been admitted to the school during the nine years covered, including many part-time students engaged in library work in the London area. A large and increasing number of these were already graduates of various universities. Easter and summer schools have been held both at home and abroad, with excellent results. The influence of the school in raising the educational standard of librarianship, improving salaries, and increasing the proportion of women, relatively to men, employed in libraries, has been considerable. The recent Government report is emphatic on the need for improved educational qualifications for librarians, and urges that the School of Librarianship, which is performing a national service, should be maintained, and that it "would appear to have a strong claim on the funds which the university receives from the State." An appeal for a permanent endowment fund has recently been launched. Classes in librarianship have also been started at Manchester, mainly for the benefit of assistants in that neighbourhood, and at Dublin for Irish students. Many library authorities now require a sound standard of general education from entrants to the service, and the Library Association specifies the matriculation standard for candidates for its certificates.

Other Library Developments.—The only obstacle to a general advance, after the Government report of 1927, as rapid and epoch-making as that which followed the Government report of 1919, is the present demand for economy. Great events are pending, and will probably, in a few years, be matters of history. The British Museum, in spite of the great extensions of a few years back, is still cramped for space; a large part of the interior is about to be reconstructed, and it is proposed to enlarge the Hendon repository and remove all newspapers there. Cambridge has decided to remove the University Library to a new building. Oxford is about to settle the problem of the Bodleian by erecting an additional building across Broad street and a repository at Jordan Hill for material not in constant request. What is healthiest at the moment is the intense interest aroused by the many-sided problems opened up by the growth of libraries, and by the widening consciousness of the immense part they must play in every department of life. The adoption of a more active policy by the Library Association, coupled with the appointment of a full time paid secretary and the acquisition of permanent headquarters, where they will probably soon be joined by other bodies having cognate interests, should help to a concentration of effort in the right direction. (E. A. Ba.)

BRITISH DOMINIONS

The majority of the British Dominions have permissive library laws. The rate limit is not so strict in every case. There is, for example, no rate limit in Tasmania; and South Australia may raise a library rate equivalent to threepence in the £. In Africa, Australia and Canada the Governments make grants to public libraries. The Canadian and Australian libraries are administered more or less on American, and those of South Africa, India, etc., on English lines.

Africa.—There are several important libraries in South Africa. The oldest library is the South African public library at Cape Town, established in 1818, which enjoys the copyright-privilege for the Cape (100,000 vols.). This library contains the collection of colonial books bequeathed by Sir George Grey. This and the Pretoria State library form together the National library; the legislatures have libraries, notably the Parliamentary library, Cape Town, which includes the Mendelssohn Collection of Africana. The chief public libraries are at Port Elizabeth, Kimberley, Durban, Bloemfontein, Bulawayo, Germiston, which has a country circulating system, and Johannesburg, the only really free public library. All charge a subscription for borrowing. The Education Department supports school libraries. The University library of Cape Town was being greatly developed in 1928. That at Pretoria deserves mention (40,000 vols.). (A summary of the literature of South African public libraries, by P. Freer, will be found in *The Library Assistant*, 1928.) In North Africa there are considerable collections at Cairo, especially the Royal library (1879) 107,000 vols., 23,000 mss., 500 papyri, and at Algiers, the latter under French control.

Australia.—The various States legislate for libraries independently, and maintain libraries. The Commonwealth library at Canberra was founded in 1927. The State public libraries circulate books to institutes, etc., in the country; Victoria subsidized local libraries. The local public libraries are those of Victoria at Melbourne, 1853 (421,000 vols.); of New South Wales, at Sydney, 1867 (401,000 vols., including the Mitchell library); this was an old subscription library bought by the Government; of South Australia, at Adelaide (139,000 vols.); of Queensland, at Brisbane, 1896 (34,200 vols.); and of West Australia, at Perth, 1860 (142,000 vols.). The university libraries are Sydney (180,000 vols., including the fine Fisher collection, 1885); Adelaide (70,000 vols.), which assists in control of the public library; Melbourne (60,000 vols.); and Brisbane (30,000 vols.).

Tasmania.—Only Hobart (Tasmanian Public library, 1849) had in 1925 used the large powers given by the act of 1867.

New Zealand.—In New Zealand there are 13 public libraries, established under acts dating from 1869 to 1877, which allow a penny rate. At Auckland the Turnbull Free Public library (1880) has Sir George Grey's Australasian collection and many rare books (140,000 vols.), Christchurch, 1859 (44,000 vols.) and Wellington, 1893, are the next largest. Wellington has the General Assembly library. The university library of Otago, Dunedin, 1872, is the chief academic library.

India and the East.—The chief library in India is the Imperial library at Calcutta (152,000 vols.). At Calcutta the Sanskrit college has 1,652 printed Sanskrit vols. and 4,000 Sanskrit mss., and many Jain mss.; Madras University library has a new and handsome building. The library of the Asiatic Society of Bengal was founded in 1784 (35,000 vols. and 20,000 mss.). The Geological Survey's library has 50,000 vols.

The Bombay branch of the Royal Asiatic Society (1804) has 100,000 printed vols. and 2,000 mss. The Moolla Feroze library (bequeathed 1831) is chiefly of mss., in Arabic and Persian. There are libraries attached to Elphinstone college and the Universities of Allahabad and Lahore (54,000 vols. each), Dacca (46,000 vols.), and Bombay (1864, 35,000 vols., including the Fawcett Economic library). The library of Tippoo Sahib, consisting of 2,000 mss., fell into the hands of the British (catalogue 1809).

Perhaps the most remarkable library in India is that of the raja of Tanjore, which dates from the end of the 16th or beginning of the 17th century. There are now about 18,000 mss. written in Devanagari, Nandinagari, Telugu, Kannada, Granthi, Malayalam, Bengali, Panjabi, or Kashmiri, and Uriya; 8,000 are on palm leaves. Dr. Burnell's printed catalogue describes 12,375 articles.

The Royal Asiatic Society has branches, with libraries attached, in many of the large cities of India and the Far East. At Rangoon there are several good libraries. The Raffles library at Singapore collects books relating to the Malayan peninsula and archipelago. In Ceylon there is the Museum library at Colombo (1877, with 15,000 vols.). The All-India Public Library Association, formed in 1923 to spread the public library movement throughout India, by means of provincial library associations, a quarterly journal, periodical conferences, the issue of pamphlets, and the training of librarians. In Baroda, Travancore, Pudukottai and Mysore the State helps liberally, and the movement has made progress. In British India hardly any Government help is forthcoming, save for libraries under State management in capital cities.

Palestine.—The chief library is the Hebrew National and University library (1925), 136,000 vols., which contains the Goldzieher Hebrew and Klein mathematical collections, and publishes a quarterly review, *Kiryath sefer*.

Canada.—The most important public library is that of Toronto (1883), which has over 400,000 vols., and includes a notable children's department in a separate building, and which compiles the annual *Canadian Catalogue* of new books since 1921–22 (published 1923); the central reference building was, in 1928, about to be rebuilt.

There were in 1909, 413 public libraries described as 131 free and 234 not free. The other most important libraries in Ontario are:—Queen's university, Kingston (1841), 150,000 vols., rich in Canadian history; Library of Parliament, Ottawa, about 300,000 vols., Legislative Library of Ontario, Toronto (1867), about 150,000 vols.; University of Toronto (1856), 220,000 vols. and 77,000 pamphlets.

In the province of Quebec, there are several large and important libraries, among which may be mentioned the Fraser institute, Montreal (1885), 103,000 vols.; McGill university, Montreal (1855), 268,000 vols., comprising many important collections; the Seminary of St. Sulpice, Montreal, about 223,000 vols.; Laval university, Quebec, 173,000 vols.; and the Library of the Legislature (1792).

In the province of British Columbia, under an act of 1919, a public library commission governs the six public libraries, 23 "public library associations," and 386 travelling libraries, and in 1928 was surveying the system (*Report* for 1926–27).

In Nova Scotia there is a system of circulating books among the school libraries. The Legislative library at Halifax incorporates that of the Nova Scotia Historical Society (1878). The school law of New Brunswick provides for grants to school libraries; in the West Indian islands, the Institute of Jamaica, Kingston (1879) and the Trinidad Public library (1841) should be mentioned. (X.; A. Es.)

LIBRARY SCHOOLS

The first school in the world established solely for the professional training of librarians was started at Columbia college, New York city, in 1887, by Melvil Dewey, then librarian of the college. Dewey's plan for a school for the training of librarians had been presented to the American Library Association as early as 1883, but was opposed by some of the leading librarians. Opposition gradually gave way, however, as the value of formal professional training for library workers was demonstrated, and other schools were established in various parts of the country, beginning with the Pratt Institute School of Library Science in 1890. In 1915 the Association of American Library Schools was organized, with ten charter members, for the purpose of maintaining standards of instruction. By 1921 three additional schools had been admitted to the association. Only five of these schools were conducted under the auspices of a college or university of standard grade, and with some of them the university affiliation was merely nominal. About 1920 a demand for university standards became perceptible, and culminated, in 1924, in the creation by the American Library Association of a board of education for librarianship, one of the principal functions of which was to be the formulation of minimum standards for library schools. Under the standards recommended and adopted by the American Library Association in 1925, the schools were classified as junior undergraduate, senior undergraduate, graduate and advanced graduate. All but one of the 13 schools have been accredited by the board, and, in addition, two others. About 8,500 students have completed at least the first year's work in the accredited schools.

For admission to a junior undergraduate school one year of college study is required, and three years for the senior undergraduate, while a bachelor's degree, in addition to other qualifications, is required by the graduate schools. The junior undergraduate schools grant a certificate on the completion of a one-year course. For three years of college study and one year of library school study a bachelor's degree is usually given by the senior undergraduate schools. Most of the graduate schools give a certificate for the first year's work, although two grant a second bachelor's degree for the first year of library school study. Four university schools grant the degree of M.A. or M.S. The curricula are made up of three types of subjects, the bibliographical, technical and administrative. While many other courses are given, from one-half to two-thirds of the student's time is devoted to bibliography and bibliographical method, reference service and book selection. The first year course is largely prescribed, although some of the schools offer elective courses. Specialized courses in library work with children were offered in at least five schools. (C. C. Wi.)

SPECIAL LIBRARIES

With a view to greater accessibility of special resources, the American Association of Special Libraries was formed in 1909, and has issued a directory (2nd ed. 1925). The formation of a corresponding British Association has already been recorded, and a similar directory was published by this body in 1928.

In Great Britain, during 1910–26 there was a great development of scientific, technical and commercial libraries and bureaux of information. The same movement has developed in America, probably to an even larger extent, though in that country the public library has, until recently, undertaken a larger proportion of this kind of service. Of great importance in this connection are compilations like the *World List of Scientific Periodicals* (1926–27), and the *Subject Index of Periodicals* (1915).

Mercantile Marine.—The British Sailors' Society has attempted this service for more than a century. Since 1920 it has revived and developed its arrangements under the stimulus of a Carnegie Trust subsidy. The Seafarers' Education Service (founded 1920), also with the aid of a trust grant, and contributions from the owners and the men's unions, has succeeded in placing substantial libraries of a more advanced kind upon ships. The Carnegie Corporation of New York has similarly financed the American Merchant Marine Library Association. In Great Britain a system of supply to lighthouses and lightships was initiated by the Carnegie Trust, with the aid of the public authorities concerned.

Libraries for the Blind, etc.—In Great Britain the needs of the blind have been met by the establishment of the National Library for the Blind in London, founded in 1882. It was severely damaged by the Thames flood of 1928. Books in Moon or Braille type are lent freely to public libraries, and individual readers. A sectional library for deaf education was set up in the library of the University of Manchester in 1920. Hospital collections are distributed under the auspices of the Red Cross Society. A collection for the use of nurses and health visitors has been set up by the College of Nursing (1921).

FRANCE

Besides the unrivalled libraries of the capital, France possesses a remarkable number of provincial libraries. In 1857 there were 340 departmental libraries with an aggregate of 3,734, 260 printed vols. and 44,436 mss. In 1908 the printed books had increased to over 20 million and are now probably 30 million at least.

Paris.—The Bibliothèque Nationale (formerly Bibliothèque du Roi, Royale, or Imperiale), is, perhaps, the finest library in the world. The real foundation of the institution may be said to date from the reign of King John, the Black Prince's captive, who bequeathed his "royal library" to his successor, Charles V. Charles V. removed the library from the Palais de la Cité to the Louvre, where it was arranged on desks in a large hall of three storeys by the first librarian and cataloguer, Claude Mallet, the king's valet-de-chambre. His *Inventaire des Livres du Roy nostre Seigneur estans au chastel du Louvre* is extant, as well as the inventories made by Jean Blanchet in 1380, and by Jean le Begue in 1411 and 1424. Charles VI. added some hundreds of mss. to the library, which, however, was sold to the regent, duke of Bedford, after a valuation had been established by the inventory of 1424, transferred to England, and finally dispersed at the regent's death in 1435. Charles VII. did little to repair the loss, but under Louis XI. another library was created; the first librarian was Laurent Paulmier, and Jean Foucquet of Tours was named the king's *enlumineur*. Charles VIII. enriched it with many fine mss. executed by his order, and also with most of the library of the kings of Aragon, seized by him at Naples. Louis XII. incorporated the Bibliothèque du Roi with the fine Orleans library at Blois, and further enriched it by plunder from Pavia, and by the purchase of the Gruthuyse collection; it was described at this time as one of the four marvels of France. François I. enlarged and removed it to Fontainebleau in 1534. He set the fashion of fine bindings, which was still more cultivated by Henri II., and which has never died out in France. During the librarianship of Amyot the library was transferred from Fontainebleau to Paris. Henri IV. removed it to the Collège de Clermont, but in 1604 another change was made, and in 1622 it was installed in the Rue de la Harpe. Under J. A. de Thou it acquired the library of Catherine de' Medici, and the Bible of Charles the Bald. In 1617 a decree ordered the deposit of two copies of every new publication, but this was not enforced till Louis XIV.'s time. The first catalogue worthy of the name was finished in 1622, describing some 6,000 vols., chiefly mss. Many additions were made during Louis XIII.'s reign, notably that of the Dupuy collection, but a new era dawned under Louis XIV. Colbert, one of the greatest of collectors, so enlarged the library that it became necessary to make another removal. It was therefore, in 1666, installed in the Rue Vivien (now Vivienne). The departments of engravings and medals were now created, and were soon important. Nic. Clément made a catalogue in 1684 according to the arrangement still used (in 23 classes, each designated by a letter of the alphabet), with an alphabetical index. After Colbert's death Louvois employed Mabillon, Thevenot and others to procure books, etc., from all parts of the world. A new catalogue was compiled in 1688 in 8 vols. by several scholars. Towards the end of Louis XIV.'s reign it contained over 70,000 volumes. Under the Abbé Bignon the library was removed to its present home in the Rue Richelieu. Between 1735 and 1739 a catalogue in 11 vols. was printed, and duplicates were sold. In Louis XVI.'s reign the La Vallière sale yielded many valuable accessions. A few years before the Revolution the printed books numbered over 300,000 vols. and opuscules. The Revolution increased the library, now called the Bibliothèque Nationale, and the other State libraries, with the forfeited collections of the *émigrés*, as well as of the suppressed religious communities, which by enactments of 1789–92 were gathered into "dépôts littéraires." (*See* below opening of account of provincial libraries.) In the difficulties made by such numerous acquisitions Van Praet showed himself a great administrator. Napoleon increased the Government grant; and by the strict enforcement of the law of deposits, as well as by the acquisition of collections, the library progressed, under him, towards his idea of universality. At the beginning of the century it held 250,000 printed vols., 83,000 mss., and 1,500,000 engravings. After 1815 the mss. which he had taken from conquered capitals had to be returned. After the World War, with the fall in the value of the franc, the library was seriously impoverished. A new administrator, P. Roland-Marcel, mitigated poverty by various means: (1) a "consortium," under a joint council, of the library with the other chief Parisian national libraries, *i.e.*, the Mazarine (which became the 5th department of the Nationale), the Sainte-Geneviève, and the Arsenal, and later, the University of Paris, by decrees of Aug. 29, 1923, and Dec. 28, 1926, purchases of books and periodicals being divided between them; (2) the library, and then the group, were by laws of April 28, 1927, and March 5, 1928, given the status of "civil personality," carrying the right to hold funds, (3) the loi du dépôt légal was amended, with the result of greatly enlarging the receipts of current French books; the weekly catalogue of accessions of new French books was amalgamated with the list of new publications issued by the trade ("Bibliographie de la France"); (4) the "salle ovale" or "salle de lecture publique," rendered less important by the development of the public libraries of the arrondissements of Paris, was, in 1928, being converted into a periodical room, equipped with (5) a bureau of information, the main feature of which is an index of the special collections in all French libraries; (6) a "service de prêts," or central exchange for loans of books between libraries, whether in France or between France and other countries, established in 1927; (8) an "Office de documentation et de recherches bibliographiques," established by the Society of Friends of the Bibliothèque Nationale. These developments greatly increased the library's effectiveness. But the sum available for purchases of printed books in 1927 (130,228 fr.) did not allow of any purchases of old or rare books.

Riches of the Bibliothèque Nationale.—According to the statistics for 1926–27 the riches of the Bibliothèque Nationale may be enumerated as follows:—(1) Imprimés: more than 4,400,000 vols., accessions in 1927, 13,215 vols. (apart from maps, music, periodicals, etc.); maps and plans, 500,000 in 28,000 vols. (2) Manuscrits: 122,000 mss. (3) Estampes: 3,015,000 pieces. (4) Médailles, 248,500 pieces.

Admittance to the "salle de travail" is obtained through a card procured from the secretarial office. The slip catalogue bound in volumes dates from 1882, and gives a list of all accessions since that date; it is divided into two parts, one for the names of authors and the other for subjects. Of the *Catalogue général des livres imprimés* (authors only), 91 vols., A.-Lecompte, had appeared in 1928. It is expected to be completed in 11 years. Anonyma, periodicals, etc., are reserved for later treatment. The preface to vol. i., by L. Delisle, is a valuable historical account of the library. The place of the unpublished volumes was, from 1925, supplied by a photographic issue of the ms. slips of the classed catalogue. Other exceptionally important catalogues, out of very many, are: *Catalogue de l'histoire de France* (1885–89, 11 vols.); *Table des auteurs, Catalogue général des incunables des bibliothèques publiques de France,* by M. Pellechet and L. Polain, t. i.–iii. A.–H. (1897–1909); *Livres d'Heures imprimés au XVe siècle conservés dans les bibliothèques publiques de Paris,* by P. Lacombe (1907), etc. L. Vallée's *Catalogue des cartes et plans relatifs à Paris et aux environs de Paris* (1908); *Bibliographie générale des travaux historiques et archéologiques publiés par les sociétés savantes de la France,* by R. de Lasteyrie in collaboration with d'E. Lefèvre-Pontalis, S. Bougenot, A. Vidier, t. i.–vi. (1885–1908); H. Omont's *Catalogue général des manuscrits français* (1895–1918, 13 vols., and index in the press, 1928). For the Greek collection important catalogues have been made by H. Omont, the present keeper of the manuscripts, and for the Latin by Delisle, M. Omont and others. For many oriental languages catalogues have been compiled; and those of manuscripts in modern languages are nearly all completed. The Départements des Médailles et des Estampes possess excellent catalogues. The former department includes vases, bronzes and gems; the catalogues of the Greek and Early French series are remarkable. The Département des Estampes has been described in the vicomte H. Delaborde's *Le Département des Estampes à la Bibliothèque Nationale* (1875); it includes drawings. F. Courboin's *Catalogue sommaire des gravures et lithographies composant la Réserve* (1900–01) is supported by many fine special catalogues. A list of works on and of the catalogues of the Bibliothèque Nationale, and most other French libraries, may be found in A. Vidier, *Annuaire des Bibliothèques et des Archives,* 1927, pp. 13–38. The second copy of every new French publication deposited by the printer is allotted by the Council of the National Libraries to one of the other institutions represented upon it.

The Bibliothèque de l'Arsenal was founded by the marquis de Paulmy (Antoine-René d'Argenson) in the 18th century; in 1786 it received 80,000 vols. from the duc de La Vallière's library. It contained, in 1926, about 950,000 vols., 11,462 mss., with the Bastille collection (2,500 portfolios) of which the inventory is complete, and 120,000 prints; it is the richest library for the literary history of France and has more than 30,000 theatrical pieces, including the Auguste Rondel collection, added in 1922, and, accordingly, it receives belles lettres in the allotment of deposited books.

The Bibliothèque Mazarine owes its origin to the great cardinal, who confided the direction to Gabriel Naudé; it was open to the public in 1642. Dispersed during the Fronde, it was reconstituted with 40,000 vols. after Mazarin's death, in 1661, and left to the Collège des Quatre-Nations, which, in 1691, made it again public. It is now one of the libraries of the national "consortium," and forms a 5th department of the Nationale; it has 300,000 printed vols., including 1,900 incunabula, and 4,600 mss.

The first library of the Genovéfains had nearly disappeared when Cardinal François de la Rochefoucauld, who had charge of the reformation of that order, constituted, in 1642, a new library with his own books. The Bibliothèque Ste.-Geneviève, in 1716. possessed 45,000 vols. It became national property in 1791, and was called the Bibliothèque du Panthéon and added to the Lycée Henri IV. under the Empire. In 1926 it contained 510,000 printed vols., 1,225 incunabula, 3,872 mss., 40,000 prints and 4,000 maps and plans. There is a special Scandinavian section under the patronage of the Governments of the four Scandinavian countries, which, in turn, appoint the librarian. The general catalogue of printed books (1891, and suppl. to 1910), of mss. (1894–96, and suppl. 1913), and others are printed.

Official.—The Bibliothèque du Ministère des affaires étrangères contains 90,000 vols., 300,000 pamphlets and 500,000 documents. The Bibliothèque du Ministère de la Guerre, formed by Louvois, possesses 180,000 vols. and 861 mss. The École supérieure de la Guerre (70,000 vols.) and other institutions come under this department. The Bibliothèque et Musée de la Guerre, founded after the World War, has 110,000 vols., apart from periodicals, documents, maps, etc. The Bibliothèque du Ministère de la Marine is of old formation (catalogue 1838–43); it contains 60,000 vols. and 376 mss.; the catalogue of manuscripts was compiled in 1907. The Service hydrographique has 70,000 vols., and 391 mss. The Bibliothèque de la Chambre des députés (1796) possesses 350,000 printed books and 1,622 mss. (printed catalogue of law and political economy, 1883, and of mss., 1907). The Bibliothèque du Sénat (1818) contains 170,000 vols., and 1,345 mss. There are also the following law libraries: Office de législation étrangère (80,000 vols.); Faculté de droit of the University (172,000 vols.); Cour d'appel, Ordre des avocats (1871), 80,000 vols. (printed catalogue, 1880–82); avocats de la Cour de Cassation, and Cour de Cassation. The City of Paris owns, among other libraries, the Bibliothèque Historique de la Ville de Paris, destroyed in 1871 but restored in 1872 (about half a million vols.); the Forney (industrial art), and those of prefectures, hospitals and schools. The arrondissements have each from three to six popular libraries, the stocks ranging from 2,000 to 17,000 vols., and averaging about 6,000. A few have children's libraries. The Association des Bibliothécaires Français in 1928 urged a development of popular public libraries in France generally.

Educational.—The library of the university is that of the Sorbonne (1762), originally including only arts and theology. In 1800 it was the Bibliothèque du Prytanée, in 1808 des Quatres Lycées, and in 1812 de l'Université de France. The faculty sections now are: (1) Sciences et des Lettres à la Sorbonne, (2) Médecine, (3) Droit, (4) Pharmacie. Before the separation of Church and State there was also (5) Protestant Theology. After the Bibliothèque Nationale, it is the richest, and above all in the fields of classics, archaeology and literature, philosophy, mathematics and physics. Installed since the year 1897 in the New Sorbonne, it is a library of the very first rank. The section of Sciences et Lettres has 700,000 printed books and 1,590 mss. Amongst important bequests are those of Leclerc, Peccot, Lavisse, Derenbourg and Beljame (the last including an important Shakespearian library).

At the Sorbonne are also to be found the libraries of the laboratories, notably the geological. The section relating to medicine, housed since 1891 in the new buildings of the Faculté de Médecine, includes 337,000 vols. and 85 mss. The Bibliothèque de la Faculté de Droit (1772), contains 172,000 vols. The fourth section, Faculté (formerly École supérieure) de Pharmacie, greatly developed since 1882, now contains 61,000 vols. The section of art and archaeology contains 100,000 vols., recently enriched by the gift of the Jacques Doucet library.

The other libraries connected with higher education include that of the École des Beaux-Arts (40,000 vols., 100,000 reproductions, 14,000 drawings); École normale supérieure (1794), has a portion of Cuvier's library, there are 400,000 vols.; École des Chartes (50,000 vols.). The library of the Muséum d'histoire naturelle (18th century) has 225,000 vols., 2,300 mss., 8,600 original drawings on vellum from 1631. The Bibliothèque de l'Office et Musée de l'Instruction publique (formerly Musée pédagogique), 1880, has 100,000 volumes. The other principal museums (Louvre, Cluny, Guimet, etc.) have large working libraries for the curators and students. In 1760 was founded the Bibliothèque de l'Institut de France, which is very rich; its acquisitions come particularly from gifts and exchanges (600,000 vols., 4,369 mss.), especially the modern one, the Fondation Thiers (75,000 vols. and 1,000 mss.), is attached to the Institut. Among other libraries may be mentioned those of the Conservatoire National de Musique et de Déclamation (1775); Observatoire (25,000 vols.); Institut Catholique (180,000 vols.); Conservatoire national des arts et métiers (60,000 vols.); Polonaise (attached to the Académie polonaise des sciences et lettres) containing the musée Adam Mickiewcz (120,000 vols., 12,000 mss. and autographs, 30,000 prints); and the Comédie Française (30,000 vols. and 1,700 mss.).

Before the Revolution there were, in Paris alone, 1,100 libraries with two million volumes. In 1791 more than 800,000 vols. were seized in Parisian religious houses and transferred to eight "dépôts littéraires," while, in the provinces, six million vols. were seized and transferred to similar local depositories. The organization of the central libraries (decree of 3 Brumaire An IV.–Oct. 25, 1795), came to nothing, but the consular edict of Jan. 28, 1803, organized the local depots, and the library system was reconstituted, alike in Paris and the provinces. Many precious books and mss. were burnt, since by the decree of 4 Brumaire An II. (Oct. 25, 1793) the Committee of Instruction ordered, on the proposition of its president, the deputy Romme, the destruction or modification of supposedly feudalist books and objects of art.

The books in public provincial libraries, numbered, in 1910, over 9,200,000 vols., 15,540 incunabula and 93,986 mss., and the number of printed books was probably nearly doubled by 1928. The number in the colonies and protected States outside France is uncertain, but in 1910 was over 200,000 vols.; to this must be added the 2,428,954 vols. then contained in the university libraries, now, doubtless, more than doubled, even without reckoning that of Strasbourg, transferred from Germany. There are over 300 departmental libraries, and as many belong to learned societies. Nearly all are administered under State control by municipalities. The collections distributed from the depots after 1803 remain State property, and the 42 libraries in which these "fonds d'État" preponderate are "classed" by the Ministry of Public Instruction; the librarians of these have higher qualifications and are less subject to local control than those of the "unclassed." They are organized by a law of 1897, and, like the universities, are subject to the inspectorate of the Ministry and its consultative commission, established in 1909. This body controls professional qualifications, and publishes collective catalogues (as of mss. and incunabula) and technical instructions.

Old Municipal Libraries.—In most towns there are, besides the learned and historical "bibliothèque de la ville," popular lending libraries, privately founded, but since 1874 subsidized, supplied with books and inspected by the Ministry. In one or two departments there is the beginning of a rural circulating system. Most municipal libraries date but a short time before the Revolution, but there are exceptions. Thus Angers owes its first collection to Alain de la Rue about 1376; it now contains 92,170 vols., 71 incunabula and 2,120 mss. That of Bourges dates from 1466 (45,900 vols., 325 incunabula, 485 mss.). That of Carpentras was established by Michel Anglici between 1452 and 1474 (83,000 vols., 184 incunabula, 2,154 mss.). Mathieu de la Porte is said to be the founder of the library at Clermont-Ferrand, at the end of the 15th century; it contained rather more than 49,000 vols. at the time of its union with the Bibliothèque Universitaire.

Amongst the libraries which date from the 16th century must be mentioned that at Lyons, founded by François I. in 1527; it possesses 600,955 vols., 897 incunabula and 9,730 mss. (many catalogues printed).

In the 17th century were established the following libraries: Abbeville, by Charles Sanson in 1685; Besançon, by Abbé Boisot in 1696; La Rochelle, by the Consistoire Réformé in 1604; St. Etienne, by Cardinal de Villeroi.

The principal libraries founded during the 18th century are the following: Aix-en-Provence (1705); Bordeaux (1738); Chambéry (1736); Dijon (1701); Grenoble (1772); Marseilles (1799); Nancy (1750); Nantes (1758); Nice (1786); Nîmes (1778); Niort (1771); Perpignan (1759); Rennes (1733); Toulouse (1782). The World War wrought very great havoc among the libraries of the northern departments. The libraries of Arras, Douai, Péronne, Rethel, Saint-Quentin, Compiègne, Noyon, Verdun, and many other places were wholly or largely destroyed; that of Reims was mainly removed to safety.

Nearly all the other municipal libraries date from the distribution of the dépôts littéraires in 1803. Those of Avignon, Montpellier, Caen, Rouen, Tours, and Versailles are specially important; in a second rank come Amiens, Auxerre, Beaune, Brest, Douai, le Havre, le Mans, Orleans, Pau, Poitiers, Toulon.

The Ministry of Public Instruction has published joint catalogues of certain classes, e.g., *Catalogues des mss. des bibliothèques de Paris et des Départements* (1885), and the *Catalogue Général des Incunables des Bibliothèques Publiques de la France,* by Marie Pellechet and M. L. Polain (vols. i.–iii., A. H.). The old university libraries, scattered and thrown into the depôts at the Revolution, were re-established by acts of 1875, 1879 and 1882, when Jules Ferry united the faculty libraries in each of the 17 academic districts in one university; civil personality, carrying financial autonomy, followed in 1896. The Bibliothèque Nationale et Universitaire, formerly the Universitäts und Landesbibliothek, of Strasbourg, founded in 1871 to replace that burned in the Franco-Prussian war, is the largest provincial university library (1,700,000 vols., 1,900 incunabula, 4,759 mss., 5,000 papyri), Others are: Aix, Algiers, Besançon, Bordeaux, Caen, Clermont, Dijon, Grenoble, Lille, Lyons, Marseilles, Montpellier, Poitiers, Rennes, Toulouse. That of Nancy was totally burned ten days before the Armistice of 1919. The library profession is organized by central legislation, starting from a royal ordinance of 1839, which assigned one-third of the higher posts to trained "archivistes-paléographes." Municipal librarians are appointed by the mayors. The prefect of the Seine appoints those of the City of Paris, since 1904 exacting certain technical training. The "classed" libraries are seeking complete nationalization, on the lines of the organization of the archives, and the establishment of a single certificate of training (Ch. Mortet, "The Public Libraries of France," in *Library Assoc. Record,* 1925, pp. 145–159).

The Association des Bibliothécaires Français (founded in 1906, its bulletin, 1907, now forming part of the *Revue des Bibliothèques*) actively promotes library reform.

GERMANY (WITH AUSTRIA AND SWITZERLAND)

Germany is emphatically the home of large libraries; there is no law of deposit wider than the individual States, and Saxony and some less important parts of the Reich have no law of deposit at all. To supply the lack of a single library, where all German books may be preserved, the national book-trade union, the Börsenverein der Deutschen Buchhändler, established one, the Deutsche Bücherei, in Leipzig in 1913; this is subsidized by the Reich, the Saxon State, and the city, and the books are deposited freely by a voluntary agreement of the publishers. It had 675,000 vols. in 1928. There is an active professional body, the Verein deutscher Bibliothekare, which, since 1902, has published a valuable year book. In 1921 the Austrian association joined the German. The number of German universities has tended to multiply considerable collections; 1,617 libraries were registered by P. Schwenke in 1891. The *Jahrbuch der deutschen Bibliotheken* for 1927, which gives statistics and administrative details of 395 German libraries, makes a total of 41,000,000 vols.; in 1909 W. Erman had reckoned 190 libraries and 23,500,000 volumes.

The State and university libraries are under State control. The earlier distinction between these two classes has become less and less marked; thus the university libraries are widely used and books are borrowed extensively, especially in Prussia. In 1924 was promulgated the Leihverkehrsordnung für die deutschen Bibliotheken, which authorized and organized mutual lending between all libraries in the country. Owing to financial exhaustion and the depreciation of the currency under 1918, German libraries were unable to acquire foreign publications, and in 1920 there was founded the Notgemeinschaft der deutschen Wissenschaft (emergency union of German learning); to secure files of recent foreign journals, to organize exchange, and to distribute foreign publications among the German libraries. By edict of Jan. 5, 1926, a national exchange bureau (Reichaustauschstelle) was formed in the Ministry of the Interior, to serve the same purposes as the Smithsonian institution.

Popular libraries (Volksbüchereien) exist in most towns, Karl Preusker formed a plan for setting them up in 1839, and four were founded in Berlin in 1850. After 1890 a number of popular libraries were established, some by municipalities, but many by associations and firms. In 1907 the Berlin City library was founded; it now has 20 districts and 90 branches, with 400,000 books. Hamburg also has a large system.

Most of the States have a consultative office for popular libraries, and the Deutsche Zentralstelle für Volkstümliches Büchereiwesen acts as a centre. The Verband Deutscher Volksbibliothekare (founded in 1922 as the Deutscher Büchereiverband) publishes an annual directory (1926). Very few Volksbuchereien, however, attempt the work of the public library of English-speaking countries, and the expenditure on them is only a halfpenny per head. In Prussia since 1907, and in Baden since 1928, a council deals with library matters at the Ministry of Public Instruction. Generally, the State does not concern itself with the town libraries and the popular libraries, but there is much in common between these two classes. Sometimes popular libraries are under the supervision of a scientifically administered town library, as in Berlin, Danzig, etc; elsewhere, as at Magdeburg, we see an ancient foundation take up the obligations of a public library. In Prussia from 1893, and in Bavaria, regulations are in force as to the professional education of librarians. This regulation has been in force as regards librarians in Bavaria from 1905. Throughout Germany librarians are divided by qualifications into three grades. There are schools of librarianship at Berlin (1921, founded at Göttingen in 1886), Munich, Leipzig, Freiburg and Bonn.

Libraries in Berlin.—Berlin is well supplied with libraries, 268 being registered by P. Schwenke and A. Hortzschansky in 1906, with about five million printed volumes. The largest of them is the State (formerly Royal) library, which was founded and made public by the "Great Elector," Frederick William, in 1661. From 1699 the library became entitled to a copy of every book published within the royal territories, and it has received many valuable accessions by purchase and otherwise. It now includes 2,128,707 printed vols. and 56,810 mss. Current catalogues of accessions since 1892, and of the Prussian University libraries, also since 1898, of academic publications of German universities, etc., are printed. The catalogues of mss. are mostly in print, vols. 1–13, 16–23 (1853–1905). The library is specially rich in oriental mss. The musical mss. are very remarkable and form the richest collection in the world as regards autographs. The building, erected about 1780 by Frederick the Great, rebuilt in 1909 and since added to, houses the University library and the Academy of Sciences. There is a regular system of mutual lending, established by ministerial edict of Jan. 27, 1893, between the State library and a great number of Prussian libraries. This is the same in Bavaria, Württemberg and Baden; the oldest system is that between Darmstadt and Giessen (dating from 1837).

Conducted by the State library are the *Gesamtkatalog der Preussischen wissenschaftlichen Bibliotheken* (describing the printed books in the Royal library and the Prussian University libraries in one general catalogue upon slips), the Auskunftsbüro der Deutschen Bibliotheken (founded in 1905 to give information where any particular book may be consulted), and the Kommission für den Gesamtkatalog der Wiegendrucke (a complete catalogue of books printed before 1500), of which 3 vols. out of 12 or more, appeared by 1928. For most of these improvements and for many others credit is due to Friedrich Althoff, for 25 years Prussian minister for education.

The University library (1831) numbers 381,000 vols., exclusive of dissertations. The library possesses the right to receive a copy of every work published in the province of Brandenburg.

Some of the governmental libraries are important, mostly those of Berlin, especially those of the War Office (363,000 vols.), Statistisches Landesamt (260,344 vols.); Reichstag (277,500 vols.); and Patent-Amt (257,000 vols.).

The Prussian University libraries outside Berlin include Bonn (511,380 printed vols., 2,140 mss.), Breslau (545,305 printed vols., 4,570 mss.), Göttingen, from its foundation, in 1736–37, the best administered library of the 18th century (734,949 vols., 8,134 mss.), Kiel, Königsberg, Marburg, Münster. Largely in consequence of the impoverishment of the years after 1918 the university libraries practise a division of the field of knowledge: according to Dr. Balcke. (C. Balcke "The German Library World," in *The Library Association Record*, 1927, pp. 101–121, the only recent general account of German libraries; this section is in part based upon it.) Bonn collects Romance, Göttingen English, Kiel Scandinavian, Breslau Slavonic, Heidelberg art and archaeology, Königsberg philosophy, Leipzig Italian and oriental, Tübingen theology and oriental, Berlin German and foreign academica, and Griefswald Low German. Under provincial administration are the (formerly) Königliche und Provinzialbibliothek at Hanover (232,000 printed vols., 4,083 mss.), and the Landesbibliothek at Cassel (230,000 printed vols., 4,400 mss.). Frankfurt a/M., Cologne and other large towns possess excellent municipal libraries.

Munich.—The libraries of Munich include two of great importance. The State (formerly Royal) library was founded by Duke Albrecht V. of Bavaria (1550–79), who made numerous purchases from Italy, and incorporated the libraries of the Nuremberg physician and historian Schedel, of Widmannstadt, and of J. J. Fugger. The number of printed vols. is estimated at 1,580,000 and about 50,000 mss. The library has 16,000 incunabula, many from the monastic libraries closed in 1803. The oriental mss. are numerous and valuable, and include the library of Martin Haug. The catalogue of the printed books are in manuscript; printed catalogue of mss. (1858). The University library (850,000 vols., 4,000 incunabula, 4,000 mss., 45,000 vols. on reference shelves) was originally founded at Ingolstadt in 1472, and removed with the university to Munich in 1826. After these two the most noteworthy is the Bayrische Armee-Bibliothek (156,950 vols.).

The chief Bavarian libraries outside Munich are the State (formerly Royal) library at Bamberg (400,000 vols., 4,320 mss.) and the University library at Würzburg (600,000 vols., 1,750 mss.). The University of Erlangen, Augsburg and Nuremberg have large libraries; at the last is also that of the Germanisches National museum (300,000 vols., 4,000 mss.).

Dresden.—In 1906 there were in Dresden 78 public libraries with about 1,495,000 volumes. The Sächsische (formerly Königliche) Landes-bibliothek in the Japanese palace was founded in the 16th century, specializes in history and literature, and has 694,800 vols. and 460,000 pamphlets, with 7,000 mss.

Leipzig University library has 675,000 vols.; the Pädagogische Central-Bibliothek der Comenius-Stiftung (283,010 vols.) is perhaps the largest educational library in the world. The Deutsche Bücherei has already been mentioned. The University library of Tübingen (713,589 vols. and 4,409 mss.) is the largest library in Württemberg.

Stuttgart.—The Royal Public Library of Stuttgart (1765) possesses 481,236 vols., 263,041 pamphlets, and 6,797 mss., with a famous collection of Bibles. The library also enjoys the copy-privilege in Württemberg. The former Royal private library, founded in 1810, contains about 105,000 vols.

Darmstadt.—The former Grand-ducal library of Darmstadt, now the Hessische Landesbibliothek, was established by the grand duke Louis I. in 1819, on the basis of a 17th century library, and includes 678,651 vols. and 3,857 mss.

Among the other libraries of Hesse the chief are the University library at Giessen and the Stadtbibliothek at Mainz (including the Gutenberg museum).

In the Grand Duchy of Baden are the Badische (formerly Hof- und) Landes-Bibliothek at Carlsruhe (276,947 vols., 4,830 mss.), the University libraries at Freiburg i./B. (420,000 vols., 700 mss.), and Heidelberg (1386), the oldest of the German University libraries. In 1623 the whole collection of the last named was given to the pope, and only the German mss. were returned. The library was re-established in 1703, and after 1800 enriched with monastic spoils; it now contains 928,301 vols., apart from dissertations etc., 3,721 mss., and about 5,200 papyri, for the most part of great value.

In other German States should be mentioned Jena, Rostock, Schwerin, Weimar, all possessing rich collections of mss.

The Ducal library of Gotha was established by Duke Ernest the Pious in the 17th century, and contains many valuable books and mss. from monastic collections. It numbers about 250,000 vols., with 7,728 mss. The catalogue of the oriental mss., chiefly collected by Seetzen, and forming one-half of the collection, is one of the best in existence.

The Herzog August (formerly Landes) library at Wolfenbüttel, founded in the second half of the 16th century by Duke Julius, was made over to the university of Helmstedt in 1614, whence the most important treasures were returned to Wolfenbüttel in the 19th century; it now numbers 350,000 vols., and 8,400 mss., and is exceptionally rich in incunabula.

The chief libraries of the Hanse towns are those of Bremen, Lübeck and Hamburg (Staats- und Universitats- formerly Stadtbibliothek), made public since 1648 (680,000 vols., 12,652 mss., among them many Mexican). Hamburg has also, in the Kommerzbibliothek (175,000 vols.), a valuable trade collection.

Austria.—The *Adressbuch der Bibliotheken der Oesterreichungarischen Monarchie,* by Bohatta and Holzmann (1900), described the libraries of the Austro-Hungarian empire. The largest library in Austria, and one of the chief in Europe, is the Nationalbibliothek (before 1920 Hofbibliothek) (1440), including a portion of the library of Matthias Corvinus. Since 1808 the library has also been entitled to the copy-privilege. The number of printed vols. is 1,210,000; 9,000 incunabula. The mss. amount to 27,000 (2,360 oriental), with 100,000 papyri of the collection of Archduke Rainer. The main room is one of the most splendid in Europe. The collection of prints was separated from the books in 1921 and annexed to the Albertina. The University library of Vienna (1775) 1,050,000 vols., was established by Maria Theresa, and is open to all; this library also lends.

The number of libraries in Vienna enumerated by Bohatta and Holzmann is 165; 25 of the chief are described by R. Teichl, *Wiener Bibliotheksführer und Plan* (1926).

The number of monastic libraries in Austria is very considerable. They possess altogether more than 2,500,000 printed vols., 25,000 incunabula and 25,000 mss. The oldest library in Austria is that of the monastery of St. Peter at Salzburg (785–821), 70,000 vols., nearly 1,500 incunabula. Kremsmünster (100,000), Admont (86,000) and Melk (70,000), date from the 11th century. Account of their mss. appear from time to time in *Zentralblatt für Bibliothekswesen.* Many of their librarians are trained in the great Vienna libraries.

Switzerland.—Among the Swiss libraries, which numbered 2,096 in 1868, there is none of the first rank. The University library at Basle (1460) the Cantonal library at Lausanne, and the Stadtbibliothek at Berne, which, since 1903, is united to the University library of that city, the Landes-Bibliothek (Bibliothèque Nationale) at Berne, and the City library of Geneva, are considerable. All the Swiss literature since 1848 is collected by the Landes-Bibliothek at Berne, established in 1895 for this special object. There is now no legal, but only a voluntary, deposit of Swiss books. Older Helvetiana are collected in the subsidized Bürgerbibliothek at Lucerne. The monastic libraries of St. Gall (830) and Einsiedeln (946), are of great historical interest. The League of Nations has its library at Geneva; The Rockefeller foundation made, 1927, a large gift to the League for a library building.

OTHER EUROPEAN COUNTRIES

Hungary.—Information about the chief libraries in Hungary under the dual monarchy was given annually up to 1911 in the Hungarian *Statistical Year Book.* The largest library in Hungary is the Széchenyi-Nationalbibliothek at Budapest, founded in 1802 by the gift of the library of Count Franz Széchenyi. It contains 400,000 printed vols. and 16,000 mss., and has 11 lending and four reference branches. The University library of Budapest (1635) includes 543,572 printed books and 3,401 mss. Since 1897 there has been in Hungary a chief inspector of museums and libraries. He has charge of a general catalogue of all the mss. and early printed books in Hungary.

After the war, the central bureau of public libraries organized exchange, distributing the literature received in this way from abroad. It also produces a general catalogue of accessions (which serves as a current national bibliography).

The library of the Benedictines at St. Martinsberg (11th century) is the central library of the order in Hungary, and contains nearly 170,000 vols. Its principal treasures were, on the secularization of the monasteries, distributed among the State libraries in Budapest.

Czechoslovakia.—The most considerable libraries in the Republic are the University library, Prague (1366:1773) with 591,245 vols., the National library at Prague (1918) with over 70,000 vols. and many State documents, and the Central library (1891) with 378,562 volumes.

During the 19th century, free libraries were founded by the clergy and school teachers, while the library periodical, *Česká Osvěta* (1904), helped to spread a knowledge of Anglo-American popular library methods. By this each community was to establish a public library, administered by special locally-elected bodies; a minimum library tax of 50, 60, 70 or 80 hellers (0.75d., 0.9d., 1.05d., or 1.2d.) per head is levied in towns of less than 5,000, 10,000 or 100,000, or of over 10,000 inhabitants respectively. All libraries thus established are controlled by the Ministry of Education, which issues statistics. In 1920 there were 3,343 libraries with 1,644,558 vols., 310,880 borrowers, 3,180,509 issues for home use, and a total income of 3,211,026 Czech crowns; in 1927 there were 15,355 libraries with 5,444,844 vols., 880,326 borrowers, 14,440,593 home issues, and income 16,275,308 Czech crowns. The average of readers to a library was 860, and one book to every two readers. The expenditure per head was 1.55 Czech crown (2.33d.) as against the sum of one Czech crown (1.5d.) laid down by the law of 1919.

Italy.—As the former centre of civilization, Italy is the home of the oldest libraries. The Vatican at Rome and the Laurentian at Florence are sufficient in themselves to give Italy primacy in respect of rare and valuable mss., and for antiquity there are the venerable relics at Vercelli, Monte Cassino and La Cava. The local rights which so long impeded the unification of Italy created and preserved many libraries which would have been lost under a Central State. Italy is still, in spite of war and collectors, rich in books. Official statistics of 1896 gave particulars of 1,831 libraries, of which 419 are provincial and communal. In 1893 there were 542 popular and circulating. A *Bollettino* for these *biblioteche popolari* was commenced in 1907, and a congress held at Rome in 1908.

Governmental Libraries.—Governmental libraries (*biblioteche governative*) are under the minister of public instruction. The pre-Fascist *Regolamento* controlling them was issued in the *Bollettino Ufficiale,* Dec. 5, 1907. They consisted of the national central libraries of Rome (Vittorio Emanuele) and Florence, of the national libraries of Milan (Braidense), Naples, Palermo, Turin and Venice (Marciana); the Biblioteca governativa at Cremona; the Marucelliana, the Mediceo-Laurenziana and the Riccardiana at Florence; the governativa at Lucca; the Estense at Modena; the Brancacciana and that of San Giacomo at Naples; the Palatina at Parma; the Angelica, the Casanatense, and the

Lancisiana at Rome; the university libraries of Bologna, Cagliari, Catania, Genoa, Messina, Modena, Naples, Padua, Pavia, Pisa, Rome and Sassari; the Ventimiliana (with the university library at Catania); the Vallicelliana and the musical library of the R. Acad. of St. Cecilia at Rome; the musical section of the Palatine at Parma; and the Lucchesi-Palli (added to the national library at Naples). The minister of public instruction is assisted by a technical board. Each library was to possess a general inventory, an accessions register, an alphabetical author-catalogue and a subject-catalogue. Catalogues of the special collections were next to be compiled. A general catalogue of the mss. was, in 1910, being issued together with catalogues of oriental codices and incunabula; books are chosen by the librarians in Government libraries, and in the university libraries partly by a professional council. The rules (*Boll. Ufficiale,* Sept. 17, 1908) allow lending to other countries under special circumstances.

The 36 *biblioteche governative* annually spent, in 1908, about 300,000 lire in books. Their accessions were 142,930; there were 1,176,934 readers. Out of 1,700 libraries confiscated from suppressed monasteries, containing two million and a half volumes, about 650 were added to public libraries already in existence; the remainder served to form new communal libraries.

The Fascist Government supervises, not only the libraries dependent upon it, but also communal, provincial, special and corporation libraries, by means of 12 *Sopraintendenze bibliografiche,* with headquarters at the chief libraries of each region, and inspectors in all library centres.

Two publications, the *Bollettino delle pubblicazioni italiane* and *Bollettino delle opere moderne straniere acquistate dalle biblioteche governative,* for many years issued from the national libraries of Florence and Rome respectively, take the place of a collective catalogue of accessions. The former is the current national bibliography.

The Vittorio Emanuele library at Rome acts as an information bureau, as it is especially well equipped with works of reference.

Vatican.—The Biblioteca Vaticana (now in the newly created Vatican State [1929]) stands in the very first rank among European libraries as regards antiquity and wealth of mss. We can trace it back to the earliest records of the *Scrinium Sedis Apostolicae,* kept first at the Lateran, and later on partly in the Turris Chartularia; but one, the doubtful survival, is the Codex Amiatinus now in the Laurentian library. There remains an inventory made under Boniface VIII. The library was moved to Avignon, where it was renewed and was increased, but this collection has only in part, and in later times, been taken into the Library of the Vatican. The latter is a new creation of the 15th century. Eugenius IV. planted the first seed, but Nicholas V. was the real founder of the library, to which Sixtus IV. consecrated an ornate abode, in the Court of the Pappagallo. Sixtus V. erected the present magnificent building in 1588, and greatly augmented the collection. The most noteworthy librarians were Marcello Cervini (the first *Cardinale Bibliotecario,* later Pope Marcel II.), Sirleto and A. Carafa. In 1600 it was further enriched by the acquisition of the library of Fulvio Orsini. Pope Paul V. (1605–21) separated the library from the archives and added the two "Pauline" halls, for the new codices. Under him and under Urban VIII. many mss. were purchased from the Convent of Assisi, the Minerva at Rome, the Capranica college, and above all the Rossano, of Bobbio (*q.v.* above, under "Mediaeval Period"). Gregory XV. (1622) received from Maximilian I., duke of Bavaria, the valuable library of the Elector Palatine, seized by Count Tilly at the capture of Heidelberg. Alexander VII. (1658) added the mss. of the dukes of Urbino. The *Libreria della Regina, i.e.,* of Christina of Sweden, of ancient mss., some from French monasteries, from St. Gall and elsewhere, and others of importance for French literature from the collection of Petau, was in great part presented by Alexander VIII. in 1689. Under Clement XI. were purchased 54 Greek mss. which had belonged to Pius II., and also oriental mss. Under Benedict XIV. was bequeathed the Capponi library, rich in Italian books; and by purchase, the Biblioteca Ottoboniana, which, in Greek, Latin and Hebrew mss. was, after the Vatican, the richest in Rome. Clement XIII. in 1758, Clement XIV. in 1769, and Pius VI. in 1775, were also benefactors. After three centuries of uninterrupted growth the Vaticana was to undergo a severe blow. In 1798, after the Treaty of Tolentino, 500 picked mss. were sent to Paris. These, however, were chiefly restored in 1815, though most of the Palatine mss. found their way back, not to Rome, but to Heidelberg. Pius VII. acquired the library of Cardinal Zelada in 1800, and among important purchases of the 19th century were the splendid Cicognara (archaeology and art, 1823); Cardinal Mai, 40,000 vols. (1856), some 300 Borghese mss. from the papal library of Avignon, the Barberini library and the Borgia collection, *De Propaganda Fide.*

The printed books in the Vaticana number some 350,000, the mss. about 53,000, and the incunabula about 6,000 with many vellum copies; 500 Aldines and a great number of bibliographical rarities, including very many presentation copies. Among the Greek and Latin mss. are some of the most ancient and valuable in the world; *e.g.,* the famous biblical *Codex Vaticanus* of the 4th century, the two Virgils of the 4th and 5th centuries, the Bembo Terence, and the palimpsest *De Republica* of Cicero.

Many important catalogues of special classes of mss. and important single volumes have been published in facsimile. A new catalogue of the printed books was made in 1927–29 to make easily available the library's rich treasures. This catalogue, made possible by the aid of the Carnegie Endowment, was worked out mainly according to the code of the American Library Association by four Vatican librarians and four American librarians.

Other Roman Libraries.—The most important library in Italy for modern requirements is the Nazionale Centrale Vittorio Emanuele (1875) (495,000 vols., 300,000 pamphlets and 5,223 mss.). This contains the *biblioteca maior o secreta* of the Jesuit college of Rome and the cloister libraries of the Provincia Romana, and has the right to copies of new Italian books. Noteworthy among the mss. are the Farfensi and the Sessoriani of Santa Croce in Jerusalem, some of these last being of the 6th to the 8th centuries. The library was reorganized in 1910. It is rich in the renaissance, in Roman topography, and generally in books of reference and in journals. A monthly *Bollettino* is issued of modern foreign literature received by the libraries of Italy. The library acts as the central bureau of bibliographical information for Italy.

The Biblioteca Casanatense, founded by Cardinal Casanate in 1698 (131,778 printed vols., 2,086 incunabula, with many Roman and Venetian editions, and 6,124 mss., some of the 8th–10th centuries), is rich in theology, mediaeval history, law and the social sciences. An incomplete catalogue of the printed books by A. Audiffredi (1761–88) still remains a model.

The Biblioteca Angelica, founded in 1614 by Angelo Rocca (120,000 printed vols. and 3,000 mss.) was the first library in Rome to be opened to the public. The library of the University of Rome is the Alessandrina, founded by Alexander VII. in 1661, with the greater part of the printed books belonging to the dukes of Urbino, and opened in 1676. In 1815 Pius VII. granted to it the right to receive a copy of every book printed in the States of the Church, which grant was continued by Italian law but limited to the province of Rome. The library possesses 200,000 printed books.

The library of the Senate, established at Turin in 1848, contains 130,289 vols. rich in the history and statutes of Italian cities. That of the Chamber of Deputies (1848) contains 250,000 vols., and specializes in more modern history, law and politics. The Vallicelliana (1581), controlled by the R. Societá Romana di Storia Patria has some important mss., including one attributed to Alcuin; the Lancisiana (1711), is valuable for its medical collections; the Accademia di San Luca possesses a good art library; the Biblioteca Militare Centrale (1893) has 100,000 printed vols. and 72,000 maps; and the Biblioteca della R. Accad. di S. Cecilia (1875), a musical collection of 150,000 vols. and 6,000 mss.; the Corsiniana, founded by Clement XII., is rich in incunabula and prints, and, since 1884, belongs to the Accademia dei Lincei. The Deutsches Institut, École Française and British and American Schools, and the International Institute of Agriculture may be mentioned. All these and many other Roman libraries are open, at least to advanced students.

Subiaco.—At Subiaco, about 40 m. from Rome, the Benedictine monastery of Santa Scolastica has only 6,000 printed vols. and 400 mss., but it is remarkable as having been, in 1465, the first seat of typography in Italy, and students may inspect the series of Sweynheim and Pannartz's original editions preserved in their first home.

Florence.—The Biblioteca Nazionale Centrale of Florence, formed from the union of Magliabechi's library with the Palatina, is the largest after the Vittorio Emanuele at Rome. The Magliabechiana became public in 1714, and in 1861 Palatina (formed by Ferdinand III., grand duke of Tuscany), was joined with it. It had long had a right to a copy of every work printed in Tuscany, a right maintained more rigorously since 1860. Since 1870 the Nazionale receives, by law, a copy of every book published in the kingdom. Its monthly *Bollettino* is the current bibliography of the national literature. The mss. include the most important extant *codici* of Dante and later Italian poets and historians. The Galileo collection numbers 308 mss. Of the 25 mss. portolani, the oldest is dated 1417, and several seem to be the original charts executed for Sir Robert Dudley (duke of Northumberland) in the preparation of his *Arcano del Mare.* Amongst the early printed books is a great number of 16th century *Rappresentazioni,* books printed on vellum, municipal histories and statutes, *testi di lingua* and maps. The library contains 750,000 printed vols., 22,207 mss., and 3,601 incunabula, besides prints and maps. A new building was completed on the Corso dei Tintori in 1929.

Milan.—The Biblioteca Nazionale of Milan, better known as the Braidense, founded in 1770 by Maria Theresa, has 500,000 printed vols., 2,000 mss., 2,500 incunabula and 913 Aldines. Amongst the mss. are letters of Galileo, poems in Tasso's autograph, and a fine series of Italian illuminated service-books, 12th to 16th centuries.

Naples.—The Biblioteca Nazionale at Naples (founded in 1734 and opened in 1804) is the largest library of that city, and has recently been splendidly re-housed. To the collection of Cardinal Seripando were added, especially in 1848 and 1860, many private and conventual libraries. The biblical section is rich. Other features are the collections of *testi di lingua,* and of books on volcanoes, the best in existence of the publications of Italian learned societies and a nearly complete set of the Bodoni press. The mss. include many illuminated books, the autographs of Leopardi, and portolani. The library contains about 1,000,000 printed vols., 11,868 mss. and 4,625 incunabula. Annexed to it is the Officina dei Papiri Ercolanesi.

The Biblioteca Nazionale of Palermo, founded from the Jesuits' libraries, is rich in 15th century books (catalogue printed in 1875), in Aldines, and Sicilian 16th century books, many being unique. The library contains 283,227 printed volumes.

Turin.—The Biblioteca Nazionale Universitaria of Turin took its origin in the private library of the House of Savoy, given in 1720 to the university by Vittorio Amedeo II. The fire of 1904 destroyed about 24,000 out of 300,000 vols., and of the 4,138 mss. there survive but 1,500, and those in a damaged condition. Among those that perished were the palimpsests of Cicero, Cassidorus, the Codex Theodosianus and the famous *Livre d'Heures.* The 1,095 incunabula escaped. Since the fire the library has been enriched by new gifts, notably Baron A. Lumbroso's of 30,000 vols., principally on the French Revolution and Empire. The library was, in 1910, transferred to the premises of the Palazzo of the Debito Pubblico.

Venice.—The Biblioteca Marciana, or library of St. Mark, at Venice, was traditionally founded in 1362 by Petrarch's gift of mss. (all now lost) and opened by Cardinal Bessarione in 1468. It has 330,000 printed books, 12,106 mss. of great value (more than 1,000 Greek codices given by Bessarione), collections on Venetian history, music and theatre, and on early geographical research, a codex of the laws of the Lombards, and the autograph ms. of Sarpi's *History of the Council of Trent.* Since the fall of the republic and the suppression of the monasteries, many private and conventual libraries have been incorporated first in the Libreria del Sansovino, from which the library was transferred in 1812 to the Palazzo Ducale, and in 1904 to the Palazzo della Zecca (the Mint).

University Libraries.—Among the university libraries under Government control some deserve special notice. First in historical importance comes that of Bologna, founded by U. Aldrovandi (1605). Count Luigi F. Marsili in 1712 increased the library and established an Instituto delle Scienze, reconstituted as a public library by Benedict XIV. in 1756. The printed books number 214,991 vols., and the mss. 5,400, the oriental being noteworthy. The grand hall, with its fine furniture in walnut wood, merits particular attention. The Biblioteca della Universita at Naples, established by Joachim Murat in 1812 in the buildings of Monte Oliveto, and thence sometimes called the "Biblioteca Gioacchimo," was transferred to the Royal university and opened in 1827. It is strongest in medicine and science; its chief mss. and early printed books were transferred about the middle of the 19th century to the Nazionale. Other important university libraries are those of Catania (1755); Genoa (1773); Pavia (1763); Padua (1629) (314,000 vols.), which in 1910 was housed in a new building; Cagliari and Sassari. Messina was destroyed in the earthquake of 1908, but the more important part of the furniture was saved, and by 1910 the library was already restored to active work.

Chief among the remaining Government libraries comes the world-famed Biblioteca Mediceo Laurenziana at Florence, formed from the collections of Cosimo the Elder, Pietro de' Medici, and Lorenzo the Magnificent. It was made public by Clement VII., who charged Michelangelo to construct a suitable edifice for its reception. Opened by Cosimo I. in 1571, it has steadily grown. The accessions in the 18th century alone were enough to double it. Its printed books number probably only 11,000, and though almost all of the highest rarity and interest, the 10,017 mss. give its chief importance to this library. More than 700 are earlier than the 11th century. Some of them are the most valuable codices in the world—the famous Virgil of the 4th or 5th century, Justinian's *Pandects* of the 6th, a Homer of the 10th, and several other very early Greek and Latin classical and biblical texts, as well as copies in the handwriting of Petrarch, about 100 codices of Dante, a *Decameron* copied by a contemporary from Boccaccio's own ms., and Benvenuto Cellini's ms. of his autobiography. Administered with the Laurentian is the Riccardiana, rich in mss. of Italian, and especially the Florentine literature. The Biblioteca Marucelliana (founded 1703, opened 1753) is remarkable for its early woodcuts and engravings; the printed volumes number 310,000 and the mss. 2,000.

Modena.—At Modena is the Biblioteca Estense, founded by the Este family at Ferrara in 1393; it was transferred to Modena by Cesare D'Este in 1598. Muratori, Zaccaria and Tiraboschi were librarians here. The printed vols. number 151,057, the incunabula 1,600, the mss. 8,567, besides the 4,958 mss. and the 100,000 autographs of the Campori collection.

The oldest library at Naples is the Brancacciana, founded in 1647 by Cardinal F. M. Brancaccio, and opened by his heirs in 1675. The Regia Biblioteca di Parma was founded definitely in 1779 by the grand-duke Philip, who employed Paciaudi to organize it. It contains 323,208 vols. and 5,290 mss., including De Rossi's biblical and rabbinical mss. Also worthy of note are the Bibl. Pubblica or governativa of Lucca, and that of Cremona.

The Ambrosiana.—Among the great libraries not under Government control, the most important is the Ambrosiana at Milan, founded in 1609 by Cardinal Fed. Borromeo. It contains 400,000 printed vols., 3,000 incunabula and 10,000 mss. Amongst the mss. are a Greek Pentateuch of the 5th century, the famous Peshito and Syro-Hexaplar, a Josephus on papyrus, supposed to be of the 5th century, several palimpsest texts, and a 7th century copy of St. Jerome's commentary on the Psalms, full of contemporary glosses in Irish, Gothic fragments of Ulfilas, and a Virgil with notes in Petrarch's handwriting. Cardinal Mai and Pope Pius XI. were former custodians here. At Genoa the Biblioteca Franzoniana (40,000 vols.), founded about 1770 for the instruction of the poorer classes, is noteworthy as being the first European library lighted up at night for the use of readers.

Monte Cassino.—The monastery of Monte Cassino (529) is due to St. Benedict, and is the prototype of all Western religious houses. The library now extends to about 70,000 vols., and that belonging to the monks contains about the same number. But the chief glory of Monte Cassino consists of the *archivio*, which is quite apart; and this includes more than 30,000 bulls, diplomas, charters and other documents, besides 1,000 mss. dating from the 6th century downwards. There are good written catalogues, and descriptions with extracts are published in the *Bibliotheca Casinensis*. The monastery was declared a national monument in 1866. At Ravenna the Biblioteca Classense has a 10th century codex of Aristophanes. At Vercelli the Biblioteca dell' Archivio Capitolare comprises nothing but mss., all of great antiquity and value, amongst them an Evangeliarium S. Eusebii, supposed to be of the 4th century; also a famous codex of Anglo-Saxon homilies.

La Cava.—The Monastero della S. Trinità, at La Cava dei Tirreni, in the province of Salerno (beginning of the 11th century), has only some 10,000 vols., but these include mss. from the 8th to the 14th century, amongst them a Codex Legum Longobardorum, dated 1004, besides a well-known geographical chart of the 12th century, over 100 Greek mss., and about 1,000 charters beginning with the year 840, more than 200 of which belong to the Lombard and Norman periods. The library is now national property, the abbot holding the office of keeper of the archives.

Not a few of the communal and municipal libraries are of great extent and interest: Bologna (1801); Brescia, Civica Quiriniana (1747); Ferrara (1753); Macerata, the Mozzi-Borgetti (1783–1835, united 1855); Mantua; Novara, Negroni e Civica (1847 and 1890); Padua; Palermo (1760); Perugia (1852), founded by P. Podiani; Siena (1758), founded by S. Bandini, fine art collection; Venice, Museo Civico Correr (1830); Verona (1792, public since 1802); Bertoliana (1708). Italian librarians are organized and there is a school for professional training in the Archiginnasio at Bologna.

Spain and Portugal.—Most of the royal, State and university libraries of Spain and Portugal have Government control and support.

The chief library in Spain is the Biblioteca Nacional (formerly Real) at Madrid (1716), with 1,210,520 printed books, including 2,412 incunabula, 30,172 mss. and 120,000 prints. Theology, canon law, history, etc., are very complete. The collection of prints was principally bought from Don Valentin Carderera in 1865. Other Madrid libraries are Biblioteca de la Real Academia de la Historia, 1738 (50,000 vols., and 8,400 mss.), which contains Spanish books of great value, including the Salazar collection. In 1808, the year the Escorial contained approximately 30,000 printed vols. and 3,400 mss., Joseph removed the collection to Madrid, but when it was returned by Ferdinand 10,000 vols. were missing. There are now about 40,000 printed volumes. The Biblioteca Provincial y Universitaria of Barcelona (1841) contains about 100,000 vols., and that of Seville (1767) has 110,000 volumes. Among other provincial and university libraries is that of Salamanca (1254).

Among the libraries of Portugal the Biblioteca Nacional at Lisbon (1796) naturally takes the first place. In 1841 it was largely increased from the monastic collections, and now has 800,000 vols. of printed books, largely on theology, canon law, history and Portuguese and Spanish literature, 16,000 mss., and 40,000 coins and medals. The Academia das Sciencias (1779), in the suppressed convent of the Ordem Terceira da Penitencia, in 1836 acquired the library of that convent (30,000 vols.) which has since been kept apart. The Archivo Nacional was brought here in 1749.

The Biblioteca Publica Municipal at Oporto, founded during the siege of 1833, and till 1874 styled the Real Biblioteca do Porto, is one of the largest in Portugal (about 300,000 vols.). The regent gave to the town the libraries of the suppressed convents in the northern provinces. The important Camoens collection is described in a printed catalogue (1880), and the mss. by H. da Cunha Rivara (1850–70). The University Library of Coimbra (1591) 300,000 vols., the Instituto Juridico, Coimbra (1912) 53,000 vols., and the Biblioteca Provincial, Cadiz 40,000 vols., may be mentioned.

Much interest in libraries has not been shown in Latin America. Most of the libraries which exist are national or legislative libraries.

Cuba.—The chief are in Havana, and the best is the Biblioteca Nacional (1901), 256,000 vols., the Biblioteca Publica. The Biblioteca Publica is one of the most actively-managed libraries in Latin America.

Mexico.—Of the 29 States the territories of the Mexican republic, many possess rare and valuable books from the libraries of the suppressed religious bodies, but few have much modern literature. Many scientific and literary associations in the republic possess books. The Society of Geography and Statistics in Mexico City (founded 1833, reorganized 1851), the most important of them, owns a fine museum and library. The ecclesiastical libraries of Mexico City were amalgamated as the Biblioteca Nacional; this now possesses over 200,000 volumes. Two copies of every book printed in Mexico must be deposited in it. Most of the libraries of Mexico, city or provincial, are subscription, and belong to societies and schools of various kinds. The American Library Association is spreading Anglo-American library technique in Mexico, and also in the Philippines.

Argentina.—There are more than 200 public libraries in Argentina. They are due to benefactions, but the Government adds an equal sum to endowments. A central commission exists to facilitate the acquisition of books and to secure good administration. The most considerable is the Biblioteca Nacional at Buenos Aires (1810), which is passably rich in mss. concerning the early history of the Spanish colonies and has 350,000 printed volumes. The Biblioteca Popular del Municipio (1879) has about 80,000 volumes. There are also libraries attached to colleges, churches and clubs.

Brazil, Chile and Peru.—The chief library in Brazil is the Biblioteca Nacional at Rio de Janeiro (1810), now comprising over 488,000 printed vols., with many mss., largely on South America. Other libraries of the capital are those of the Faculty of Medicine, Marine library, National museum, Portuguese Literary club, Biblioteca Fluminense, Benedictine monastery, and the Biblioteca Municipal (60,000 vols.). There are provincial and town libraries throughout Brazil.

The Biblioteca Nacional at Santiago (1813) is the chief library in Chile. It possesses about 232,000 volumes. There is also a university library at Santiago (40,000 vols.) and the Biblioteca Publica at Valparaiso (50,000 vols.).

The Biblioteca Nacional at Lima was founded by a decree of the liberator, San Martin, in 1820, from those of the university of San Marcos and of several monasteries, and books presented by the liberator; it is rich in the history of Peru.

Netherlands.—Since 1900 there has been considerable progress made in both Belgium and Holland in the development of public libraries, and many towns in the latter country have established popular libraries after the fashion of the municipal libraries of the United Kingdom and America.

Belgium.—The national library of Belgium is the Bibliothèque Royale at Brussels, based on the Bibliothèque des ducs de Bourgogne, the library of the Austrian sovereigns of the Low Countries in 1772. In 1794 a number of volumes were transferred to Paris, the majority being returned in 1815; in 1795 the remainder were formed into a public library under the care of La Serna Santander, who was also town librarian, and who was followed by van Hulthem. At the end of the administration of van Hulthem a large part of the precious collections of the Bollandists was acquired. In 1830 the Bibliothèque de Bourgogne was added to the State archives. Van Hulthem died in 1832; his private library (catalogue printed 1836), mostly relating to Belgian history, was purchased in 1837, and, having been added to the Bibliothèque de Bourgogne and the Bibliothèque de la Ville (open since 1794), formed the Bibliothèque Royale de Belgique. The printed volumes now number over 800,000, with 31,200 mss., 34,600 maps, 1,267,700 prints and 80,000 coins and medals. There are printed catalogues of special collections of mss., of accessions, etc. There is no free legal deposit of books in Belgium; the Government purchases new books from the publishers and deposits them in the

Royal library. The financial crisis after 1918 led to proposals, by a governmental committee of economics, to divide the foreign accessions of the library among those of various ministries; but in 1928 the scheme had been severely animadverted on and seemed unlikely to be pressed. There are libraries attached to most of the departments of the Government. Other important libraries are the Bibliothèque Collective des Sociétés Savantes (1906), with a union catalogue on cards, and the Bibliothèque du Conservatoire Royal de Musique (1832) with 31,000 volumes. The popular or communal libraries of Brussels (1842) and of the suburbs are distributed through the schools. At Antwerp the town library (1505) has now 500,000 volumes. The valuable collection of books in the Musée Plantin-Moretus (1640) should also be mentioned. It contains 427 mss. and 20,000 printed books, comprising the works issued by the Plantin family and many 15th century books, besides the archives of the firm.

The university library of Ghent (declared public in 1797, opened in 1798), was known successively as the Bibliothèque de l'École Centrale and Bibliothèque Publique de la Ville. On the foundation of the university in 1817 the town placed the collection at its disposal, but it has since remained under State control. The printed volumes now amount to 450,000 and the mss. to 2,650. The Bibliothèque de l'Université Catholique of Louvain (1636) is based upon the collections of Beyerlinck, bequeathed in 1627, and of Jacques Romain, professor of medicine. There were over 211,000 vols. in 1914, when the library was totally destroyed by fire at the German occupation. On the foundation of the University of Liége (1817) the old Bibliothèque de la Ville was added to its library (now 454,000 printed vols., 184,500 pamphlets, and 2,140 mss.). The Liége collection, bequeathed by M. Ulysse Capitaine and the Bibliothèques Populaires of Liége (1862), are circulated among the school children. The Bibliothèque publique of Bruges (1798) contains 145,000 printed books and mss. housed in the old Tonlieu (1477). Every town has a communal library, mostly small and open only part of the day; the chief are those of Alost, Arlon (1842), Ath (1842), Courtrai, Malines (1864), Mons (1797), Namur (1800), Ostend (1861) and Tournai (1794, housed in the Hotel des Anciens Prêtres, 1755); those of Ypres and other towns in the war area were destroyed in 1914–18. A complete list will be found in the *Annuaire de la Belgique scientifique, artistique et litteraire* (1908).

By a law of Oct. 17, 1921, communes may singly or in conjunction establish public libraries, and if complying with certain conditions receive State subsidies.

The "Union des villes et communes belges" at Brussels is planning a national scheme of federation and mutual lending between public libraries; and similar associations at Louvain, Antwerp, Bruges, Ermeton, near Namur (for the Walloon districts) are similarly engaged. Rural circulating libraries are brought by the law of 1921 under the same control as those of the communes. (*See* J. van Meel, *Bibliothèques publiques,* 192.)

Holland.—Information on Dutch libraries can be obtained from J. D. C. von Dukkum and G. A. Evers, *Nederlandsche Bibliotheekgids,* 2nd ed., 1924.

The national library of Holland is the Koninklijke Bibliotheek at The Hague (1798). The library of the princes of Orange was then united with those of the defunct Government bodies to form the national Bibliotheek. In 1805 the present name was adopted; and since 1815 it has become the national library. In 1848 the Baron W. Y. H. van Westreenen van Tiellandt bequeathed his library and antiquities to be preserved in his former residence as a branch of the royal library. There are now about one million printed books and over 6,000 mss. Books are lent all over the country. The library is the richest in the world in books on chess, Dutch incunabula, Elzevirs and in Spinozana. In 1800–11 a printed catalogue was issued, and since 1866 a yearly list of additions.

The next largest library is that of the Academia Lugduno-Batavia, which dates from the foundation of the University of Leyden in 1575. Valuable additions include those from the libraries of Golius, Joseph Scaliger, Isaac Voss, Ruhnken and Hemsterhuis. The library of the Society of Netherland Literature, placed here in 1877, Legatum Warnerianum of oriental mss., and the collection of maps bequeathed in 1870 by J. J. Bodel Nyenhuis, are noteworthy. Published catalogues are: books and mss., 1716; supplements of books added in 1814–47, and of mss., 1850; and oriental mss., 1851–77. The Bibliotheek der Rijks Universiteit (1575) at Leyden contains about 800,000 vols. and 3,400 oriental mss., many of value.

The University library at Utrecht (292,500 vols.) is based on conventual collections brought together in 1581. The public library thus formed was soon enriched by books bequeathed by Hub. Buchelius and Ev. Pollio, and was transferred to the university on its foundation in 1636. Among the mss. is the famous "Utrecht Psalter," which contains the oldest text of the Athanasian creed. Printed catalogues are of printed books of 1834 (supplement 1845, index from 1845–55, and additions 1856–1870), and of mss., 1887. Titles of accessions are printed.

The University library at Amsterdam is based on a 15th century collection. Since 1877 the collection has been known as the University library, and in 1881 it was removed to a building modelled on the British Museum library. It includes the best mediaeval collection in Holland, and the Bibliotheca Rosenthaliana of Hebraica (30,000 vols., catalogue 1875). The libraries of the Dutch Geographical and other societies are preserved here. The library contains about 800,000 volumes. There are popular subscription libraries with reading-rooms in all parts of Holland, and in Rotterdam there is a society for the encouragement of social culture which has a large library. At The Hague, Leyden, Haarlem, Dordrecht and other towns popular libraries have been established, but ecclesiastical divisions hamper free development. Dutch librarians are organized in a professional body.

The library of the Genootschap van Kunsten en Wetenschappen at Batavia contains books printed in Netherlandish India, or relating to the Indian archipelago.

Denmark.—Owing largely to so many Scandinavian librarians having been trained and employed in American libraries, a greater approach has been made to Anglo-American library ideals in Norway, Sweden and Denmark than anywhere else on the continent of Europe.

A survey of 384 Danish libraries in 1915 (*Dansk Biblioteksfoerer*) was published by Svend Dahl; and a statistical list of popular libraries appears yearly in *Bogens Verden.*

The beginning of the national library, the great Royal library (Kongelige Bibliothek) at Copenhagen may be credited to Christian III. (1533–59); but to Frederick III. (1648–70) is mainly due the collection of Icelandic literature and the acquisition of Tycho Brahe's mss., and also the present building (in the Christiansborg castle), begun in 1667. In 1793 the library was opened as the national library. Two copies of every book published in Denmark must be deposited here. The incunabula and block books form an important series. In foreign literature it specializes in the humanities. There are printed catalogues of the de Thott collection (1789–95); French mss., Oriental mss. (1846); the Danish collection (1875), etc. There are now 850,000 printed books and 30,000 mss. The Royal library has nearly completed publication of *Bibliotheca Danica,* a bibliography of Danish books, 1482–1830.

The University library (1482), destroyed by fire in 1728, but soon re-established, receives, since 1894, a copy of every Danish publication, and has 430,000 vols. and 7,000 mss., including the Arne-Magnean collection, specializing in the natural sciences. The Statsbiblioteket of Aarhus (1894) possesses about 270,000 vols. and the Landsbokasafn Islands (National library) of Reykjavik, Iceland, about 118,000 printed books and 7,830 Icelandic mss. A State library commission supervises the State-supported libraries. An association for promoting public libraries was formed in 1905, and in 1909 the minister of public instruction appointed a special adviser.

Modern developments show, perhaps more clearly than elsewhere in Europe, a tendency to co-ordinate all the libraries.

Norway.—The Norsk Bibliotekforening in 1924 published a statistical account of 266 libraries (*Handbok over norske Biblioteker*).

The chief library in Norway is the University library at Oslo (Christiania), founded in 1811 by Frederick VI., with a large donation of duplicates from the Royal Library at Copenhagen. There are now over 700,000 vols. in the collection. The Deichmanske Bibliotek at Oslo was founded by Carl Deichmann in 1780 as a free library, and is maintained by endowments and by the city. It now contains about 195,000 volumes. The Free library at Bergen (1874) has 163,758 vols. and has been re-housed. The Kongelige Norske Videnskabers Selskab at Trondhjem has also a large library.

Sweden and Finland.—Swedish libraries were surveyed in 1924 in Einar Sundstrom's *Svenska Bibliotek.*

The first Royal library at Stockholm, established in 1585, was given to the University of Uppsala by Gustavus II. Charles X.'s library was burned in 1697, and the present library was organized shortly afterwards. The Benzelstjerna-Engestrom library (rich in Swedish history) is now annexed to it. Natural history, medicine and mathematics are left to other libraries. Among the mss. the *Codex Aureus* of the 6th or 7th century, with an Anglo-Saxon inscription, is noteworthy. The library contained, in 1924, 460,000 printed books and over 12,000 mss. The Karolinska Institutet, in Stockholm, contains a library of medical books numbering over 60,000.

The University library at Uppsala was founded as mentioned above by Gustavus Adolphus in 1620, from the remains of convent libraries, and endowed. The mss. chiefly relate to the history of the country, but include the *Codex Argenteus* of the Gothic gospels of Ulfilas, published in facsimile by the library in 1928. Printed catalogues are: general (1814), foreign accession lists (annually from 1850), and Arabic, Turkish and Persian mss. (1846). The library now contains about 600,000 printed books and mss. The University library at Lund (1668) was based upon the old cathedral library. The mss. include the de la Gardie archives, acquired in 1848. There are about 145,385 vols. in the library. The Stadsbibliotek of Gothenburg (1890) contains about 240,000 vols., and has a printed catalogue.

Finland has the University library of Helsingfors (1640–1827), about 500,000 vols., and the parliamentary library (1872), 58,500 volumes.

Russia.—The Gosudarstvennaya Publichnaya Biblioteka at Leningrad, formerly the Imperial public library at St. Petersburg, the State library of the Union of Soviet Socialist Republics, is perhaps the largest library in the world. In 1910 it had about 1,800,000 printed vols. and 34,000 mss., as well as large collections of maps, autographs, photographs, etc. It is now said to contain 4,566,645 printed books and 240,000 mss., and autographs. It originated in the books seized by Peter the Great in Courland in 1714; the library, however, only attained to the first rank in 1795, by the acquisition of the famous Zaluski collection. The Zaluski library was formed by the Polish count, Joseph Zaluski, who collected 200,000 vols., added to by his brother Andrew, bishop of Cracow. At his death it was left to the Jesuit college at Warsaw; on the suppression of the order it was taken by the Commission of Education; and in 1795 it was transferred by Suvarov to St. Petersburg as a trophy of war. It then had 260,000 printed vols. and 10,000 mss., but in consequence of the dispersal of many works among other institutions, hardly 238,000 vols. remained in 1810. After the World War the Zaluski collection was returned to Poland. By a law passed in 1810 two copies of every Russian publication must be deposited in the library. Very many valuable special collections have been added, such as the Tolstoy Slavonic collection (1830), Tischendorf's mss. (1858), the Dolgorousky oriental mss. (1859), and the Firkowitsch Hebrew (Karaite) collection (1862–63), and the national mss. of Karamzin (1867). Some departments are thus exceedingly rich, while others are comparatively meagre.

The glory of the mss. is the *Codex Sinaiticus* of the Greek Bible, brought from the convent of St. Catherine on Mount Sinai by Tischendorf in 1859. Other important biblical and patristic codices are to be found among the Greek and Latin mss.; the Hebrew mss. include some of the oldest extant, and the Samaritan collection is one of the largest; the oriental mss., and the French mss. (notably the historical) are of great value. The Biblioteka Vsemirnoj Literatury (1919) has about 90,000 and the University library (1925) 711,000 volumes.

The library at the Hermitage was founded by the empress Catherine II.'s purchase of Voltaire's and Diderot's books and mss. In 1861 it possessed 150,000 vols., of which nearly all but those on the history of art were then transferred to the Imperial library. There are many large and valuable libraries attached to the Government departments in Leningrad, and most of the academies and colleges and learned societies are provided with libraries. The national library published in 1928 material for a directory of the learned libraries of the city.

The second largest library in Russia is the Lenin Memorial Library in Moscow (formerly Rumyantzov Museum collection, renamed after Lenin's death in 1924). It has over three million volumes, is rich in early printed books, Russian history, and mss. The latter number 5,000, including many ancient Slavonic codices, historical documents and the archives of the masonic lodges in Russia between 1816 and 1821; catalogues of the mss. and of some special collections are printed. The University at Moscow (1755) has a library of over 310,000 vols., and the Duchovnaja academy has 120,000 volumes. The (formerly Imperial) Russian Historical museum (1875–83) in Moscow contains nearly 200,000 volumes. Among Russian university libraries mention may be made of Kazan (1804), Kharkov (1805), Kiev (1832) and Odessa (1865). There are also communal or public libraries at Kharkov (1886), Odessa (1830) in the Ukraine, and many other towns. The Soviet Government has established many popular libraries. The Lenin Institute of Library Science at Moscow trains librarians and has published text-books.

Poland.—The Jagiellonska library at Cracow (1400) 524,000 vols. and 6,711 mss., at present serves as national library for Poland. As the headquarters of the Government is at Warsaw, however, it is now debated whether all publications concerning Poland should be housed in the National Library there (1917) 91,532 vols., or whether they should be divided between the two cities. It is suggested that the Jagiellonska library be made into a historical collection containing books to the year 1918, the date of the reconstitution of the Polish State, and that the Warsaw library be confined to accessions since that date, and organized on the lines of the Deutsche Bücherei at Leipzig. A bibliographical institute will be attached to the Warsaw collection and will disseminate information through a special bureau, the functions of which are at present fulfilled by the Jagiellonska and by the Warsaw section of the libraries of the Ministry of Public Instruction. The National Library at Warsaw has also been enriched by the famous Zaluski collection, described in the paragraph on Russian libraries. The Warsaw university library (1817) has 730,000 volumes. Besides the Cracow and Warsaw libraries, that of Posen (formerly Kaiser Wilhelm Bibliothek) may be mentioned. Lemberg (Lwow) has three noteworthy collections housed in the University library, the Ossolinsky library and Museum and the Bavorovsky library. Chwalewik's *Les Collections polonaises* (2 vols.) gives a complete list of Polish libraries, and 427 libraries are listed in the Mianowski Foundations Year Book (1927), pp. 162–221. There is no general catalogue, but its place is taken at present by Charles Estreicher's *Bibliografia Polska* (1870–). The Lett city of Vilna also has a public library (1856).

Elsewhere in Eastern Europe.—Latvia has the city and university libraries of Riga (with 375,000 and 60,000 vols.). Estonia has the university library of Tarfu (Dorpat 1806) with 270,000 vols., and the city library of Tallinn.

The university libraries of Belgrade and Sofia (1888), 192,039 vols., and the national library at Sofia (1924), over 200,000 printed books and 5,500 mss., are the chief in the Balkans. There is a Bulgarian State Library Commission, which organizes local libraries and trains librarians.

At Athens the national library (1842) possesses about 400,000 vols., 3,800 mss., and 200,000 historical documents.

Constantinople has a National library (1925) and a public library, the Oumoumiye, of about 300,000 volumes. There are over 120,000 vols. in the University library (1910), and there are also libraries at the Greek literary society and the Theological school. The mosque of St. Sophia contains a library of some thousands of mss., of which a printed catalogue is obtainable, consisting mostly of Korans and service books. The old Seraglio contains many important books.

THE FAR EAST

China.—The earliest notice of a library in China is that of the imperial Chou dynasty whose capital was at Loyang in the modern province of Honan. According to a tradition preserved in Ssu-ma Ch'ien's "Historical Record" the philosopher Lao-tse, who lived in the seventh century before Christ, was keeper of books in this library. National collections of books in the modern sense, however, originated with the attempts made to recover the books scattered or destroyed by the so-called "First Emperor" in 220 B.C. Hence the earliest catalogue of Chinese books is preserved in the "History of the Former Han Dynasty" (206 B.C.–23 A.D.) and written in the first century of our era. The histories of nearly all succeeding dynasties have likewise left catalogues of books preserved in their libraries or known to their times. After the invention of printing in China private libraries became increasingly numerous. From time to time these were destroyed or dispersed, but catalogues of many of them remain. There are still some fourteen large private libraries in various parts of China some of which contain as many as two hundred thousand volumes.

According to a survey made by the Library Association of China in 1927 there were then 503 public and private libraries in China proper and Manchuria. Of this total the province of Kiangsu has 145; the city of Shanghai 60, Peking 42, and Nanking 20. The largest single collection of books is found in the Metropolitan Library, Peking. Each provincial capital also has its own library. The following universities boast large and rapidly growing collections of both Chinese and western books: Peking National University, Sun Yat Sen University (Canton), Tsinghua University (Peking), Yenching University (Peking), Amoy University, and Nanking University. The most common classification of books in Chinese libraries—the so-called *Ssu K'u* system which has been in vogue for fifteen centuries—divides all Chinese literature into four classes: classics, history, philosophy, and belles lettres. A few of the modern Chinese libraries have discarded this system entirely, but most of them combine with it a modified Dewey or Library of Congress classification. (*See* the files of the Library Science Quarterly, *T'u Shu Kuan Hsüeh Chi K'an,* the official organ of the Library Association of China which was founded in 1925.)

Japan.—The ancient history of libraries in Japan is analogous to that of China.

Perhaps the most extensive library of the empire is that of the Imperial Cabinet (1885) at Tokyo with 507,600 vols., consisting of the collections of various Government departments.

The Imperial library at Uyeno Park (1872) contains 387,208 vols., of which some 297,000 are in Japanese or Chinese. At Tokyo there is also the Ohashi library (1902), 81,154 vols., the Hibiya library (1908), 153,000 vols., and the Nanki library (1899), 87,000 vols. The library of the Imperial University of Kyoto (1899) contains nearly 650,000 vols., of which a large proportion are in European languages. Kyoto and other towns have considerable municipal libraries. Kasan in Korea has a library (1804) of about 250,000 vols.

LIBRARY ASSOCIATIONS AND TRAINING

The first and largest association established for the study of librarianship was the American Library Association (1876), which includes Canada. The Library Association of the United Kingdom was formed in 1877, as an outcome of the first International Library Conference, held at London, and in 1898 it received a royal charter. It publishes a *Year Book,* the quarterly *Library Association Record.* It also holds examinations. The Library Assistants' Association was formed in 1895 and has branches in different parts of England, Wales and Ireland. It issues a monthly magazine entitled *The Library Assistant.* The Association des Bibliothécaires Français was founded in 1906 and publishes an important journal. There are two associations in Germany, the Verein deutscher Bibliothekare, and the Verein deutscher Volksbibliothekare, which issues a year-book giving information concerning the libraries of the country; a similar organization in Austria-Hungary is now merged into the former. An Association of Archivists and Librarians was formed at Brussels in 1907, and there are similar societies in France, Italy, Spain, Holland, Denmark, Norway, Sweden, and, since 1927, in China also. In every country there is now some kind of library association.

The movement, since the World War, partly because of the financial crisis in Europe, and partly because of the increased consciousness of each other among the nations, has been one of co-operation and closer organization, so that the world's library resources are far better utilized.

Two agencies further international co-operation between libraries: (1) The Institut International de Bibliographie, founded in 1897 at Brussels by Paul Otlet and Henri Lafontaine, but shortly to be moved to Geneva, aims at amalgamating the catalogues of the world's chief libraries into an universal card bibliography. It has also produced a more thorough (decimal) classification for books and papers. (2) The Institut International de Co-opération Intellectuelle at Paris, an institution of the League of Nations, by its committee of library experts (mostly the heads of the great national libraries), has brought into mutual relations the national bureaux of bibliographical information, and publishes reports from them.

It has been calculated by E. Sparn (*El Crecimiento de las grandes Bibliotecas de la Tierra*) that the larger libraries of the Old World were doubled, and those of North America trebled, in content in the first quarter of the 20th century.

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(X.; A. Es.)

THE UNITED STATES

The earliest libraries in the colonial period of America were private. Among the notable libraries of this kind were those of Elder William Brewster of Plymouth, Gov. Winthrop of Connecticut, Dr. Cotton Mather of Boston, Col. Ralph Wormeley of Virginia and the Rev. John Harvard. Toward the end of the 17th century the so-called Bray parish libraries began to appear. These were collections mainly of religious books sent to America through the efforts of the Rev. Dr. Thomas Bray of London, designed particularly for the use of the clergy, though open to the public. The first subscription library in the colonies was projected by Benjamin Franklin in 1731 in Philadelphia. Many of the early subscription and proprietary libraries have become the foundations of public libraries. A few of them, however, still flourish. The Boston Athenaeum (1807) had in 1928 a collection of 305,000 volumes and was especially rich in historical material. The Providence Athenaeum (1753) had 104,000 volumes. The New York Society library (1754) had a general collection of 125,000 volumes. its special strength being in fine arts, early fiction and Americana.

Endowed Libraries.—The gift or bequest of great private libraries or large sums of money for the erection of library buildings and the organization and maintenance of libraries for free public use has been a favourite form of philanthropy in America. In New York the Astor library, founded by a bequest of John Jacob Astor, was incorporated in 1849 and opened to the public in 1854 as a reference library of the most valuable books on all subjects. The Lenox library was established in 1870 by James Lenox, a New York merchant and one of America's greatest book collectors. In addition to funds for a library building and endowment amounting to $1,247,000, he gave his valuable collection of books and art treasures. From the estate of Samuel J. Tilden, the City of New York in 1892 received the private library of the former governor of the State and about $2,000,000 for library purposes. In 1895 the Astor library, the Lenox library and the Tilden Trust were consolidated under the name of the New York Public library, Astor, Lenox and Tilden Foundations, which was soon to become the largest public library system in the world (2,971,209 volumes and pamphlets). In 1901 the New York Free Circulating library, with 11 branches, and later other circulating libraries, were consolidated with the new system as the Circulation Department of the New York Public library. In 1901 also Andrew Carnegie gave $5,200,000 for the construction and equipment of free circulating libraries in Greater New York. Chicago has two important endowed reference libraries, the Newberry library (1887), with 443,757 volumes and pamphlets, and the John Crerar library (1894), with 820,000. The Enoch Pratt Free library (1886) of Baltimore and the Providence (R.I.) Public library (1878) are typical of the numerous endowed public libraries, many of which are supported in part by municipal appropriations.

At the head of the list of library benefactors stands the name of Andrew Carnegie, whose first library gift was made in 1881 to Dunfermline, his native town in Scotland. His second gift of a library was made in 1890 to Allegheny, Pa. Pittsburgh received a large central building in 1895 and later eight branches. The total amount given by Carnegie and the Carnegie Corporation for library building in the United States and Canada was $43,665,000. In its gifts for library buildings the corporation, organized in 1911, followed the wishes of its founder, until its gifts for libraries were discontinued in 1917.

College and University Libraries.—The history of college and university libraries is also a record of generous gifts from private collectors and friends of education. Harvard college library dates from 1638, when John Harvard bequeathed to it his collection of 330 volumes. By 1764 the library had grown to 5,000 volumes, when all but one of the original volumes were destroyed by fire. The library of Yale college was founded in 1700, but grew so slowly that even with the 1,000 volumes received from Bishop Berkeley in 1733 it had only 4,000 volumes in 1766, and some of these were lost in the Revolutionary War. The library of King's college, renamed Columbia college after the Revolutionary War, dates from 1756, when Joseph Murray, a governor of the college, bequeathed to it his private library. It is estimated to have had only about 2,000 volumes at the outbreak of the Revolution. Though stored in the city hall for safe keeping, many of the books were carried off by British soldiers and the rest scattered and never recovered except for a few volumes which are now in the library of Columbia university. The rehabilitation of the library after the Revolution was accomplished very slowly. In 1863 it had only 14,941 volumes.

The Harvard college library has about doubled in size every 20 years for over a century, and this rate of growth has been equalled or exceeded by most of the larger college and university libraries, especially in recent decades. In 1927 the number of volumes in these libraries were: Harvard, 2,622,400; Yale, 1,838,099; Columbia, 1,092,343; University of California, 665,680; University of Chicago, 768,559; Cornell university, 787,127; University of Illinois, 708,850; University of Michigan, 649,912; University of Minnesota, 501,507; University of Pennsylvania, 635,070; Princeton university, 594,195.

Library of Congress.—The Library of Congress has become in fact if not in name the national library of the United States. It was established in 1800 by Act of Congress as a legislative library and was housed in the Capitol until 1897 when it was moved to its own building which is the largest, most ornate and most costly library building in the world. It occupies $3\frac{3}{4}$ ac. of ground, contains over 10,000,000 cu.ft. of space, and has a floor area of over $13\frac{1}{2}$ acres. The original cost was $6,347,000—including the site, close to $7,000,000.

On June 30, 1927, the Library of Congress contained 3,556,767 books and pamphlets, making it the third largest library in the world. The principal sources of growth have been deposits under the copyright law, exchanges of official publications with foreign Governments, and the Smithsonian exchanges which add extensive files of the transactions of foreign learned societies. The main collections are strongest in bibliography, history, political and social sciences, public law and legislation, the fine arts, American local history, biography and genealogy.

Besides its research and other services for members of Congress and the Government Departments, it offers excellent facilities for serious scholars. It is also performing the functions of a national library by extending bibliographic and other services to all the libraries of the country. It stands at the head of a recognized inter-library loan system, by lending to college, university, State, municipal and other libraries books which they do not possess and cannot obtain elsewhere.

Public Libraries.—The modern public library, maintained by the municipality or some other unit of local government from the proceeds of taxation, was scarcely known before 1850 and has developed for the most part since the formation of the American Library Association in 1876. The earliest tax-supported library is supposed to have been the town library of Salisbury, Conn., established in 1803. The oldest existing library of this kind is said to be the one at Peterborough, N.H., which dates from 1833. Legislative sanction for the use of taxation to maintain public libraries was given in New York in 1835, the school district being the library area. By the Michigan Constitution of 1835 the legislature was given power to establish a library in every school district. In 1848 the Massachusetts general court authorized the city of Boston to raise $5,000 a year to maintain a public library, and in 1851 this Act was applied to all towns in the State. Similar laws were soon passed in other States. In 1928 legislation authorizing the establishment and maintenance of municipal public libraries was found in every State except Delaware, where the school district was the only unit recognized for this purpose.

The latest statistics show about 6,000 public libraries in the United States, with an average *per caput* income of $0.33 and an annual *per caput* circulation of 2·13 volumes. It is estimated, however, that 5% of the urban population and 82% of the rural population live in areas with no local public library service at all. Most of the well organized city library systems spend from $0.75 to $1.00 or more *per caput*. In 1926 Cleveland led all other cities, with a *per caput* library expenditure of $1.69, followed by Boston with $1.42, Indianapolis with $1.14, Los Angeles with $1.05 and Minneapolis with $1.00.

One of the ways in which the modern public library attempts to make its service of value to the community is by specialization in its service and organization. Specialization by subject is frequently represented by separate departments, in charge of specialists, of business, technology, art, music, education, etc. In some of the recent central library buildings book stacks and reading rooms are arranged to facilitate departmental organization. Specialized service such as work with children and co-operation with schools is usually not confined to the central library but operates also through different kinds of distributing agencies. Branch libraries and sub-branches have their own collection of books and are located near the centre of the local business or residence area to be served. It is assumed in the best library systems that there should be one branch to every 25,000 to 40,000 population. In less densely populated districts a branch cannot effectively serve so large a number. Deposit stations are located in stores, schools, factories, clubs, etc., and are provided with collections of from one to several hundred volumes which are changed frequently. Delivery stations have no books on hand but fill orders from a central stock. Travelling libraries consist of small collections of books, 25 or 50 to several hundred, lent to factories, stores, clubs, etc. In many communities the public library has undertaken to supply books needed in the public schools by furnishing classroom libraries. In some cities the school and library authorities co-operate in providing what are known as school libraries, and in a few cities branch libraries are established in school buildings.

The governing body of the municipal public library supported wholly or in part by public funds is usually a board of trustees, appointed by the mayor or some other official or body designated by law. In a few cases the library board is self-perpetuating. In some States the public library is operated under the board of education, and in certain cities which are under the city manager or the commission form of government there is no library board at all, the public library being administered as a department of the city government with the librarian directly responsible to the mayor or city manager.

A special library for children was established in New York city as early as 1885. In 1890 a separate room for children was opened in the public library at Brookline, Mass., and in the next few years public libraries began generally to provide special rooms or other facilities for children. By 1900 a separate children's room, with specially trained children's librarians to give skilled and sympathetic guidance in the use of books and periodicals, had come to be considered an essential part of every well conducted public library. To-day in public libraries in which organized work with children is carried on the juvenile circulation amounts to from 30 to 50% of the total. From one-quarter to one-third of its total book fund is considered a reasonable proportion for the average public library to devote to children's books. In libraries which combine the children's department and work with schools, the children's librarians select books to be sent to classrooms, visit schools to talk to the children, give talks to parents and teachers, and give instruction in the use of books and libraries to classes sent to them regularly from the schools.

State Libraries.—In the beginning the State library was essentially a law and legislative library for State officials. The State library of New Hampshire was started in 1770 as a colonial library. The New Jersey State library dates back to 1796. A legislative library was established in South Carolina in 1814. The largest and best State library, that of New York at Albany, was founded in 1818. While the State library is primarily a special reference library for the legislative or executive departments of the State Government, or for both, it is generally open to the public for reference purposes. About 1887 State libraries began to assume leadership of the State commission movement and in 13 States library extension work is now a function of the State library. In 13 States the State law library is separate from the State library. In nine States the legislative reference bureau is also separate. In certain States miscellaneous functions have been assumed, such as historical research and the care of museums.

The term library extension is usually applied to the efforts of some State authority to aid in providing local public library service, or some substitute for it, in the smaller towns and rural districts. Over 90% of the population living in towns and cities of more than 2,500 population in the United States enjoy the service of a local public library of some sort, while less than 20% of the population in the smaller towns and in the open country have any kind of local public library service. The first State to attack this problem was Massachusetts, which in 1890 created a State board known as the Free Public Library Commission, whose function was to aid in establishing and developing free libraries throughout the State. New Hampshire followed in 1891. In 1892 the New York State library was made a central bureau for promoting, stimulating, aiding and directing local libraries. A commission similar to that in Massachusetts was created in Connecticut in 1893, in Vermont in 1894 and in Wisconsin in 1895. Other States quickly followed their examples. In 1904 the League of Library Commissions was organized "to promote by co-operation such library interests as are within the province of library supervision by the State." In 1928 39 States had a library extension agency in operation, three more had laws providing one, leaving seven States that had no extension agency nor legal provision for one. In 13 States, as noted above, the State library is the extension agency; in 12 the function is performed by the State board or department of education; and in 14 there is an active library commission. The functions actually performed by library commissions or other State agencies responsible for library extension include aid in improving local public library service; establishment of new libraries where needed; promotion of co-operation between libraries; assistance in providing library service for schools, and for State charitable, penal and reformatory institutions; provision for library service where local service is impracticable; distribution of State documents; library service for the blind; and legislative reference work.

The travelling library represents one of the earliest forms of State library extension. In 1892 a system of travelling libraries was created in New York under the leadership of Melvil Dewey. Travelling collections of books were used in 1928 in 35 States. The State travelling library is a collection varying from 50 to several hundred volumes for general reading, although special collections are sent out in some States. "Package libraries," consisting of pamphlets and magazine and newspaper clippings on current events and topics on which there are no books, are sent out through the mail by some extension agency in several States for the use of high school debaters, club women, discussion groups, etc. Nearly all the extension agencies make a practice of mailing one or several volumes directly to individuals.

County Libraries.—The most effective form of library extension being carried on is the development of county library systems. The county library is a tax-supported library serving an entire county (excluding in some cases the larger towns and cities which have their own library service) through a central library, usually located at the county seat, and a system of branches and deposit stations, all served and directed by skilled librarians. To reach the more isolated sections book automobiles are used by some county libraries. From the middle of the 19th century sporadic efforts were made to establish county libraries, and some of them met with a fair degree of success; but it was in California beginning about 1909 that the first real system of county libraries developed. The California library law of 1911 gave that State the leadership in the county library movement and has had much influence on county library legislation in other States. Thirty-three States have laws authorizing county library service in some form. Management is usually in the hands of a county library board. In a few States, California for example, the county library system is managed directly by the county supervisors. To maintain the highest standard of service the county library system should be under the supervision of some State agency. In 1928 public funds were being appropriated for county public library service in only 251 out of the 2,806 counties in the United States. California headed the list of States with 46 counties out of a total of 58, less than 3% of the population being outside public library service areas.

School Libraries.—The new curriculum of the high school and the newer methods of teaching have made the school library a necessity. The first modern high school libraries were started by the librarians of public libraries, and all of them have appeared since 1905, when full time high school librarians began to be appointed. Strictly speaking, a library even though located in a school building is not a school library unless maintained and administered primarily for the benefit of pupils and teachers. Administration of school libraries of this kind may be undertaken by the school authorities themselves or turned over to the public library. The importance attached to the school library in modern education is reflected in the State laws and the regulations of State education authorities. The standards prescribed usually apply only to high schools and cover such matters as the annual appropriation, the initial cost or value of the books, the expenditure per pupil, the number and kind of books selected, the housing and equipment of the library and the qualifications, education, training and duties of the librarian. In some States the standards adopted are not compulsory but are merely recommended to local school boards. It is usually assumed that a full time librarian is required in schools of 500 or over. In the smaller high schools a teacher—most frequently the teacher of English—serves as teacher-librarian.

Special Libraries.—Specialization in all fields of endeavour necessarily has its counterpart in library service. A very large tax-supported public library can specialize its collections and service to some extent, particularly in the direction of some dominant industrial or other interest of the community. Endowed public libraries have more freedom to neglect certain fields and concentrate their efforts on others. Public libraries, on the other hand, may build up special collections in various subjects and provide specialized service for schools, for children, for the blind, for business men, for Government officials, etc., but it is seldom possible for them to carry specialization in either collections or service to the extent that is required by the educational, business, professional and other interests of the community. Professional and other groups, therefore, find it desirable to organize and maintain their own libraries so that in populous centres are to be found privately supported libraries of law, medicine, engineering, etc. Some of these are for the use of members or subscribers only; others are open to the public. Educational institutions require libraries that are built up and administered to meet the special needs of students and teachers. With the development of the modern business corporation the need arose for a specialized library service which could not ordinarily be furnished by the public library. The result has been the rapid development since about 1910 of collections of printed matter in special fields, in charge of persons familiar with the subject matter, for the use of a more or less limited group. In 1909 a Special Libraries Association was organized and began publishing the monthly journal *Special Libraries*. While the association draws its membership from many types of special libraries, the business interests predominate. It has now become quite common to find special libraries maintained by banks and investment houses, insurance companies, advertising agencies, newspaper offices, public service corporations and a great variety of industrial and commercial companies.

The American Library Association, organized in 1876, is an association of libraries, librarians, trustees and other friends of libraries, pledged to carry out the purpose of its founders "by disposing the public mind to the founding and improving of libraries." It had in 1927 a membership of more than 10,000. Its total budget in the fiscal year 1927 was more than $325,000, the largest items of expenditure being for the promotion of professional library education and the publication of text-books, professional literature and aids to book selection. Headquarters are located in Chicago. During the World War, the association provided libraries for soldiers, sailors and marines, sending more than 2,000,000 books overseas from 1917 to 1920. Other associations affiliated with the A.L.A. are the American Association of Law Libraries, the League of Library Commissions, the National Association of State Libraries, and the Special Libraries Association. Nearly every State has its own library association or joins with neighbouring States in a regional association. Library clubs are found in many of the larger cities. (C. C. Wi.)

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Administration.—In the United States details of administration differ because of varying requirements from local and State governments, with marked tendency toward uniformity due to the influence of library schools and the A.L.A.

In general the public library is administered by a board of trustees or directors elected by the community or chosen or appointed by the mayor, city manager, council, or some similar officer or board. A few libraries are controlled by the local school boards, and fewer by self-perpetuating boards related to the city by contract or agreement. That in 13 cities of over 30,000 inhabitants boards of trustees have been discontinued, is an indication of a growing trend under city commission or city manager control. State aid—and therefore control—is a growing factor. Growth in county library service (even super county libraries) is noteworthy. The trustees are charged with the duty of fixing the policy for the institution, establishing principles governing the staff, determining the kind of library best fitted for the community. They usually work through committees. Tenure of office and length of service may differ in detail, but the aim and intent generally seem to be the choice of a middle ground between changes so frequent and rotation in office so constant as to make impossible continuity of policy, and so infrequent as to suggest danger of dry rot.

The librarian is usually recognized as executive officer of the board.

Current rules seem to emphasize fair play for all users of books, equitable treatment for the public, rather than convenience for the staff. How many volumes may be taken at one time, length of withdrawal before renewal, fines for failure to return books for renewal, regulations for summer or vacation privileges, special consideration for teachers or other classes of readers, these and similar administrative controls differ widely because of varying local conditions. Most libraries limit loans for ordinary books to two weeks, set fines of one or two cents a day for books not renewed, grant special privileges when general harm or inconvenience will not follow.

Support usually comes from public funds granted by the committee or board fixing the local tax levy. Money thus granted is turned over to the library board for spending under proper accounting, or is paid from the office of the local disbursing agent when warrants are presented bearing proper authorization.

Book selection through librarian and staff is increasing, decreasing through trustees. Occasionally books must be bought by public bids and tenders, but the tendency seems towards giving the librarian greater discretion as to purchase of books and supplies. Preliminary steps and details are in many cases regulated by statute, but once the books have passed this stage their administrative processes are fairly uniform, thanks to standardizing of methods and processes resulting from the influence of the library schools and the training classes. Cataloguing, accessioning, subject heading, classifying, charging to borrowers, registration of borrowers, inventory work, reading the shelves are all coming to show little variation. One important element in uniformity of cataloguing is the growing use of printed cards supplied by the Library of Congress. Several classification schemes had ardent advocates a generation ago; today the Dewey decimal system is almost universal among the more popular libraries, and the Library of Congress system bids fair to equal it among the larger college, university, and reference libraries. A similar tendency toward uniformity in the reporting of activities is shown by the growing use of the system recommended by the A.L.A.

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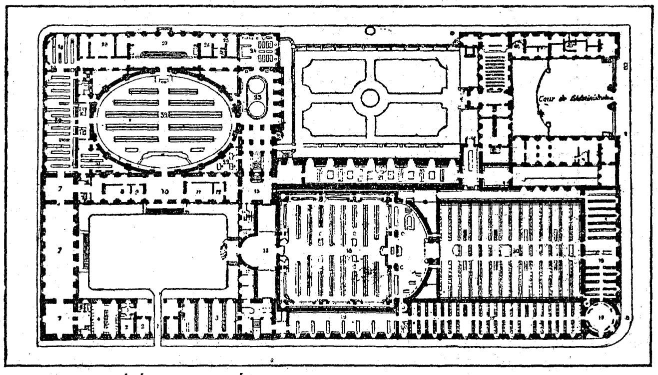
LIBRARY ARCHITECTURE. Architecturally, the library is a modern problem. There were, of course, many famous libraries before modern times, but from the description that we have of those of antiquity, and from the examples still existing of libraries of the Renaissance on to the end of the 18th century, it is clear that the great collections of books were kept simply in rooms or galleries furnished with shelves or cupboards, and sometimes with heavy, pulpit-like counters on which the ponderous folios could be rested. Aesthetically, the treatment of these rooms was often masterful, as in the Vatican, the Biblioteca Lorenziana in Florence and the old Ste. Geneviève library (now in the Lycée Henri IV.) in Paris; but not until the 19th century were buildings or portions thereof designed to solve the special problems encountered in the cataloguing and storing of printed material and its use by readers. For private libraries, or libraries open only to a selected public, such as those of clubs, scientific



FROM GAUDET, "ÉLÉMENTS ET THÉORIE DE L'ARCHITECTURE," (LIBRAIRIE DE LA CONSTRUCTION MODERNE)
FIRST FLOOR PLAN OF THE BIBLIOTHÈQUE NATIONALE, PARIS

institutions and special departments in our modern universities, the old scheme, in which the shelves of books provide a decoration for the walls rivalling the finest tapestries, is likely to continue. But for the requirements of the modern *public* library, which has to meet demands peculiar to modern conditions, the old plan cannot serve.

A scientific approach to library planning first became necessary during the tremendous growth in the number of books published and the development of the democratic desire to place well-classified collections at the service of the general public. The mere extension of the type of libraries as then existed was found to be no solution. We have the record of such a scheme in the library project of Boulée (1729–99), entitled *Memoir on the Means to Secure for the King's Library the Advantages Required for this Monument* (1785). This memoir is accompanied by a drawing showing a gigantic gallery covered by a barrel vault, supported on two colonnades which vanish in the distance at a terminal apse, and admitting the light only through a rectangular opening in the centre. Under the colonnades there are three platforms, each supporting a tier of books. Aesthetically, the design is not without merit in its severity, and it shows, moreover, an appreciation of the magnitude of the new problem. But the solution was not to be found in a mere increase in size; rather in a frank segregation of the public in reading rooms and of the creation of separate store-rooms for the books. These store-rooms are what we now call the "stacks," where in general the public is not admitted and an intensive use of space can be made.

As early as 1835, the French architect, Benjamin Delessert, suggested for the proposed Bibliothèque Nationale in Paris, a circular reading room, with the book-stacks surrounding it, lying radially to the centre. The old Wolfenbuttel library (1706), and its derivative, the Radcliffe library at Oxford, had already been built on a circular plan, but without the separate book-stacks. This circular reading room recommended itself by allowing the librarian (installed on a raised platform in the centre) an easier supervision of the readers. Delessert's plan probably suggested that of the reading room of the British Museum (R. and S. Smirke, architects, 1852) where, however, the stacks are rather awkwardly arranged around the central dome.

When Henri Labrouste was appointed architect for the new Ste. Geneviève library in Paris (1843) the site selected, being long and narrow, almost forced the solution of a reading room occupying the entire upper floor of the building and containing many of the books, as in the old libraries, but with other spaces for books beneath,—a scheme that in recent years has been used in many important libraries. Although the shape of the lot unfortunately made it necessary to divide the book storage into two sections, Labrouste had, nevertheless, evolved a masterly solution of his problem, a solution so daring in his frank treatment of structural elements that this building remains one of the prototypes of modern architecture.

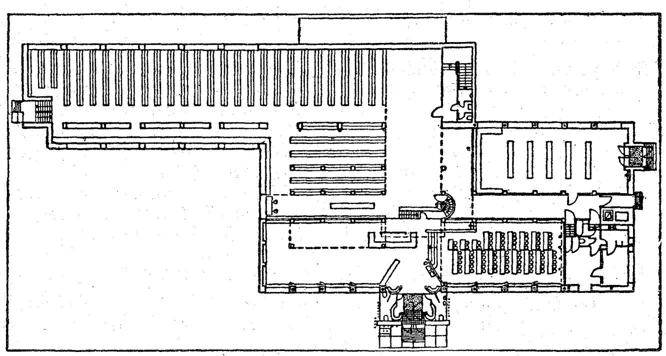
Later, in the plans for the Bibliothèque Nationale in Paris (1854), where he was less hampered by the exigencies of space, Labrouste gave another remarkable building. The main reading room is square, with an apse, where the librarians are installed, facing its entrance and commanding that to the stacks. The reading room is surrounded by three tiers of shelves, with the light coming through a large opening on the north side, and from nine domes which each rest on four light steel columns. The atmosphere of the rooms is quiet and restful and the light is excellent. The most remarkable part of the composition, however, is the book-stack (*magasin des imprimés*), a huge room, 90 ft. by 120 feet. Here the principle of the modern book-stack is first evolved. The shell of masonry is covered by a glass skylight, which allows daylight to penetrate every corner, while inside this shell, the metal framework of the book tiers and the passages between is an entirely independent construction resting on the basement floor. These are the essentials of the modern book-stack, the invention of which has been attributed quite incorrectly to W. H. Ware and Bernard Green; the only improvement contributed by these gentlemen, many years later, was the closer packing of the shelves and the elimination of such woodwork as remained.

LIBRARY PLANNING

The three types of libraries represented by the two works of Labrouste and the British Museum, furnished the patterns for most large libraries of late 19th and early 20th centuries. To the type of the Ste. Geneviève; *i.e.*, with a reading room lighted on both sides, with books along the walls or in alcoves, and with a storage under the reading room, belong the New York public library (Carrère and Hastings, architects, 1897), the library of the University of Chicago (Shepley, Rutan and Coolidge, architects, 1910) and the Philadelphia free library (H. Trumbauer, architect, 1915–27). To the type of the Bibliothèque Nationale; *i.e.*, with a reading room parallel or perpendicular to the stacks, belong the project for the library of Berlin by Hosfield (1875), the Widener Memorial library at Harvard, the Toronto library and many university libraries. To the type of the British Museum; *i.e.*, with a circular reading room surrounded by the book-stacks and lighted by high windows or skylights, belong the Columbia university library, New York (McKim, Mead and White, architects, 1897), the library of Strasbourg (Hartel and Neckelmann, architects, 1895) and the library of Congress, Washington, D.C. (Smighmeyer, Pelz and Casey, architects, 1886–97). The original scheme for this last library had radiating book-stacks, like the Delessert scheme, but it was abandoned for a block entirely filling the light courts.

The economy of space which this effects cannot be questioned, but opinions differ widely as to the advisability of packing the book-stacks so closely without allowing other than artificial light.

A marked progress in library design was noticeable around 1930. In the design of the Bibliothèque Nationale Suisse in Berne (1931, Oeschger, Kaufmann and Hostettler, architects), a straightforward functional solution of library needs expressed itself in



FLOOR PLAN OF MUNICIPAL LIBRARY, VIIPURI (VIBORG). ALVAR AALTO, ARCHITECT the plans and elevations. Emphasis within was laid on clarity of vision, ease of access to books and uniform day and night lighting facilities. The library of the League of Nations, Geneva (Nénot and Flengenheimer, architects), has gained international recognition as a reference library.

The municipal library at Viipuri (Viborg) (1934, Alvar Aalto, architect), shows a departure from the formality of axial relationships and symmetry hitherto employed in library planning. The technical requirements for shadowless lighting, mechanical ventilation and acoustical treatment influenced the shape of rooms and contributed the interest in the wall and ceiling surfaces formerly supplied by surface decoration. The storage annex at Versailles of the Bibliothèque Nationale in Paris solves the problem caused by the immense accumulation and continuing growth of material to be stored by libraries. A separate building was built for newspaper storage 15 km. from the central library and well outside city congestion.

At the Library congress held in 1937 at the Paris exposition, the use of miniature photographs to reduce storage space was discussed. Printed material photographed on 35 mm. film, on an average diminishes the bulk and weight of material by 95%. Branch libraries and reference libraries specializing in particular fields likewise tend to overcome the unwieldiness of the central libraries.

American Libraries.—In the United States the number of people who borrow books for home reading exceeds the number of those who use the reading rooms in the library. This has given rise to a new service, the essential feature of which is the delivery room with its desk in direct communication with the stacks, and its catalogues and open shelves so arranged that the readers in the reading rooms need not be disturbed.

In the larger libraries, the card-catalogue has developed to such an extent as to require a special room. In the New York public library the catalogue room is on the third floor where readers must pass it on their way to the reading room.

Excellent examples of public libraries with the delivery room as the central feature and the reading rooms secondary to it, are best seen in those by Albert R. Ross at Washington, D. C., and Denver, Colo., and even possibly more so in those at St. Louis, Mo., and Detroit, Mich., both by Cass Gilbert.

A special type of university library was evolved for Johns Hopkins university, Baltimore, Md., by Parker, Thomas and Rice (1914).

In this case, special emphasis was laid on affording the small groups of advanced students working in classes in the building (seminar groups) an easy access to the stacks. For this purpose the stacks, in two units, are placed in the centre of the block opening into the corridors of the seminar rooms, which are on the outer sides of the building. The main reading room is at the end of the composition.

In the first quarter of the 20th century, a standard type was evolved for the libraries of smaller communities or for the branch libraries in the cities (*e.g.,* branch libraries in Detroit and Philadelphia, and Carnegie libraries in England).

Although the plan of such may vary slightly to admit some special requirement such as a lecture or picture gallery, it is generally that of a one-story, rectangular building over a basement and standing free on a lot, in order to ensure lighting from every side.

The entrance, on the long side, leads directly to the delivery desk, while the spaces to right and left are devoted to the adult reading room and to the children's reading room, separated, in the majority of cases, only by a low enclosure, to afford general supervision by a small staff from the delivery desk.

EXTERIOR AND INTERIOR TREATMENT

Recognition of the need for a logical expression in the elevations of the functional requirements of the plans did not come until the end of the third decade of the 20th century. Before this, libraries were treated in the modernized classic tradition or, as in some American university libraries, in the general style of collegiate Gothic architecture adapted for the group. As remarkable studies for elevations may be mentioned the Ste. Geneviève library, the library of the École de Médecine, by Ginain, both in Paris, the New York public library, the Boston public library and the Columbia university library, the last two by McKim, Mead and White, and the Detroit public library. In the smaller libraries in the United States, there is a wider range in the styles of the façades, which are often inspired by the dominant note in the suburban architecture (*e.g.,* colonial types or Spanish mission).

The technical equipment of libraries has followed the general trend of the times in the progressive elimination of all woodwork in the shelving, unless kept for decorative reasons, in the effort to utilize a maximum of space for storing books, and in the simplification of service by book-lifts, conveyors, etc.

Bibliography.—American Library Association, *Bibliographies on Library Architecture and Equipment* (1937); American Library Association, *Committee on Library Architecture and Building Planning* (1939); Architectural Forum, *Museums and Libraries,* vol. 56 (June 1932); L'Architecture d'Aujourd'hui, *Les Bibliothèques,* vol. 9 (March 1938); Dana Q. McComb, *Public Library Buildings* (1935).

(P. P. Cr.; W. F. B.)

LIBRATION, a slow oscillation, as of a balance; in astronomy especially the seeming oscillation of the moon around her axis, by which portions of her surface near the edge of the disc are alternately brought into sight and swung out of sight.

LIBRETTO (It., dim. of *libro,* a book), term for the text, or "book" of an opera.

LIBYA, Greek name for northern Africa (Λιβύη) and modern name for the Italian colony comprising Tripolitania and Cyrenaica (*qq.v.*). Ancient Libya did not include Egypt, then part of Asia and first assigned to Africa by Ptolemy, who made the isthmus of Suez and the Red Sea the boundary between the two continents. The name Africa came into general use through the Romans.

The old name was reintroduced by Diocletian, by whom Cyrenaica was divided into Marmarica (Libya inferior) in the east and Cyrenaica (Libya superior) in the west. A further distinction into Libya interior and exterior is also known. The former (ἡ ἐντός) included the interior (known and unknown) of the continent, as contrasted with the N. and N.E. portion; the latter ἡ ἔξω was called simply Libya. *See* Africa, Roman.

Modern Libya, comprising 679,183 sq.mi., was organized on Jan. 1, 1934, into four provinces: Bengasi, 58,684 sq.mi., pop. (1936 census) 113,744; Derna, 43,143 sq.mi., pop. 46,788; Misurata, 38,191 sq.mi., pop. 215,877; and Tripolitania 73,803 sq.mi., pop. 392,564; and a military territory in the south of 465,362 sq.mi. and a pop. of 48,403. In 1938 the population of Libya was estimated at 888,401. By a decree of Jan. 9, 1939, the four provinces were incorporated into the national territory of Italy, but the Libyan Sahara territory was not affected.

Crop production in 1937 included barley 42,500 short tons; wheat 17,500 tons; olives 16,300 tons; and grapes 7,000 tons. In 1938 sponge fisheries yielded 107 tons and tunny fisheries 1,022 tons. Over 40,000 tons of salt were produced. Livestock in 1938 included 726,000 goats, 890,000 sheep, 70,000 cattle and 90,000 camels. Imports in 1938 were valued at $46,400,600, exports $5,731,900. Nearly 90% of the trade was with Italy. Italian forces were driven out of Libya in World War II, and a British military government was set up.

LICATA, seaport, Sicily, province of Agrigento, 24 mi. S.E. of Agrigento direct; 54 mi. by rail. Pop. (1936) 30,641 (town), 31,611 (commune). The river Salso, east of the town, is the ancient *Himera meridionalis.* On the promontory, which has the town at its foot, and is called the Poggio di Sant' Angelo, the Ecnomus of the Greeks, is the site of the town Phintias of Aeragas built after the Mamertines destroyed Gela (281 B.C.). It was off this promontory that the Romans defeated the Carthaginian fleet in the spring of 256 B.C., while in the plain to the north, Hamilcar defeated Agathocles in 310 B.C.

The modern port refines and exports sulphur. It was bombed by the Allies in World War II.

LICENCE, permission, leave, liberty, hence an abuse of liberty; in particular, a formal authority to do some lawful act Such authority may be either verbal or written; when written, the document containing the authority is called a "licence." Many acts, lawful in themselves, are regulated by statutory authority, and licences must be obtained. (*See* Liquor Laws and Liquor Control, etc.)

LICENSED VICTUALLER. A "licensed victualler," in the original English meaning of the term, was the keeper of what the old licensing statutes called a "victualling house." As a descriptive term the name is one of considerable historical interest and importance. It bears clear witness to the intention and purpose of the State in the institution of the liquor licensing system, and also to the character of the social service which the licensee was expected and required to render to the community. He was not, and was not intended to be, a mere dram-seller, *i.e.,* a retailer whose primary and practically exclusive business it was to supply alcoholic liquors to the public, but a *victualler, i.e.,* a retailer of food and drink other than, and in addition to, the alcoholic beverages commonly consumed, the sale of which by the licensed victualler was merely an ancillary part of his victualling trade.

The idea, like other institutional ideas, did not long endure in practice, although until the 17th century at least it continued to represent the intention and object of the State. Lax and negligent administration and—much later—fiscal and legislative changes obscured the idea until it ceased to govern or even to influence the trading methods of the licensee. The "licensed victualler" became a publican whose primary and practically sole business was and is the retailing of alcoholic beverages. The name has lost its ancient and specific meaning. In modern (and accepted trade) usage it applies only to the holder of an ordinary "full" (publican's) licence, and is so restricted in the rules of the Incorporated Society of Licensed Victuallers, the oldest and most prosperous of "trade" benevolent societies. Changes in the connotation of names and terms are not uncommon in the history of social institutions, but such changes are usually changes of expansion, involving an enlargement and improvement of the scope of the service rendered. In the case of the public-house (the licensed "victualling house") the change has been of a different kind. It has not been, in the strict sense, an evolutionary change, but a departure from a governing idea which was the *raison d'être* of the institution itself, and it has involved not an enlargement, but an unhappy restriction, of the social service which the institution was intended to render. In the process of the change the "victualling house" became, against law and State intention, a "drinking house." That the State subsequently, but not until the beginning of the 18th century, accepted and accelerated the change by legalizing the worst form of dram-shop is true, but the "victualling house" by that time had disappeared, and the name alone survived in the statute-book. It is only in recent years that the name itself has fallen into legal (legislative) disuse.

Why "Victualling" Disappeared.—This was not, as is sometimes assumed, due to changes in social and economic conditions. These emerged as co-operating causative factors at a much later stage in British social history. It was due primarily to the play and pressure of commercial motives and was made possible by the default of the controlling authority. The incentives were plain. The victualling trade was, in the nature of things, a limited trade with natural bounds set to its expansion. It ministered to a limited demand. Profits were relatively small and not easily earned. The sale of liquor, on the other hand, was a simple trade; the expenses were small, the profits ample and quickly earned, and the demand was one which was easily fostered and dependable. The liquor business drew a larger, surer, more profitable patronage than a strictly victualling business. Given facilities, it provided a livelihood for a much greater number of sellers.

Even so, the incentives, powerful as they were, could not, unless tolerated and encouraged, have prevailed over the intention of the law. They found their opportunity in lax administration of the law. Licences were granted by justices in many districts with a careless and often a shameless disregard of local needs which drew upon them repeated admonitions from the Privy Council and from judges of assize, and required frequent resort to summary measures of licence suppression. These suppressions were sporadic and intermittent and they had no appreciable effect in re-establishing the public-house as a "victualling house." The intention of the law, nevertheless, remained clear and it was the reassertion of this intention in the notorious Tippling Acts of James I. (1603–4 and 1623–24) and Charles I. (1625) that gives these futile acts their historical significance. The object of this special legislation was made plain in the preamble to the first of the Tippling Acts. It was to restore the "ancient, true and principal use of inns, ale-houses, and victualling houses" as places "for the receit, relief and lodging of wayfaring people travelling from place to place, and for such supply of the wants of such people as are not able by greater quantities to make their provision of victuals and not meant for entertaining and harbouring of lewd and idle people to spend and consume their money and time in lewd and idle manner."

The Tippling Acts notoriously failed. Prolonged inefficiency in regulative control and widespread maladministration of the licensing statutes had gone too far to make a summary cure possible; but the clearly avowed object of the Tippling Acts is of great historical importance in a survey of the original purpose and intention of the English licensing system. The ultimate responsibility for the final departure from the original idea of a victualling house rests, however, with the State, which, by its unhappy fiscal and legislative policy at the end of the seventeenth and in the early decades of the eighteenth century, took the first of two steps, each of which had demoralizing social effects, which finally sealed and disastrously aggravated a departure in aim and policy which heretofore had casually developed from administrative negligence.

The Gin Shops.—The economic and fiscal policy of William and Mary at the end of the 17th century, continued as it was by Anne in 1704, brought in its train a flood of gin shops which established in England a new and immeasurably worse type of "tippling" house whose increase and activities put a vicious stamp upon the character of the English public-house which it has never wholly lost. In the Gin Acts, the old idea and ideal of the "victualling house" was not merely ignored but destroyed. The evil wrought by these acts was further aggravated, a century later, by the Act of 1830, which established the beer-houses—a new form of drinking saloon—which, although subsequently restricted, but endowed with a vested interest, still exist in large numbers.

It is to these departures from the original aim and purpose of the English licensing system that we owe the difficulties and complexities of the public-house problem as it exists in England to-day. It is these departures, due partly to negligence and partly to lamentable mistakes in fiscal and legislative policy, that have saddled Great Britain with a "drink problem." Their effects are manifest. They have created a problem of redundancy which is not disputed but which is buttressed and beset by legal interests which make an equitable adjustment of facilities for sale to public need and demand difficult and slow. A return to the idea of the "victualling house," which, if preserved, would automatically have determined and controlled the supply of facilities, is not easy. Modification of the original requirement and long permitted departure from the "victualling house" idea have stimulated and fostered a habit of dram and "bar" drinking which cannot be summarily suppressed. Sweden is the one country in Europe which has slowly but progressively retraced its steps and, by eliminating private profit interests in the sale of spirits (the national beverage), has been able to substitute the "victualling house" for the dram-shop by compulsorily coupling the "on" sale of spirituous liquors with the sale of food.

The British Parliament in 1910 made it a ground of refusal of the renewal of an "old on-licence" (other than an ante-1869 beer-house licence) that the holder of the licence has persistently and unreasonably refused to supply suitable refreshment (other than intoxicating liquor), at a reasonable price. The Act of 1921 went a step further. By abolishing the old-time "closing-hour," but limiting the sale of intoxicants to what are called "permitted hours," it leaves the publican free to keep his premises open for the sale of food and non-intoxicants at any hour of the day or night. The privilege has not so far (1928) been used. (A. Sh.)

LICHENS constitute a class of small plants, in common speech included usually under the mosses, but actually belonging with the fungi, from which they differ in that they contain and live upon cells of living algae, in a relation more symbiotic than parasitic, as explained later.

Lichens are seen in waste places unsuited to other vegetation, also covering the ground, the bark of trees, rock surfaces and logs, in woods and fields untouched by fire and otherwise undisturbed. They are most plentiful in exposed, little-shaded places, mountain tops, bogs, arctic tundra, where atmospheric moisture is supplied by frequent fogs or by proximity to large bodies of water. Few of them thrive on fertile soils where vegetation is rank, while none at all grow in the neighbourhood of large cities, where they are killed by smoke and gases.

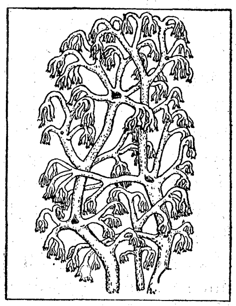


FIG. 1.—REINDEER MOSS (CLADONIA RANGIFERINA) (AFTER "THE LICHEN BOOK")

From true mosses, which are usually bright green or dark green, clothed with small green leaves, lichens are distinguished by the absence of leaves, except that some are covered with leaf-like or fin-like scales thicker and more opaque than leaves, and by the colour, which when dry is rarely bright green. Prevailing shades are pale gray, greenish gray and white, with yellow, olive, black, brown, orange and red less frequent. When moist many lichens turn dull green or olive, sometimes bright green.

Among the most familiar lichens are the stalked forms of the large genus Cladonia, which form extensive sods of closely packed flakes, or in some species flakeless incrustations, from which arise fruit-stalks called podetia, extremely variable in shape, often capped by the fruits (apothecia), which may be red, brown or variously coloured. Cladonia includes the Reindeer Moss (fig. 1), covering large areas of ground with tangled, gray tufts as much as 6 in. high. Other stalked lichens grow upright, not from a sod, but from a single point of attachment, and some hang down from the branches of trees, a striking feature in the landscape, familiarly called Old Man's Beard (fig. 2).

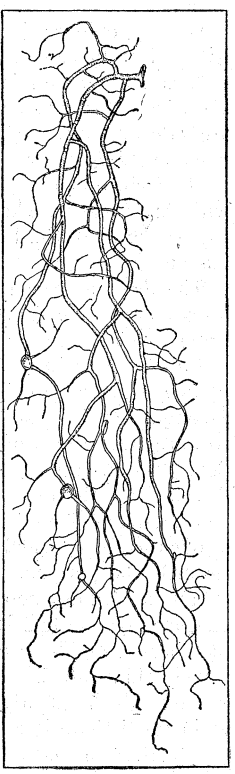


FIG. 2. — OLD MAN'S BEARD (USNEA TRICHODEA) (AFTER "THE LICHEN BOOK")

The larger rosette lichens form conspicuous, target-like mats on tree-trunks and rocks, spreading circularly to a diameter of a foot or more, plainly visible from a distance. These belong chiefly to the genera Parmelia and Sticta, with many of smaller dimensions, especially Physcia. Even more numerous are the crust lichens which cling to the surface of rock or tree, often as a mere discoloured area, studded with disk-shaped or pimple-like fruits. The colour of age in rocks commonly referred to as weathering may be due in large part to the presence of these small lichens.

The commoner lichens are distributed throughout most of the world, the same or closely related species occurring in the arctic, antarctic and both temperate zones. In the tropics and warmer regions of the temperate zones, however, specialized lichens rare in colder climates appear in great numbers, including the leaf lichens and numerous graphids, in some of which the fruits resemble Arabic script.

Lichens exhibit a considerable choice of habitat and form more or less constant associations of lichens only or with other plants. They are the pioneers of vegetation and soil-formation. By their delicate filaments they cling to the rock surfaces which they gradually penetrate and disintegrate. By mechanical action due to alternate wetting and drying of the gelatinous hyphae a sucker-like detachment of minute rock particles is constantly taking place (Fry 1924; 1926); by chemical action the acids discharged by the hyphae (carbonic, oxalic or lichen acids) dissolve the hardest rocks and even old window glass. The detached particles and the humus of cast-off portions of the thallus, together with blown dust, form a nidus for other vegetation—mosses and flowering plants—and mixed associations arise. The chief ecological factors are the types of substratum: the associations or communities are therefore naturally divided into:—1, arboreal and lignicolous, 2, terricolous, 3, saxicolous and 4, localized communities such as maritime lichens. Within these great groups there are minor associations influenced by the kind of bark, the nature of the soil (sand, clay or humus), the character of the rock (siliceous or calcareous) and also by conditions of temperature, moisture and exposure. A very distinct association is that of nitrophilous lichens: it constantly occurs on any kind of habitat in places frequented by birds and small mammals, and near to farmyards or on roadsides where the dust is mixed with nitrogenous animal matter. As in other plant communities there is a struggle for place and light. Crustaceous species are invaded and ousted by those of thicker or squamulose thallus or by the larger foliose species. Some mischance may in time dispossess them all and colonization begins afresh.

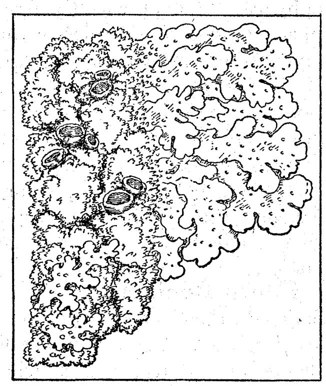


FIG. 3. — PARMELIA RUDECTA (AFTER "THE LICHEN BOOK")

ECONOMIC AND TECHNICAL

Lichens occupy an important place in the economic field. Mites and other small insects, caterpillars and slugs feed on them especially when they are moist and the acids not too pronounced. Petch has stated that they are the staple food of the black termites in Ceylon. Abbé Hue considered that the abundance and perfect development of lichens in the antarctic was due to the absence of insect life. In northern latitudes several kinds, for example *Cladonia alpestris*, are of great service as provender for domestic animals. *Cladonia rangiferina*, the reindeer moss (fig. 1), is the special food of the reindeer. In times of scarcity it has been found advantageous to grind up lichen thalli after elimination of acids, and to mix the powder with meal for human consumption. *Lecanora esculenta*, a rock lichen and often erratic, is abundant in eastern deserts and has been similarly used: it has been considered that that lichen was the manna of the Israelites. Species of *Umbilicaria* and *Gyrophora* called *tripe de roche* have been used by arctic explorers to stay the pangs of hunger. *Gyrophora esculenta*, an eastern maritime rock lichen is greatly esteemed as an edible plant both in Japan and in China.

Their value in medicine rested in the past on a somewhat fanciful basis—that of the "doctrine of signatures": certain characteristics of form by their resemblance to organs of the body, were considered to indicate curative properties. Some very bitter species such as *Pertusaria faginea* served as a substitute for quinine. *Cetraria islandica*, the "Iceland Moss" (*q.v.*), owing partly to its gelatinous consistency has been used with good effect in chest troubles, and is now the only lichen recognized in the British Pharmacopeia.

Their use as dye-plants has been known from the earliest times, and before the discovery of aniline dyes the rich and varied colours obtained from lichens were highly valued. The colouring principle of the dyes is contained in the peculiar lichen-acids. Treatment with an alkali is generally necessary to extract the colour; mordants are frequently used. With some lichens, boiling the plants with the material to be dyed is sufficient to secure the desired colour. The dyes can be used only on animal fibres such as wool and silk; they have no effect on linen or cotton. Purple lichen dyes—orchil, litmus or cudbear—are obtained from *Roccella tinctoria,* a maritime lichen, *Lecanora tartarea* and a few others. Other serviceable colours are the varied yellows and browns so much used in home or village industries. But abundant though dye lichens are, they can only furnish a limited quantity and could never meet any large demand.

About 1900 the use of *Evernia prunastri* and other lichens in the manufacture of perfume was revived after having lapsed since ancient times. The lichen and the perfume derived from it are both called Oakmoss (*q.v.*).

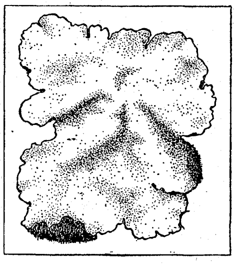


FIG. 4. — UMBILICARIA DILLENII (AFTER "THE LICHEN BOOK")

Lichens are of unusual interest in that the vegetative body or thallus is a composite plant formed by the interdependent growth of unicellular or filamentous green or blue-green algae Myxophyceae or Chlorophyaceae (fig. 5), with the filaments (hyphae) of one of the higher fungi—Ascomycetes or, in one or two genera only, Basidiomycetes. On this basis of combination or symbiosis there has been evolved a great series of distinctive plants, capable of vigorous life and of reproduction from generation to generation. Phycolichens signify those that contain blue-green, Archilichens those with bright-green algae, designated as lichen gonidia. The fungus is the dominant partner as it provides the fruiting bodies.

Lichen Gonidia.—For long it was accepted that the green bodies in the lichen plant were cells budded off from the colourless hyphae that gradually acquired a green colour. It was known that minute portions of a lichen plant—the soredia—each composed of a few green cells with entangled colourless filaments were agents of propagation. Wallroth (1835), for that reason, coined for the green cells the term *gonidia* to signify their reproductive function (fig. 6). In most lichens there is a gonidial zone near the surface and to that he gave the name *stratum gonimon.* In a lesser number the gonidia are distributed through the thallus (fig. 7). These two types he distinguished as *heteromerous* with distinctive layers, and *homoimerous* where there is no such diversity.

The belief in the genetic origin of the green cells within the thallus held sway for many years, though observations of a disturbing character were not lacking. Agardh (1821) had suggested that they were transformed algae as he had followed the development of the blue-green alga, *Nostoc,* to the complete thallus of the lichen, *Collema.* The view gradually gained ground that the bright-green gonidia of many lichens were comparable to the alga *Protococcus.* The explanation given was that these free growing algae were lichen gonidia escaped from the thallus that had continued independent growth. Wallroth spoke of them as "unfortunate brood cells" that could not again form a lichen plant. Finally in 1867 Schwendener published his bold theory that lichen gonidia were true algae imprisoned and parasitized by fungal hyphae. The statement was welcomed by many as enlightening and convincing. Others, among whom were the renowned Finnish lichenologist, W. Nylander and the British J. M. Crombie, scornfully rejected the new view. The theory was, however, successfully tested by cultures of lichen spores with free-growing algae—first by Rees (1871), then by Bornet (1872) and others who followed the development from spore to fruiting stage, a slow growth of several years' duration.

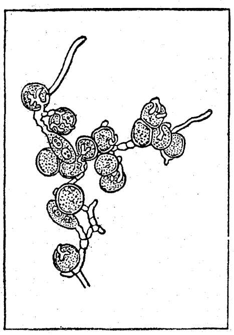


FIG. 5.—LICHEN HYPHAE AND GONIDIA. ASSOCIATION OF LICHEN HYPHAE AND GONIDIA X 250. (AFTER BONNIER)

Symbiosis.—The relation between the two organisms was regarded at first as a parasitism of the fungus on the alga, or as *helotism.* Reinke (1873) pointed out the insufficiency of a condition of parasitism to explain the healthy lichen, and he therefore proposed the term *consortium* as a truer conception. A few years later de Bary (1873) suggested *symbiosis* as an adequate term and it is now generally accepted as a *mutual symbiosis.* This view has been confirmed by culture experiments. In general the alga supplies carbohydrates by photosynthesis, the fungus provides salts and water storage. Symbiosis in lichens is a fairly stable life-balance which may tip, however, to the detriment of one or other of the organisms: there are instances, perhaps more frequent than we have supposed, of gonidia perishing in the grip of the fungi, but there are also cases where owing to some unfavourable condition, the fungus has succumbed while the algae increased enormously. There is no doubt as to the normal healthy condition of the thallus and of both symbionts. The interest in lichen gonidia has of late centred in the globose bright-green alga considered to be a species of Protococcus, said by Paulson and Somerville Hastings (1920) to have a massive parietal chromatophore, and to multiply freely and abundantly in the thallus by the free cell formation of aplanospores. The season of greatest increase was from February to April, or after heavy rain following a season of drought; zoospores were not seen in the gonidial state. The sporulating gonidia were most abundant in the actively growing regions. More recently Puymaly (1924) has proposed a new genus, *Trebouxia,* for the alga without and within the lichen thallus. He describes it, however, as possessing a massive stellate chromatophore. In view of Paulson's observations, again renewed, it is impossible to regard the gonidium chromatophore as of stellate form.

Lichen Algae.—The algal constituents of the thallus belong to two classes. I. Myxophyceae (blue-green algae) and II. Chlorophyceae (bright-green algae). They are, in general, aerial forms and in a free condition inhabit moist shady situations. Though the determination of algal species is somewhat uncertain, the genus can be more easily recognized.

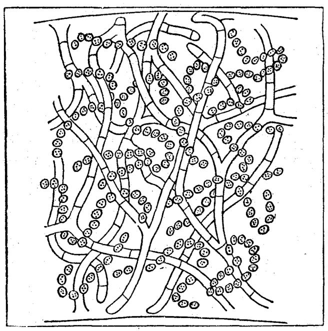


FIG. 6.—THALLUS WITH GONIDIAL ZONE. SECTION OF HETEROMEROUS THALLUS X 500. (AFTER SCHWENDENER)

I. Myxophyceae associated with Phycolichens in Collemaceae and other families. The algae of most frequent occurrence are *Gloeocapsa, Nostoc, Scytonema* and *Stigonema.*

II. Chlorophyceae associated with Archilichens. Those of most importance are the globose algae belonging to the Protococcaceae and *Trentepohlia,* a filamentous alga.

The alga may become modified in the gonidial state: *Gloeocapsa* loses colour, *Nostoc* chains, and *Trentepohlia* filaments may be broken up into cell units.

Lichen Hyphae.—These undergo considerable modification as lichen symbionts. The fruiting form indicates their origin as ascomycetous or basidiomycetous, and their affinity can be traced to ancestral groups of fungi. Bonnier (1889) in describing their development from the spores in synthetic cultures noted three distinct types:—(1) clasping filaments with repeated branching which surround and secure the alga; (2) filaments with short swollen cells destined to form several lichen tissues and (3) towards the periphery, searching filaments that form the hypothallus and annex new algae. In five days after germination the clasping hyphae had laid hold of the alga and symbiotic growth had begun. In the growing regions the hyphae remain comparatively thin-walled. In other parts—especially in the cortex, etc. —the walls frequently become thick and gelatinized. In lichens as in fungi there is no true cell structure or parenchyma, but in the cortices of many lichens a pseudo-parenchyma or plectenchyma arises by the closely packed growth of the septate tips of the hyphae. Plectenchyma also occasionally appears in other parts of the thallus.

Cultures in artificial media apart from gonidia have been made by several workers: by Möller (1887) with *Lecanora subfusca;* by F. Tobler (1909) and by Killian (1925) with *Xanthoria parietina* (fig. 8). Also by Killian and Werner (1924) with the spores of *Cladonia squamosa*. In all cases the results were fairly similar: growth was slow and finally ceased—in *Xanthoria parietina* in eight or ten months. A series of tissues was however observed in the last culture: (1) a dense layer of filaments representing the medulla; above that (2) a looser tissue in the position of the gonidial layer and (3) a second dense tissue representing the cortex from which arose aerial hyphae. Tobler further records that growth became more lichenoid when the gonidial alga was introduced and the yellow acid parietin appeared in the tissues. Werner (1927) tested hyphal growth on various media and found that galactose was the most advantageous food supply. Organic nitrogen was added as peptone and asparagin, inorganic as nitrate

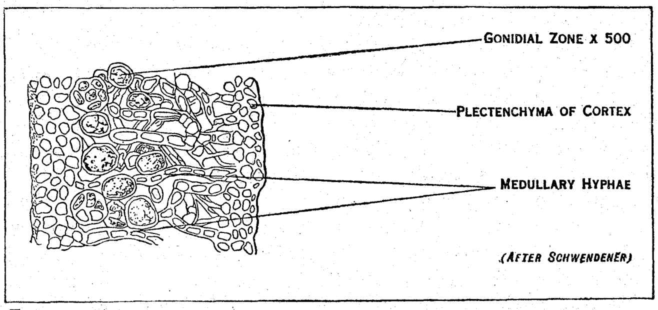


FIG. 7.—THALLUS WITH DISPERSED GONIDIA. SECTION OF HOMOIOMEROUS THALLUS X 250. (AFTER "B. M. HANDBOOK OF BRITISH LICHENS")

of ammonium. Growth was slow, but the addition of gonidia to the culture retarded it yet more, so that the algae gained in numbers.

MORPHOLOGY

The main interest in morphology lies in tracing the effect of symbiosis on development. The fungus as the dominant partner provides the structure of the thallus but the variety of forms evolved is due to the necessity of securing light and air to enable the alga to carry on the work of photosynthesis.

General Structure of Ascolichens.—In these there are two main types of thallus:—(1) the *stratose* which includes flat spreading plants, crustaceous or foliose, in which the upper surface alone is exposed to light; and (2) the *radiate* which in the lichen competition for sunlight and space has developed upwards from a rooting base to shrub-like branching fronds or pendulous filaments.

(1) The simplest stratose lichens consist of a film of loose hyphae with scattered gonidia. In further advanced species there is a more bulky thallus formed of an upper cortical protecting layer, generally of dense hyphae with more or less swollen walls and with the lumen of the cells almost obliterated (decomposed cortex); beneath the cortex a gonidial zone of massed gonidia and intermingled slender hyphae, the latter passing downwards to form a loose medulla. Projecting hair-like hyphae anchor the plant to the rock, tree or soil. The upper surface may be smooth or uneven, or seamed and cracked into small compartments called areolae. Not infrequently the crustaceous thallus is wholly embedded in the substratum as in Graphidaceae. In contrast to the surface or *epiphloeodal* forms, such lichens on trees are termed *hypophloeodal,* a stain on the bark usually indicating their presence; the fructifications are formed on the surface. Similarly rock lichens are *epilithic* or *endolithic*. The latter live in limestone, which they penetrate to various depths. Friedrich (1906) noted in an immersed species, *Biatorella simplex,* a slight cortical layer, below that a zone of gonidia 600–700 μ in thickness, while the medullary hyphae reached a depth of .47 in. An instance has been recorded of a lichen penetrating to 1.2 in. below the surface. Still higher in development are the squamulose thalli of tiny leaflets and the larger foliose (fig. 10) forms in both of which the thallus is raised from the substratum

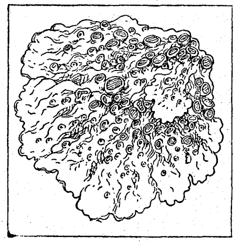


FIG. 8. — XANTHORIA PARIETINA (AFTER "THE LICHEN BOOK")

partly or entirely and in which the free under-surface also acquires a protecting cortex which generally repeats that of the upper-surface—either of decomposed cells, of plectenchyma or of hyphae parallel with the surface (fibrous cortex). Stratose lichens start from a centre, the growing tissue is situated in the gonidial zone and the greatest increase is at the periphery, the lichen gradually enlarging on all sides, in some to a size of one foot or more in diameter. Growth is continuous, but divisions may arise that are imbricate and leaf-like. In squamulose forms the squamules arise in succession from the spreading hypothallus—the travelling ground hyphae. Foliose forms are attached at irregular intervals by rhizinae.

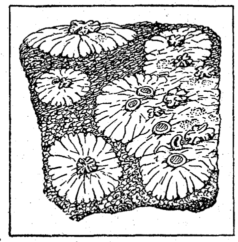


FIG. 9. — CRUSTACEOUS LICHEN (LECANORA GELIDA) WITH CEPHALODIA (AFTER "THE LICHEN BOOK")

(2) Radiate lichens, upright fruticose forms (fig. 11), start from a rooting base; the fronds are exposed to sun and air on all sides and the structure is alike round the whole surface. The cortex is of several types:—of decomposed cells, of densely packed, fastigiate hyphae or of longitudinal, thick-walled fibres. All these variations give strength and pliancy to the fronds. Other strengthening structures are the "sclerotic" fibres which extend up the frond either just within the gonidial zone as in *Ramalina* or, as in *Usnea,* in one strong chondroid central strand of great toughness and strength. Growth in radiate lichens is apical or intercalary. Fronds of *Rocellae, Ramalinae,* etc., reach a height of several inches; pendulous lichens often grow in long streamers: a length of 11 yd. has been recorded for *Usnea longissima* in the tropics.

In *Cladoniae,* the cup lichens, there is a double thallus: leaflet squamules of stratose structure, with upright stalks or *podetia,* frequently widening to a cup or *scyphus* at the top (fig. 13). The podetium becomes hollow in time but is firm and strong owing to the sclerotic fibres that line the central tube. Fructifications are borne on the tips of the podetia or on the edges of the scyphus, which seems to indicate that the podetium originated as a fruit stalk. There is great variety of form, texture and colour in each of these main groups.

Special Lichen Structures.—*Cyphellae.* There are no stomata in lichens, but ample provision is made for aeration and for gaseous exchange. Definite aeration structures (fig. 14), cyphellae or pseudo-cyphellae pierce the thick under-cortex of the Stictaceae. They are small and cup-like, in cyphellae with an overarching margin; the base rests on the medulla and the cup is filled with small loose cells. Pseudo-cyphellae lack the cup margin. In other lichens there occur dot-like openings; the lines between the areolae admit air, or the surface is seamed by cracks and delicate reticulations; soredial openings are present in many species, and in *Parmelia exasperata* there are true breathing-pores — minute cone-like outgrowths, open at the summit.

Cephalodia. These occur as excrescences on the thallus of Archilichens (with bright green gonidia), and always contain blue-green cells, mostly *Nostoc* or *Scytonema*. They are small bodies of various form and size from the minute pustules on the surface of *Peltigera aphthosa* (fig. 15) to the coralloid masses on *Lobaria laciniata*. Blue-green cells alight by chance on the thallus and the cortical hairs grow out and gradually form a cortex round them. In a few instances there are groups of blue-green cells which are absorbed into the thallus by the under-surface, and a layer of blue-green algae, below the normal bright green zone in *Solorina crocea,* also rank as cephalodia. These alien bodies seem to indicate an ancestral association of the particular lichen with blue-green gonidia, the power to combine having persisted along


FIG. 10.—FOLIOSE LICHEN (PARMELIA TILIACEA) (AFTER "THE LICHEN BOOK")

with the presumably more recent symbiosis with the bright green alga.

Soredia. As already indicated these are minute portions (hyphae and gonidia) that break away from the parent thallus and serve for propagation of species. The simplest types are diffuse soredia that in certain conditions of shade or moisture cover the surface of the plant. More defined forms are termed *soralia* which arise by the upward push of hyphae in the gonidial zone, and emerge as roundish or oblong bodies packed with soredial granules. These multiply and, as they become detached, are easily dispersed. Soralia are more or less specifically constant in form and size and in their position on the surface or margins of the lobes.

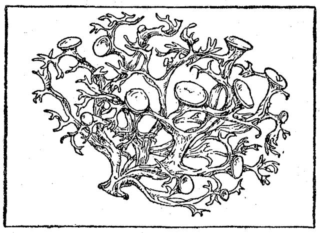


FIG. 11. — FRUTICOSE LICHEN (RAMALINA CALICARIS) (AFTER "THE LICHEN BOOK")

Isidia. Many lichens are rough on the surface owing to small outgrowths called isidia. So noticeable are they that Acharius established the genus *Isidium* to include isidiose lichens. They are cortical structures and begin generally as a small swelling or wart: they are upward extensions of the tissues and the cortex is continuous over their surface; sometimes they are darker in colour than the normal thallus as in *Evernia furfuracea* (fig. 12).

Structure of Basidiolichens.—There are three genera recorded in this group of tropical lichens: *Cora, Corella* and *Dictyonema.* The gonidia, *Chroococcus* or *Scytonema* are Myxophyceae. *Cora* and *Dictyonema* are of a thin bracket-like form; they grow on the trunks and branches of trees, very rarely on the ground, and are attached by rhizinae. No proper cortex is formed, but in *Cora* the hyphae take an upward direction towards the surface where they become horizontal, so that a compact protective tissue lies over the top; the gonidia (*Chroococcus*) form a zone at the base of the upward hyphae. In *Corella* and *Dictyonema* the *Scytonema* trichomes retain their form and are surrounded by the lichen hyphae.

Basidiolichens are related to the fungal family Thelephoraceae: the fructification is by basidiospores borne on the under-surface of the thallus.

REPRODUCTION

Lichens with few exceptions (Basidiolichens and primitive indeterminate forms) are Ascolichens, their method of reproduction corresponding to that of Ascomycetes, *i.e.*, by the production of ascospores in open or closed ascophores—apothecia or perithecia. In the slow-growing symbiotic plants these fruit bodies have been provided with special protective tissues that secure prolonged spore formation, differing in this respect from the fugitive ascophores of fungi.

Apothecia.—In lichens these are of several forms to which special names have been given:—ardellae, the irregular spot-like fruit of Arthoniaceae; lirellae, elongate, slit-like, dark-coloured bodies in Graphidaceae; in the larger majority of lichens open discoid apothecia. Those surrounded by a protective thalloid margin are called lecanorine (fig. 16), such as occur in the genus *Lecanora.* Those consisting solely of hyphal tissue surrounded by a hyphal or "proper margin" only as in *Lecidea* are described as lecideine (fig. 17). If that margin is obscure with the disk often brightly coloured they are biatorine, as in the sub-genus, *Biatora.* These are true distinctions, and are of value in the determination of genera and species. The difference is due to their origin in the thallus: in the lecanorine series gonidia are carried up with the developing fruit, and algal cells extend along the base and, entering into the "thalline margin," surround the apothecium. The lecideine tissues, solely hyphal, pass up through the gonidial zone, pierce the cortex and expand above it, the outer sterile hyphae forming the protective "proper margin." Minor differences in growth occur, with different types of apothecia—sessile or stalked, etc., and in size from a minute body to one of over 1.2 in. in width according to the genus or species of lichen. The disk or thecium is composed of a compact series of filamentous upright simple or branched paraphyses and of asci—club-like structures within which eight spores (fewer or more numerous) are produced by free cell formation. These, constituting the hymenium, are subtended by a layer of tissue, the hypothecium; the tips of the paraphyses projecting above the asci form the epithecium, generally coloured; the surrounding sterile filaments represent the parathecium; the thalline margin when present forms the amphithecium.

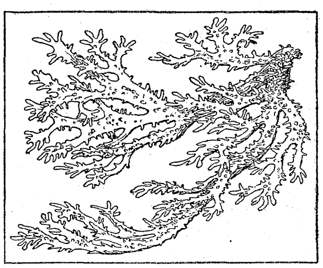


FIG. 12. — EVERNIA FURFURACEA (AFTER "THE LICHEN BOOK")

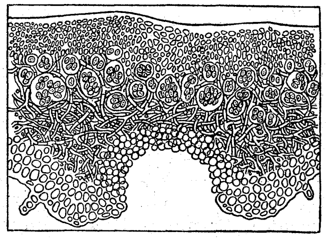
Perithecia.—These differ from the apothecia in being comparatively small, globose or pear-shaped, closed bodies immersed or semi-immersed in the thallus, and opening above by a pore, the ostiole. When the outer dark wall is continuous it is described as entire, and when absent at the base as dimidiate. In some genera the paraphyses dissolve as the asci mature.

Apothecia and perithecia are long lived like the thallus and may produce spores continuously or at definite seasons for several years, in *Solorina saccata,* for instance, over a period of two to four years, as observed by Hilitzer (1926).

Spermogonia or Pycnidia.—These are small closed bodies outwardly resembling perithecia; the hyphae that line the interior walls bud off minute pycnidiospores. As spermogonia they were considered of great importance as the male organs that produce the spermatia. There is no reliable evidence of their sexual nature and they are now generally classified as pycnidia resembling similar bodies that form a secondary stage in the fruit cycle of the Ascomycetes. It has been proved that the spermatia germinate and produce hyphae, a characteristic of spores.

FIG. 13.—SQUAMULES AND PODETEA OF CLADONIA VERTICILLATA (AFTER "THE LICHEN BOOK")

Cytology.—This aspect of reproduction has excited great interest since Fuisting (1866) observed in a crustaceous *Lecidea* the fruit primordium or ascogonium as a coiled hypha. Stahl (1877) announced the further discovery in a *Collema* of a trichogyne, a filament that travelled upwards from the ascogonium and emerged above the surface. He noted also an empty spermatium (pycnidiospore) adhering to the tip of the trichogyne after presumed fertilization. Other workers made similar observations both in gelatinous and in non-gelatinous lichens, and in open and closed fruits. Copulation with the spermatium has also been demonstrated but the behaviour of the spermatial nucleus has escaped observation. The ascogonium may be a coiled hypha or simply a complex of cells distinguished by their richer contents, and changes in these cells have been observed that seem to imply spermatial fertilization. It may be that in some lichens fusion takes place between neighbouring cells in the ascogonium: F. Bachmann (1912) found that copulation took place deep down in the thallus of *Collema* sp. between an internal trichogyne and a free spermatial cell. Apogamy, however, undoubtedly prevails in many lichens: either no trichogynes are formed or they fail to reach the surface and fertilization by spermatia is doubtful. Zahlbruckner (1924) has expressed the opinion that reproduction by sexual organs—present in the more primitive lichens—tends to die out in more developed forms. The whole subject bristles not only with the difficulties of observation in these slow growing plants, but also with the perplexities of interpretation: the function of the lichen trichogyne, a multiseptate hypha of vigorous growth, is not understood; but it may be of some service to the deep seated ascogonium. From the ascogonium arise the hyphae that are destined to form the asci. As in fungi the nuclei of two adjacent cells at the tips of these hyphae fuse and become the definitive nucleus of the ascus. There are normally eight spores, but the number varies in different genera and species from one, as in *Varicellaria,* to the large numbers in *Acarospora.* They are colourless or brown, and simple, variously septate or muriform, and they differ in size from a few microns in *Acarospora,* etc., to the large one-septate spore in *Varicellaria* ($350\times115\ \mu$). Large simple spores, as in *Pertusaria,* are multinucleate. Spore ejection is brought about by pressure of the paraphyses when moistened.



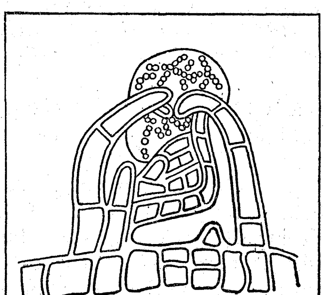
AFTER "B. M. MONOGRAPH OF BRITISH LICHENS"

FIG. 14.—SECTION OF THALLUS OF STICTA, WITH CYPHELLA ON UNDER-SURFACE MUCH MAGNIFIED

PHYSIOLOGY AND BIONOMICS

Cells and Cell-contents.—In the study of lichen physiology attention must be given to the activities of the symbionts as well as to those of the symbiotic plant. Gonidia do not greatly differ from the allied algae growing in the open: they possess chloroplasts and form starch by photosynthesis. Mameli (1920) and Tobler (1923) demonstrated minute granules of starch on the outside of the gonidia—a ready food for the fungus. The hyphal cells have been more affected by symbiosis, and a much slower growth than in fungi has become a fixed character as proved by artificial cultures. The cell-walls, as in fungal tissues, are formed of hemi-celluloses, chitin being present in nearly all lichens. There is no true cellulose, but a substance, lichenin ($C_6H_{10}O_5$), allied to starch, has been demonstrated as well as a slightly different substance, isolichenin, the latter proved by Ziegenspeck (1924) to be a reserve material. Amyloid hyphae giving a blue reaction with iodine are present in the medulla of several species. Swollen cells filled with oil, probably an excretory substance, occur in many lichens, especially in limestone species. Oxalic acid is also frequently found in lichen tissues in the form of crystals, small granules, or in large clear masses as in *Pertusaria communis.*

Lichen Acids.—These are the most interesting and characteristic of lichen products. They are deposited on the outside of the hyphal cells as minute coloured specks or as colourless substances, and show a wide range of chemical formulae and a great variety of crystalline form. They are the product of the symbiotic plant as was proved by Tobler (1909) in his cultures of lichen tissues. Many of them are bright yellow, orange or red, and give the clear pure tone of colour to many familiar lichens. They are strongly influenced by light: *Xanthoria parietina* (fig. 8), a brilliant yellow plant in full exposure, becomes gray-green in the shade, with a small acid content. Some of these acids are rare, others are widely distributed, *e.g.*—usninic acid, found in some 70 widely diverse species; atranorin, first discovered in *Lecanora atra,* in about 70 species; salazinnic acid is equally common. They are abundant chiefly on well-aerated portions of the thallus—the soredial hyphae, the outer cortex, the loose medullary tissue and on the disk of the apothecia.



FROM J. BABIKOFF, "DU DÉVELOPPEMENT DES CÉPHALODIES SUR LE THALLUS DU LICHEN PELTIGERA APHTHOSA," HOFFIN BULLETIN (ACADEMY OF SCIENCE, U.S.S.R.)

FIG. 15.—CEPHALODIUM OF PELTIGERA APHTHOSA EARLY STAGE, MUCH MAGNIFIED

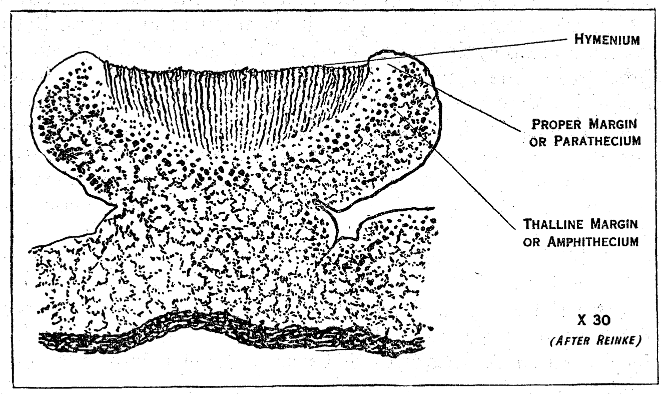
Chemical Grouping. The acids have been arranged by Zopf (1907) in 1, the fat series and 2, the benzole series.

1. The fat series. Zopf includes five groups in this series: three of the series are colourless substances, the coloured include vulpinic acid from the yellow lichen, *Letharia vulpina,* stictaurin deposited in orange-red crystals on the hyphae of *Sticta aurata* and rhizocarpic acid obtained from the yellow lichen *Rhizocarpon geographicum.*

2. The benzole series, with two sub-series—orceine and anthracine derivatives. The colourless orceine contains the colouring principle of commercial orchil. In the anthracine derivatives some of the acids are also coloured, such as parietin from *Xanthoria parietina* and solorinic acid from *Solorina crocea.* Asahina (1936) listed 19 lichen acids found in the genus Cladonia.

The question has been debated as to the service rendered by the acids: to some extent they protect the plants from wholesale destruction by snails, insects, etc., as they render the thallus more or less unpalatable. Goebel (1927) demonstrated that they are also a protection against water-logging. He found that outgrowths of hyphal hairs, cilia, etc., formed efficient water conductors, but if acids were abundant they remained dry: when the acids were removed by chemical means saturation was easily achieved. As acids are present on all aerated portions, they must be a powerful aid in keeping the air-channels open and thus serve a useful purpose.

General Nutrition.—Water is supplied by rain, mist or dew, mist being the most favourable for lichen requirements (Stocker 1927). Dew is important in extremely dry localities such as deserts. Inorganic substances are obtained to some extent from the substratum but mainly from air borne particles. Organic food is



BY COURTESY OF MESSRS. BORNTRAGER

FIG. 16.—SECTION OF LECANORINE APOTHECIUM (LECANORA SUBFUSCA)

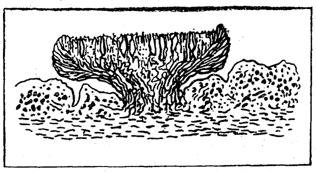
provided by the algae or may be procured by the hyphae from humus, etc.

Lichens show marvellous resistance as regards heat or cold. They survive the high temperatures of direct illumination and they endure seasons of extreme cold on mountains or in the polar zone. It is to their power of drying up to a condition of latent vitality that they owe this resistance. Light that can penetrate the thickened cortex and reach the gonidial zone is essential, but the same dense cortex protects the gonidia from too intense sunlight as do the acids and pigments. Light is of first importance in fruit formation, and the fruit bodies are therefore situated on well lighted portions of the thallus.

Bionomics.—The response of lichens to their environment is intimately associated with their physiological properties. Their scanty subsistence entails slow development though a few may be ranked as relatively quick growers—mostly soil lichens in touch with moisture. Such are *Peltigera canina* (fig. 18) that spreads over damp lawns, etc., and crustaceous forms such as *Baeomyces* spp., *Lecanora tartarea,* and *Lecidea uliginosa;* the latter has been known to spread over an area several feet in diameter in one season, and has been reported as a pioneer plant forming a dark film over sand dunes in Alberta. But in many lichens growth is often almost stationary: the large foliose *Lobaria pulmonaria* (fig. 19) and the crustaceous *Rhizocarpon geographicum* have been observed to make practically no advance during a period up to 50 years. Accurate measurements of more active *Parmeliae,* etc., have given a general increase of .39 in. per annum; their fruiting bodies require in general four to eight years to develop.

Lichens do not grow on friable rocks or on peeling bark. They require, for the first stages at least, a substratum to which they can be firmly attached by filaments or by rhizinae. In fruticose branching and straggling forms compactness is often secured by *haptera,* which form a bridging connection between the fronds of the same lichen or to other vegetation, as for instance, *Cladonia sylvatica,* which becomes detached from the soil and adheres to the growing heather, thus securing not only attachment but light and air. Some few species become loose and continue growth while they drift about as erratic lichens. Several *Parmeliae, Alectoriae* and *Lecanora esculenta,* etc., are erratic forms.

PHYLOGENY AND CLASSIFICATION



FROM A. L. SMITH, "LICHENS" (UNIVERSITY PRESS, CAMBRIDGE)
FIG. 17.—SECTION OF LECIDEINE APOTHECIUM (LECIDEA PARASEMA) (AFTER "B. M. HANDBOOK OF BRITISH LICHENS")

Phylogeny.—It would be interesting to know when the symbiotic plant originated and whether the first association of the fungus was with Myxophyceae or Chlorophyceae; but lichens, owing to the gelatinous nature of the thallus, become soft in water and there is little or no evidence in the rocks as to their antiquity: there is only a doubtful record of an *Opegrapha* in Mesozoic chalk. It is concluded from their elaborate morphology and physiology that they are very old plants, but the symbiotic organism—the lichen—is obviously of more recent descent than its component ancestors. Both symbionts are polyphyletic in origin: the algae are blue-green or bright green; the hyphae belong to various phyla of the fungi from which they are late derivatives. Basidiolichens are related to one fungus family, Telephoraceae; Ascolichens to Ascomycetes and to several distinct phyla within that class. The ascophore, which marks the phylum, has undergone considerable alteration which is recognized in classification. Phylogenetic development has, however, mainly taken place in the thallus which presumably began as a loose association of straggling hyphae with algal cells. It progressed to the definite crustaceous structure, and finally to the foliose and fruticose lichen. The greatest advance must have occurred when the thalline particle took an upward direction—a small outgrowth that was to develop into numerous forms.

The intimate relation between lichens and fungi is evident in the species that have remained on the border line. Some with scanty thallus appear to lose the algal symbiont as the ascophore matures, and the hyphae apparently revert to saprophytism as exemplified, for instance, in *Calicium,* a lichen genus, with *Mycocalicium,* the fungal counterpart. Others classified now as lichens and now as fungi live on an alien lichen thallus though not always as simple parasites; in a number of cases their hyphae penetrate the thallus and draw sustenance by symbiosis with the algal cells: these have been designated half-parasites. Lichen thalli are, however, a favourite host for many micro-fungi.

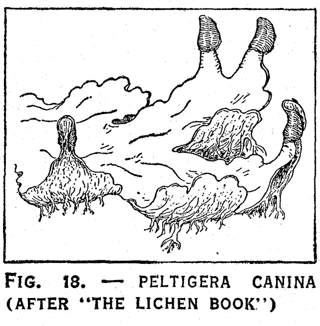


FIG. 18. — PELTIGERA CANINA (AFTER "THE LICHEN BOOK")

Classification. — Before the true nature of lichen plants was understood, many attempts had been made to classify them in relation to each other and to other members of the plant kingdom—to mosses, hepatics or algae. Tournefort (1700) placed them all in one genus *Lichen,* and was followed by Linnaeus (1753). Knowledge of their number and variety increased, and Acharius (1803) gave diagnoses of 23 genera with their included species. Nylander (1854) issued what he considered a final statement on lichen families and genera and of their relationships. His arrangement began with those nearest akin to algae, gelatinous blue-green forms, and wound up with those he considered to be most like fungi—the Pyrenocarpineae. Later students have worked from this basis.

Of the various systems proposed for showing the relationship of the lichens to each other and to the fungi, none is entirely satisfactory. Fink (1935) published an arrangement probably acceptable currently to a majority of lichenologists:

Class Ascolichenes
  Subclass Pyrenocarpeae
    Order Pyrenulales
  Subclass Gymnocarpeae
    Order Caliciales
    Order Hysteriales
    Order Lecanorales
Class Hymenolichenes
Class Lichenes Imperfecti

The exact arrangement of families and genera in this scheme is not yet well agreed upon. The best known genera in the Pyrenulales are Verrucaria, Endocarpon, Pyrenula, Trypethelium. The Caliciales, a small order, include Calicium and Sphaerophorus. Arthonia, Graphis and Roccella are typical of the Hysteriales. The Lecanorales include most of the common lichens, Lecanora, Lecidea, Parmelia, Usnea, Physcia and many others. The Hymenolichenes are few and unimportant, while the Lichenes Imperfecti embrace common forms so little understood that it can hardly be said they are classified.

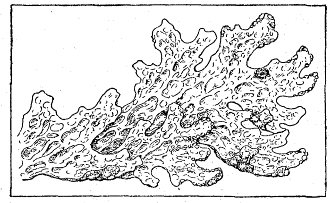


FIG. 19. — LOBARIA PULMONARIA (AFTER "THE LICHEN BOOK")

In all, more than 200 genera have been named and an incalculable number of species. It cannot be said, however, that any such number of distinct forms actually exist. The names await simplification, following more thorough studies of the true relationships.

BIBLIOGRAPHY.—Lichens are discussed in general text-books, especially in those devoted to cryptogamic botany. Only the publications concerned exclusively with lichenology are cited here. In most of these will be found lists of books and papers that deal with various aspects of the subject as outlined above.

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LICHFIELD, a city, county of a city, and municipal borough in Staffordshire, England, 115¾ mi. N.W. from London. Pop. (est. 1938) 8,760. Area 5.6 sq.mi. The town is on a stream with low hills to the east and south. There is a tradition that "Christianfield" nearby was the site of the martyrdom of 1,000 Christians during the persecutions of Maximian about 286. At Wall, 3 mi. distant, there was a Romano-British village of Letocetum ("gray wood"), from which the first half of the name Lichfield is derived. The first authentic notice of Lichfield occurs in Bede's history, where it is mentioned as the place where St. Chad fixed the episcopal see of the Mercians. At the time of the Domesday survey Lichfield was held by the bishop of Chester, who held the lordship and manor of the town until the reign of Edward VI, when they were leased to the corporation. Richard II gave a charter (1387) for the foundation of the gild of St. Mary and St. John the Baptist; this gild obtained the whole local government, which it exercised until its dissolution by Edward VI, who incorporated the town (1548). The only existing fair is a small pleasure fair of ancient origin held on Ash-Wednesday; the annual fête on Whit-Monday claims to date from the time of Alfred. King Edward VI's grammar school was founded in 1495.

The cathedral dates from the 13th and early 14th centuries. Its fine exterior has a lofty central and two lesser western spires, of which the central, 252 ft. high, is a restoration attributed to Sir Christopher Wren after its destruction during the Civil Wars. Among numerous monuments are memorials to Samuel Johnson (born at Lichfield, 1709), and to David Garrick, who spent his early life and was educated there. The bishop's palace (1687) is adjacent to the cathedral. There are many old houses, among which is that in which Johnson was born. Brewing is the principal industry, but there is some metal-working, and in the neighbourhood are large market gardens. The borough was extended in 1934 and is in the Lichfield parliamentary division.

LICH-GATE or LYCH-GATE, the roofed-in gateway to churchyards (O.E. *lic*, "a body, a corpse"). Lich-gates existed in England 13 centuries ago, but comparatively few early ones survive, as they were almost always of wood. One at Bray, Berkshire, is dated 1448. Here the clergy meet the corpse and some portion of the service is read. The gateway served to shelter the pall-bearers. The most common form of lich-gate is a simple shed composed of a roof with two gabled ends, covered with tiles or thatch.

LICHNOWSKY, KARL MAX, PRINCE (1860–1928), German diplomatist, was born at Kreuzenort, Upper Silesia, on March 8, 1860, the son of the 6th Prince Lichnowsky and of Princess Marie de Croy. He entered the German foreign office in 1884, and served in various legations until 1889 when Bülow recalled him to the foreign office. In 1912 he became ambassador in London. During his stay in London he worked hard for pacific relations between England and Germany; and the colonial agreement which was ready for signature in 1914 was largely his work. When the Serbian crisis arose in the summer of that year Lichnowsky urgently recommended the acceptance in Berlin of Sir E. Grey's mediation proposals. He had repeatedly warned Berlin of the dangers underlying the Anglo-German rivalries, but his warnings were neglected. On the outbreak of war he returned to Berlin a broken man, and found that in some quarters he was held guilty of not having done his utmost to prevent British intervention. He wrote an apologia, *Meine Londoner Mission,* of his conduct of affairs in London for private circulation, which fell into the hands of German pacifists who printed it in 1918. He was then excluded from the Prussian upper house. In 1925 he published an appeal against this exclusion, *Flugschriften des Bundes Neues Vaterland;* and in 1927 wrote *Auf dem Wege zum Abgrund* (Eng. trans. 1928), dealing with the origins of World War I. He died at his estate of Kuchelna on Feb. 27, 1928.

LICHTENBERG, GEORG CHRISTOPH (1742–1799), German satirical writer and physicist, was born at Oberramstadt, near Darmstadt, on July 1, 1742. In 1763 he entered Göttingen university, where in 1775 he became ordinary professor of physics. This post he held till his death Feb. 24, 1799. As a physicist he is best known for his investigations in electricity, more especially as to the so-called Lichtenberg figures. As a satirist and humorist, Lichtenberg takes high rank among the German writers of the 18th century. His biting wit involved him in many controversies with well-known contemporaries, such as Lavater, whose science of physiognomy he ridiculed, and Voss, whose views on Greek pronunciation he satirized in *Über die Pronunciation der Schöpse des alten Griechenlandes* (1782). He resided for some time in England; his *Briefe aus England* (1776–78), with admirable descriptions of Garrick's acting, are the most attractive of his writings. He contributed to the *Göttingisches Magazin der Literatur und Wissenschaft,* of which he was co-editor (1780–82). He also published in 1794–99 an *Ausführliche Erklärung der Hogarthschen Kupferstiche.*

Lichtenberg's *Vermischte Schriften* were published by F. Kries in 9 vols. (1800–05; new editions in 8 vols., 1844–46 and 1867). Selections by E. Grisebach, *Lichtenbergs Gedanken und Maximen* (1871); by F. Robertag in Kürschner's *Deutsche Nationalliteratur* (vol. 141, 1886); and by A. Wilbrandt (1893). Lichtenberg's *Briefe* have been published in 3 vols. by C. Schüddekopf and A. Leitzmann (1900–02); his *Aphorismen* by A. Leitzmann (3 vols., 1902–06). *See* also R. M. Meyer, *Swift und Lichtenberg* (1886); F. Lauchert, *Lichtenbergs schriftstellerische Tätigkeit* (1893); and A. Leitzmann, *Aus Lichtenbergs Nachlass* (1899).

LICHTENBERG, formerly a small German principality on the Rhine, now belonging to the district of Trier, Prussian Rhine province. The principality includes parts of the electorate of Trier, and Nassau-Saarbrücken. Originally called the lordship of Baumholder, it owed the name of Lichtenberg and its elevation in 1819 to a principality to Ernest, duke of Saxe-Coburg, to whom it was ceded by Prussia, in 1816. The duke restored it to Prussia in 1834. The area is about 210 sq.mi.

LICINIANUS, GRANIUS, Roman annalist, probably lived in the age of the Antonines (2nd century A.D.). He wrote a brief epitome of Roman history based upon Livy. Accounts of omens and portents apparently took up a large portion of the work.

Editions by C. A. Pertz (1857); seven Bonn students (1858); M. Flemisch (1904); *see* also J. N. Madvig, *Kleine philologische Schriften* (1875), and the list of articles in periodicals in Flemisch's edition (p. iv).

LICINIUS (FLAVIUS GALERIUS VALERIUS LICINIANUS), Roman emperor, A.D. 307–324, of Illyrian peasant origin, was born probably about 250. He was elevated to the rank of Augustus by Galerius, his former friend and companion in arms, on Nov. 11, 307, receiving as his immediate command the provinces of Illyricum. On the death of Galerius, in May 311, he shared the entire empire with Maximinus, the Hellespont and the Thracian Bosporus being the dividing line. In April 313 he inflicted a decisive defeat on Maximinus at Heraclea Pontica, and established himself master of the east while his brother-in-law, Constantine, was supreme in the west. In 314 his jealousy led him to encourage a treasonable enterprise against Constantine. When his perfidy became known a civil war ensued, in which he was twice severely defeated. The outward reconciliation left Licinius in possession of Thrace, Asia Minor, Syria and Egypt, but added numerous provinces to the western empire. In 323 Constantine again declared war against him, and, having defeated his army at Adrianople, succeeded in shutting him up within the walls of Byzantium. The defeat of Licinius' fleet compelled his withdrawal to Bithynia, where a last stand was made; the battle of Chrysopolis, near Chalcedon, finally resulted in his submission. He was executed in the following year.

See Zosimus ii 7–28; Zonaras xiii 1; Victor, *Caes.* 40, 41; Eutropius x 3; Orosius vii 28.

LICINIUS CALVUS STOLO, GAIUS: *see* ROME: *Ancient History.*

LICINIUS MACER CALVUS, GAIUS (82–47 B.C.), Roman poet and orator, the son of the annalist Licinius Macer. As a poet he followed his friend Catullus in style and choice of subjects. As an orator he was the leader of the opponents of the florid Asiatic school, who took the simplest Attic orators as their model and attacked even Cicero as wordy and artificial. Twenty-one speeches by him are mentioned, among which the most famous were those delivered against Publius Vatinius. Calvus was very short of stature, and is alluded to by Catullus (Ode 53) as *Salaputium disertum* (eloquent Lilliputian).

For Cicero's opinion see *Brutus,* 82; Quintilian x 1. 115; Tacitus, *Dialogus,* 18. 21; the monograph by F. Plessis (Paris, 1896) contains a collection of the fragments (verse and prose).

LICTORS [Lat. *lictores*], in Roman antiquities, a class of the attendants (*apparitores*) upon certain Roman and provincial magistrates. As an institution they went back to the regal period and continued to exist till imperial times. The majority of the city lictors were freedmen; they formed a corporation divided into decuries, from which the lictors of the magistrates in office were drawn; provincial officials had the nomination of their own. In Rome they wore the toga; on a campaign and at the celebration of a triumph, the red military cloak (*sagulum*); at funerals, black. As representatives of magistrates who possessed the *imperium,* they carried the fasces (*see* FASCES). They were exempt from military service; received a fixed salary; theoretically they were nominated for a year, but really for life. They were the constant attendants of the magistrate to whom they were attached. They cleared a passage for him (*summovere*) through the crowd, and saw that he was received with the marks of respect due to his rank. They stood by him when he took his seat on the tribunal; mounted guard before his house, against the wall of which they stood the fasces; summoned offenders before him, seized, bound and scourged them, and (in early times) carried out the death sentence. Directly a magistrate entered an allied, independent state, he was obliged to dispense with his lictors. Each of the consuls had 12 lictors; the dictator, as representing both consuls, 24; the emperors 12, until the time of Domitian, who had 24. The Flamen Dialis, and each of the Vestals were also accompanied by lictors. These lictors were probably supplied from the lictores curiatii, 30 in number, whose functions were specially religious, one of them being in attendance on the pontifex maximus. They originally summoned the comitia curiata, and when its meetings became merely a formality, acted as the representatives of that assembly.

Bibliography.—For the fullest account of the lictors, *see* Mommsen, *Römisches Staatsrecht*, i. 355, 374 (3rd ed., 1887), *cf.* J. E. Sandys, *Companion to Latin Studies* (1921).

LIDCOMBE: *see* Sydney (New South Wales, Australia).

LIDDELL, HENRY GEORGE (1811–1898), English scholar and divine, was born at Binchester, near Bishop Auckland, on Feb. 6, 1811. He was educated at Charterhouse and Christ Church, Oxford, became a college tutor, and was ordained in 1838. In 1846 he became headmaster of Westminster school. Early in 1834 he and Robert Scott began the great *Lexicon* (based on the German work of F. Passow) which became his life work, and the 1st edition was published in 1843. It is still the standard Greek-English dictionary (revised ed. by H. S. Jones in 1925). In 1855 he became dean of Christ Church, and took an active part in the first Oxford University Commission. He resigned the deanery in 1891 and retired to Ascot, where he died on Jan. 18, 1898.

See H. L. Thompson, *Henry George Liddell* (1899).

LIDDESDALE, the valley of Liddel Water, Roxburghshire, Scotland, extending 21 mi. from the Peel Fell to the Esk. The Waverley route of the L.N.E.R. runs down the dale, and the Catrail, or Picts' Dyke, crosses its head. At one period points on the river were occupied with freebooters' peel-towers, but many have disappeared. Larriston Tower belonged to the Elliots, Mangerton to the Armstrongs and Park to "little Jock Elliot," the outlaw who nearly killed Bothwell in 1566. Hermitage castle, a massive H-shaped fortress and one of the oldest baronial buildings in Scotland, stands on a hill overlooking Hermitage Water, a tributary of the Liddel. It was built in 1244 and captured by the English in David II's reign. It was retaken by Sir William Douglas, who received a grant of it from the king. In 1492 Archibald Douglas, 5th earl of Angus, exchanged it for Bothwell castle on the Clyde with Patrick Hepburn, 1st earl of Bothwell. It passed to the duke of Buccleuch. It was there that Sir Alexander Ramsay of Dalhousie was starved to death by Sir William Douglas in 1342, and that James Hepburn, 4th earl of Bothwell, was visited by Mary, queen of Scots, after the assault referred to.

LIDDON, HENRY PARRY (1829–1890), English divine, was the son of a naval captain and was born at North Stoneham, Hampshire, on Aug. 20, 1829. He was educated at King's College school, London, and at Christ Church, Oxford. As vice-principal of the theological college at Cuddesdon (1854–59) and as vice-principal of St. Edmund's Hall, Oxford, he withstood the liberal reaction against Tractarianism, which had set in after Newman's secession in 1845. In 1864 he became prebendary of Salisbury cathedral. In 1866 he delivered his Bampton Lectures on the *Divinity of Our Lord* (13th ed., 1889), which established his fame. In 1870 he was made canon of St. Paul's Cathedral, London, where his preaching attracted vast crowds. In 1870 he had also been made Ireland professor of exegesis at Oxford. His position gave him extensive influence over the Church of England. In 1886 he became chancellor of St. Paul's. He died on Sept. 9, 1890.

See J. Johnston, *Life and Letters of Dean Liddon.*

LIDICE, a mining village in Czechoslovakia, near the coal fields of Kladno. This unknown village sprang into world fame at the very day of its complete destruction, announced officially by the Germans on June 10, 1942. The Germans suspected that some inhabitants had supported the patriots who killed the German police general, Reinhard Heydrich, reichsprotektor for Bohemia and Moravia. According to official German statements, all the male inhabitants, irrespective of age, and 56 women were immediately executed. The other women were put into concentration camps; the children were carried off to correction schools, "all buildings of the village were levelled to the ground and the name of the village was immediately abolished." These actions aroused world-wide sympathy and protest. Towns in several countries were renamed to commemorate the Czech village, among them Lidice, Illinois, near Joliet, U.S.A., inaugurated July 12, 1942, and Lidice, Mexico, formerly known as San Geronimo, near Mexico City.

LIE, JONAS LAURITZ EDEMIL (1833–1908), Norwegian novelist, was born on Nov. 6, 1833, close to Hougsund (Eker), near Drammen. In 1838, his father being appointed sheriff of Tromsö, the family removed to that Arctic town. Here Lie gained acquaintance with the wild seafaring life which he was afterwards to describe. He studied at Christiania (Oslo), where Ibsen and Björnson were among his fellow-students. On completing his studies he began to practise as a solicitor at Kongsvinger. In 1860 he married his cousin, Thomasine Lie, who collaborated with him in his works. In 1866 he published his first book, a volume of poems. Financial embarrassment drove him to Christiania to try his luck as a man of letters. As a journalist he had no success, but in 1870 he published a melancholy little romance, *Den Fremsynte* (Eng. trans., *The Visionary*, 1894), which made him famous. Lie proceeded to Rome, and published *Tales* in 1871 and *Tremasteren "Fremtiden"* (Eng. trans., *The Barque "Future,"* Chicago, 1879), a novel, in 1872. *Lodsen og hans Hustru* (*The Pilot and his Wife*, 1874) placed him at the head of Norwegian novelists, and brought him a small government stipend. Lie spent the next few years partly in Dresden, partly in Stuttgart. He then returned to Norway for a short time, and there wrote some novels of contemporary Norwegian life. But he was back in Germany very soon. From 1882 to 1891 he made Paris his headquarters. His later years were spent in Norway, and he died at Christiania on July 5, 1908. Two of the most successful of his numerous novels were *The Commodore's Daughters* (1886) and *Niobe* (1894), both of which were included in the International library. In 1891–1892 he wrote, under the influence of the new romantic impulse, twenty-four folk-tales, printed in two volumes entitled *Trold.* Some of these were translated by R. N. Bain in *Weird Tales* (1893), illustrated by L. Housman. His *Samlede Vaerker* were published at Copenhagen in 14 vols. (1902–1904). As a novelist Jonas Lie stands with those minute and unobtrusive painters of contemporary manners who defy arrangement in this or that school. He is with Mrs. Gaskell or Ferdinand Fabre; he is not entirely without relation with that old-fashioned favourite of the public, Fredrika Bremer.

LIE, MARIUS SOPHUS (1842–1899), Norwegian mathematician, was born at Nordfjordeif, near Bergen, on Dec. 17, 1842, and was educated at the University of Christiania (now Oslo). In 1869 he went to Berlin and there met Klein, in conjunction with whom he afterwards published several papers. In 1871 he was appointed assistant tutor in Christiania university, in the same year submitting for his doctor's degree his famous memoir *Ueber Complexe, insbesondere Linien- und Kugel-Complexe, mit Anwendung auf die Theorie partieller Differential-Gleichungen*, in which he advanced the theory of tangential transformations. He was appointed extraordinary professor in 1872, and the following year began his researches on continuous transformation groups, and discovered his transformation, making a sphere correspond to a straight line (*Comptes Rendus*, vol. lxxi.). In 1884 Engel went to assist Lie, and after nine years' work was published *Theorie der Transformationsgruppen* (3 vols., Leipzig, 1893), a work of wide range and great originality. In 1886 Lie succeeded Klein in the chair of mathematics at Leipzig, Engel being appointed his assistant. In 1898 he returned to Christiania to accept a special post created for him, but his health was already broken and he died on Feb. 18, 1899. Besides his development of transformations, Lie made contributions to differential geometry, but his primary aim was the advancement of the theory of differential equations.

An analysis of Lie's works is given in the *Bibliotheca Mathematica* (Leipzig, 1900).

LIEBER, FRANCIS (1800–1872), German-American publicist, was born at Berlin on March 18, 1800. He served with his two brothers under Blücher in the campaign of 1815, fighting at Ligny, Waterloo and Namur, where he was twice dangerously wounded. Shortly afterwards he was arrested for his political sentiments, the chief evidence against him being several songs of liberty which he had written. After several months he was discharged without a trial, but was forbidden to pursue his studies at the Prussian universities. He accordingly went to Jena, continuing his studies at Halle and Dresden. He subsequently took part in the Greek War of Independence, publishing his experiences in his *Journal in Greece* (Leipzig, 1823, and under the title *The German Anacharsis,* Amsterdam, 1823). In 1827 he went to the United States and as soon as possible was naturalized. He settled at Boston, and for five years edited *The Encyclopaedia Americana.* From 1835 to 1856 he was professor of history and political economy in South Carolina college at Columbia, S.C., and during this period wrote his three chief works, *Manual of Political Ethics* (1838), *Legal and Political Hermeneutics* (1839) and *Civil Liberty and Self Government* (1853). In 1857 he was elected to a similar post in Columbia college, New York, where in 1865 he became professor of constitutional history and public law. During the Civil War Lieber rendered services of great value to the Government. Upon the requisition of the president, he prepared the important *Code of War for the Government of the Armies of the United States in the Field.* This code suggested to Bluntschli his codification of the law of nations, as may be seen in the preface to his *Droit International Codifié.* During this period also, Lieber wrote his *Guerilla Parties with Reference to the Laws and Usages of War.* He died Oct. 2, 1872.

His *Miscellaneous Writings* were published by D. C. Gilman (Philadelphia, 1881). *See* T. S. Perry, *Life and Letters* (1882), and biography by Harby (1899). Consult also Ernest Nys, "Francis Lieber, His Life and Work," *Am. Jour. Internat. Law,* vol. v., pp. 84–117, 335–393 (1911); Chester Squire Phinmy, *Francis Lieber's Influence on American Thought* (1918); and Louis Martin Sears, "The Human Side of Francis Lieber," *So. Atlantic Quar.,* vol. xxvii., p. 42–61 (1928).

LIEBERMANN, MAX (1847–1935), German painter and etcher, was born in Berlin on July 20, 1847. After studying under Steffeck, he entered the school of art at Weimar in 1869. Though the straightforward simplicity of his first exhibited picture, "Women plucking Geese" (Berlin, National gallery) in 1872, presented already a striking contrast to the conventional art then in vogue, it was heavy and bituminous in colour. In his course he was confirmed by Munkacsy's influence in Paris in 1872. A summer spent at Barbizon in 1873, where he became acquainted with Millet and studied the works of Corot, Troyon and Daubigny, resulted in the clearing and brightening of his palette. He subsequently went to Holland, where the example of Israels confirmed him in the method he had adopted at Barbizon; on his return to Munich in 1878 he caused much unfavourable criticism by his realistic painting of "Christ in the Temple," which was condemned by the clergy as irreverent. Henceforth he devoted himself exclusively to the study of light and to the painting of the life of humble folk. He found his best subjects in the orphanages and asylums for the old in Amsterdam, among the peasants in the fields and village streets of Holland, and in the beer-gardens, factories and workrooms of his own country.

Liebermann did for his country what Millet did for France. His pictures hold the fragrance of the soil and the breezes of the heavens. His people move in their proper atmosphere and their life is stated in all its monotonous simplicity. His work being at variance with the academic tradition he became the leader of the Secession. His first success was a medal awarded him for "An Asylum for Old Men" at the 1881 salon. Then followed "The Cobbler's Shop" (1881) and "The Flax Spinners" (1887) both of which are now in the National gallery, Berlin. In 1884 he settled in Berlin, where he became president of the Academy. Liebermann is represented in most of the German and other continental galleries. His etchings are to be found in the leading print rooms of Europe. In 1933 he elected, as a Jew, to leave Germany.

LIEBIG, JUSTUS VON, Baron (1803–1873), German chemist, was born at Darmstadt on May 12, 1803. His father, a drysalter and dealer in colours, used sometimes to make experiments in the hope of improving his processes and thus the son early acquired familiarity with practical chemistry. For the theoretical side he read all the textbooks which he could find. At the age of 15 he entered the shop of an apothecary at Heppenheim near Darmstadt; but he soon found how great is the difference between practical pharmacy and scientific chemistry. He next entered the university of Bonn, but migrated to Erlangen with the professor of chemistry, K. W. G. Kastner (1783–1857). He then went to Paris, where by the help of L. J. Thénard he gained admission to the private laboratory formerly used by Vauquelin and occupied by H. F. Gautier de Glaubry (1792–1873), professor of chemistry at the École de Pharmacie, Paris. Soon afterwards, by the influence of A. von Humboldt, he was given quarters in the laboratory of Gay-Lussac. He attended lectures of Gay-Lussac, Thénard, Dulong, Petit, Laplace and Cuvier. There he concluded, in 1824, his investigations on the composition of the fulminates. On Humboldt's advice he determined to become a teacher of chemistry, and after overcoming many difficulties he was appointed extraordinary professor of chemistry at Giessen in 1824, becoming ordinary professor two years later. His most important work was accomplished at Giessen. He persuaded the Darmstadt government to provide a chemical laboratory in which the students might obtain a proper practical training. This laboratory, unique of its kind at the time, in conjunction with Liebig's unrivalled gifts as a teacher, soon rendered Giessen the most famous chemical school in the world. In it were trained many accomplished chemists and it gave a great impetus to the progress of chemical education throughout Germany. Liebig remained at Giessen for 28 years, until, in 1852, he became professor of chemistry at Munich university. He died at Munich on April 18, 1873. His grave is in the Alt Süd Friedhof.

Work on Pure Chemistry includes improvements in technique of organic analysis, his method for determining the natural alkaloids and for ascertaining the molecular weights of organic bases by means of their chloroplatinates, his process for determining the quantity of urea in a solution, and his invention of the potash bulb, formerly known in every laboratory. He did not invent the condenser commonly known as the "Liebig" condenser, but popularized its use. His contributions to inorganic chemistry were numerous, including investigations on the compounds of antimony, aluminum, silicon, etc., on the separation of nickel and cobalt, and on the analysis of mineral waters, but they are outweighed in importance by his work on organic substances. In this domain his first research was on the fulminates of mercury and silver, and his study of these bodies led him to the discovery of the isomerism of cyanic and fulminic acids. Further work on cyanogen and connected substances yielded a great number of interesting derivatives. He described an improved method for the manufacture of potassium cyanide and for the analysis of cyanides by titration with silver nitrate.

In 1832 he published, jointly with Wöhler (*q.v.*), one of the most famous papers in the history of chemistry, that on the oil of bitter almonds (benzaldehyde), wherein it was shown that the radicle benzoyl might be regarded as forming an unchanging constituent of a long series of compounds. Berzelius hailed this discovery as marking the dawn of a new era in organic chemistry. A continuation of their work on bitter almond oil by Liebig and Wöhler resulted in the elucidation of the mode of formation of that substance and in the discovery of the ferment emulsin as well as the recognition of the first glucoside, amygdalin. Another and not less important and far-reaching inquiry in which they collaborated was that on uric acid, published in 1837. About 1832 he began his investigations into the constitution of ether and alcohol and their derivatives. These on the one hand resulted in the enunciation of his ethyl theory, by the light of which he looked upon those substances as compounds of the radical ethyl (C_2H_5); on the other they yielded chloroform, chloral and aldehyde, as well as other compounds, and also the method of forming mirrors by depositing silver from a slightly ammoniacal solution by acetaldehyde. In 1837, with Dumas, he published a note on the constitution of organic acids, and in the following year an elaborate paper on the same subject appeared under his name alone; by this work T. Graham's (*q.v.*) doctrine of polybasicity was extended to the organic acids. Liebig also did much to further the hydrogen theory of acids.

Animal and Vegetable Physiology.—These and other studies in pure chemistry mainly occupied his attention until about 1838, but the last 35 years of his life were devoted more particularly to the chemistry of the processes of life, both animal and vegetable. In animal physiology he attempted to trace out the operation of chemical and physical laws in the maintenance of life and health. To this end he examined such vital products as blood, bile and urine; he analyzed the juices of flesh, establishing the composition of creatin and investigating its decomposition products, creatinin and sarcosin; he classified the various articles of food in accordance with the special function performed by each in the animal economy and expounded the philosophy of cooking. In opposition to many of the medical opinions of his time he taught that the heat of the body is the result of the processes of combustion and oxidation performed within the organism. A secondary result of this line of study was the preparation of his food for infants and of his world-famous extract of meat.

Vegetable physiology he pursued with special reference to agriculture. His first publication on this subject was *Die Chemie in ihrer Anwendung auf Agricultur und Physiologie* in 1840, which was at once translated into English by Lyon Playfair. Rejecting the old notion that plants derive their nourishment from humus, he taught that they get carbon and nitrogen from the carbon dioxide and ammonia present in the atmosphere, these compounds being returned by them to the atmosphere by the processes of putrefaction and fermentation, while their potash, soda, lime, sulphur, phosphorus, etc., come from the soil. Of the carbon dioxide and ammonia no exhaustion can take place, but of the mineral constituents the supply is limited because the soil cannot afford an indefinite amount of them; hence the chief care of the farmer, and the function of manures, is to restore to the soil those minerals which each crop is found, by the analysis of its ashes, to take up in its growth. On this theory he prepared artificial manures containing the essential mineral substances together with a small quantity of ammoniacal salts, because he held that the air does not supply ammonia fast enough in certain cases, and carried out systematic experiments on ten acres of poor sandy land which he obtained from the town of Giessen in 1845. But in practice the results were not wholly satisfactory, and it was a long time before he recognized one important reason for the failure in the fact that to prevent the alkalis from being washed away by the rain he had taken pains to add them in an insoluble form, whereas, as was ultimately suggested to him by experiments performed by J. T. Way about 1850, this precaution was not only superfluous but harmful, because the soil possesses a power of absorbing the soluble saline matters required by plants and of retaining them, in spite of rain, for assimilation by the roots.

Liebig's literary activity was very great. The Royal Society's *Catalogue of Scientific Papers* enumerates 318 memoirs under his name, exclusive of many others published in collaboration with other investigators. In 1832 he founded the *Annalen der Pharmazie,* which became the *Annalen der Chemie und Pharmazie* in 1840 when Wöhler became joint editor with him, and *Annalen der Chemie* in 1874. In 1837 with Wöhler and Poggendorff he established the *Handwörterbuch der reinen und angewandten Chemie.* After the death of Berzelius he continued the *Jahresbericht* with H. F. M. Kopp.

The following are his most important separate publications, many of which were translated into English and French almost as soon as they appeared: *Anleitung zur Analyse der organischen Körper* (1837); *Die Chemie in ihrer Anwendung auf Agrikultur und Physiologie* (1840); *Die Thier-Chemie oder die organische Chemie in ihrer Anwendung auf Physiologie und Pathologie* (1842); *Handbuch der organischen Chemie mit Rücksicht auf Pharmazie* (1843); *Chemische Briefe* (1844); *Chemische Untersuchungen über das Fleisch und seine Zubereitung zum Nahrungsmittel* (1847); *Die Grundsätze der Agrikultur-Chemie* (1855); *Über Theorie und Praxis in der Landwirthschaft* (1856); *Naturwissenschaftliche Briefe über die moderne Landwirthschaft* (1859). A posthumous collection of his miscellaneous addresses and publications appeared in 1874 as *Reden und Abhandlungen,* edited by his son George (b. 1827). His criticism of Bacon, *Über Francis von Verulam,* was first published in 1863 in the *Augsburger allgemeine Zeitung,* where also most of his letters on chemistry made their first appearance. His autobiographical notes appeared in *Berichte der deutschen chemischen Gesellschaft* (1890).

See also *The Life Work of Liebig* (London, 1876) by his pupil A. W. von Hofmann, which is the Faraday lecture delivered before the London Chemical Society in March 1875, and is reprinted in Hofmann's *Zur Erinnerung an vorangegangene Freunde;* also W. A. Shenstone, *Justus von Liebig, his Life and Work* (1895); Tilden's *Famous Chemists* (1921); A. Kohut, *J. Liebig, Sein Leben und Werken* (1903); J. Volhard, *Justus von Liebig,* 2 vols. (1909); R. Blunck, *Justus von Liebig* (1938); R. Winderlich, Essay in Bugge's *Das Buch der grossen chemiker* (1930); R. E. Oesper, *Journal of Chemical Education* (1927); etc. His extensive correspondence with Wöhler, Schönbein, Mohr, Berzelius, etc. has been published, likewise his letters to his parents. The laboratory at Giessen and the birth house at Darmstadt have been made into museums. Imposing monuments were erected at Giessen and Munich.

LIEBKNECHT, KARL (1871–1919), German socialist, was born in Leipzig on Aug. 13, 1871. The son of Wilhelm Liebknecht (*q.v.*), he qualified as a lawyer, and became a prominent member of the extreme left wing of the Social Democrat party. After serving a sentence of 18 months' imprisonment for high treason, in 1908 he was elected to the Prussian chamber of deputies, and in 1912 entered the reichstag as a Social Democrat. He was one of a small group who refused to vote war credits in 1914. He violently opposed the war and the successive votes of credit. He organized antiwar demonstrations, and in 1916 gave the police the desired opportunity for arresting him by shouting "down with the war" to some troops passing through the Potsdamer Platz. He was condemned to two years' penal servitude, and was released only on Oct. 22, 1918. Before his imprisonment he had founded the international group, later the Spartacus Union, the policy of which was based on the full execution of the Erfurt programme. Liebknecht's condemnation was the signal for a strike of the metal workers in Berlin organized by the Spartacists independently of the trade unions. On his release in 1918 he placed himself at the head of the Spartacists and demanded a "free socialist republic," but the independent socialists had joined hands with the Ebert party, and Liebknecht's efforts failed. During the insurrection of the Spartacists in Jan. 1919 Liebknecht was arrested; while being conveyed from military headquarters in the west end of Berlin to the prison at Moabit on Jan. 15, he was brutally murdered, on the usual pretext of attempted escape. His comrade, Rosa Luxemburg, perished the same night. Their bodies were thrown into the canal; Liebknecht's was recovered and received a public funeral.

See his *Militarismus und Antimilitarismus* (1908, Eng. trans. 1918); *Briefe aus dem Felde, aus der Untersuchungschaft und aus dem Zuchthaus* (1919); H. Schumann, *Karl Liebknecht, ein unpolitisches Bild* (1919).

LIEBKNECHT, WILHELM (1826–1900), German socialist, was born at Giessen on March 29, 1826, and educated at the universities of Giessen, Bonn and Marburg. His political activities, which resulted from socialistic convictions acquired in his youth, led to his expulsion from Berlin, and in 1846 he left Germany for Switzerland where he earned his living by teaching. Returning in 1848, he endeavoured to found a republic in Baden and after suffering eight months' imprisonment was again forced to flee the country. He went to Geneva, where he came into intercourse with Mazzini; but being expelled from Switzerland he went to London, where he lived for 13 years in close association with Karl Marx. He endured great hardships, but secured a livelihood by teaching and writing; he was a correspondent of the *Augsburger Allgemeine Zeitung.* The amnesty of 1861 opened for him the way back to Germany, and in 1862 he accepted the post of editor of the *Norddeutsche Allgemeine Zeitung.* Only a few months elapsed before the paper passed under Bismarck's influence, but Liebknecht remained faithful to his principles and resigned his editorship. He became a member of the *Arbeiterverein,* and after the death of Ferdinand Lassalle he was the chief Socialist leader in Germany and was instrumental in spreading the influence of the newly-founded *International,* which stood under the leadership of Karl Marx. Expelled from Prussia in 1865, he settled at Leipzig, and it is primarily to his activity in Saxony among the newly-formed unions of workers that the modern Social Democrat party owes its origin. Here he conducted the *Demokratisches Wochenblatt.* In 1867 he was elected a member of the North German reichstag, where he opposed the policy of compromise of Lassalle's followers.

Liebknecht was strongly influenced by the "great German" traditions of the Democrats of 1848, and distinguished himself by his attacks on the policy of 1866 and the "revolution from above," and by his opposition to every form of militarism. His adherence to the traditions of 1848 are also seen in his dread of Russia, which he maintained to his death. His opposition to the War of 1870 exposed him to insults and violence, and in 1872 he was condemned to two years' imprisonment in a fortress, for treasonable intentions. The union of the German Socialists, which was achieved by a fusion of the groups under Liebknecht's leadership and the Lassalleans, in 1874 at the congress of Gotha was a triumph of his influence, and from that time he was regarded as founder and leader of the combined party. From 1874 till his death he was a member of the German reichstag, and for many years also of the Saxon diet. He was one of the chief spokesmen of the party, and he took an important part in directing its policy. In 1881 he was expelled from Leipzig, but took up his residence in a neighbouring village. After the lapse of the Socialist law (1890) which had made socialist organizations, publications and propaganda illegal, he became chief editor of the *Vorwärts* and settled in Berlin. If he did not always find it easy in his later years to follow the new developments, he preserved to his death the idealism of his youth, the hatred both of liberalism and of state socialism; and though he was to some extent overshadowed by Bebel's greater oratorical power, he was the chief support of the orthodox Marxian tradition. Liebknecht wrote numerous pamphlets and books, among which were: *Robert Blum und seine Zeit* (Nuremberg, 1892); *Geschichte der Französischen Revolution* (Dresden, 1890); *Die Emser Depesche* (Nuremberg, 1899) and *Robert Owen* (Nuremberg, 1892). He died at Charlottenburg on Aug. 7, 1900.

See Kurt Eisner, *Wilhelm Liebknecht, sein Leben und Wirken* (1900).

LIECHTENSTEIN, one of the smallest independent sovereign states of Europe (*see* SAN MARINO and MONACO), 65 sq.mi. in extent, and bounded by the right bank of the Rhine a few miles above Lake Constance. Westward lies the canton of St. Gallen (Switzerland). To the east lies the former Austrian Vorarlberg, and southward are the western crests of the Rhätikon, between Liechtenstein and Graubunden (Switzerland). The country, geographically, is more German-Austrian than Swiss—politically its interests have oscillated between both. The major physical divisions are: (1) A small narrow strip along the Rhine valley, widening northward into the triangular lowland of the confluence of the Rhine and the tributary Ill. (2) The larger upland area, practically bisected by the Samina which feeds the Ill. The highest peaks lie southward, with Falkais (8,401 feet), central south, and Naafkopf (8,432 feet), southeast, at the meeting points of the three frontiers. The chief settlements are at the western foot of the uplands and not on the Rhine itself. In order from the south, they are Balzers, Triesen, Vaduz (capital and seat of government, pop. 2,020), Schaan and Nendeln. They are linked by the road joining Ragaz (Switzerland) with Feldkirch (Germany). Two small settlements, Eschen and Mauern, lie in the northern triangular lowland. Liechtenstein's only railway crosses the centre of the western frontier from Buchs (Switzerland) and then parallels the road through Schaan and Nendeln. Pop. (1941) 11,102, is largely German in origin and speech, Roman Catholic in religion and agricultural in interest. Corn, wine and fruit are grown and cattle are reared. There are also small manufactures of cotton, leather and pottery.

The principality, founded in 1719, consisted of the lordships of Schellenburg and Vaduz, and formed part of the Holy Roman empire. From 1806–15 it was included in the Rhine confederation, and from 1815–66 in the German confederation. Since 1866 it has been independent. Prince Johann II (1840–1929) succeeded his father in 1858. The constitution after 1921, provided a *Landtag* of 15 members elected by direct vote; suffrage is universal. The standing army was abolished in 1868. Public debt (Jan. 1, 1940), 5,600,000 francs. Until 1919 Liechtenstein was closely allied with Austria; in 1921 it adopted Swiss currency, and after 1924 it was included in the Swiss Customs union. Switzerland administers its telegraph and postal services. Franz I (1853–1938) succeeded his brother in 1929, and was in turn succeeded by his great-nephew, Franz Josef, in 1938.

See *Tätigkeits- und Rechenschaftsberichte der fürstlichen liechtensteinischen Regierung* (Vaduz Annual); J. von Falke, *Geschichte des fürstlichen Hauses Liechtenstein* (Vienna, 1868–83); J. C. Heer, *Vorarlberg und Liechtenstein Feldkirch* (1906); A. Helbock, *Quellen zur Geschichte Vorarlbergs und Liechtenstein* (Berne, 1920).

LIEDERTAFEL (Ger., lit. "song table"), a type of musical society formerly very popular and numerous in Germany, devoted to four-part singing for male voices, and combining refreshments and social intercourse with its music, whence the name. In recent years the older Liedertafeln have been more or less superseded by the larger male voice choirs, though the name has been retained for the public invitation concerts given by the latter.

LIÉGE, one of the nine provinces of Belgium, the successor of the old prince-bishopric, touching on the east Dutch Limburg and Rhenish Prussia. Its towns are Liége, Verviers, Spa, Seraing, Huy, etc. The Meuse flows through the centre, and its valley from Huy to Herstal is one of the most productive mineral districts in Belgium. Agriculture in the Condroz district south of the Meuse has been much developed. There are three administrative arrondissements, 28 cantons and 373 communes, and the districts of Eupen, Malmédy, St. Vith and the former neutral district of Moresnet after 1919 became part of the province. Area 1,525 sq.mi. Pop. (est. 1939) 969,948 or 636 per square mile.

LIÉGE (Flemish, *Luik,* Ger. *Lüttich*), capital of the Belgian province of Liége, on the Meuse, long the seat of a prince-bishopric, the centre of the Walloon country.

The great cathedral of St. Lambert was destroyed in 1794, and in 1802 the church of St. Paul, dating from the 10th century but rebuilt in the 13th, was declared the cathedral. The law courts are installed in the old palace of the prince-bishops, constructed between 1508 and 1540. The university has separate schools for mines and arts and manufactures.

Liége had a population of (est. 1939) 161,187, and is the centre of the iron and armament manufacture of Belgium and of a coal-mining district. The production of zinc and of motorcars has also become important. There is also a large cattle market. Suburbs have arisen on the heights to the north, and a circular boulevard has been laid out with connecting roads.

HISTORY

Liége first appears in history about the year 558, at which date St. Monulph, bishop of Tongres, built a chapel near the confluence of the Meuse and the Legia. A century later the town, which had grown up round this chapel, became the favourite abode of St. Lambert, bishop of Tongres, and here he was assassinated. His successor, St. Hubert, raised a splendid church over the tomb of the martyred bishop about 720 and made Liége his residence. It was not, however, until about 930 that the title bishop of Tongres was abandoned for that of bishop of Liége. The episcopate of Notger (972–1008) was marked by large territorial acquisitions, and the see obtained recognition as an independent principality of the empire. The popular saying was "Liége owes Notger to God, and everything else to Notger." By the munificent encouragement of successive bishops Liége became famous during the 11th century as a centre of learning, but the history of the town for centuries records little else than the continuous struggles of the citizens to free themselves from the exactions of their episcopal sovereigns, the aid of the emperor and of the dukes of Brabant being frequently called in to repress the popular risings.

The long episcopate of Eberhard de la Marck (1505–38) was a time of good administration and of quiet, during which the town regained something of its former prosperity. The outbreak of civil war between two factions, named the *Cluroux* and the *Grignoux,* marked the opening of the 17th century. Bishop Maximilian Henry of Bavaria (1650–88) at last put an end to the eternal strife and imposed a regulation (*règlement*) which abolished all the free institutions of the citizens and the power of the guilds. The French revolutionary armies overran the principality in 1792, and from 1794 to the fall of Napoleon it was annexed to France, and was known as the department of the Ourthe. The Congress of Vienna in 1815 decreed that Liége, with the other provinces of the southern Netherlands, should form part of the new kingdom of the Netherlands under the rule of William I., of the house of Orange. The town of Liége took an active part in the Belgian revolt of 1830, and after that date the ancient principality was incorporated in the kingdom of Belgium.

Heavily fortified, Liége was the scene of intense fighting between Belgian and German armies in both World Wars I and II. The town itself was occupied by German troops Aug. 7, 1914 while the 12 surrounding forts held out for several more days. (*See* Belgium, Invasion of, 1914.)

In World War II, the surprise capture on May 11, 1940, of Fort Eben Emael, strongest link in Liége's defenses, hastened the collapse of Belgian arms.

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LIEGE, an adjective of uncertain derivation which seems originally to have meant "simple," "unconditioned." The word is historically important because it was early used as a qualification of legal terms such as homage. In feudal law, liege homage is the homage due from a tenant to his chief lord. In course of time the idea prevailed that liege homage was due to the king, above and beyond the homage done to any immediate lords. From this idea is ultimately derived the employment of the abstract noun "allegiance," to denote the subject's duty to his sovereign.

See Pollock and Maitland, *History of English Law* (2nd ed., 1898), i. 298–300.

LIEGNITZ, a town in the Prussian province of Silesia, Germany, on the Katzbach, just above its junction with the Schwarzwasser, and 40 mi. W.N.W. of Breslau, on the main line of railway to Berlin via Sommerfeld. Pop. (1939) 83,000. Liegnitz is first mentioned in an historical document in the year 1004. In 1163 it became the seat of the dukes of Liegnitz, who greatly improved and enlarged it, and who are buried in the church of St. John. On the death of the last duke of Liegnitz in 1675, the duchy came into the possession of the Empire, which retained it until the Prussian conquest of Silesia in 1742. On Aug. 15, 1760 Frederick the Great gained a decisive victory near Liegnitz over the Austrians. It consists of an old town, and several suburbs. The palace, formerly the residence of the dukes of Liegnitz, and rebuilt after a fire in 1835, is used as the administrative offices of the district. The Ritter Akademie, founded by the emperor Joseph I., was reconstructed as a gymnasium in 1810. The church of SS. Peter and Paul (restored in 1892–1894) dates from the 14th century. The manufactures are considerable, the chief articles made being cloth, wool, leather, tobacco, pianos, clogs, sugar, carriages and machinery. Its trade in grain and its cattle-markets are likewise important. There are large market gardens in the suburbs.

LIEN. The word lien signifies the right of a person in possession of property belonging to another to detain such property until some debt or demand in connection with the property detained is satisfied. This right of lien arises either by implication of law or by express contract. Where, however, an express contract for security is made between parties such agreement excludes, to the extent of the express contract, any lien upon property to which it might otherwise have been subject. The possessory right conferred by lien is not a right *ad rem,* that is to say it does not convey to the person in possession of goods any property in them, it merely gives him a legal right to retain them until his demand is satisfied. Consequently, apart from statute or legal process authorizing him so to do, he is not entitled to sell the goods to recover what is due to him.

If the goods be not in possession of the claimant of lien, as in the case of the furniture of a tenant owing rent to a landlord, the law will indeed assist the landlord to seize the property and enable him to sell it in due course in order to pay himself out of the proceeds, but it will not give him any property in the furniture itself.

There are two descriptions of lien recognized by the English law: particular and general. Particular liens exist where persons have a right to retain possession of property in respect of labour or money expended by them on the identical chattel which constitutes the *res gestae* or subject matter of the dispute. Liens of this description are usually favourably regarded by the court. General liens are claims made in respect of a general balance of account between the parties.

Liens are created in three ways, either (1) by express contract, (2) by usage of trade, or (3) by some legal relation between the parties, where there is no express contract, nor any usage of trade. The term legal relation applies either to those persons on whom the law throws an obligation to perform certain services whenever required so to do by any member of the public, such as an inn-keeper or a common carrier, or else to a person who usefully expends time, work or money on the reparation of the chattel of another, such as a jobbing tailor, a boot repairer, a furrier, a calico printer, or indeed any person to whom goods are delivered in order to have some service performed in connection with them for which such delivery is necessary. But the mere safeguarding of the article, apart from work done upon it, will convey no right to lien in this particular form of deposit.

Again, a ship-master (on behalf of the owner) has a lien upon cargo for freight; and if, upon landing, notice of such lien is given to the wharfinger or warehouseman, the cargo is bound thereby in his hands, and may be subsequently sold by him upon compliance with statutory conditions (Merchant Shipping Act, 1894, secs. 494–498). And a like rule applies to passengers' luggage (except wearing apparel actually in use) for unpaid passage money.

A claim to general lien, though, as already stated, not regarded with favour by the courts, may be established by special or necessarily implied agreement, or by the custom of a certain trade. By virtue of accepted custom of trade or profession, wharfingers, bankers, insurance brokers and solicitors have a lien upon the property of their employers, not only for debts arising out of the particular transaction for which the property was delivered to them, but also for a general balance of account between the parties, and this rule has been held to apply to statute barred debts (*Courtenay* v. *Williams,* 3 Hare at p. 552).

A similar principle as to general balance of account has been held applicable to the lien of calico printers and packers, and locally (by the custom of Exeter) to fullers. The right to general lien is, however, incapable of transference.

Maritime Lien differs from all other forms of lien in that it neither includes nor requires actual physical possession of the ship in respect of which a maritime lien arises. It presupposes the giving of a credit coupled with a postponement intentionally made of the right to enforce it. It follows as a necessary consequence that unless the creditor has forfeited the right because of his own laches he can take legal proceedings against the ship notwithstanding any change there may have been in the ownership, and he has priority over all other titles to the ship which are not based on superior or equal liens, including mortgages already existing. It is otherwise with an existing possessory lien of a ship repairer. (Carver's *Carriage by Sea,* 55. 320, 692.)

The principal instances in which the law recognizes maritime liens are bottomry (*q.v.*) (*i.e.,* mortgage of ship's keel), salvage wages, master's wages, disbursements, liabilities, damage from collision, in which case the lien attaches to the wrong-doing ship.

Right of Sale or Transference of Lien.—Apart from statute a mere lien confers no right of sale on the party entitled to retain the chattels against the true owner, even if the detention be attended with trouble and expense (*Thames Iron Company* v. *Patent Derrick Company*, 1860, 29 L.J., Ch. 714). A statutory right of sale, however, of any goods left by a guest in his custody enures, after six weeks, to an innkeeper for the amount of his bill, by virtue of the Innkeepers Act, 1878 (sec. 1). By the Merchant Shipping Act, 1894 (secs. 497–498), a wharfinger or warehouseman, at the expiration of 90 days from the time when goods are placed in his custody (or a shorter time if the goods be perishable) is entitled to sell them by public auction; and sec. 97 of the Railway Clauses Act, 1845, authorizes railway companies to detain and sell any goods delivered to them for carriage upon default of payment of their tolls. Neither the custody of the chattel nor the accompanying lien is capable of legal transference to a third party, who is consequently, after demand and refusal, liable in trover to the true owner of the goods.

The lien of an unpaid vendor for the price of the article which he has sold to an insolvent purchaser subsists until the chattel has either been actually or constructively delivered into the hands of the latter. This lien for the price of specific goods is not determined by the mere delivery of the chattels to a carrier for the purpose of conveyance. Consequently, if the vendor can arrest the goods at any stage of the transit before they reach the hands of the purchaser or his agent the vendor reverts to the same position as if he had not parted with the possession of the goods.

The right is not de-vested by the purchaser endorsing over a bill of lading of the goods by way of security or for valuable consideration to a third party, with notice of the consignee's insolvency, or by a purchaser's sub-sale of the goods before the termination of the *transitus*, without delivery of the documents of title to an innocent third party.

Waiver and Determination of Lien.—A lien may be waived, and the right to assert the claim lost, by conduct on the part of the holder of the goods obviously inconsistent with the existence of such a right. A lien is determined by actual payment or tender of the full amount of the legal claim for which the goods are detained, but part payment of such demand is not sufficient, neither is a general tender or offer to discharge the claim without actual tender or what, in point of law, is equivalent thereto.

(W. W.-P.)

U.S. Differences.—In the United States, speaking generally, the law relating to liens is that of England, but there are some considerable differences occasioned by three principal causes. (1) Some of the Southern States, notably Louisiana, have never adopted the common law of England. When that State became one of the United States of North America it had (and still preserves) its own system of law. In this respect the law is practically identical with the Code Napoleon, which, again speaking generally, substitutes privileges for liens, *i.e.*, gives certain claims a prior right to others against particular property. These privileges being *strictissimae interpretationis*, cannot be extended by any principle analogous to the English doctrine of equitable liens. (2) Probably in consequence of the United States and the several States composing it having had a more democratic government than Great Britain, in their earlier years at all events, certain liens have been created by statute in several States in the interest of the working classes which have no parallel in Great Britain, *e.g.*, in some States workmen employed in building a house or a ship have a lien upon the building or structure itself for their unpaid wages. This statutory lien partakes rather of the nature of an equitable than of a common-law lien, as the property is not in the possession of the workman, and it may be doubted whether the right thus conferred is more beneficial to the workman than the priority his wages have in bankruptcy proceedings in England. Some of the States have also practically extended the maritime lien to matters over which it was never contended for in England. (3) By the constitution of the United States the Admiralty and inter-State jurisdiction is vested in the Federal as distinguished from the State courts, and these Federal courts have not been liable to have their jurisdiction curtailed by prohibition from courts of common law, as the court of Admiralty had in England up to the time of the Judicature Acts; consequently the maritime lien in the United States extends further than it does in England, even after recent enlargements; it covers claims for necessaries and by material men, as well as collision, salvage, wages, bottomry and damage to cargo.

Difficulties connected with lien occasionally arise in the Federal courts in Admiralty cases, from a conflict on the subject between the municipal law of the State where the court happens to sit and the Admiralty law; but as there is no power to prohibit the Federal court, its view of the Admiralty law based on the civil law prevails. More serious difficulties arise where a Federal court has to try inter-State questions, where the two States have different laws on the subject of lien; one for example, like Louisiana, following the civil law, and the other the common law and equitable practice of Great Britain. The question as to which law is to govern in such a case can hardly be said to be decided. "The question whether equitable liens can exist to be enforced in Louisiana by the Federal courts, notwithstanding its restrictive law of privileges, is still an open one" (Derris, *Contracts of Pledge*, 517; and see *Burdon Sugar Refining Co.* v. *Payne*, 167 U.S. 127).

LIEPĀJA (*Libau*), a seaport of Latvia in 56° 32′ N., 21° 2′ E., at the northern extremity of a narrow sandy peninsula which separates Lake Libau (12 mi. long and 2 mi. wide) from the Baltic sea. Pop. (1939) 57,098. There are four harbours: the Commercial, with stone quays, storehouses for merchandise and three grain elevators; the Winter, with numerous timber yards round the quays; the Avant pier or New harbour, where regular passenger steamers berth; and the War harbour (closed shortly after the start of World War II) with two dry docks, each 600 ft. Vessels drawing more than 28 ft. cannot enter the port. It is open practically the year round with the help of icebreakers.

The chief imports are coal, iron, salt, herrings, grain, cotton, machinery, chemical manure and phosphates. The exports include rye, barley, oats, wool, linseed, sleepers, deals, pitprops, pulpwood, skins and hides, wheat and eggs. The port also serves as a coaling and oiling station.

Primarily because of the loss of Russian commerce, trade fell in 1920 to approximately 20% of the 1913 level. Industries before 1913 included iron and steel works and engineering yards, veneering, flour-milling, bacon-curing, tobacco manufacture, the extraction of vegetable oils, the making of colours and varnishes, brewing, distilling and leather work. Many of the factories ruined during the conflict, 1914–19, were never repaired and put into production. An immense state-owned factory, dominating the water front, produces agricultural and other heavy machines.

The port of Libau, Lyra portus, is mentioned in 1263, when it belonged to the Livonian order or Brothers of the Sword. In 1418 it was burned by the Lithuanians and in 1560 mortgaged by the grandmaster of the Teutonic order, to which it had passed, to the Prussian duke Albert. In 1701 it was captured by Charles XII of Sweden, and in 1795 annexed to Russia. After 1872, when it was brought into railway connection with Moscow, Orel and Kharkov, Liepāja became an important port and developed rapidly. The Russians constructed an extensive naval port, protected by moles and breakwaters in 1893–1906. The Latvian government removed here when Riga was in German occupation in 1917–19, and Liepāja itself was occupied by German troops in 1919. Certain areas were still in ruins in 1941, when the Germans again re-occupied the town, following the Russian occupation of 1940–41.

LIERNE, in architecture, a small, subordinate vaulting rib, which runs between the more important structural ribs. With the English tendency to sub-divide vaulting areas during the 14th century, the invention and development of the lierne was a necessary consequence. Used more for decorative than for structural reasons, liernes are especially grouped near the vault ridges, where they form extremely rich and complicated intersecting patterns. These generally fall into two types, that known as reticulated, or net-work patterns, as in the choir of Gloucester (completed 1377); and star patterns, as in the nave of Canterbury cathedral (*c.* 1400). The intersections of liernes with each other or of liernes with the major ribs, are usually decorated with carved, projecting bosses.

LIERRE (French for Lier), a town in the province of Antwerp, Belgium, 9 mi. S.E. of Antwerp. Its church of S. Gommarus (completed 1557) has three fine windows, given by Archduke Maximilian to celebrate his wedding with Mary of Burgundy. The cutlery and beads industries are very important and a little silk is manufactured. Pop. (est. 1939), 28,604.

LIESTAL, the capital of the half canton of Baselland, Switzerland. Population 6,698.

LIEUTENANT, one who takes the place, office and duty of and acts on behalf of a superior or other person. The word in English preserves the form of the French original (from *lieu,* place, *tenant,* holding), which is the equivalent of the Lat. *locum tenens,* one holding the place of another. The usual English pronunciation appears early, the word being frequently spelled *lieftenant, lyeftenant* or *luftenant* in the 14th and 15th centuries. The modern American pronunciation is *lewtenant,* while the German is represented by the present form of the word *Leutnant.* In French history, *lieutenant du roi* (*locum tenens regis*) was a title borne by the officer sent with military powers to represent the king in certain provinces. With wider powers and functions, both civil as well as military, and holding authority throughout an entire province, such a representative of the king was called *lieutenant général du roi.* The first appointment of these officials dates from the reign of Philip IV. the Fair (*see* CONSTABLE). In the 16th century the administration of the provinces was in the hands of *gouverneurs,* to whom the *lieutenants du roi* became subordinates. The titles *lieutenant civil* or *criminel* and *lieutenant général de police* have been borne by certain judicial officers in France (*see* CHÂTELET and BAILIFF AND BAILIE: *Bailli*). As the title of the representative of the sovereign, "lieutenant" in English usage appears in the title of the lords lieutenant of the counties of the United Kingdom. (*See* COUNTY; MILITIA: *Militia of England.*)

The most general use of the word is as the name of a grade of naval and military officer. In Italy and Spain the first part of the word is omitted, and an Italian or Spanish officer bearing this rank is called *tenente* or *teniente* respectively. In the British and most other navies the lieutenants are the commissioned officers next in rank to commanders, or second class of captains. Originally the lieutenant was a soldier who aided, and in case of need replaced, the captain, who, until the latter half of the 17th century, was not necessarily a seaman in any navy. At first one lieutenant was carried, and only in the largest ships. The number was gradually increased, and the lieutenants formed a numerous corps. Lieutenants now often qualify for special duties such as navigation, or gunnery, or the management of torpedoes. In the British army a lieutenant is a subaltern officer ranking next below a captain and above a second lieutenant. In the United States of America subalterns are classified as first lieutenants and second lieutenants. In France the two grades are *lieutenant* and *sous-lieutenant,* while in Germany the *Leutnant* is the lower of the two ranks, the higher being *Ober-leutnant* (formerly *Premier-leutnant*). A "captain lieutenant" in the British army was formerly the senior subaltern who virtually commanded the colonel's company or troop, and ranked as junior captain, or "puny captain," as he was called by Cromwell's soldiers.

LIFE, the kind of activity characteristic of living creatures. No doubt this activity is, in its objective aspects, an integration of numerous chemical and physical processes, and there is no warrant for postulating any mysterious "vital force." On the other hand, it must be allowed that life is a unique kind of activity, for the formulae of matter and energy, electrons, protons and electro-magnetic radiations or ether-waves, as at present understood, do not suffice to describe (*a*) the everyday functions of the body in their orchestration, (*b*) the self-preservative activities of any organism at any grade of being, (*c*) the purposive behaviour of higher animals well-endowed with brains, (*d*) the phenomena of development and heredity or (*e*) the facts of evolution. Everyone allows that living is in part analysable into chemical and physical processes, yet these are modified by their occurrence in the colloidal medium of the chemically very complex protoplasm. In conditions of extreme complexity, a new aspect of reality—Life—emerges. Moreover, when the chemical and physical ledger is added up, it does not give a unified description of what has actually occurred when, *e.g.,* a migrant bird makes its journey. For to describe this it is necessary to introduce concepts beyond physics and chemistry, such as enregistration of the past, awareness of the present and purposiveness towards the future. In at least the higher reaches of the animal kingdom, behaviour is correlated with psychical activity, incommensurable with physical processes. Thus life is an activity of organisms which requires for its description concepts transcending those of mechanism. This view does not in any way contradict the theory that living organisms may have arisen on the earth from nonliving materials. When the materials were complex enough and in an appropriate collocation, living organisms may have emerged.

Characteristics of Organisms.—(*a*) The self-preservative persistence of an organism is associated with the building-up and breaking-down of proteins, which have large complex molecules, representing an accumulation of potential chemical energy. Anabolic processes counterbalance the katabolic, repair counteracts waste; rejuvenescence wards off senescence. The organism is like a clock that winds itself up as it runs down. No doubt this quality is to be analysed as far as may be,—in terms, for instance, of the characteristic fermentations and their reversibility. Much depends on the fact that the proteins are always colloidal, admitting of intensity and rapidity of chemical reactions on the surface of the multitudinous ultra-microscopic particles or droplets suspended in the liquid phase. Another feature is the chemical individuality everywhere manifest, for each distinct type of organism seems to have some distinctive protein of its own, and some characteristic rate or rhythm of metabolism. Thus under the general quality of persistence amid unceasing metabolism, there is a triad of facts: (1) the building-up that compensates for the breaking-down of proteins, (2) the occurrence of these proteins in a colloidal state and (3) their specificity from type to type.

(*b*) A second triad of qualities includes the organism's characteristic powers of *growing, multiplying* and *developing.* A surplus of income over expenditure is the primal condition of organic growth. As contrasted with the growth of a crystal, an organism can grow at the expense of materials more or less different from those of the growing body; it implies active assimilation, not mere passive accretion; and it is a definitely regulated process—regulated from within. Growth naturally leads to the simplest forms of multiplication or reproduction, for persistent growth tends to bring about organic instability, which may be intracellular as in unicellular organisms and in ordinary cell-division, or localized along a line of weakness or low vitality, as in the fragmentation of some lower multicellular animals. Asexual multiplication is a regularized form of discontinuous growth, and sexual reproduction by liberated germ-cells is a secondary specialization, anticipated in the spore-formation of many of the Protozoa and Protophyta (*see* REPRODUCTION).

Development is the progressive attainment of full-grown complexity from comparatively undifferentiated simplicity, whether that be in stump or fragment, in leaf or bud, in spore-cell or germ-cell. It implies an expression of hereditary initiatives in appropriate nurture, and often in such a way that the individual stages in the ontogeny can be correlated with great steps in the racial history or phylogeny. Development, with its central fact of progressive differentiation and integration, is particularly to be thought of in connection with the building up of the embryo, but it cannot be separated from the everyday repair of worn-out tissue, the replacement of periodically deciduous structures (like leaves and hair), and the frequent regeneration (*q.v.*) of lost parts, thus linking back with reproduction and growth.

(*c*) In the third place living creatures stand apart from nonliving things in their purposive behaviour, in their power of enregistering experience, and in their capacity for giving rise to the new—a third triad. Many non-living things, such as explosives, react forcefully to outside stimulus, but organisms are marked by the self-preservative efficiency of their reactions. Only the higher big-brained animals can be credited with perceptual purpose, but the quality of purposiveness seems to be co-extensive with life. The organism is an agent that gets things done, at various levels of behaviour—intelligent, instinctive, tropistic, reflex, and so forth. The mental aspect may in many cases be subordinated to the bodily, but in the majority there is the bent bow of endeavour, even though the creature's awareness of that endeavour may be dim. The mental aspect seems to be struggling for expression throughout, and the organism appears as a psycho-physical being, now (mind)-BODY and again (body)-MIND (*see* BIOLOGY).

A bar of iron is never quite the same after it has been severely jarred; a violin suffers from mishandling. But these are hardly more than vague analogies of the distinctive power that living creatures have of enregistering the results of their experience, of establishing internal rhythms, of forming conditioned reflexes and habits, and of remembering. Individual experience is built into the individual organism and influences subsequent reactions.

Finally, it must be recognized as characteristic of organisms that they give origin to what is new; they have evolved in the past, and the evolution of many is still going on. Variability and evolvability must be ranked as fundamental characteristics of living beings. The organism selects stimuli from its environment and often moves from one environment to another; the organism is often experimental, moulding itself by its efforts; it tests the newness of its inheritance in its ceaseless trafficking with circumstances. The central secret of life is missed if the organism is not recognized as in some measure a struggling sub-personality.

To sum up, the characteristics of organisms are:—(*a*) *Persistence of integrity amid ceaseless change,* there being (1) a self-preservative compensation of down-breaking by up-building, (2) a metabolism of proteins and other complex substances in a colloidal state, (3) a chemical individuality; (*b*) *a triad of linked capacities,* namely, (4) growth, (5) multiplication, (6) development; and (*c*) the crowning triad of (7) effective behaviour, (8) enregistration of experience, (9) evolvability.

Aspects of Life.—The biologist works with three co-ordinates—the organism, its functions and the environment. These are the three sides of the biological prism. At times what is observed is the insurgent organism acting on its environment, both animate and inanimate; and this may conveniently be summed up by using the first letters, $O \longrightarrow f \longrightarrow e$, giving the Organism a capital. But at other times, and just as familiarly, the Environment closes in upon the organism, stimulating and inhibiting, fostering and weathering, warming and cooling, feeding and starving. This may be formulated again $E \longrightarrow f \longrightarrow o$, reversing the capitals. Thus, as Patrick Geddes points out, living implies an ever-changing ratio $\frac{Ofe}{Efo}$. Most animals are less in the grip of their environment than most plants, and sedentary corals more than pelagic medusae, the very young more than the resiliently mature, and the summer hedgehog more than the hibernater. In the article BIOLOGY it has been suggested that since an organism without its everyday functions is rather an empty abstraction, the term function in the $O \longrightarrow f \longrightarrow e$: $E \longrightarrow f \longrightarrow o$ formula, should rather read "functionings," *i.e.*, the work or on-goings, the actions and reactions of the organism as a whole.

The Drama of Life.—What has been said gives too cold an impression of life, which must be envisaged as a drama on a crowded stage. (1) Whatever the secret of vital activity may be, it must be thought of as an overflowing spring. Organisms accumulate energy acceleratively and must multiply. Life is like a river that is often in flood. (2) From the ant-hill, the bee-hive, the rookery, the rabbit warren, there comes the impression of urge and endeavour. Whether the urge be vegetative, appetitive, tropistic, instinctive or intelligent, organisms are almost always after something—never satisfied. The more they get the more they want. (3) But the quality of life rises to what may be called insurgence. Animals in particular are full of daring and adventure. As Goethe said, they are always attempting the next to the impossible and achieving it. This is well illustrated by gossamer-spiders making aerial journeys, or by Arctic terns within the Antarctic Circle; but it finds many an unsensational expression. (4) Another quality, so universal that it must be called characteristic, is adaptiveness. Practically every organism is a bundle of adaptations or fitnesses. As Weismann said, "If all the adaptations are taken away from a whale, what is there left?" (5) It is perhaps an expression of this adaptiveness that so many living organisms form linkages with others. There is no aloofness in the realm of organisms; nothing lives or dies to itself. Thus animate nature is characteristically a system,—a fabric that changes in pattern and yet endures. Though the individual threads of the web are always dying, they are replaced without a discontinuity. There is wear, but no tear, except when man carelessly interferes with the loom, or when some physical violence, like flood or fire, causes an inevitable rent. (6) But this leads to another characteristic of the biosphere that marks it off from the cosmosphere: there is continual sifting. A new star often appears in the sky, but there is no indication of any struggle for existence or selection of the relatively more fit. But who can describe the advancement of life and leave out winnowing? There is cosmic flux and there is organic flux, but only in the latter is there discriminate elimination. (7) Another characteristic of living creatures is their beauty. All independently-living organisms are artistic unities, with protean wealth of beauty in form and colour, in pose and movement, expressing a harmonious life from which the discordant has been more or less completely eliminated. Apart from exceptions, like parasites, which prove the rule, organisms are like works of art. (8) Nothing can be said as to the mental aspect of a wood-anemone and only a little about that of a sea-anemone, but a picture of life must include the fact that in organisms there is the promise and potency—and in higher animals the epiphany—of "Mind." Perceptual inference is a relatively late achievement; conceptual inference or reason is man's prerogative; but throughout the animal kingdom there is a stream of inner life, of feeling and purpose, even when there is not very much in the way of intelligence. The probability is that "Life" and "Mind" are co-extensive. (9) But the crowning characteristic of life is its progressiveness. No doubt there have been eddies and stagnant pools, but on the whole there has been a flow in the stream of life, and it has been uphill! As epoch has succeeded epoch for inconceivably long ages, life has been slowly creeping—sometimes swiftly leaping—upwards, towards greater fullness and freedom. The whole process must be envisaged in the light of its outcome, organic evolution in the light of man.

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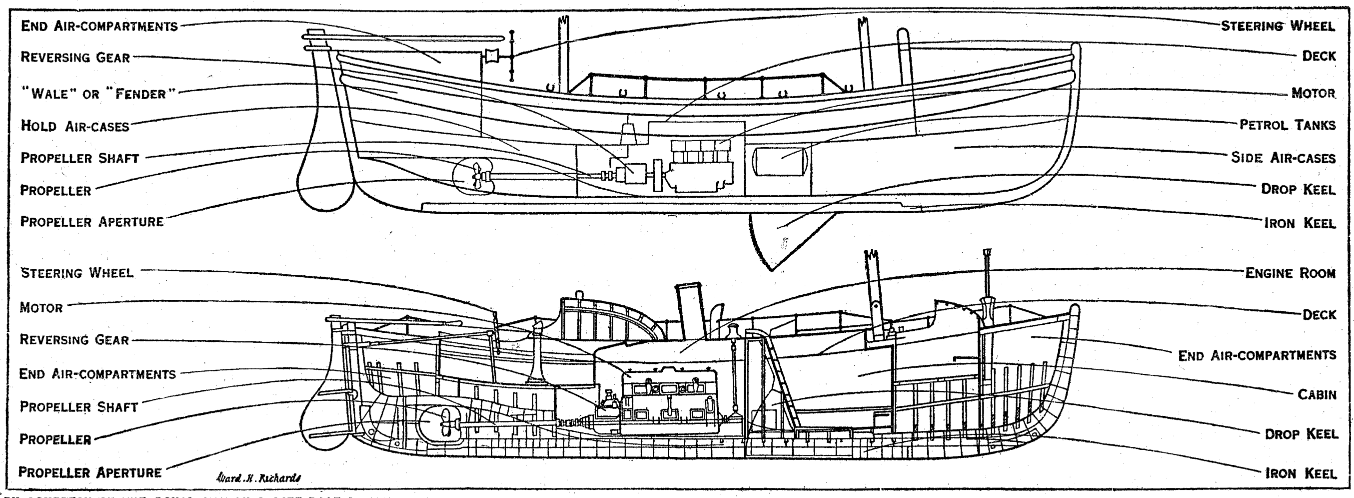
LIFE-BOAT AND LIFE SAVING. The article on DROWNING AND LIFE SAVING (*q.v.*) deals generally with the means of saving life at sea, but under this heading it is convenient to include the appliances connected specially with the life-boat service. The ordinary open boat is unsuited for life saving in a stormy sea, and numerous contrivances, in regard to which the lead came from England, have been made for securing the best type of life-boat.

The first experimenter in England was Lionel Lukin, a London coach-builder, later Master of the Worshipful Company of Coach-makers. Encouraged by the prince of Wales (George IV.), he converted a Norway yawl into what he called an "unimmergible" boat, which he patented. Buoyancy he obtained by means of a project-



BY COURTESY OF THE ROYAL NATIONAL LIFE-BOAT INSTITUTION

FIG. 1.—TYPES OF MODERN LIFE-BOATS

Top: self-righting life-boat, 40 ft. by 10 ft. 6 in., with 40 h.p. motor, also fitted with rowlocks for oar propulsion. Below: Watson type cabin motor life-boat, with 80 h.p. motor

ing gunwale of cork and air-chambers inside—one of these being at the bow, another at the stern. Stability he secured by a false iron keel. The self-righting and self-emptying principles he seems not to have thought of; at all events he did not compass them. Lukin was thinking rather of making all boats safer than of constructing a boat for the special purpose of life saving, but he was associated with the earliest known attempt at establishing a Life-Saving Service when, in 1786, he converted a coble into a "safety-boat" for Archdeacon Sharp. This boat was employed for some years at Bamborough in saving life from shipwreck, the village becoming thereby the first life-boat station.

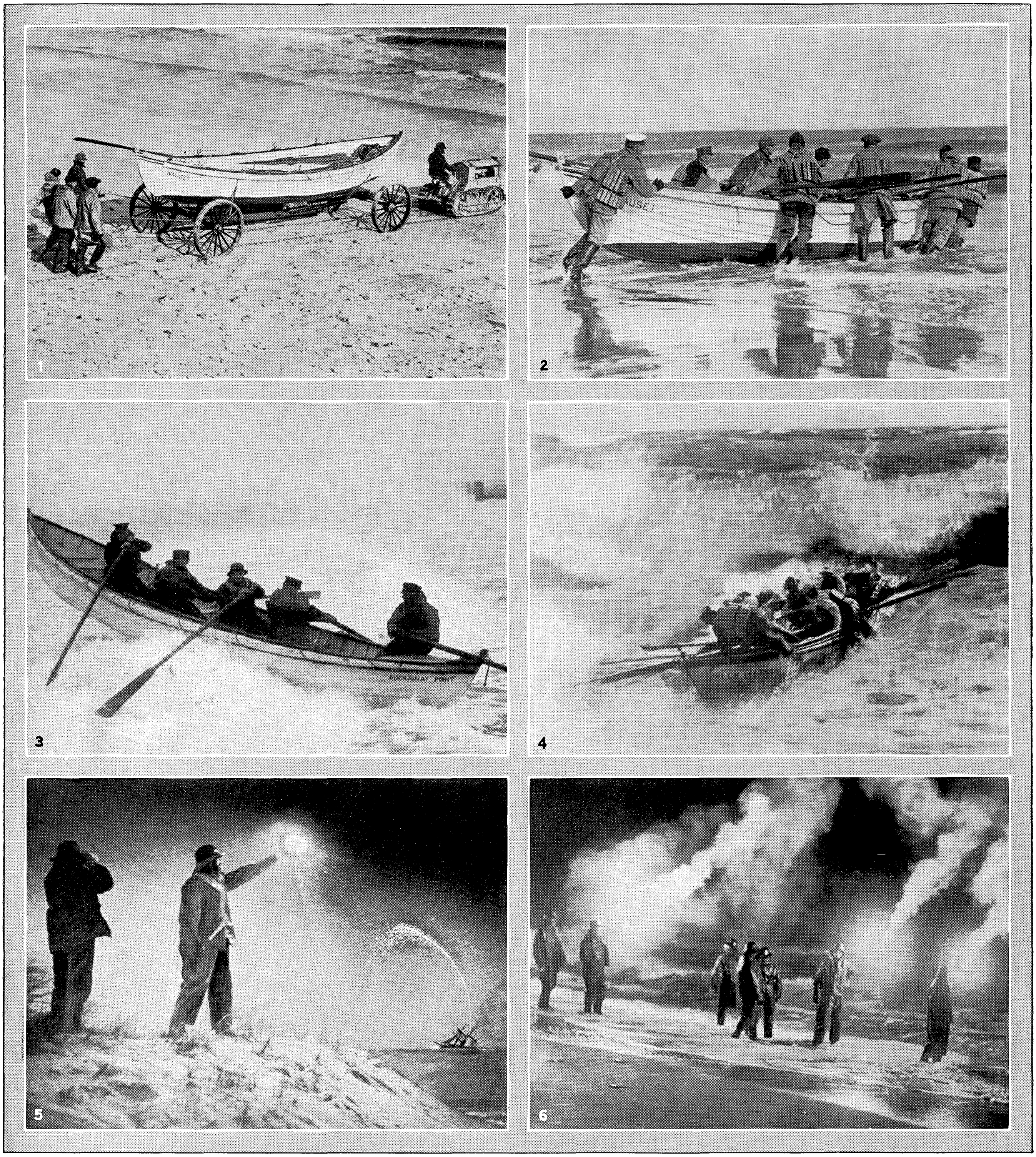
Public apathy in regard to shipwreck was temporarily swept away by the wreck of the "Adventure" of Newcastle at the mouth of the Tyne in 1789. This vessel was stranded only 300yd. from the shore, and her crew dropped, one by one, into the raging breakers in presence of thousands of spectators, none of whom dared to put off in an ordinary boat to the rescue. An excited meeting among the people of South Shields followed; a committee was formed, and premiums were offered for the best models of a life-boat. This called forth a number of plans, among those who submitted them being William Wouldhave, a house painter and a teacher of singing, and Henry Greathead, a boat builder, both of South Shields. Wouldhave's model was so constructed that, if capsized, it would immediately right itself, and Wouldhave is entitled to be considered the discoverer of that principle, which is now used in more than half the life-boats round the British coasts. But the committee did not adopt this principle, nor was it entirely satisfied with Wouldhave's design. It gave him half the reward and then, from this and the other designs submitted, prepared a model of its own from which Greathead built the first life-boat.

The First Life-boat.—This boat was rendered buoyant by nearly 7cwt. of cork, and had very raking stem and stern-posts, with great curvature of keel. The total cost was just under £150. This life-boat, the "Original," served until 1830 and rescued hundreds of lives. No other life-boat was launched till 1798, when the duke of Northumberland ordered Greathead to build him a life-boat which he endowed. This boat also did good service, and its owner ordered another in 1800 for Oporto. In the same year Mr. Cathcart Dempster ordered one for St. Andrews, where, two years later, it saved twelve lives. Thus, the value of life-boats began to be recognized, and before the end of 1803 Greathead had built thirty-one boats—eighteen for England, five for Scotland and eight for foreign lands. In this work he was materially helped by Lloyds. Four years later Lukin, the coach-builder, again appeared on the scene, being invited by the Suffolk Humane Society to superintend the building of the first sailing life-boat. This boat, launched at Lowestoft at the end of 1807, was the forerunner of the Norfolk and Suffolk type of life-boat still used on that part of the coast.

In spite of these efforts, however, by individuals and local societies acting independently of one another, public interest in life-boats was not thoroughly aroused until 1823, when an appeal to the nation was made by Lt.-Col. Sir William Hillary, Bt., a resident in the Isle of Man. It is to him that we owe the establishment of a national life-boat service. He saw many terrible wrecks on the stormy coasts of the Isle of Man, and he helped to save no fewer than 305 lives. His appeal was a carefully thought out plan of what a life-boat service should be, of those to whom it should look for support, and how it should carry on its work. As Sir William Hillary planned the service more than a century ago so, in all the main features of its work, it is to-day. These main features were: That a life-boat service must be a matter for national concern; that those who carried out the dangerous work of rescue should not only be rewarded, but should be certain that, if they lost their lives, their dependents would be provided for; that the life-boats should be at the service of all in peril round the coasts, whatever their nationality; and that the service should be maintained by voluntary contributions. Within a year, and with the help of two members of parliament—Mr. Thomas Wilson and Mr. George Hibbert—Hillary had founded the "Royal National Institution for the Preservation of Life from Shipwreck."

The Royal National Life-boat Institution.—This, perhaps the grandest of England's charitable societies, and now named the "Royal National Life-boat Institution," was founded on March 4, 1824. It began its career with a sum of only £9,826. In the first year twelve new life-boats were built and placed at different stations, besides which thirty-nine life-boats had been stationed on the British shores by benevolent individuals and by independent associations over which the institution exercised no control, though it often assisted them. In its early years the institution placed the mortar apparatus of Captain Manby at many stations, and provided for the wants of sailors and others saved from shipwreck,—a duty subsequently discharged by the "Shipwrecked Fishermen and Mariners' Royal Benevolent Society." At the date of the institution's second report it had contributed to the saving of three hundred and forty-two lives, either by its own life-saving apparatus or by other means for which it had granted rewards.

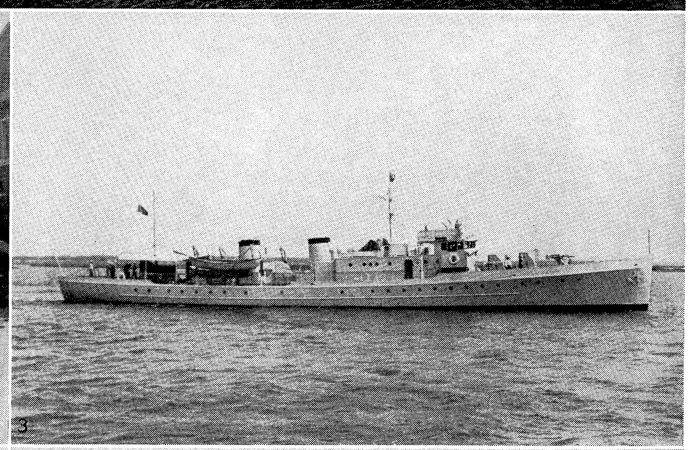
In the year 1849, came another tragedy at the mouth of the Tyne. The life-boat "Providence," when out on service, capsized, and of her double crew of 24 no fewer than 20 were drowned. Tragic though this event was, it yet served to re-direct public attention to the needs of the life-boat service, and as such marks a turning point in its history. These first twenty-five years of the institution's history had been years of great national stress, and the institution had inevitably suffered. In 1849–50 its income had fallen as low as £354, and the majority of the life-boats were

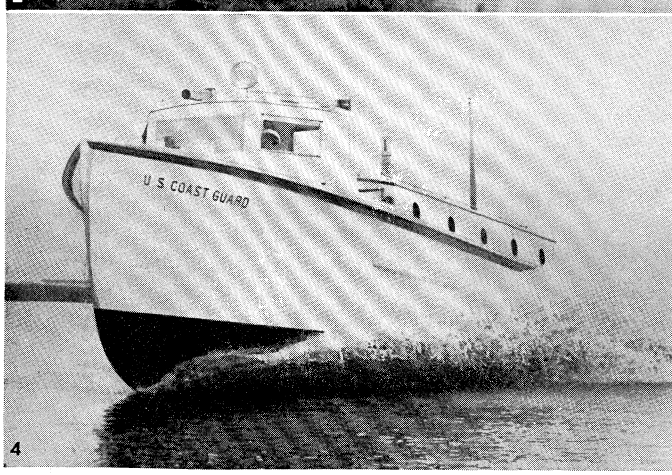


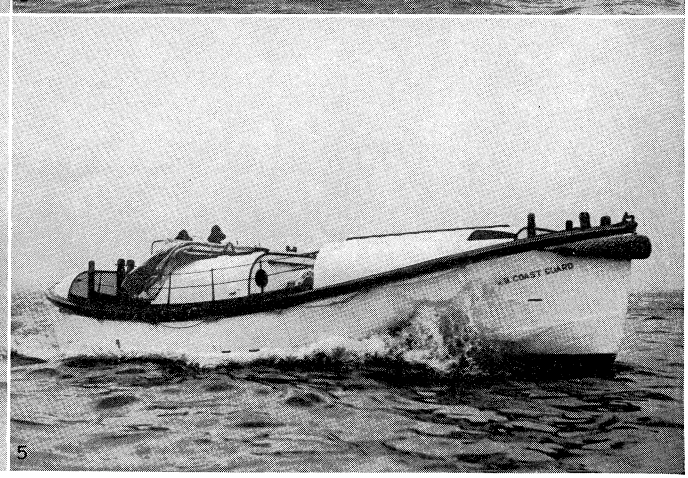
BY COURTESY OF THE U.S. COAST GUARD

UNITED STATES COAST GUARDSMEN USING FLARES AND LAUNCHING LIFEBOATS FOR RESCUE WORK

1. Hauling surfboat to beach abreast of wreck for launching. Boat is mounted on a specially constructed cradle chassis, and is hauled by a tractor, or ordinary truck, horses, or members of the crew
2. Launching the surfboat. Steersman (extreme left) is the last to enter the boat when it is afloat and the oarsmen in their places. Every member of the crew is required to wear a lifebelt
3. Surfboat at Rockaway Point station, New York, just after launching through the surf
4. Surfboat just entering the surf, the men in their places and the captain in the act of leaping aboard. Skill and strength, with steady nerves and trained teamwork, are required to launch or land a boat through a surf such as that shown
5. Surfman, upon discovery of a vessel in distress burning a rocket flare, answering with the Coston light or beacon signal, to let the sailors know that help is at hand
6. A life-saving crew burning flares to illuminate the scene of a wreck. Stations are supplied with powerful acetylene searchlights for this purpose, which are practically wind and waterproof, and afford an intense diffused light over the entire field of operations at a wreck. The hand lights are generally used only for signalling to warn vessels standing into danger, or to notify a stranded vessel that it is discovered and help is at hand



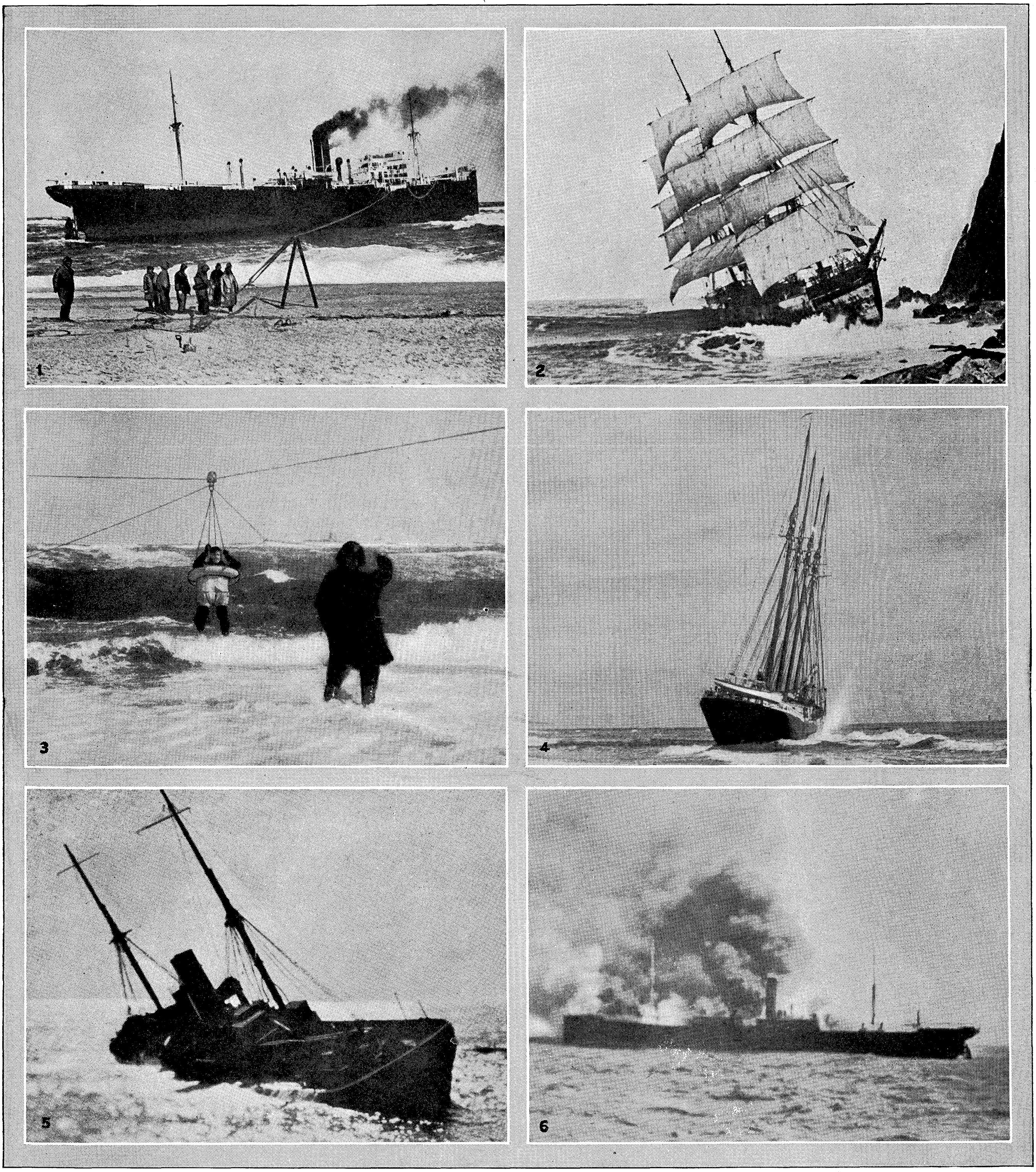




BY COURTESY OF THE U. S. COAST GUARD

COAST GUARD AIRPORT AND PLANE AND TYPES OF BOATS

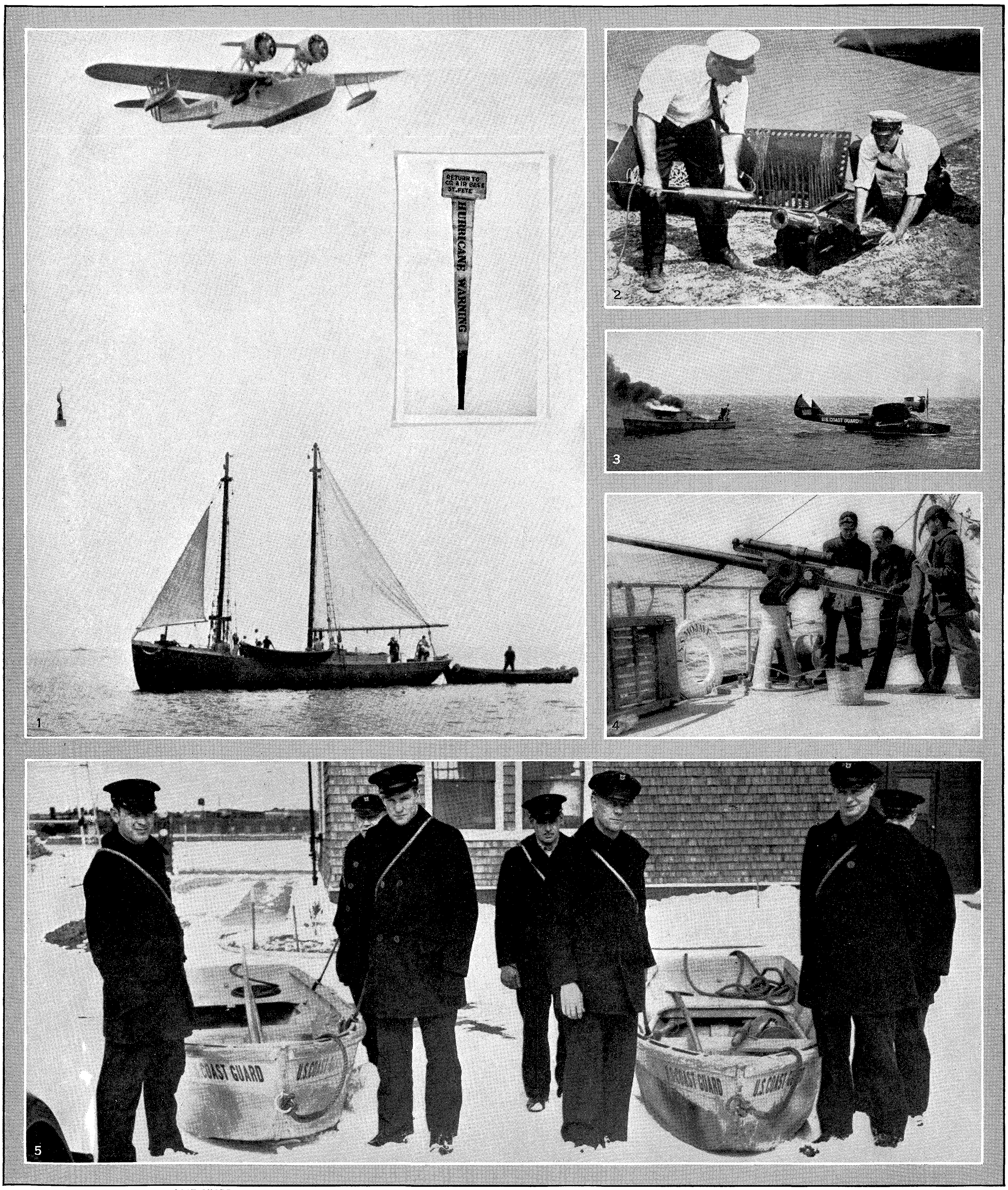
1. Miami air station
2. Seaplane
3. 165-foot patrol boat
4. 38-foot cabin picket boat
5. Lifeboat



BY COURTESY OF THE U.S. COAST GUARD

RESCUE WORK IN PROGRESS AND VESSELS ASHORE AND AFIRE AFTER LIFE SAVING

1. The British steamer "Thistlemore" ashore, Peaked Hill Bar, Cape Cod, Mass., Feb. 1922. Coast guardsmen on the beach have shot a lifeline to the ship by means of the Lyle line-throwing gun. Persons are taken from the ship in life car or breeches buoy (*see* fig. 3)
2. Full-rigged British ship "Glenesslin" ashore on Oregon coast. Many vessels were lost along dangerous coasts during earlier days before the establishment of life saving stations. Sailing vessels were particularly liable to disaster on a lee shore because of difficulty in manoeuvring
3. The breeches buoy, a life-saving device which travels on a hawser rigged between the disabled vessel and the shore. The buoy consists of a cork life-preserver having breeches attached. Suspended by a pulley on the lifeline, the apparatus holds occupant securely. Ropes to ship and shore control passage
4. Schooner "Annie C. Ross" stranded on sandy beach near Pensacola, Florida. Hull of ship rests on sand, lessening chance of breaking up
5. A steam trawler or fishing vessel ashore, resting on her port side. This type of vessel operates largely outside of regular ship lanes, where the danger of running ashore is increased by the absence of lighthouses
6. Steam freighter "Cabo Hatteras" afire at sea. Crew was rescued and the ship, which had become a menace to navigation, was later sunk by gunfire and mines from U.S. Coast Guard Cutter "Seminole"



BY COURTESY OF THE U. S. COAST GUARD

THE AEROPLANE AND OTHER MODERN LIFE-SAVING DEVICES

1. Coast Guard plane dropping message block to warn fishermen of approaching hurricane. Insert shows close-up of message block, with streamer attached. At the first notice of approaching hurricane, Coast Guard planes take off with a number of these hurricane warning blocks and drop them near small fishing boats, which are not equipped with radio or other means of communication
2. Drill with Lyle line-throwing gun, Rockaway Point Station, New Jersey. This gun is used by shore stations for firing a line to stranded or distressed vessels
3. Coast Guard plane making preparations to rescue the crew of a burning craft at sea
4. The Camden line-throwing projectile about to be fired from the 6-pounder. This projectile and gun are used in extremely bad weather for throwing a line to a distressed craft, where the shoulder line-throwing gun would be inadequate
5. Specially constructed boats, used mostly on Great Lakes, where it is often necessary to haul the boats for miles over rough ice before reaching water where they can be launched.

no longer seaworthy. Public interest in it had almost ceased. The Tyne disaster helped to recall the public to the importance of their life-boat service and the need to support it. In 1850 the Prince Consort became vice patron of the institution in conjunction with the king of the Belgians, and Queen Victoria, who had been its patron since her accession, became an annual contributor to its funds. In 1851 Algernon, fourth Duke of Northumberland, became the institution's president. He was known as the "Sailor Duke." He entered the Navy in the year of Trafalgar, was now a Rear Admiral, and a little later became First Lord of the Admiralty. He brought a new spirit to the work, and from that day to this the institution has never looked back. It has gone from strength to strength, and it is many years now since it was first able to say that a life-boat had been stationed at every point on the coast where it was required, and where an efficient crew could be found.

In 1850 its committee undertook the immediate superintendence of all the life-boat work on the coasts, with the aid of local committees. Periodical inspections, quarterly exercise of crews, fixed rates of rewards for coxswains and men, on a sliding scale according to the season of the year, and the day or night, were instituted; and the duke of Northumberland, realising that the "first and most obvious step was to endeavour to introduce an improved life-boat," offered a prize of one hundred guineas for the best model, and appointed a committee of experts to report on those sent in. In reply to the offer no fewer than two hundred and eighty models were sent in, not only from all parts of Great Britain but from France, Germany, Holland and the United States. The prize was gained by Mr. James Beeching of Great Yarmouth, whose model, slightly modified by Mr. James Peake, one of the committee of inspection, was adopted by the Institution. Mr. Beeching's model embodied most of Wouldhave's ideas with improvements of which he had never dreamed, and, coming sixty-two years later, was the model for the first genuine self-righting boat ever built. This boat, with minor alterations, is practically the type of the self-righting life-boat of to-day.

The Watson Life-boat.—Another important step was taken in 1887, following on an accident at the end of 1886 to two self-righting life-boats on the Lancashire coast, in which twenty-seven out of twenty-nine of the two crews were drowned. A permanent technical sub-committee was appointed by the Institution whose object was, with the help of an eminent consulting naval architect —a new post created—and the Institution's technical officials, to give its careful attention to the improvement of the design of life-boats. The immediate result was the designing of a new type of life-boat, by Mr. G. L. Watson, the famous yacht designer, who had been appointed consulting naval architect, and held that post for many years. The Watson life-boat did not self-right. It was a larger and more stable boat than the self-righter, had beautiful lines, was safe, weatherly, quick in stays and with a good turn of speed. With the design of this type a new principle was introduced, the principle on which the Institution's life-boats are still built. Broadly speaking, it is that with large life-boats intended to go well out to sea, it is better to set aside the self-righting principle and aim at great buoyancy and stability. Besides the Watson boats there are six other types of life-boat which do not self-right, in the Institution's fleet. More than half the fleet consists of self-righters, more than a quarter of Watson boats, and the remainder of these other types. The choice of boat is largely determined by the conditions of the coast on which it will be placed, but the crews are always consulted, and no crew is given a new life-boat unless it has already inspected it and expressed itself as satisfied. The first of the Watson life-boats was designed in 1890, and in the same year the first steam life-boat, named "Duke of Northumberland," was stationed at Harwich.

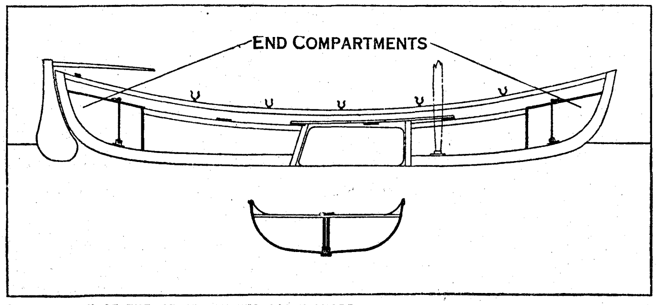
The Motor Life-boat.—The first experiments with an internal combustion engine were made during the year 1903. With these experiments began the modern era of life-boat work. To design an engine which should comply with the stringent requirements of the service might well seem an insoluble problem. Such an engine had to be water-tight but not air-tight, and able to run under all conditions of night and storm without attention. It had to have controls not only simple but easy to distinguish by touch, so that they could be worked in the darkness. It had to run and to lubricate itself with certainty at any angle. At the same time, when the capsizing point was reached it had to cut itself off automatically, for, otherwise, if the boat were of the self-righting type, she would right herself and be carried away by her engine, leaving the crew in the water. In addition to all this, the engine must interfere neither with the self-righting quality of the boat, nor with its sailing powers. The first life-boat to be converted to motor power was completed in 1904, and sent to Tynemouth. She had a 12 h.p. two-cycle motor. The Institution has now sixty-five motor life-boats in its fleet, and it is hoped in the next few years to increase this number to over a hundred. By its ability to attain a speed and to cover distances impossible for boats which depend upon sails and oars; by its power to force its way in the face of winds and seas, before which rowing and sailing boats would be helpless, and, above all, by its great manoeuvring power when close to the wreck, the motor life-boat can save lives which, without it, would be beyond the reach of human aid.

Greathead's life-boat was an open rowing boat, 30 feet long. She had no other source of buoyancy than cork could give her, no other means of ridding herself of water than by baling, no other means of propulsion than by oars. That the largest of the modern motor life-boats are twice as long is the smallest part of the difference. Instead of baling tins they have automatic valves which empty out the water as fast as the sea can pour it in. Instead of cork they have as many water-tight compartments as a modern battle-cruiser. Twenty holes might be knocked in each side, and they could still go on with their work. They are practically unsinkable. Instead of oars they have engines so designed that they can go on running when completely submerged, so long as the air-intake is above water. They have cabins; electric searchlights; line-throwing guns, with a range of 80 yards; and oil-sprays for spraying oil on heavy seas. The largest of these life-boats, the Barnett Twin Screw type, has two engines, each of 76 h.p. She has 15 main and 100 minor water-tight compartments, and two cabins with accommodation for between 50 and 60 people. In a calm sea she could take 300 people on deck. Under most conditions of bad weather she could in safety carry 150 people in addition to her crew. She carries enough petrol to be able to travel 500 miles at a cruising speed of 8 knots, and her maximum speed is $9\frac{1}{2}$ knots. This may not seem a high speed, but a life-boat is not built for high speed, but so that she can maintain her speed under practically any conditions of weather.

All the Institution's engines for motor life-boats use petrol for fuel in order to obtain the greatest power for a given weight. The earliest types were adaptations of various designs of commercial engines, the most successful being an adaptation of an engine built by Messrs. Tylor and Company for lorries. It was, however, soon found that a water-tight engine was essential in order that it might continue to work even when the life-boat had been holed in the engine-room. As there was no such engine on the market the Institution produced a design of its own for a six cylinder 76 h.p. engine, and the first was built in 1923. This has been followed by an improved type, of which there are two variants, one being a four cylinder engine producing 40 h.p. and the other a six cylinder engine producing 60 h.p., one, or two, of these engines being installed in a life-boat, according to its size and type. A light 35 h.p. engine has also been adapted to the Institution's requirements for use in the specially light type of life-boat built for launching from the beach.

Life-boat Houses and Slipways.—The largest type of motor life-boats lie afloat, and in one or two cases the life-boats lie on the open beach, but for the most part they are kept in houses, various methods of launching being used according to the type of foreshore. The most effective, because the quickest, is down a slipway. For a slipway to be built, however, it is necessary that the shore should be steep enough to give a sufficient depth of water for launching the boat at any state of the tide. Slipways, for the most part, are built of reinforced concrete, the longest, at Porthdinllaen, Carnarvonshire, being 351 feet in length. The usual slope is 1 in 5. The great majority of houses with slipways for motor life-boats are provided with power winches for hauling up the boats. On flat sandy beaches life-boats are still launched off a carriage which is taken out into the sea, until a sufficient depth is reached to float the boat, and a specially light type of motor life-boat is built for such stations. Instead of horses, motor caterpillar tractors are now used at an increasing number of stations; these tractors not only drag the life-boat down to the water's edge, but push it out into the sea.

Modern Life-Boat Equipment.—All motor life-boats are provided with a line-throwing gun, specially designed for the Institution by the Birmingham Small Arms Company. The gun is similar to a carbine, with Martini Henry breech action. The line is coiled up in a tin cylinder which fits over the barrel. One end of it is attached to a hollow steel projectile, and this projectile has a rod down the centre, the rod having the diameter of the bore of the gun. The gun is "loaded" by slipping the projectile over the muzzle so that the rod goes inside the barrel, while the rest of the projectile fits outside it, in the space between the barrel and the cylinder holding the line. The projectile is fired with a small cordite cartridge, which has a very small recoil, and as the weight of the gun, complete with projectile and line, is only 14lb. it can be easily handled. There is no need for firing sights, and the correct angle at which the gun should be held is automatically obtained by a small plumb-bob suspended from a leaf-sight fixed at an angle of 30 degrees. The line used is $\frac{3}{16}$in. in diameter, and it can be thrown a distance of sixty to eighty-five yards, according to the conditions of the weather.



BY COURTESY OF THE UNITED STATES COAST GUARD

FIG. 2.—PROFILE AND MIDSHIP SECTION OF 26-FT. SURF BOAT

The majority of motor life-boats are provided with electric searchlights, specially designed to be water-tight and simple to manipulate. They are of two kinds, a portable searchlight of 100 candle-power, and a mounted searchlight of 2,000 candle-power, the latter being used only on the largest type of boats. The largest type of life-boat, the Barnett twin-screw, is provided with a net, stretched amidships, into which those on board the wreck can jump as the life-boat lies alongside.

The Crew.—All pulling and sailing life-boats are launched for an exercise once a quarter, and all motor life-boats once a month, for testing the machinery and once a quarter for drilling the crew. A crew varies in number from 6 and 8 in the case of motor life-boats to 13 and 17 in the case of pulling and sailing life-boats.

The Life-boats in the World War.—At the beginning of the World War there were already nineteen motor life-boats on the British coast. For four and a half years all construction was suspended. Boats already begun were left unfinished until the war was over. Even the work of repairing damaged boats was sometimes impossible. But though the war came at a time of critical development in the life-boat service, and delayed that development for over four years, it found the service ready for every emergency. The brief chronicle of its war-rescues is that from the outbreak of war in Aug. 1914, to the signing of peace in July 1919, the life-boats were launched 1,808 times and 5,322 lives were rescued. The boats were launched 552 times to the help of ships or aircraft of the navy, or to merchant vessels wrecked or in distress on account of the war. Besides those 5,322 lives the life-boat saved 186 boats and vessels. The bulk of the crews who did such fine work in the mine-sweepers, trawlers and drifters were drawn from the fishing population which, for generations, has manned the life-boats. On one occasion, of a crew of eighteen, twelve were over fifty years of age and two of the twelve were men of seventy-two.

Relations with the Government.—In 1893 a representative of the Institution moved a resolution in the House of Commons that, in order to decrease the serious loss of life from shipwreck on the coast, the British Government should provide either telephonic or telegraphic communication between all the coast-guard stations and signal stations on the coast of Great Britain; and that where there are no coast-guard stations the post offices nearest to the life-boat stations should be electrically connected, the object being to give the earliest possible information to the life-boat authorities at all times, by day and night, when the life-boats are required for service; and further, that a Royal Commission should be appointed to consider the desirability of electrically connecting the rock lighthouses, lightships, etc., with the shore. The resolution was agreed to without a division, and though its intention has never been entirely carried out, the development of wireless should, in due course, provide a simple and efficient means by which, eventually, all lighthouses and lightships will be connected with the shore.

Finance.—When the Institution was founded, it was laid down as one of its chief objects to reward those who rescued life from shipwreck, and give relief to the widows and families of those who lost their lives in attempting to save others. In carrying out these objects the Institution has long since worked on a carefully prepared scheme of rewards and pensions. In 1898 a pension and gratuity scheme was introduced by the committee of management, under which life-boat coxswains, bowmen and signalmen of long and meritorious service, retiring on account of old age, accident, ill-health or abolition of office, receive special allowances as a reward for their good services. This was followed in 1917 by a pension scheme for the widows and dependent children of life-boatmen who lose their lives as a result of rescuing or attempting to rescue life from shipwreck. For many years before that date it had been the practice of the Institution to pay a gratuity of at least £100 to the widow, and £25 for each dependent child. The financial obligation assumed by the Institution towards those who risk their own lives in attempting to rescue life from shipwreck may be summarised as follows:—It gives retaining fees to coxswains, second coxswains, etc., and wages to motor mechanics; it gives rewards for every rescue or attempted rescue from shipwreck round the coasts of Great Britain and Ireland by whomsoever performed; it compensates life-boatmen injured on service. It pays pensions or gratuities to coxswains, bowmen and signalmen of long and meritorious service; it pensions the widows and dependent children of life-boatmen who lose their lives on service.

The 40 years after the duke of Northumberland reorganized the Institution were years of many experiments and immense developments. In 1851 there were only 30 life-boats on the coast, and the Institution's income was under £800. In 1890 there were 300 life-boats, and the ordinary income of the Institution was over £42,000. Unfortunately, developments outstripped the increase in income, great as this had been, and in the year, 1891, the total expenditure was over £75,000, nearly double the income. Once again the life-boat service was in the greatest need of increasing public interest in its work, and it found the means in the Life-boat Saturday Fund, which was founded by Sir Charles W. Macara, Bt., in 1891. This fund was started as a result of the public interest aroused by the disaster, already mentioned, to the two life-boats on the Lancashire coast in 1886. It remained in existence until 1910, when its work and organization were taken over by the Institution, and during those 19 years it raised nearly £300,000.

The use of mechanical power wherever possible, while it has greatly increased the efficiency of the service, has necessarily increased its cost. At the end of the 19th century a thousand pounds was sufficient not only to build but to endow a life-boat, so that, out of that sum, it could be replaced in perpetuity. To-day a motor life-boat costs, to build alone, from £4,500 to £14,000, while the boat house and launching slipway cost, on an average, as much as the boat. At the beginning of the century the Institution required annually, to provide and maintain the service,

£100,000. It now requires £250,000. In order to obtain this much larger sum it has greatly extended its methods of appeal. In 1921 the Ladies' Life-boat Guild was formed, to unite in one body the many hundreds of women who were working for the Institution. In addition to over 200 life-boat stations, the Institution has over a thousand financial branches and guilds, with thousands of voluntary workers attached to them. It is one of the remarkable features of the Institution's work that, in spite of the great changes and developments which have been made in the course of over a century, it is still maintained by voluntary means.

National and International Aspects.—It is still more remarkable that even those who believe in nationalization would not nationalize the life-boat service, and one of the best tributes to its success as a voluntary organization was paid by a leading exponent of socialist theory, Mr. Sidney Webb, when he was president of the Board of Trade. He said that "one of the Institution's glories is that it is entirely voluntary," and to that he added an interesting analysis of the reasons why the Institution has succeeded as a voluntary body. "One of the advantages of voluntary organization is that it can initiate and experiment, which is very difficult for a Government department."

The British life-boat service has been the acknowledged model of the other life-boat services of the world, and of the fourteen other countries which have national services, Holland, Belgium, the United States, Germany, Denmark, Norway, Sweden, France, Russia, Spain, Japan, Portugal, Latvia and Iceland, only four are maintained by the State, those in the United States, Belgium, Denmark and Russia. Four of the remaining nine—those in Germany, Norway, Sweden and Spain—were originally State-services, but they have since been handed over to voluntary organizations, or such organizations have been set up to supplement the State-service.

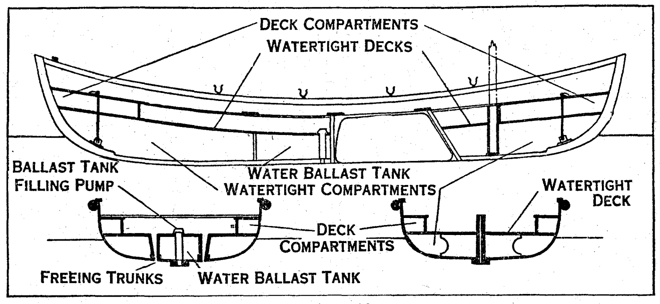
In 1924, by which year it had given rewards for the rescue of nearly 60,000 lives, the Institution celebrated its centenary, and those celebrations showed what a secure place it holds in the pride and affection of the British people. The King personally decorated with the Medal of the Order of the British Empire the eight men still living out of the eighty-seven who during the century had won the Institution's Gold Medal, the Victoria Cross of the Life-boat Service. On its hundredth birthday, March 4, the Institution held a centenary meeting at the Mansion House. Shortly afterwards an international conference was held in London, attended by delegates from eight foreign countries, while five of them sent life-boats, so that, for the first time, an international life-boat fleet lay on the Thames. At this conference it was unanimously decided that an international life-boat organization, on the lines of the Red Cross Society, ought to be formed, and that it was desirable to have some organization for saving life from shipwreck in all the maritime countries of the world. This resolution was brought to the notice of the governments of all maritime countries and of the League of Nations. It was discussed at a meeting of the League's sub-committee on Ports and Maritime Navigation in the following year, at which the Institution was represented by its secretary, and the sub-committee decided that it could best encourage the promotion of life-boat services by asking governments to induce their national life-boat organizations to keep in constant touch with one another. For this purpose the sub-committee placed its own secretariat at their disposal. Thus, a little more than a century after Sir William Hillary launched his appeal for a national life-boat service, the international value of such services, and the duty of all maritime countries to provide them for the succour of the seafarers of their own and other nations, were fully and formally recognized.

For the use of rockets in life saving, *see* ROCKET AND ROCKET APPARATUS. (G. F. SH.)

THE UNITED STATES

Life-saving work upon the coast of the United States is a function of the United States Coast Guard, the former Life-Saving Service having been merged with the Revenue Cutter Service in 1915, the combined service taking the name of the Coast Guard (*q.v.*).

Extent of Operations.—In the extent of coast-line covered, the magnitude of operations, and the extraordinary success which has crowned its efforts, the life-saving work of the United States Coast Guard is not surpassed by any other institution of its kind in the world. Notwithstanding the exposed and dangerous nature of the coasts stretching between the approaches to the principal seaports, and the immense amount of shipping concentrating upon



BY COURTESY OF THE UNITED STATES COAST GUARD

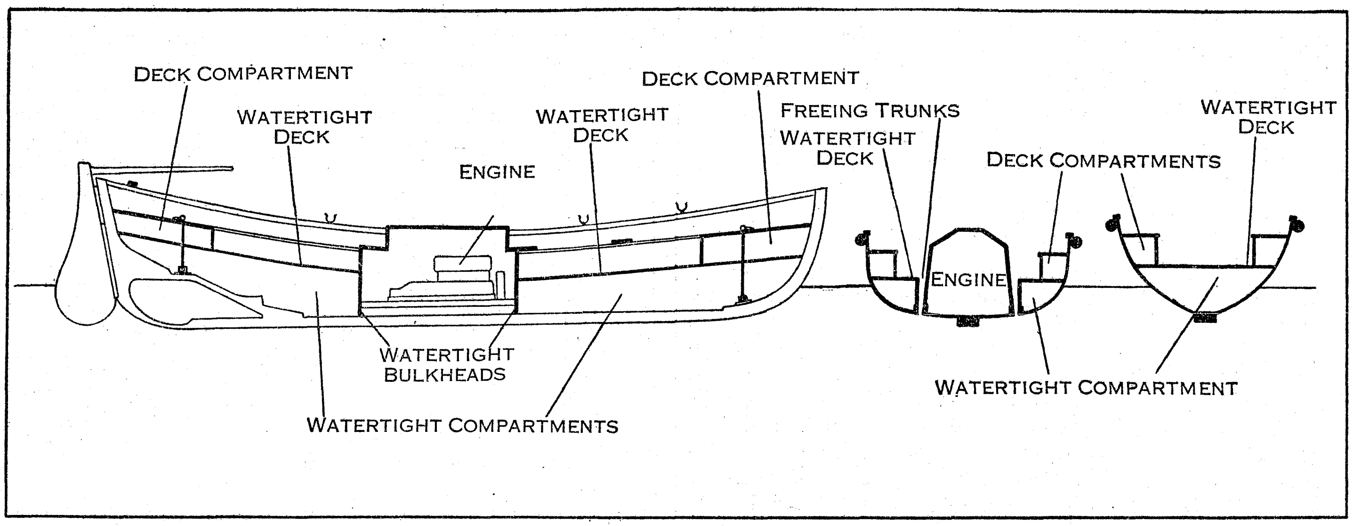
FIG. 3.—PROFILE AND TWO SECTIONS OF 25-FT. 6-IN. SELF-BAILING SURF BOAT (MODEL H)

them, the loss of life of persons imperilled by marine casualty within the scope of operations of the service is less than 1%, and even this small total is made up largely of persons washed overboard immediately upon the striking of vessels and before any assistance from shore could possibly reach them, or lost in attempts to land in their own boats, and persons thrown into the sea by the capsizing of small craft.

In the service, next in importance to the saving of life is the saving of property from marine loss.

The Massachusetts Humane Society, as early as 1789, began the erection of rude huts along the coast of Massachusetts for the shelter of any destitute persons who might escape death in the sea. At first no attempt was made to provide means of rescue, but in 1807 a station, equipped with a boat for use by volunteer crews, was erected at Cohasset, Mass., and additional stations were placed at exposed points along the coast from time to time. The Federal Government, soon after its organization at the close of the Revolutionary War, commenced the erection of lighthouses, which were placed under the charge of the Treasury department; but it was not until 1838 that it was suggested, by two officers of the navy who had been assigned to make a general inspection of the lighthouse system, that life-boats be added to the equipment of seven of the lighthouses, and it is not recorded that this suggestion bore any immediate fruits. However, on March 3, 1847, Congress appropriated the sum of $5,000 "for furnishing the lighthouses on the Atlantic coast with means of rendering assistance to shipwrecked mariners." No steps having been taken to expend this sum, the Massachusetts Humane Society in the following year made application to the secretary of the Treasury and was granted the use thereof. The society at that time represented that it was maintaining "16 or more life-boats on the coast at the most exposed places, also a number of houses on exposed beaches." During the period from 1849 to 1870 this society secured additional appropriations aggregating $40,000 from Congress for the prosecution of its work.

First Government Efforts.—The first Government life-saving stations were plain boat-houses, a few of which were erected along the coast of New Jersey in 1848, each equipped with a fisherman's surf-boat, a mortar for firing a line across a stranded vessel, a life-car or enclosed metallic boat to be hauled between the shore and a wreck, and a few simple accessories. In 1849 the service was extended to the coast of Long Island, and in 1850 one station was placed on the Rhode Island coast, thus protecting the coasts converging on the principal American seaport, New York city. No provision was made for crews or even for responsible caretakers, and as a result the buildings and equipment rapidly deteriorated from the ravages of the elements, and much of the equipment was stolen or destroyed. In 1854 provision was made for the appointment of paid keepers for the New Jersey and Long Island stations, and a superintendent for each of these coasts, marking the begin-



BY COURTESY OF THE UNITED STATES COAST GUARD

FIG. 4.—PROFILE AND TWO SECTIONS OF 26 FT. MOTOR SELF-BAILING SURF BOAT (MODEL H)

ning of an organized, effective governmental life-saving service. Volunteer crews were depended upon until 1870, when Congress authorized crews at each alternate station for the three winter months.

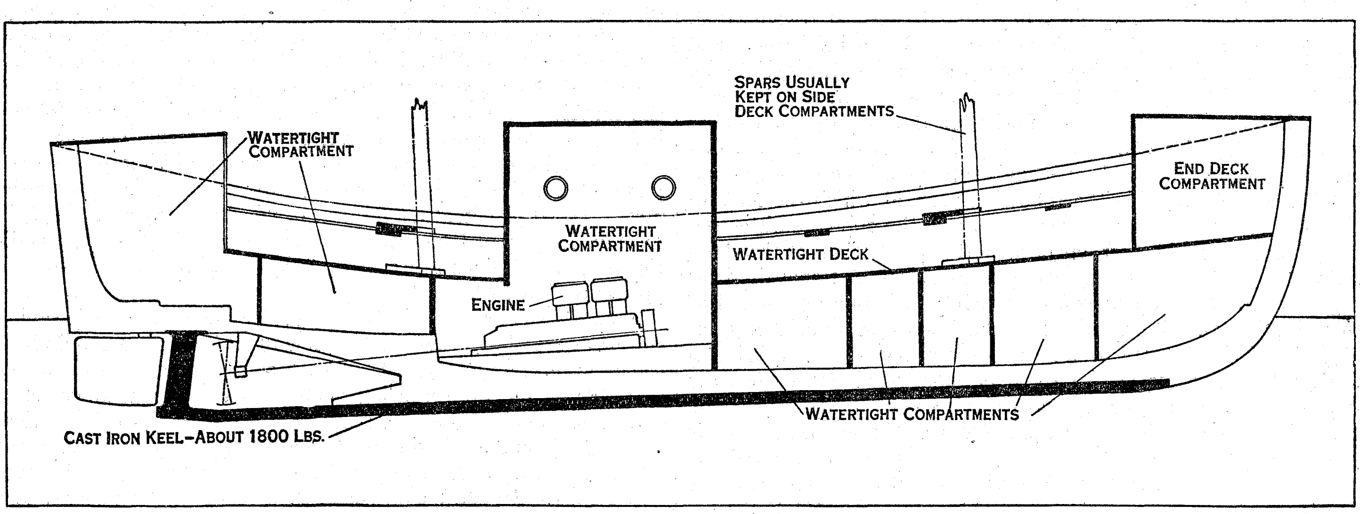
The present extensive and thoroughly organized system was inaugurated in 1871 by Sumner I. Kimball who in that year was appointed chief of the Revenue Cutter Service which, some years earlier, had been given charge of the embryo system. He secured from Congress an appropriation of $200,000, and authority for the employment of crews for all stations for such periods during the year as were deemed necessary. The existing stations were thoroughly overhauled and put in condition for the housing of crews; the best available boats and equipment were provided; inefficient station keepers, who had secured appointment through political influence, were succeeded by men carefully selected for their skill and experience; additional stations were established, and all were manned by capable surfmen; the merit system of appointments and promotions was inaugurated, and effective regulations for the government of the service and training of the crews were adopted and enforced. A beach patrol maintained throughout the hours of darkness and in thick and stormy weather in the daytime, for the warning of vessels standing into danger and the prompt discovery of such as were cast ashore, was instituted. The result of this transformation was immediate and striking. At the end of the year not a life had been lost within the domain of the service; and during the next year but one life was lost although the service now embraced the dangerous coast of Cape Cod.

Establishment of Regular Service.—The service continued to grow rapidly in extent and importance until, in 1878, Congress established the Life-Saving Service as a distinct and independent organization, operating under the Treasury department. The Life-Saving Service became the United States Coast Guard in 1915.

Organization.—The Coast Guard in 1939 embraced 13 districts, with shore stations of which 197 were active, situated at selected points upon the sea and lake coasts. Five districts on the Atlantic and Gulf coasts contained 128 stations, including three houses of refuge on the coast of Florida, each in charge of a keeper only, without crews; two districts on the Great Lakes contained 52 stations, including one at the falls of the Ohio river at Louisville, Ky.; and three districts on the Pacific coast contained 23 stations, including one within the Arctic circle at Nome, Alaska.

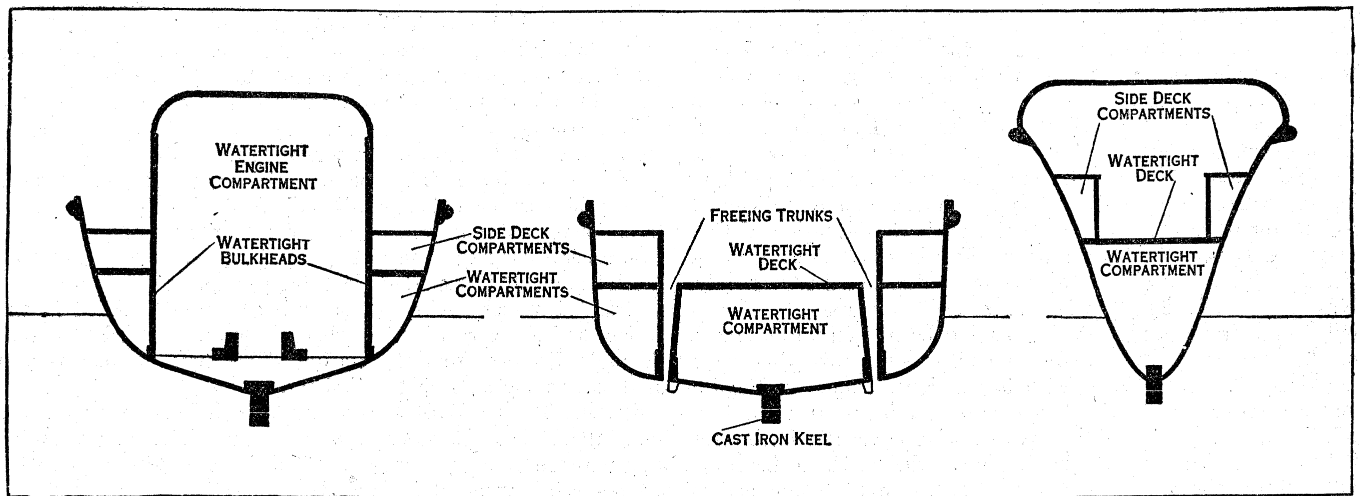
Each Coast Guard district is in charge of a district commander, who is a commissioned officer. The district commander has immediate supervision over the operation of the stations, the selection and enlistment of the crews and their assignment, the enforcement of discipline, the procurement of supplies and equipment, and the payment of compensation. He is held responsible for the efficiency of the stations in his district.

The maintenance of the property, buildings, wharves, launchways, sea walls, etc., is in the hands of a civil engineer attached to headquarters in Washington, with a number of assistants in immediate personal charge of extensive sections of the coast. The general administration of the service is conducted by the commandant of the Coast Guard with headquarters at Washington.



BY COURTESY OF THE UNITED STATES COAST GUARD

FIG. 5.—PROFILE OF 36 FT. SELF-BAILING AND SELF-RIGHTING MOTOR LIFE-BOAT



BY COURTESY OF THE UNITED STATES COAST GUARD

FIG. 6.—THREE SECTIONS OF A 36 FT. SELF-BAILING, SELF-RIGHTING MOTOR LIFE-BOAT

Station crews are composed of an officer in charge holding the rank of a boatswain, and, at a majority of the stations, from six to eight surfmen, with a larger number, up to as many as fifteen, at certain stations where the service is particularly arduous. The number of men in each crew is determined principally by the number and kind of boats, the extent and nature of the coast-line to be served, the climatic conditions at various seasons, and the amount of shipping in the locality. Nearly all stations are now equipped with motor-powered boats. One or more of the members of the crew are trained in the care, operation and repair of these engines, those so qualified being rated motor machinists.

For this purpose there is maintained, at the ship repair and boat building yard of the service, at Baltimore, Md., a school for the special instruction of men who show an aptitude for this work. The surfmen are enlisted for periods of from one to three years, after a thorough medical examination. All stations on the ocean coasts are in commission and fully manned throughout the year. The floating station at Louisville, and a number of stations on the Great Lakes situated at harbours where shipping is in operation during the winter months, are in continuous commission.

Stations.—The stations contain, as a rule, suitable living quarters for the officer in charge and members of the crew, and a boat and apparatus room. Many of the stations, particularly on the Lakes, have living quarters for the family of the officer in charge. Each station has a look-out tower for the day watch, on the station building proper, or separately placed at a point of vantage. In some places the dwelling and boat-house are built separately, and a number of stations also have additional boat-houses situated at danger points distant from the main station. Those equipped with the larger life-boats have launchways or marine railways for the launching of the boats directly into deep water, with power winches and cradles for launching and hauling out. The Louisville station guards the falls of the Ohio river, where life is much endangered from accidents to vessels passing over the falls, and to small craft which are liable to be drawn into the chutes. It consists of a dwelling with look-out tower, apparatus room, and ways for small boats, the whole mounted on a scow-shaped hull. Its equipment includes several river skiffs which can be quickly launched directly from the ways at one end of the station. These skiffs are modelled much like surf-boats, designed to be rowed by one or two men.

Equipment.—The equipment of the stations consists of the beach apparatus—line-throwing guns, hawsers, breeches-buoys and life-car—flag and pyrotechnic signals, heaving sticks and lines, life-preservers and life-boats, surf-boats and other special types of boats. The outfits are practically the same at all stations, but the boats are of various types, depending upon their suitability for rescue work on the different coasts. The larger life-boats are too heavy to be launched from the beach into the surf, and launching ways are provided for them where comparatively smooth water prevails—on rivers, bays and inlets. The surf-boats are mounted on boat-wagons by which they are drawn to a point abreast of a wreck and launched directly from the beach.

Beach Patrol.—The system of beach patrols maintained at all stations is of distinctly American origin, and has proved of great value in the saving of life and property. A fixed beat or patrol is laid out in each direction along the shore, varying according to the conformation of the coast with respect to inlets, headlands, etc., from one-half to two, three or four miles in length. The station crew is divided into regular watches of two men each, who during the hours from sunset to sunrise, and during thick and foggy weather in the daytime, patrol these beats, keeping a sharp look-out seaward. The usual schedule is: first watch, sunset to 8 P.M.; second watch, 8 P.M. to midnight; third watch, midnight to 4 A.M.; fourth watch, 4 A.M. to sunrise.

Positive evidence of the integrity of the patrol and watch is required. Where stations are sufficiently close to one another to permit the entire intervening distance to be patrolled, a half-way point is established, at which point each patrol-man must deposit a brass check bearing the name of his station and his number in the crew. This is taken up on the next visit by the patrol-man from the adjacent station, who in turn leaves his check. The first patrol-man at night returns all checks of the previous night. Where the patrols do not connect the patrol-man carries a watchman's clock or time detector, in which there is a dial that can be marked only by means of a key which registers the exact time of marking. This key is secured in a safe embedded in a post at the limit of the patrol, and the patrol-man must reach that point in order to obtain the key with which to register his arrival.

In some cases telephones are placed in half-way houses or at the end of patrols, by means of which the patrol-man reports to his station. In other cases the patrol-man is provided with a small portable telephone set with which he can communicate with the station from any point along his patrol. The Coast Guard owns and operates a telephone line system consisting of 183 separate lines, with a total mileage of approximately 2,650, including 500 m. of submarine cable. Practically all of its shore stations, 160 lighthouses, and a number of other Government agencies such as naval radio compass stations, weather bureau stations, etc., are served by these lines, which are connected with commercial exchanges for both local and long distance service.

Assistance and Rescue.—On discovering a vessel standing into danger the patrol-man burns a pyrotechnic signal which emits a brilliant red flare, to warn the vessel of her danger. The number of vessels thus warned averages over 200 annually. The extent of the loss of life and property thus averted can never be known. When a stranded vessel is discovered, the patrol-man's Coston signal apprises the crew that they are discovered and assistance is at hand. He then notifies his station, either by telephone or by an electric hand flash using the telegraphic code. When such notice is received at the station, the officer in charge determines the means by which to attempt a rescue, whether by boat or beach apparatus. If the beach apparatus is chosen, the apparatus cart is hauled to a point directly opposite the wreck by motor tractor or truck, by horses, or by the members of the crew. The breeches-buoy gear is unloaded and while it is being set up the officer in charge fires a line over the wreck with the Lyle gun, a small bronze cannon weighing, with its 18 lb. elongated iron projectile to which the line is attached, slightly more than 200 lb., and having an extreme range of about 700 yd., though seldom available at wrecks for more than 400 yd. This gun is the invention of Col. David A. Lyle, retired, U.S. army. Shotlines are of three sizes, $\frac{4}{32}$, $\frac{7}{32}$, and $\frac{9}{32}$ of an inch in diameter, designated respectively, Nos. 4, 7 and 9. The two larger are ordinarily used, the No. 4 only for extreme range. A line having been fired within reach of the persons on the wreck, an endless rope rove through a tail-block is sent out by it with instructions, printed in English and French on a tallyboard, to make the tail fast to a mast or other elevated portion of the wreck. This done, a 3 in. hawser is bent on to the whip and hauled off to the wreck, to be made fast a little above the tail-block, after which the shore end is hauled taut over a crotch by means of tackle attached to a sand anchor.

From this hawser the breeches-buoy or life-car is suspended and drawn between the ship and shore by means of the endless whip-line. The life-car can also be drawn like a boat between ship and shore without the use of a hawser. If any of the rescued persons are frozen, as often happens, or injured, first aid and simple remedies are furnished. Dry clothing, supplied by the Women's Nat. Relief Assn., is also furnished to survivors.

Boat Equipment.—All stations are equipped with boats adapted to the special requirements of the different localities and occasions. The three principal types of life-boats used in rescue work are a self-righting and self-bailing motor life-boat, a self-bailing motor surf-boat and self-bailing pulling boat.

The motor life-boat is 36 ft. in length with an overall beam of 9 ft. $5\frac{1}{4}$ in., and an approximate draft of 2 ft. 8 inches. Its weight with full equipment, not including fuel and crew, is about 14,300 pounds. It is constructed of wood with $1\frac{1}{8}$ in. planking. It is fitted with numerous water-tight compartments and has a water-tight deck, end compartments and a house over the engine. A cast iron keel weighing 1,800 lb. extends the full length of the bottom and protects the propeller and rudder from injury. A semi-tunnel for the propeller is provided in order to obtain shallow draft. This boat develops to the highest degree the self-bailing and self-righting qualities so essential to a life-boat. It is equipped with a 44 h.p. gasolene engine, driving a 3-bladed propeller of 22 in. diameter, and 16 in. pitch, and has a speed of about 9 m. p.h. under usual service conditions. Sails and oars are also provided for auxiliary use when needed. This type of boat is used at practically all stations on the Great Lakes, and along the ocean coasts in localities where sheltered inlets are available in which it can be safely launched or moored. It is an extremely able craft and will go through practically any surf and live in any sea.

The power surf-boat has a length of 26 ft., a beam of 7 ft., and is equipped with a 20 h.p. gasolene engine. Like the larger life-boat, this type is also provided with self-bailing features, but is not self-righting. The construction, in general, follows that of the larger boat except that water-tight end compartments and a house over the motor are not fitted. A small water-tight enclosure protects the motor from spray and seas. The boat is rather lightly but strongly constructed, and a semi-tunnel and shoe provide protection for the propeller when the boat is grounding. No sails are fitted, but oars and thwarts for the crew are provided. This type of boat is used generally at stations where it can be launched into the water on a carriage. It is also issued to the larger coast guard vessels for use as a life-boat.

A third type of life-boat which is generally used is the self-bailing pulling surf-boat, 25 ft. 6 in. in length, and weighing about 2,200 lb. This boat has no engine, but is manoeuvred under oars and sails only. The construction is very similar to that of the life-boat and power surf-boat already described, having water-tight compartments and deck above the load water line with freeing trunks, which give it the self-bailing feature. Although not self-righting, it can be readily righted by means of righting lines provided along the sides, which enable the crew easily to roll it right side up, when it quickly clears itself of water through the bailing trunks. It is fitted with a water-ballast tank filled by means of a hand pump, which increases the stability and sailing qualities of the boat. This type of boat is light and handy for use in launching through the surf directly from the beach, and is an exceptionally able boat when used in rescue work in broken waters. It is generally mounted on a specially built boat-wagon on which it can be quickly transported along the beach to a point abreast of a stranded vessel. Sails and centreboard are embodied in the design, and are very effective when the boat is called to a considerable distance from the station. This type of boat is also used extensively as a ship's life-boat.

Special Service Boats.—Another type of boat in general use along the New England coast is an open whaleboat commonly known as the Monomoy surf-boat. This boat is neither self-righting nor self-bailing. It is propelled by oars and sails, and is a very seaworthy craft. A number of stations are supplied with fast motorboats especially designed for law enforcement duties, as distinguished from those here described, of heavier construction and less speed, provided for rescue work under adverse conditions of weather and sea in which the paramount consideration is seaworthiness and reliability of operation. Others, situated in sheltered harbours, where the principal source of danger is from accidents to pleasure craft, are provided with light skiffs or with small motorboats designed more particularly for speed.

(A. T. T.; X.)

LIFE GUARDS: *see* GUARDS AND HOUSEHOLD TROOPS.

LIFE INSURANCE, a contract insuring the payment of money on the happening of any contingency, or one of a variety of contingencies, dependent on human life; as this definition would, however, include contracts for annuities or pure endowments, it should be limited by the condition that one of the contingencies should be death (except death by accident only). The sum insured is agreed upon at the outset and may be added to from time to time, out of profits or otherwise; life insurance therefore differs in character from other forms of insurance, the essence of which is indemnity to the insured for actual loss incurred.

The word assurance is more commonly used than insurance in connection with life contracts, the latter word being applied in general to contracts of indemnity; it is not, however, incorrect to use either word in any context.

Primitive Form of Life Insurance.—The principle that groups of persons should agree to make common cause against dangers which threaten all, but are individual in operation, is an old one. Action of this nature was moreover, in its origin, dictated by the interest of the group rather than by the interests of its members. As communications became more widely organized, the character of the group granting the benefit naturally tended to become that of a class or trade union, but until what are historically known as modern times, insuring associations were associations of persons, not of capital, and insurance of members would only have been one of their reasons for existence. Modern life insurance, mainly by companies, is concerned only with the risk to be insured against, and even institutions which were, in their origin, distinguished by some bond of class or calling among their members, are usually open to do business with all comers, and retain but a shadow of their earlier exclusiveness.

The beginnings of true life insurance, that is to say, the payment of certain benefits on death, against certain periodical subscriptions, are to be found in the Roman Collegia. The gilds of mediaeval times would, in many cases, make provision for the decent burial of a member, but the extent of such assistance would depend on the actual needs of the dead man's dependants and was not, therefore, life insurance in the full sense.

Marine insurance is generally believed to have an earlier origin than life insurance and it is therefore natural that the first definite contracts of life insurance, made with underwriters as a matter of business, should have been on the lives of mariners. The earliest contract of this type, recorded to have been made in England, was effected in 1583.

The First Companies.—An important step was the foundation in England of the first insurance companies. The Amicable Society for a Perpetual Assurance was founded in 1705, but provided merely for the dividing up of certain sums between the representatives of those members who died each year. The Royal Exchange Assurance Corporation and the London Assurance Corporation, both incorporated by royal charter in 1720, were, however, true life insurance institutions, and, with the Amicable, held the field for 40 years. During this period they effected only a moderate amount of life insurance business; also the contracts were still of the simplest nature, being as a rule for a term of one year.

The period of scientific insurance began with the foundation of the Equitable society in 1762. Until that date there had been no endeavour to graduate premium rates according to the age of the person insured, despite the obvious fact that such differentiation was called for. The material for calculating rates was, however, in existence, although it was imperfect: Dr. Edmund Halley's tables, based on the deaths in the city of Breslau in the years 1687–91, and the death rates derived from the London bills of mortality of the period, were the foundation of the society's first table of premiums. It is moreover notable that in addition to differentiating rates, the society introduced the principle of making a policy renewable from year to year throughout life. The success of the new venture was soon apparent: in 1776 it made its first actuarial valuation of assets and liabilities and returned part of the premiums paid to the insured by way of bonus; this was the beginning of the with-profit system, which might have been much longer in making its appearance, had it not been for the fact that the rates charged by the Equitable were decidedly on the safe side, although in most cases substantially less than the £5 to £6 per £100 for a year's insurance which had been the general rule until 1762.

The Gambling Act.—The Life Assurance Act of 1774, usually referred to as the Gambling Act, is a highly important landmark in the history of life insurance. Speculation in the lives of other persons, particularly public men, had become something of a scandal.

The Act forbade the issue of policies in which the names of the persons interested did not appear and also prohibited the insuring of lives in which the insured had no interest; the path was thus cleared for the development of life insurance for provident purposes only—its principal function.

The Equitable had the field to itself until towards the end of the century when the Westminster society was founded. This society instituted the principle of paying commission to agents for the introduction of business.

Many offices came into existence in the first half of the 19th century—a natural concomitant of the growth of the joint stock enterprise which marked that period: incidentally the Joint Stock Companies' Registration Act of 1844 brought in a number of recruits, but many of these were mushroom concerns and most of the leading offices had commenced business before that date.

Events Leading to Act of 1870.—There was little restraint or check on the earlier operations of the companies (the Act of 1774 was a check on the insured, not the insurer) and it is therefore not a matter of surprise that concurrently with many carefully-managed institutions, there should have grown up others whose existence was undesirable. The description given by Dickens in *Martin Chuzzlewit* of the business methods of the Anglo-Bengalee Disinterested Loan and Life Assurance Company suggests what may have been the state of affairs with certain offices; but it was not wholly a caricature. Matters were brought to a head by the disclosure of the difficulties of two companies, the Albert and the European. Both these offices had been active in absorbing lesser concerns, and, in their greed for large figures, had in many cases paid unjustifiable prices to the shareholders of the companies absorbed, without regard to the interests of the original policy-holders or those to whom they subsequently became responsible. The Albert closed its doors in 1869, and although the European did not do so for another three years, its position was a factor in hastening much needed legislation. The provisions of the Life Assurance Companies' Act of 1870 are essentially those which have governed the business in Great Britain ever since. Like most acts of parliament, it has been subject to amendment as the result of experience and it will probably be further amended in certain important respects by the bill of 1927.

The Scottish Widows Fund Life Assurance Society, established in 1815, was the first life insurance office founded in Scotland, where the business has, in proportion to the population, acquired even greater importance than it has in England.

Development Outside the United Kingdom.—Life insurance on the Continent, and in America, developed later than in Great Britain. The first successful venture in France was made in 1819, when the *Compagnie d'Assurances Générales sur la Vie* was founded. In Germany, branches of English offices were operating before the end of the 18th century, but the first German company was not founded until 1828. As for the rest of the Continent, just as the English companies had extended branches into Germany, Holland and Scandinavia, so the French companies pushed theirs into Italy, Spain, Belgium and Switzerland, and the existence of these branches gave an impetus to the formation of companies of national origin.

In addition to being served by English and Scottish offices, most of the British dominions and colonies have developed life insurance institutions of their own and the dominion offices have also carried their operations with vigour into the mother country.

The Contract and the Policy.—The first step in the taking out of a life insurance policy is the submission to the insuring company of a written statement called a proposal, setting out particulars as to the proposer's age, health, past illnesses and family history. The proposer warrants the correctness of his statements and the contract is voidable by the insurer should any of them prove untrue. In practice it is unusual for an office to make use of this power unless there has been a deliberate intention to defraud. If there is a medical examination, the truth of the statements made to the doctor is also warranted. In legal terms, an insurance contract is *uberrimae fidei,* that is to say based on the utmost good faith between the parties, and the proposer is bound to disclose all circumstances material to the risk, not excluding any in regard to which he may not be specifically questioned. The necessity for this arises from the fact that many matters essential to the contract can be only within the private knowledge of the person desiring to be insured.

Insurable Interest.—Another condition precedent to the granting of a policy is that the person effecting it should have an interest in the life to be insured, known as an insurable interest. This arises mainly from the provisions of the Act of 1774. Every adult person has, of course, an unlimited insurable interest in his or her own life. A wife has an unlimited insurable interest in the life of her husband, and it was decided in 1909 (*Griffiths* v. *Fleming*) that a husband has a similar interest in the life of his wife. Except in the cases named the interest must be pecuniary, *e.g.,* the interest which a creditor has in the life of his debtor for the amount of the debt.

The proposal, the warranted statements to the doctor, and the policy, constitute the entire contract between insurer and insured.

Modern British policies are simple in form, the essential facts and figures being incorporated in a schedule. Of the many restraints formerly in vogue, the only one in common use is the restraint on suicide during the first 12 months of the policy.

Surrender Values, etc.—Under whole life and endowment assurance contracts, where the annual premium is more than sufficient in the early years to cover the yearly risk, the office will return, after, on the average, two years' cash payments, a sum known as the surrender value. As current risk and expenses have to be allowed for, this is for policies of short duration considerably less than the total of the premiums paid. An alternative is to obtain a policy for a reduced amount, free from further premiums; this is known as a paid-up policy. Offices are as a rule prepared to lend back to the insured a proportion of the surrender value, 90% to 95%; the maximum amount which can be thus lent is the loan value. Under the laws of the State of New York, insurance companies are bound to state in their policies the surrender value for each of the first 20 years, and this is also done voluntarily by many British companies.

What are known as non-forfeiture regulations provide for the continuance in full force, for a period, without payment of premiums, of policies carrying surrender values under which a certain number of years' premiums have been paid. The period may be for a year or it may be for a number of years until the surrender value is exhausted; a provision of the former type is common in Great Britain, while the last mentioned plan is usual in America.

Proof of age, usually by the production of a birth certificate, is required, and this is best done at the outset, though it may be left until the policy becomes a claim.

Extra Risk.—In between those risks which an office can accept at its tabular rate of premium and those which are unacceptable lie a large body of risks which can be accepted on special terms. In Great Britain these are usually dealt with: (1) by an addition to the premium, (2) by the deduction, for a period of years, of a level or diminishing sum from the amount insured—described as a debt. The assessment of these risks is a matter of great difficulty, but special researches into the question of over and under weight, cancer, phthisis, circulatory disease, etc., are by degrees making the treatment of the problem less empirical. In America the question is usually decided by a system of numerical rating, positive and negative marks being given for different qualities and defects, while in certain Continental countries under-average lives are sometimes dealt with by reinsurance companies or pools, created *ad hoc.*

Extra risk due to the surroundings or occupation of the insured, as distinct from his individual peculiarities, is of a different nature. Extra premiums are charged for certain tropical countries, removable as a rule on return to a healthy climate, and in any case after a period of years; these are known as climate extras, but the portion of the world to which they apply is an ever contracting one. The additional risk for the army and navy can usually be covered by a moderate extra, 5s to 10s per £100 per annum, payable in peace time: no further extra is then demanded on the outbreak of war. The extra to be charged for the Air Force is still in process of evolution. Other occupations regarded as extra-hazardous are the liquor trade, and to a less extent, seafaring. Formerly it was usual to charge an extra to women under 40.

A person who has no definite prospect of going abroad or engaging in a hazardous occupation is given a policy which is termed world-wide and indisputable, and no climatic or occupation extra can thereafter be charged under such a policy, no matter where the insured goes or what he does.

Different Types of Insurance.—Life insurance policies may be for a definite sum throughout, or they may share in the profits of the company, such profits being allotted in the form of cash, additions to the sum insured, or reductions of the premiums. In the following brief descriptions of the principal types of policy the word assurance is employed as being that in common use.

Whole Life Assurance.—If the term is used without qualification, the sum insured is payable at death, and the premiums throughout life.

Whole Life Assurance by Limited Payments.—The sum insured is payable at death, and premiums cease at death or at the end of an agreed period.

Endowment Assurance.—The sum insured is payable at death or at the end of a fixed period, when premiums cease.

Double Endowment Assurance.—As above, except that the sum payable on survival of the agreed period is double that payable on death.

Joint Life Assurance.—The sum insured is payable when the first death arises out of a group of two or more persons. Effected by partners in a business to provide a fund on the death of either of them.

Term Assurance.—The sum insured is payable only if death arises within a period agreed upon. School fees policies are term assurances for sums payable annually until the expiry of a certain period, corresponding to that of a child's education.

Options.—A term assurance premium may be increased so as to allow the insured to continue the policy at the end of a certain period as a whole life or endowment assurance at normal rates, whatever may then be his or her state of health.

Deferred Assurance.—Children's lives may not be insured except for small sums under industrial policies. A deferred assurance policy may, however, be effected under which premiums are returnable in the event of the child's death before age 21, and which the child can continue after 21 as a whole life or endowment assurance, irrespective of health.

Group Assurance.—Insurance for a certain sum on the life of each member of a group of employees, usually term assurance renewable yearly, the sum insured often being one year's wages.

Certain special benefits are sometimes offered concurrently with life insurance. Disability benefit involves the suspension of premium payments during permanent disability, and in its most developed form, the payment in addition of a monthly sum to the insured, usually 1% of the sum insured, without prejudice to the ultimate payment of the sum insured in full. Free medical overhaul at intervals and financial assistance towards surgical treatment are further examples of special benefits offered by certain offices.

Pure endowments, payable on survival over a certain period, are not strictly life insurance, but the granting of these forms part of a life insurance company's business.

Institutions Granting Life Insurance.—*Mutual life insurance institutions* are without shareholders and all profits go to the participating policy-holders.

Proprietary life insurance institutions are nominally controlled by shareholders, who, however, only receive as a rule about 5% to 10% of the profits, the remainder going to the participating policy-holders.

Composite offices are those which transact more than one kind of insurance; they are, as a rule, proprietary.

Mortality Tables.—As this subject is dealt with under the heading DEATH-RATE, the following remarks will be confined to a brief description of the principal tables used in connection with life insurance.

Breslau Table.—Used by the Equitable society for its first premium tables.

Northampton Table.—Based on deaths in Northampton, 1735–80. Constructed on unsound basis, but erring on the safe side when issued in connection with insurance contracts. The standard table till 1815.

Carlisle Table.—Based on census and death records in two parishes of Carlisle, 1779–87. The standard table till 1872, and used after that for valuing reversions, etc.

Seventeen Offices Table.—Constructed in 1838 from the experience of insured lives, but used more in America than Great Britain.

H^m. (Healthy Males) Table.—Based on experience of insured lives till 1863. The standard British table for 30 years from 1872.

O^m. (Office Males) Table.—Based on experience of insured lives 1863–93. The standard table from 1903 onwards.

American Experience Table.—Published in 1867. Adopted as standard in several States of the U.S.A.

Thirty American Offices Table.—Based on the experience of 30 American offices and published in 1881.

American Medico-actuarial Mortality Investigation.—An investigation into the mortality of special groups, based on the experience of American and Canadian life insurance companies. Deviations due to climate, race, height and weight, and various diseases and occupations, were analysed and published in 1903 and 1912.

Among the best known Continental tables are the A.F. (France) and the Gotha (German).

Sundry tables relating to the experience of residents in the tropics, both native and European, have been compiled.

The construction of a mortality table from the crude data is a complex process, but the tabulation of particulars taken from office records is greatly facilitated by mechanical devices as the Powers and Hollerith calculating, sorting, and tabulating machines. Graduation, that is to say the removal or smoothing down of irregularities not inherent in the data, is the next step, and the tables in use by actuaries are eventually compiled by associating the graduated rates of mortality with various rates of interest to form what are technically known as commutation functions, the shaped bricks of the actuary's stock-in-trade, the combination of which in various ways enables him to compute his rates and value his risks. Select tables, as distinct from aggregate tables, are those in which the duration of the policy as well as the age of the insured is taken into account, effect being thus given to the light mortality resulting in the earlier years of insurance from the elimination of unfit lives.

New life insurance tables are in course of preparation which will unquestionably render the O^m. table obsolete.

Life Insurance Legislation.—The following are the principal British Acts relating to life insurance:—

The *Life Assurance Act, 1774,* which stopped gambling insurance.

The *Life Assurance Companies Act, 1870,* which was amended by the *Assurance Companies Act, 1909,* is to be further amended by the *Insurance Undertakings Bill, 1927* (drafted by Departmental Committee, but not yet [1928] introduced to Parliament). The essential provisions of the Act of 1909 are (1) deposit of £20,000 with the High Court, (2) annual balance sheets and revenue accounts in form prescribed, (3) valuation returns in form prescribed at least once in five years, (4) separate funds for life business, fire business, etc. The most noteworthy additions of the 1927 bill are (1) separation of assets of different classes of business as well as separation of funds, (2) more detail and greater uniformity in returns, (3) powers enabling the Board of Trade to initiate steps for winding up an apparently insolvent company.

The *Policies of Assurance Act, 1867,* regulates the notification of dealings with policies to the insurance company.

The *Married Woman's Property Act, 1882* (*Clause 11*) and the *Married Woman's Policies of Assurance* (*Scotland*) *Act, 1880* confer certain powers on married women enabling policies to be effected for their benefit on their own lives or those of their husbands.

The *Life Assurance Companies* (*Payment into Court*) *Act, 1896* enables life assurance companies to pay money, the ownership of which is doubtful or in dispute, into Court in certain cases.

The principle of British legislation is freedom combined with publicity.

The legislation of most of the British dominions and colonies is modelled on the Act of 1870 and amending acts. An additional provision met with in dominion legislation is the protection of the first £1,000 to £2,000 of life insurance, unless specifically pledged, against a deceased man's creditors. Canada follows the American model. In Australia insurance is regulated by the laws of the different States; in 1928 there was still no Commonwealth legislation, but the Government had announced its intention to remedy this defect. It may be noted that New South Wales had no specific legislation regulating life insurance up to 1927.

Legislation on the Continent of Europe is as a rule more restrictive than that of Great Britain; in general it imposes a basis of valuation and places limits on investments.

Premiums, Reserves and Bonus Distribution.—Although in practice his functions are much wider, the primary business of the actuary of a life insurance company is to calculate premiums, value risks, and deal with the distribution of profits. The basis of an office's tabular premiums is a pure or net premium, "loaded" to provide for expenses, and, in the case of with-profit premiums, for bonus additions also; the margin for contingencies is, from the nature of things, larger for non-profit than for with-profit premiums. The annual premium for a whole life or endowment assurance is, owing to the fact that the risk increases from year to year, larger at first than is required to meet the bare risk (*i.e.,* the policy's contribution to the claims expected in the year) and from this there arises the necessity to set aside and invest the balance; the amount so accumulated is called the reserve. The excess interest earned, and the saving of mortality and expenses (relatively to the assumptions on which the premiums are based), provide the main profits; to these there may be added certain extraneous profits, such as those arising from non-profit business. The different methods of allotting surplus have already been described, and there are various plans for dealing with bonus which is distributed by the reversionary bonus method, that is to say by way of additions to the sum insured. The principal of these are:—(1) The *simple bonus* plan, which provides additions at a given rate for each £100 of original insurance and each year (within the valuation period) of duration; (2) the *compound bonus* plan, providing additions at a given rate to the sum assured and previously declared bonuses; (3) various *contribution* plans, which aim in theory at a return to the insured of the surplus actually contributed. The tendency is for the valuation period to shorten; prior to the Act of 1909 the maximum was seven years, but that Act reduced it to five, and there is a growing inclination towards triennial and yearly distributions. It is obvious that while in non-profit business the rate charged is the main consideration, with-profit rates should be judged in relation to prospective bonus results, and that a high rate for a with-profit premium is not necessarily an uneconomic one.

Finance and Investments.—The investment of the funds of a life insurance office is one of the most important duties of its administration, and it is on the successful accomplishment of this function that its bonus earning power, and, in the long run, its general prosperity, depend. The primary essential is security of the capital, and, subject to this, the earning of the highest rate of interest practicable. Formerly it was held that a life insurance company should keep a small proportion of its assets in readily convertible securities, but under normal conditions this is not really necessary, as the income of a progressive company exceeds its outgo and it is moreover in a position to obtain without difficulty all the credit it is likely to require to enable it to meet an individual emergency or to take advantage of an investment opportunity. In this respect its position differs from that of a bank and also from that of a fire office, which must always be in a position to meet the loss occasioned by a big conflagration, such as the San Francisco fire of 1906. The analogy in the case of life insurance would be an epidemic comparable to the plague, a negligible risk.

Mortgages are highly suitable investments and generally absorb on the average rather more than a quarter of the funds. British government securities also account (1927) for about a quarter of the funds of all companies combined, but this is largely a result of the war and the proportion is diminishing. Home railway debenture and preference stocks are much favoured and sound industrial debentures are also bought to a certain extent. There are, moreover, certain types of security which give little or no immediate yield from interest but are certain to appreciate in value, such as low yielding redeemable stocks standing at a heavy discount, and reversionary interests: these are unsuited to the private investor, but thoroughly adapted to the needs of a life insurance office. As the funds commonly run to many millions of pounds, those responsible for their investment are of course able to effect the saving which arises from being able to underwrite new issues, and to take up large lines of stock on preferential terms. Ordinary stocks and shares are engaging a certain amount of attention but only figure to a modest extent in life office balance sheets.

Amalgamations.—The amalgamation and transfer of British life insurance business is regulated by legislation. The tendency of recent times has been for companies not to absorb other concerns but rather to secure control of them by acquisition of shares and so to avoid the amalgamation procedure necessary under the Act of 1909. A provision of the Insurance Undertakings Bill is that investments in and loans to controlled companies must be shown separately in the balance sheet; the sanction of court must be obtained for any fresh purchases of insurance stock or shares.

Expenses.—The expenses of a life insurance company are usually measured by comparing them with the annual premium income. The percentage thus arrived at is the expense ratio and it is generally in the neighbourhood of 15%. The expense ratio may be unduly lowered when the year's income includes a large proportion of single premiums, or where bonuses are used extensively to reduce premiums; on the other hand, a high expense ratio, where business is large and increasing, does not necessarily indicate extravagance. To avoid misleading comparisons, allowance should therefore be made for these factors.

Life Insurance and Income Tax.—Formerly a distinction was made between the method of taxing a purely life office and that of taxing the life insurance section of a composite office, but in 1915 this was altered, and the basis is the interest earned, less expenses. Should the profits exceed this they become the basis of assessment, but this is rarely the case.

A policy-holder is entitled to a rebate on the premiums paid by him on a life insurance policy. The scale of rebate depends on the date of the policy, *e.g.*, on insurances effected up to June 22, 1916 (inclusive), if the income does not exceed £1,000, half the standard rate; if the income exceeds £1,000 but does not exceed £2,000, three-quarters of the standard rate; if the income exceeds £2,000, the full standard rate. As regards insurance made after June 22, 1916, for all incomes subject to tax, half the standard rate. The proportion of the premium subject to rebate is limited to one-sixth of the income and 7% of the amount guaranteed by the policy to be paid at death.

Life Insurance Outside the United Kingdom.—Although life insurance owed its early development to the efforts of British companies, the extent to which it is practised in the United States and certain of the British dominions is greater than in the country of origin. In 1924, for example, it was estimated that the average amount of insurance per head of the population was £109 in the United States, £84 in Canada, and £44 in Great Britain. Moreover, the aggregate funds of the American offices are from three to four times those of Great Britain. The colossal dimensions of the leading American offices may be gauged from the fact that the Metropolitan Life Insurance Company of New York had (1927) funds of nearly £500,000,000—the largest aggregate of capital in the world.

Life insurance in the Crown colonies is extending and in India insurance on the lives of natives, both by British and Indian companies, is on an increasing scale.

On the Continent of Europe the practice of life insurance is not so widespread as it is amongst the English-speaking peoples. Sums insured per head vary from about £25 to £30 in Holland and Scandinavia to a few pounds in Germany, France, and Italy, where other forms of thrift are favoured. It is, however, probable that the average amount insured would have been considerably larger in all of the last mentioned countries had it not been for the currency depreciation caused by the World War.

Life Insurance and the World War.—A large proportion of the policies actually in force on the lives of civilians who joined His Majesty's forces were indisputable, and British insurance offices decided to make no extra charge even in cases where they were entitled to do so. Extras for new insurances ranged from £7 7s. per £100 at the outbreak of hostilities to as much as £20 per £100 per annum, and many offices declined to undertake the risk.

There were three main sources of war loss. Mortality in excess of the pre-war ratio cost the offices about £3,000,000 a year. Excess depreciation of investments—which was partly the result of increased income tax, and partly due (*e.g.*, Russian bonds) to actual default—accounted for approximately £4,000,000 a year. Increased income tax added £500,000 a year to the loss. These losses rather more than absorbed the normal profits of the period.

The change in the character of life office investments was marked. United States railway bonds, which were largely held before the war, were sold freely, and replaced by war issues, and the holdings of British government securities rose from about 1% to a maximum of 38% of the total funds. The geographical field for securities has of course been greatly narrowed, the United States and Canada being unsuitable on account of the relatively low yield of investments there, while other portions of the world have had to be avoided on account of the insecure conditions prevailing.

Post-War Developments.—Post-war currency depreciation proved disastrous in many Continental countries. In Germany and Austria it eventually became useless to collect premiums and the efforts of the companies were devoted to converting such assets as remained into forms which would not depreciate in proportion to the currency. After the achievement of stabilization, it was, however, possible to do justice to the older policy-holders under various valorization schemes and to start building up reserves again on a sound foundation.

The recovery of the British offices from the effects of the war has been remarkable. All war losses have been dealt with, and as the companies are actually able to invest, after allowing for income tax, at a higher rate than before the war, and mortality becomes steadily lighter, bonuses are on a higher scale than at any time in life insurance history. Expenses have been brought down nearly to the pre-war level. The temporary withdrawal of the American offices from the United Kingdom has resulted in an increase of business to Canadian and British offices.

The failure of the City Life Assurance Company in 1923 (and of the City Equitable Fire Insurance Company) emphasized the fact that although the Board of Trade might be fully aware that a company was in difficulties, it could take no action of itself, and that it might be difficult in practice to get the policy-holders to do so. To remedy this and other defects in the Act of 1909 a departmental committee was appointed in 1924 and its report resulted in the Insurance Undertakings Bill, already referred to.

Group insurance, disability benefit business, and insurance without medical examination, have all developed rapidly since the war. A policy without medical examination is no longer subject to any special restrictions, and the amount of insurance which companies are prepared to grant on any given life under this plan is increasing. An extension is also taking place in insurances on the lives of women.

A notable symbol of the restoration of normal working in life insurance was the holding in London, in June 1927, of the eighth International Congress of Actuaries, the first held since 1912. These congresses had previously been held at intervals of three years. The papers read on this occasion were therefore of great interest and value, embodying, as they did, the experience of all the leading countries of the world over a period of unprecedented changes.

Bibliography.—*See* the *Institute of Actuaries Textbook;* C. J. Bunyon, *The Law of Life Assurance* (4th ed., 1904); E. J. MacGillivray, *Insurance Law* (1912); A. F. Jack, *Introduction to the History of Life Assurance* (1912); T. D. Lister, *Medical Examination for Life Insurance* (1921); R. C. Simmonds and J. H. Matthews, *Insurance Guide and Handbook* (1922); S. G. Warner, "The Effect on British Life Assurance of the European War (1914–1918)," *War and Insurance* (London, Oxford and New Haven, 1927). *See* also the *Journal of the Institute of Actuaries,* the *Transactions of the Faculty of Actuaries* (the Scottish body), the *Journal of the Institute of Actuaries Students Society,* the *Transactions of the Actuarial Society of America,* the *Journal of the Chartered Insurance Institute* and the *Transactions of the Assurance Medical Society,* in which the technical literature of the subject is mostly contained. Useful yearbooks are, the *Post Magazine Almanack,* the *Insurance Blue Book and Guide, Bourne's Insurance Directory,* and the *Assekuranz-Jahrbuch* (Vienna and Leipzig) which gives a survey of insurance in the principal countries of the world. (C. C. N.)

UNITED STATES

The first American companies were stock companies which have since given up the insurance and annuity business and have devoted their attention exclusively to banking or to execution of trusts—the Pennsylvania Company for Insurance on Lives and Granting Annuities, organized 1809, New York Life Insurance and Trust Company, 1830 (renamed Bank of New York and Trust Company, 1922) and Girard Insurance, Annuity and Trust Company, 1836. The first mutual company was the Mutual Life Insurance Company of New York which received a charter April 1842 and began business on Feb. 1, 1843; its first premium rates were based on the Carlisle and Northampton Tables and were those used previously by the New York Life Insurance and Trust Company. The New England Mutual, though chartered as early as 1835, did not begin the issuance of policies until Dec. 1843. The Nautilus Insurance Company was chartered 1841 as a joint stock company, was changed to mutual 1843, began business 1845 and was renamed New York Life Insurance Company 1849. Other early companies were the Mutual Benefit, 1845 and Connecticut Mutual, Penn Mutual and State Mutual, all 1847.

Growth and Institutions.—There are now (1928) over 300 companies with assets, as of Dec. 31, 1927, of over $15,000,000,000 and insurance in force of over $90,000,000,000; in 1927 the premium income was nearly $3,000,000,000 and the new insurance issued about $19,000,000,000. All but about 50 are stock companies but the list of mutual companies includes almost all the very large companies so that about $61,500,000,000, or over two-thirds of the total insurance, is carried by these mutual organizations. In addition to the regular stock and mutual companies are fraternal associations, primarily social or fraternal in character, with about $10,000,000,000 in force and assessment associations and stipulated premium companies with relatively small amounts.

Types of Insurance.—The life insurance now in force in the regular companies is made up of (1) ordinary, (2) industrial and (3) group. "Ordinary," issued by every company, includes policies for $1,000 or more with premiums payable annually, semi-annually or quarterly (or in rare instances, monthly). "Industrial," most of which is in three large companies, is that paid for by a weekly premium of a multiple of five cents, collected at the policy-holder's home. "Group," the greater part of which is transacted by ten companies, is that issued to an employer to cover a stated minimum number of employees on some underwriting plan precluding individual selection. The insurance in force at Dec. 31, 1927, may be roughly sub-divided into $67,000,000,000 ordinary, $15,000,000,000 industrial and $8,000,000,000 group.

State Legislation and Supervision.—An outstanding feature of the life insurance business in the United States has been the growth and character of State (as distinguished from Federal) legislation and the degree of supervision implied thereby. Each State has power to prescribe the terms and conditions upon which the insurance business may be conducted in the State and as a result insurance departments and codes of laws have evolved. The administration of the insurance department and the execution of the State law are in the hands of an insurance commissioner or superintendent of insurance whose powers and duties are defined by law. The general objectives are safety and equity to policy-holders and economy of operation.

Character of State Laws.—The New York Law is of special significance because about 90% of the insurance in force in the United States companies and 85% of their assets are in companies authorized to operate in New York. The limitations on amounts of new business and of contingency reserve are peculiar to New York. Wisconsin also has an expense limitation and some other distinctive provisions. Colorado and Oregon permit the full preliminary term method of valuation which allows a large margin for initial expenses and reduces the reserve. Illinois and several other States recognize a modified preliminary term method which produces smaller margins and larger reserves on the higher-priced policies. Texas requires companies doing business therein to invest in Texas at least 75% of the reserves on Texas business. Minnesota policies must provide that the company may defer a policy loan not more than six months from the time application is made therefor. These specimen provisions will illustrate the diversity of State laws.

Agency Methods.—The growth of life insurance in America is largely due to the development and effectiveness of the agency systems, of which there are two types, (1) general agency, under which the total field agency expense is paid to a general agent for a specified territory—city, county, State or group of States—who pays all expenses including sub-agents' compensation, the margin being his profit and (2) branch office or managerial, whereunder the compensation of sub-agents and all other organization expenses are paid by the company through a salaried manager.

Finances and Investments.—Investments, being governed by State laws, differ widely but in general are limited to (1) real estate, (2) mortgage loans, (3) collateral loans, (4) Government, State, county and municipal bonds, (5) mortgage bonds of railway and other commercial and industrial enterprises, (6) to a limited extent, preferred stocks and, to a still more limited extent, common stocks of the corporations referred to in (5) and (7) policy loans.

Taxation.—State taxes, aside from licence fees, usually consist of a tax on premiums collected in the State of from 1% to 3% (2% is used by about half the States) with varying interpretations as to what constitutes "premiums." Reciprocity usually affects the application of such laws as between States. Massachusetts is unique in levying a tax (¼%) on reserves. The Federal tax is an income tax, now (1928) 12% of the total income from interest, dividends and rents after deducting tax-exempt interest, 4% of mean reserve fund for year, dividends on stocks, investment expenses paid, taxes and other real estate expenses and minor items.

War and Post-War Experience.—War mortality was not serious even for the few companies with extensive foreign business. For the latter the depreciation of foreign currencies more than offset extra losses. The influenza mortality of 1918–19 was extremely severe, amounting to about $110,000,000 in the companies doing business in New York State. Post-War developments have included an enormous expansion in volume of business, the lowest mortality ever experienced, and a progressive decline (since about 1920) in the interest rate with corresponding appreciation of security values.

Bibliography.—*National Fraternal Congress Table,* based on experience of some of the largest and oldest fraternals and largely used in valuing liabilities of fraternal societies (1898); *Standard Industrial Table,* based on industrial experience of Metropolitan Life, 1896–1905, recognized by New York as the valuation standard for industrial policies (1907); *American-Canadian Mortality Investigation,* compiled by a joint committee of Actuarial Society of America, American Institute of Actuaries and National Convention of Insurance Commissioners in response to a request of the latter for a table exhibiting recent mortality among American insured lives and based on experience, 1900–15, of new and old standard business of about 60 American and Canadian companies (1918–19). Many tables were derived. (*See* the mortality tables listed in the article on p. 52.)

Chief repositories of both technical and general articles of current and permanent interest are: *Transactions,* Actuarial Soc. of Amer.; *Record,* Amer. Inst. of Actuaries; *Proceedings,* Ass. of Life Insurance Presidents; *Proceedings,* Association of Life Insurance Medical Directors; *Proceedings,* American Life Convention. For statistical summaries:—*Reports* of the insurance departments of New York, Massachusetts and Connecticut; *Life Insurance Year Book,* Spectator Company of New York. For information regarding policy forms and other details of company operations, including current dividend scales: *Handy Guide,* Spectator Company; *Unique Manual-Digest,* National Underwriter Company. For critical review of company operations: *Life Insurance Reports,* Alfred M. Best Company. For actuarial text-books and reports: H. Moir, *Life Insurance Primer;* J. B. Maclean, *Life Insurance; Actuarial Studies,* reports of specialized, medico-actuarial and American-Canadian mortality investigations, Actuarial Society of America. For investments: L. W. Zartman, *Investments of Life Insurance Companies.* For insurance law: A. J. Parker, *Insurance Law of New York; Corpus-Juris and Cyclopedia of Law and Procedure,* American Law Book Company. (J. S. T.)

LIFE TABLES. It has long been recognized that there are certain influences which normally affect the duration of life, and that for a large number of individuals of a homogeneous class it is practicable to frame an estimate of their mortality experience. Such estimates at first were based on conjecture rather than on the scientific analysis of observed facts. This appears to have been the case amongst the Romans who had tables for calculating the values of life interests, and no more authentic bases seem to have been discovered until towards the end of the 17th century. The first approximately accurate mortality tables were compiled by Edmund Halley, and were based on the records of baptisms and deaths in the city of Breslau in Germany. About half a century later, De Parcieux published his *Essai sur les probabilités de la Durée de la Vie Humaine* in which were incorporated several mortality tables which were for many years in general use in France. Meanwhile De Moivre had propounded his well-known theory of the law of mortality, "that the number of lives existing at any age is proportional to the number of years intercepted between the age given and the extremity of old age." As he assumed that 86 was the limiting age, according to his table the number living at any age x was $86-x$.

In 1762 the Equitable Society (London) was formed and the business of life assurance began to develop. It was not, however, until the publication in 1771 of a table, prepared by Dr. Price for the records of baptisms and deaths in the parish of All Saints, Northampton, that the science of the construction of mortality tables can be said to have been founded. A revived form of this table, published in 1783, afterwards became famous as *The Northampton Table.*

A Mortality Table.—This consists of two columns showing the numbers, out of an assumed number of births, surviving and dying at each subsequent year of age. The term *life table* in actuarial phraseology designates any collection of columns of functions involving life contingencies. The two terms are, however, commonly used indiscriminately in either sense.

There are two main sources from which material for the construction of a mortality table is obtainable, (*a*) the census returns and death registers of a community, and, (*b*) the records of assurance companies and other bodies whose operations involve the duration of life. The statistics relating to the general population are subject to misstatement of age and other inaccuracies, and it frequently happens that the information is available only in groups of ages, a circumstance which necessitates the subdivision of the group figures into numbers at individual ages The numbers both of the population and the deaths are invariably recorded according to age last birthday. On the other hand, the data obtained from assurance companies are compiled from the individual records of policy-holders who are usually required to furnish evidence of their age before the contract is completed. The numbers living at each age, known as "the exposed to risk," can therefore be scheduled according to nearest age, age last birthday, or any other arrangement that may be convenient.

The functions most usually included in a life table and their relations to one another are:—

l_x=the number of persons surviving at exact age x,

d_x=the deaths in the year of age x to $x+1$ among the l_x persons who enter on that year,

$p_x=\frac{l_{x+1}}{l_x}$, the probability of a person aged x living a year,

$q_x=\frac{d_x}{l_x}$, the probability of a person aged x dying in a year, or the rate of mortality at age x,

$\mathring{e}_x=\frac{\Sigma l_{x+1}}{l_x}+\frac{1}{2}$, the complete expectation of life, or the total future life-time which, on the average, will be passed through by a person aged exactly x.

Actuaries frequently use tables involving other decremental forces operating in conjunction with mortality, *e.g.,* marriage, widowhood, remarriage and withdrawal.

The construction of a mortality table is carried out by obtaining from the observation of a number of persons over a limited period the rates of mortality, q_x, to which they have been subject at each age. The values of q_x having been obtained, the mortality table is formed by selecting a suitable *radix,* usually taken for convenience as 100,000 at the youngest age in the table, and obtaining successive values of l_x by the formulae $l_x \times q_x = d_x$, $l_x - d_x = l_{x+1}$, or, since $q_x = 1 - p_x$, by the formula $l_x \times p_x = l_{x+1}$.

The other columns of the table can then be completed by means of the appropriate formulae.

If the recorded numbers of the population and of the deaths were free from irregularities and errors, the rates of mortality directly derived from them would, if plotted graphically, be capable of being represented by a smooth curve. These conditions are never fulfilled in actual experience and it is necessary to submit the data, or the rates derived from the data, to a process of adjustment, technically known as graduation.

Factors Affecting Mortality.—Various factors influence the rate of mortality. Age, of course, is a fundamental cause of variation, as the form of a mortality table implicitly indicates. At birth, the rate of mortality is high, but it immediately drops, and steadily decreases until about age 10 or 11, when it is at a minimum. Thereafter it increases, slowly at first, but more rapidly with advancing age.

Sex is another element to be taken into consideration. Female mortality is generally lighter than that of males. Certain special classes of lives are subject to abnormal mortality rates. Race, climate, social status, occupation, degree of urbanization or density of population, housing conditions and other aspects of environment, geographical situation, types of various diseases, are also factors which affect vitality. Of the utmost importance in connection with the experience of assured lives is the variation of mortality according to duration of assurance. Before a life assurance policy is issued, the proposer is usually required to undergo a medical examination or at least to furnish satisfactory evidence of good health. At entry into insurance the policy-holder is, therefore, a "select" life. Select rates of mortality vary according to age at entry and duration of contract, and a "select table" is arranged in a form showing the select rates converging towards and finally running into the "ultimate" rates which vary only with age. When the effects of selection are ignored and all the data irrespective of duration are combined in one mortality experience, the table is designated an "aggregate" table.

Separate tables have sometimes been constructed by excluding the first five years' experience from the data obtained for the aggregate tables, and are called "truncated aggregate" tables.

When it is desired to compare the results of different investigations of mortality experience, several criteria may be adopted, *e.g.,* (*a*), the rates of mortality at selected ages throughout the table, (*b*) the number of survivors at selected ages, (*c*) the probability of surviving a specified term of years from the attainment of selected ages, and (*d*) the expectation of life at selected ages. Of these criteria (*c*) is, perhaps, most generally satisfactory.

One feature which has been disclosed by successive investigations of the mortality experience of lives of the same class is the progressive improvement in vitality, the later investigations almost invariably revealing the lighter rates of mortality at all ages. There are no indications of any retardation in this tendency, and in several instances endeavours have been made to forecast its effects, in the one case by a definite modification of the rates of mortality directly deduced from the experience, and in the other by a suitable adjustment of the annuity values.

Standard Tables.—Brief reference may now be made to the principal mortality tables.

The *Northampton Table* was constructed by a method which gave unduly heavy rates of mortality, particularly at the higher ages. It was, however, the only authoritative measure of mortality available for many years, and the assurance companies which perforce had to adopt it as the basis of their scales of premium were enabled to accumulate large profits. The Government adopted it in 1808 for the grant of annuities, and thereby incurred a loss estimated at two million pounds before discarding it 20 years later. It was gradually superseded by the *Carlisle Table,* formed by Joshua Milne. This table was a great improvement on previous ones, and the extensive monetary tables which were based upon it are even now referred to.

The compulsory registration of births, marriages and deaths was introduced into England and Wales in 1837. The statistics which have thus become available, taken in conjunction with the successive decennial censuses, have led to the publication of a most valuable series of *English Life Tables.* The earliest tables were prepared by Dr. William Farr, whose services in the development of the science of vital statistics are pre-eminent.

Simultaneously with the publication of the national tables various sectional tables have usually been prepared, *e.g.,* the three successive *Healthy English Life Tables,* derived from the experience of the districts showing a low death rate. The most recent national table is the *English Life Table No. 9,* based on the 1921 Census and the deaths in the years 1920, 1921 and 1922.

In the United States of America the first important tables prepared by the Government were based on the 1910 Census and the deaths in 1909, 1910 and 1911 in certain States situated mainly in the north-eastern section of the country. Numerous tables have been prepared from the records of life assurance companies, the earliest being those of Griffith Davies, based on experiences of the Equitable Society of London. Tables in general use have, however, been compiled from the combined experience of a number of Life Offices. The first table of this nature was the *Seventeen Offices, or Actuaries' Table.* The date of the close of the observations was Dec. 31, 1837. It was a weakness of this table that it was based on contracts a large proportion of which were of short duration.

A more extensive investigation, that of the combined experience of 20 British Offices up to the end of 1863, was carried out by the *Institute of Actuaries.* Two very important tables were obtained from this investigation, those relating to healthy male lives, the aggregate H^m table, and the truncated aggregate $H^{m(5)}$ table. Dr. Thomas Bond Sprague later prepared a select table, the $H^{[m]}$, based on the assumption that the experience of the first five years of assurance could be linked up with the $H^{m(5)}$ experience. Assurance business in Great Britain was for many years conducted on the basis of these tables.

The most recent investigation of the experience of assured lives in Great Britain is that known as the *British Offices Experience,* compiled from the experience of 60 British Offices during the period 1863–93. This investigation was carried out on a most elaborate and comprehensive scale, and the volume describing *"The Principles and Methods"* adopted is an indispensable handbook for all students of life tables. The principal tables were the $O^{[m]}$ select and the O^m and $O^{m(5)}$ aggregate tables, and the $O^{[nm]}$ select and aggregate tables, based on the experience of participating and non-participating policies respectively. The mortality of other types of policies was also investigated, and indicated that generally the contracts with the lowest rates of premium showed the highest rates of mortality.

The mortality of annuitant lives was also examined, and the results published in the $O^{[am]}$ and $O^{[af]}$ tables, which displaced the tables derived from the earlier *Government Life Annuitant* investigations as the authoritative standard for annuity contracts. These tables are, in turn, being superseded by the *Life Office Annuitants 1900–1920 Tables* $A^{[m]}$ and $A^{[f]}$, and those based on the contemporaneous mortality experience of Government Life Annuitants. In the United States the most recent authoritative table for annuitants is the "American Annuitants" table, compiled from the experience of 20 companies carried down to the year 1918. (*See* ANNUITY.)

In the United States the table which in addition to the *Seventeen Offices or Actuaries Table* is used as a standard mortality table is the *American Experience Table, 1868,* compiled by Mr. Sheppard Homans. It was intended to represent the death rate among insured lives in America after the effects of medical selection were eliminated, and has been universally employed for valuation purposes.

The most recent American investigation produced in 1918 the *American Men Mortality Table,* derived from the experience of 59 companies during the period 1900–1915, which has already had a great influence on the operations of American insurance companies.

BIBLIOGRAPHY.—*The Institute of Actuaries, Text Book, Part II.,* by Mr. George King has for nearly half a century been recognized throughout the world as the standard work on life contingencies. *Life Contingencies,* by Mr. E. F. Spurgeon, is a more recent textbook, published by the Institute of Actuaries as the successor to Mr. King's work. There are numerous papers in the *Journal of the Institute of Actuaries,* and in the *Transactions of the Faculty of Actuaries. The Theory of the Construction of Tables of Mortality,* by the late Sir G. F. Hardy, deals particularly with graduation. *The Principles and Methods* volume gives an account of the British Offices experience, and in *Mortality of Annuitants, 1900–1920,* selection and future improvement in vitality are discussed. All these as well as numerous volumes of life tables are published by C. and E. Layton, London. A useful non-technical work, *"The Construction of Mortality and Sickness Tables—a Primer,"* by W. P. Elderton and R. C. Fippard, is published by A. and C. Black, London. The English Life Tables are contained in successive *Decennial Supplements* to the Reports of the Registrar General, published by the Stationery Office. The English Life Table No. 9, together with a *Report on Life Tables,* by Sir Alfred W. Watson, K.C.B., the Government Actuary, is contained in Part I. of the 1921 Decennial Supplement. *The Mortality of Government Life Annuitants, 1900–1920,* is also a Stationery Office publication. The Actuarial Society of America has published a number of volumes on the investigation of mortality experience, and the *Transactions* of the Society include many important papers. Other works on life tables are included in the publications of the Spectator Company of New York. (P. G. B.)

LIFT: *see* ELEVATORS.

LIGAMENT, anything which binds or connects two or more parts; in anatomy a piece of tissue connecting different parts of an organism (*see* CONNECTIVE TISSUES; JOINTS AND LIGAMENTS).

LIGAO, a municipality (with administrative centre and 14 *barrios* or districts), near the centre of the province of Albay, Luzon, Philippine Islands. It is on the railway running to Legaspi (Albay). Pop. (1939) 27,927. The Mayon volcano, with its near-perfect cone, rises to the east. Although it has erupted with destructive effects on several occasions (as in June 1928), the lava which it has spread has resulted in a fertile soil which produces abacá (Manila hemp), palay (rice) and coco-nuts. Bikol is the vernacular. Of the inhabitants aged 6 to 19 inclusive, 26·5% in 1939 attended school, while of the total population 10 years old or over, 44·9% was literate.

LIGGETT, HUNTER (1857–1935), American soldier, was born at Reading, Pa., on March 21, 1857. He graduated from the U.S. Military Academy in 1879, and saw service in the west against the Indians. In the Spanish-American war in 1898 he served on the staff of the adjutant general, and later was in the Philippines where, as major of volunteers he served for three years. In 1902 he was appointed a major in the regular army and spent several years with the department of the lakes and at Fort Leavenworth. In 1909 he attended the War college, and on being graduated in 1910 was appointed a director there, and in 1913 president, becoming brigadier general in the same year. From 1915 to 1917 he was again in the Philippines, being for one year commander of the department. In 1917 he was made major general and commander of the western department, but in September went to France as commander of the 41st Division of the American Expeditionary Force. He was at the second battle of the Marne, at St. Mihiel and in the Argonne, commanding the I. Army Corps and later the I. Army, and commanded the III. Army of Occupation on the Rhine. In 1919 he was commander of the Western Division, and in 1920 commander of the IX. Corps area, retiring on March 21, 1921, with the rank of major general.

LIGHT, subjectively, the sense impression formed in the eye. (*See* VISION.) The present article deals with it purely objectively and is concerned with the more fundamental characteristics of light and optical instruments. For the more practical applications, which are not here discussed in detail, *see* OPTICS; TELESCOPE; MICROSCOPE; INTERFEROMETER; PHOTOMETRY. The subject is conveniently still further subdivided according as to whether we are more interested in how the light originates or how it behaves after it has been emitted. The first subject is treated under RADIATION, RAYS; and SPECTROSCOPY; the present article is chiefly concerned with the behaviour of light after it has been emitted, a branch of the subject often called Physical Optics, dealing almost entirely with the Wave Theory of Light.

INTRODUCTION

It might perhaps be expected that we should begin by saying what light "really" is, and should then develop its characters from such a starting point; but this procedure is not possible, since light is essentially more primitive than any of the things in terms of which we might try to explain it. The nature of light is only describable by enumerating its properties and founding them on the simplest possible principles As these principles transcend our ordinary experiences they must be cast in a purely logical, that is to say mathematical, form. But that is never enough, for, though logic tells us what deductions must be right, it does not tell us what will be interesting, and so gives no guidance as to the *direction* the theory will take. In choosing this direction much help is derived from analogies and models, which are often loose and incomplete, but without which no proper understanding of the subject can be acquired. We shall therefore describe, largely by means of analogies, the behaviour of light, and this *is* the "real" nature of light.

Types of Radiation.—Light would be taken strictly speaking to mean only that which is seen, but it is customary to include in the term various types of invisible radiation, because, though they cannot be seen, in all other respects their behaviour is similar. These are the ultra-violet and infra-red radiations which are adjacent to the visible, and, more remotely, on the side of the ultra-violet, the X-rays or Röntgen rays, γ-rays (*see* RADIO-ACTIVITY) and the extremely penetrating *cosmic rays;* while on the side of the infra-red we have the electromagnetic vibrations of wireless telegraphy. All these radiations have one property in common, an equal speed of propagation. The most accurate measures of the velocity of light (*see* VELOCITY OF LIGHT) assign it the value $2{\cdot}99796 \pm 4 \times 10^{10}$ cm. per sec. The distinction between the various types of radiation depends on wave-length, and the following list shows roughly their wave-lengths measured in centimetres.

Electric Waves.	
Wireless telegraphy	1×10^{5}
Beam wireless	5×10^{2}
Shortest electric waves	2×10^{-2}
Infra-red Rays.	
Longest heat waves	3×10^{-2}
Longest "rest-rays"	$1{\cdot}5 \times 10^{-2}$
Average "rest-rays"	5×10^{-3}
Infra-red down to	7×10^{-5}
Visible Light.	
Limit of red	$7{\cdot}2 \times 10^{-5}$
Yellow	$5{\cdot}8 \times 10^{-5}$
Green	$5{\cdot}0 \times 10^{-5}$
Blue	$4{\cdot}5 \times 10^{-5}$
Limit of Violet	$4{\cdot}0 \times 10^{-5}$
Ultra-violet Rays.	
Limit of transparency of glass	$3{\cdot}5 \times 10^{-5}$
Limit of transparency of quartz	$1{\cdot}8 \times 10^{-5}$
Lyman region	1×10^{-5}
"Hot spark" region	1×10^{-6}
X-Rays.	
Longest X-rays	1×10^{-7}
Average X-rays	1×10^{-8}
Shortest X-rays	1×10^{-9}
γ-rays	2×10^{-10}
Cosmic rays	4×10^{-12}

It is not convenient to use the same units throughout such an enormous range. It is customary to measure wireless waves in metres. The "rest-rays" are often measured in units called μ, the thousandth of a millimetre, but for light the unit universally used is the Angström Unit (A.U.) which is 10^{-8} cm. This is also most frequently used for X-rays, though in precision work X-units of 10^{-11} cm. have been introduced. Much of what we shall say here applies to the whole range, but it is not unnatural that there should be differences, and when these occur we shall restrict ourselves to the case of light, visible, ultra-violet and infra-red.

The Appearance of Ordinary Things.—In many branches of science, though we start with familiar and crude observations, we very soon find it necessary to discuss much more recondite questions, and this leads to an elaboration of the theory, until the most important things in it are quite different from what is familiar to us. This is very emphatically true of light. For example, the most familiar thing about light is that it goes in straight lines, and hardly any of our ordinary experiences disagree with this fact. But by more refined experiments it is easy to exhibit that light is sometimes bent (diffracted) and such cases prove more important to the theory than the commonplace observations. Almost the only example of these phenomena, diffraction and interference, which is a matter of common experience, is the iridescent colours that appear on soap-bubbles and on the surface of greasy water.

So it comes about that the theory of light is not much concerned with the appearance of ordinary things, and, as we shall later have very little to say about them, we may consider them briefly here. In things we see, we may distinguish between the luminous and the non-luminous—in day-light between the sun and everything else. The non-luminous objects are only visible by light reflected from some luminous source, the sun or a lamp, and their different appearances are solely due to the different ways in which they reflect light. Thus a black object is one which does not reflect at all. A coloured object is one which reflects some colours but not others. This is easily proved by illuminating a piece of red paper by light passed through a green glass, when it will appear black because there was no red light for it to reflect. White being a mixture of all the colours, a white object is one which reflects all colours about equally, and so it looks coloured if lit by a coloured light. When two pigments are mixed together the resulting colour will be that which they are *both* capable of reflecting, and may be quite different from the colour seen when the light of two coloured lamps is projected together on to a white screen; for example if the light from red and green lamps is compounded in this way the result is a brilliant yellow, but red and green paints when mixed give a dark muddy colour because there is little light which they can both reflect (*see* COLOUR).

Many substances are really nearly transparent, but appear opaque because they are not homogeneous, so that the entering light is reflected and refracted many times until it is completely scattered. The most obvious example of this is ground glass, but the same is largely true of paper and white wood. An easy test of whether a substance is opaque in this way or by an inherent opacity to light is to see whether it is of the same colour for reflected and transmitted light. A sheet of red paper looks red whether we look at it or through it at a light, because in both cases what we see is light which has got tangled in the fibres, and at each reflexion has lost a little of the green and blue light by absorption, so that only the red emerges on both sides. On the other hand if a substance is truly opaque the colours on the two sides will be quite different. For example the yellow colour of gold is due to the fact that it reflects the yellow light more effectively than other colours and, by a paradox which we shall explain later, this means that it absorbs the yellow more strongly. If then we take a very thin sheet of gold, the yellow light will not penetrate it so easily and transmitted light will be bluish green.

HISTORY

The ancients were acquainted with mirrors and with the burning glass, but their theories of optics were rather of the metaphysical character so much more congenial than experiment to the Greek temperament. The Pythagoreans believed in an emission theory, supposing that the seen object emitted particles which bombarded the eye, but the Platonists complicated the matter by supposing that vision was produced by a triple interaction between rays emitted by the sun, the object viewed and the eye itself. Among these speculations we can only distinguish the discovery of one real scientific law, enunciated by Hero of Alexandria who saw that the equality of the angles of incidence and reflection at a mirror could be expressed by saying that the ray took the shortest possible course between object and eye. This law is the first statement of the general "principle of least action," a principle which now dominates not only geometrical optics but also dynamics.

We may omit the other speculations of the Greeks, Romans and Arabs and come to the revival of learning. The earliest developments were practical, such as the invention of spectacles and later of the telescope, with which we shall not be concerned here. The first great theoretical discovery was the law of refraction discovered by Snell in 1621, but not published until after his death by Descartes. This law asserts that when a ray of light passes from one medium to another, the plane of the two rays contains the normal to the surface, and the sines of the angles of incidence and refraction are in a constant ratio, the refractive index. Descartes was led by a metaphysical argument to maintain that light was some sort of pressure in a medium (in a very indefinite way something like the present wave theory), and thought that the velocity of light must be greater in a denser medium. This view was combated by Fermat, also on metaphysical grounds, and modern theory supports Fermat though not his reasoning. It seems to be the rule rather than the exception that correct results are first obtained from quite incorrect arguments. Fermat asserted that nature performs its operations always by the most direct path, and that therefore a ray of light between two places must take the shortest possible time. The rectilinear propagation of light and the law of reflection conform to this principle, and therefore refraction must do so too. Snell's law then implies that the velocity of light in a medium is inversely proportional to its refractive index. Fermat's "principle of least time" is the natural extension of that of Hero of Alexandria, and was later erected by Hamilton into a general method of great beauty for dealing with optical systems.

The Age of Newton and Huygens.—The first great era in the theory of light is the second half of the 17th century. Grimaldi discovered (and named) the phenomenon of *diffraction,* that light going through a fine slit cannot be prevented from spreading on the further side, and that no matter how small the source of light, the edge of a shadow cannot be perfectly sharp. Hooke independently discovered the same thing, and offered a theory approaching closely to the wave theory in that he had the idea of *wave-fronts* and of light being some sort of oscillation; but it was more than a century before it was seen that the strongest possible argument for this theory lay in the discovery of diffraction. During the same era Roemer measured the velocity of light for the first time, by a comparison of the calculated and observed times of the eclipses of Jupiter's satellites.

Of all the founders of the theory of light undoubtedly the greatest were Newton and Huygens. Newton discovered the theory of the spectrum. By passing a fine beam of sunlight through a glass prism he resolved it into its component colours:—red, orange, yellow, green, blue, indigo, violet. It had already been known that white light was resolved into colours on passing through glass or water (for example the rainbow had been explained), but it was supposed that the glass had produced a definite alteration in the light. Newton showed that, if the light passed through a second prism reversed, the coloured lights would recombine into white, but that if a single colour were selected from the spectrum, no subsequent treatment could change it in any way. He was thus led to the correct explanation of white light as a compound of all the colours, but the further details of this question would lead us into physiological optics (*see* VISION).

Newton also investigated the colours of thin plates such as soap bubbles. He placed a slightly convex lens on a flat piece of glass and observed the light reflected. At the centre the surfaces are in contact and nothing is reflected, but round this point, where they are very close, though not in contact, there appears a succession of brilliantly coloured rings, the succession of colours being black, faint blue, strong white, orange, red, dark purple, violet, blue, faint green, vivid yellow, etc. The rings become narrower and fainter as we go outwards and soon become invisible. These are not the colours of the spectrum, and their origin is better appreciated by considering the case where the illumination is by monochromatic instead of white light. There is then a dark centre surrounded by a large number of rings of the colour used. (*See* Plate, fig. 1.) The sizes of the rings depend on the colour of the light; they are closer together for blue than for red. If then we illuminate simultaneously with red and blue light there will be places where the rings fall together, so that we get alternately purple and dark, and other places where they fall apart and we get alternate rings of red and blue. Plate, fig. 2 is a photograph of this type; as the camera is unequally affected by the two colours, in some regions the rings look blurred, in others sharp. The rings in white light can be explained in the same way as due to a superposition of all the colours, and at no great distance from the centre so many of the coloured rings overlap that they become invisible.

Newton was very cautious in making theories and he did not really succeed in explaining his rings, but he attributed them to certain "fits" of reflection and transmission which later were seen to be very like the *phases* of the wave theory. As to the general theory of light he was also very non-committal, but he criticized the wave theory as being unable to explain rectilinear propagation and his followers, interpreting his views in a much narrower way than he intended, adopted a complete corpuscular theory of light which held the field for more than a century. This theory supposed that light consists of minute particles, or corpuscles, shot out from the luminous body, and attempted to explain all the phenomena by suitably modifying the properties of these corpuscles. The theory implies that the velocity of light must be proportional to the refractive index, not inversely proportional as in Fermat's principle and the wave theory, and this was later to provide a critical test which condemned it.

Huygens is the real founder of the wave theory of light. He based his belief in it primarily on the fact that, if a beam of light were like a flight of arrows, then when two beams cross these should be collisions between the arrows. He succeeded in explaining reflection and refraction, and we may consider his construction, as it lies at the foundation of modern methods. The general idea is that light is a disturbance in a medium, but it need not be specified what is the character of the disturbance; for purposes of rough visualisation we may think of the medium as a jelly which is distorted so that its particles move out of their usual places. Any disturbance then acts as a centre causing the propagation of a wave of disturbance to go out at a constant speed, so that at any subsequent time the effects of the initial disturbance will be found on a sphere surrounding it. When the initial disturbance is not confined to a single point, each point of it is to be regarded as a source, and the subsequent disturbance is the geometrical envelope of the spheres surrounding all these sources. Refraction is explained by supposing that the velocity of light is different in different media. Consider light obliquely incident on a flat surface, say of water (*see* fig. 1). The velocity of propagation outside is C the velocity of light; in the water it is v a slower velocity. The advancing disturbance is at one moment spread as a pulse over the surface AB. Each point of AB gives out a spherical pulse and, to reconstruct the wave later, we draw spheres of equal radii round all the points of AB. Obviously one such set of spheres will give the line CD as their envelope, and this shows that the light goes in the direction AC outside the water. But if we repeat the construction starting at CD we have to allow for the fact that the velocity is less in water than in free space. Thus, corresponding to the sphere of radius DF about D, we draw round C a sphere of radius $CE = v/cDF$, and it is evident that EF will be bent round more nearly parallel to the face than was CD. After this both spheres are in the water and the propagation goes straight again on to GH. This construction immediately gives Snell's law of refraction, for $\sin ACM/\sin GCN = DF/CE = c/v$, and the refractive index is simply the ratio of velocities. The construction fails in the case of very oblique incidence if v is greater than c, for then the circle round C may have radius actually greater than CF itself. Refraction is then impossible and all the light is reflected. This is the phenomenon of total internal reflection which we shall discuss later. A simpler construction than that we have given applies for reflection, and the same principle also explains diffraction, but Huygens did not find this out.

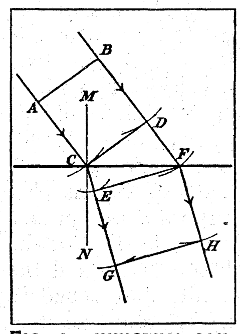


FIG. 1.—HUYGENS' CONSTRUCTION FOR REFRACTION

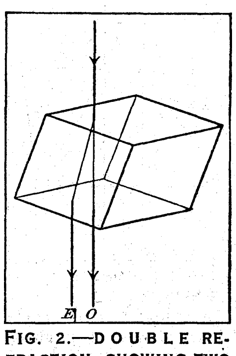


FIG. 2.—DOUBLE REFRACTION, SHOWING TWO RAYS EMERGING WHEN A LIGHT RAY STRIKES A CALCITE CRYSTAL PERPENDICULARLY

Huygens' other great investigation is connected with *double refraction.* Certain crystals of calcium carbonate, from Iceland, called calcite or Iceland spar, have the extraordinary property that objects viewed through them appear double. To reduce the matter to simpler terms it can be expressed thus: a crystal of calcite resembles a cube that has been compressed along one of its diagonals. Suppose that a narrow beam of light is incident on one face perpendicularly. If the crystal were glass the beam would emerge from the opposite face in the same line. Actually two beams emerge, one in the same way as for glass, but the other, in a new line though in a direction parallel to the first (*see* fig. 2). These are called the ordinary and extraordinary rays. Huygens successfully applied his wave construction to explain them by supposing that two surfaces must be constructed round each point, one a sphere which would give the ordinary ray, but the other a spheroid with its axis of revolution determined by the crystal axis (that is by the shortened diagonal of the cube) for the extraordinary ray. This is illustrated in fig. 3. Round the points C and D we draw, not only a sphere, but also a spheroid, which is such that the two surfaces touch at the points that lie in the direction of the crystal axis (the point K in fig. 3). The envelope of the spheres is the plane EF which shows the path of the ordinary ray, while the plane GH is the envelope of the spheroids and shows the path of the extraordinary ray. Observe that the latter ray is not perpendicular to the wave front.

Huygens also discovered, though he did not explain, the phenomenon of polarization. If we rotate our crystal about an axis in the direction of the beam and observe the projections of the two rays on a screen, the ordinary ray will stay fixed, and the extraordinary, which will be equally bright, will rotate round it. But now suppose that we isolate the ordinary ray and pass it in the same way through a second crystal. In general it will give rise to two rays, ordinary and extraordinary, but this time they will usually be of unequal brightness. If the two crystal axes are parallel, the extraordinary ray will be absent altogether, but as the second crystal is turned it will gradually grow in brightness at the expense of the ordinary, until, when the crystal has turned through a right angle, the ordinary ray will be entirely extinguished. Rotation through a further right angle will restore the ordinary ray and destroy the extraordinary. A similar rule applies for the extraordinary ray from the first crystal; it usually gives both types, but only an extraordinary ray when the crystals have their axes parallel. Newton recognised the essential features of the matter in saying that a ray of light may have *sides;* in fact that this light differs from ordinary light as a thin lath differs from a round stick. The idea of transverse vibrations had not yet been formulated, so that no further advance could be made at this stage.

We may here remark that the Huygens' wave construction explains what some may regard as a philosophic difficulty in Fermat's principle. According to this principle the rays of light between two points A and B adopt that path which takes the shortest time; and though the only way we have ordinarily of determining a minimum is to try a number of paths and see which is quickest, yet the ray appears to adopt the right course without any alternative trials. The wave construction explains why it does so, for it shows that the wave is, so to speak, all the time trying alternative routes, and is adopting the shortest because the waves in other paths cancel out.

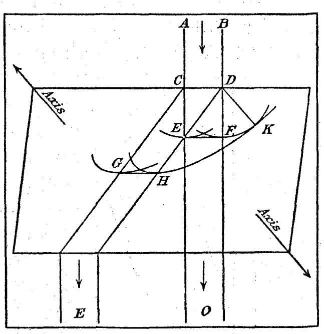


FIG. 3.—HUYGENS' CONSTRUCTION FOR DOUBLE REFRACTION
Each point of C and D sends out a sphere and spheroid wave. The spheres give the ordinary ray through EF, the spheroids the extraordinary ray through GH

In spite of these great advances the state of knowledge at the end of the 17th century was really insufficient to give a decision between the two theories, and moreover there was hardly the beginning of a mathematical wave theory as yet, so it is perhaps not surprising that the corpuscular theory of light gained the upper hand. The 18th century was singularly barren in optics and the only first-class discovery appeared strongly to support this theory. This was the discovery of stellar aberration, by Bradley (*see* ABERRATION OF LIGHT), which for corpuscles is immediately explained by the idea of relative motion; whereas with waves, though a crude explanation is not hard, the final solution was only obtained in the 20th century with the advent of relativity.

The Age of Fresnel.—The second great period of discovery coincided with the beginning of the 19th century, and the first successes fell to Young. He adopted the wave principle of Huygens, but extended its application. Thus Huygens had only considered waves of the form that we should now call pulses, but Young made use of continuous periodic waves, and so was enabled to explain Newton's rings in a manner we shall discuss later. He clearly stated the general principle of *superposition,* that "when two undulations from different origins coincide, either perfectly or very nearly in direction, their joint effect is a combination of the motions belonging to each." This principle is quite general, but Young perceived that interesting results would only follow when the two sources are *coherent,* that is to say when two beams from the *same* source are brought to superposition, for only so could the irregularities in the process of emission be the same for both. He therefore set up what has proved to be one of the classical experiments of optical theory.

Two holes are made close together in a screen, and light from a distant point passes through them and illuminates another screen. If the holes are large there will be merely two patches of light on the screen, but when the holes are made smaller diffraction occurs, so that the rays of light spread and the patches are larger instead of smaller as might be expected at first sight. When the holes are very small the patches will overlap and it is then observed that they are crossed by a number of fine bands. To understand this let us suppose the light to be monochromatic (of a single wave-length) so that the vibrations of the light-wave are in the form of a travelling sine-curve. The source of light is equidistant from the two holes A and B (fig. 4), so that at those points the waves are in the same phase (shown diagrammatically in the figure). On passing through the small hole each beam emerges as a spherical wave. At the central point O of the screen the distances to A and B are equal so the phases agree at every moment; the effect from the two holes will reinforce one another and O will be illuminated. Consider however a point P which is half a wave-length nearer to A than B. Here the waves from A and B are at every time in opposite phases (in the diagram when one wave is at the top the other is at the bottom, etc.) and so cancel, with darkness as the result. At the point Q, which is a whole wave-length nearer to A than B, the waves will reinforce each other again, because one wave is exactly a wave-length behind the other, and there will be light. Proceeding in this way the whole field is seen to be covered by alternate bright and dark bands. In the case of white light there will be a few coloured bands in the middle and the rest will look white; the colours can be worked out in just the same way as with Newton's rings. Young's interference pattern is by no means easy to observe, as it requires very careful adjustments on account of the exceedingly short wave-length of visible light. To give an idea of its magnitude, if the holes are 1 mm. apart and the screen is at a distance of 1 metre, then for red light the bright bands are a distance 0·6 mm. apart.

The investigation of polarization at this epoch received a great impetus by the discovery of Malus that, when sunlight is reflected from glass, the reflected ray may be polarized. Brewster studied the matter and found the rule that the reflected light was completely polarized when the reflected and refracted rays were perpendicular to one another. In the course of this work he discovered experimentally the formulae for the intensity of the two polarized components of light reflected from a transparent substance. If i is the angle of incidence and r that of refraction, the fraction reflected is $\sin^2(i-r)/\sin^2(i+r)$ or $\tan^2(i-r)/\tan^2(i+r)$, according to the direction of polarization. These expressions are usually called Fresnel's sine and tangent formulae, and have played a part in the history of optics. In the special case where $i+r=90°$ the tangent formula vanishes and, as the other does not, the reflected light is completely polarized. Brewster also made the important discovery that some crystals exhibit double refraction of a different type from that of Huygens. In these crystals there are two directions instead of only one for which the light does not become polarized. We may also here mention the discovery by Arago of *gyration* (formerly called "optical activity"). When a beam of polarized light is sent through a quartz crystal along the axis, or through a sugar solution, it is observed that, on emergence of the beam, the plane of polarization has rotated by an amount proportional to the length of the path it has traversed. We shall discuss all these matters in detail later.

The greatest investigator of this period was Fresnel, and in his hands optical theory attained the outline which it has kept ever since. As we shall have to deal with his work in detail we shall here only mention his discoveries without explaining them.

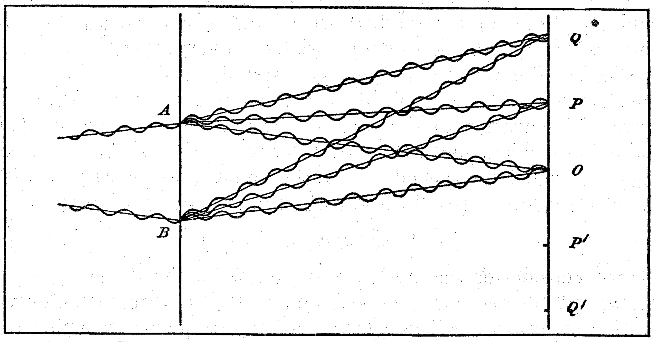


FIG. 4.—YOUNG'S INTERFERENCE EXPERIMENT
Monochromatic light falls on the two holes A, B. Point O is equidistant from them, so that the waves reinforce each other. P is ½ a wave-length nearer to A than B, so that the waves cancel out, while Q is a whole wave-length nearer, and they reinforce again. Bright bands will appear at O, Q,Q′, and darkness at P,P′

First he adapted Huygens' construction to explain diffraction, and thereby established the superiority of the wave theory over the corpuscular. In the course of this work he demonstrated the remarkable fact that there is a bright spot exactly in the centre of the shadow of a circular screen. Like Young he also made various experiments to exhibit the interference of two beams of light. He then turned his attention to the optical effects of moving bodies (including the motion of the earth) and correctly formulated all the principles; this important work had a great influence in connection with relativity theory, but is outside our scope here. Next he made the discovery (with Arago) that, when two beams of light are differently polarized, even if they arise from the same source, it is impossible to make them interfere. At this period the vibrations of light were thought to resemble those of sound, so that there seemed to be no room for polarization in the theory, but Young hit on the solution that the vibrations were transverse, so that a wave of light may have sides, as Newton had said. Fresnel next turned his attention to double refraction and completely solved the whole problem, uniting into a single system both Huygens' uniaxial and Brewster's biaxial types. Finally he deduced theoretically the laws of refraction and reflection, and obtained the sine and tangent formulae to which we have referred. Fresnel's whole work was devoted to establishing rigorous principles for light, and the enormous progress he made is the more remarkable when we remember that the mathematical theory of waves was only in its infancy, and that there hardly existed at all any dynamical theory of continuous media.

The Dynamical Theories of the 19th Century.—With the discoveries of Fresnel, the more geometrical part of the wave theory of light was practically complete; but it was still necessary to build a proper dynamical formulation, and this was the chief preoccupation of theorists during most of the 19th century. It was felt necessary to make a model of some sort of matter which should behave like the optical medium. The most obvious model suggested was that of an elastic solid, and, with the help of this, Cauchy, Neumann and others had considerable success in explaining the phenomena for a single medium, but the theories got into difficulty when it came to the passage of light from one medium to another. Only by highly artificial hypotheses was it possible to obtain the sine and tangent formulae.

The work of Green on the propagation of waves in elastic solids is the real beginning of the modern mathematical theory of waves. A piece of solid matter can be strained (altered in form or position) in three ways. It may be compressed without other change of form, or it may be sheared so that a square becomes a rhombus, or, without changing its shape, it may be rotated in position. The third type of strain can take place without the necessity of forces, but the first two require the action of forces in order that they may occur. The solid will possess two elastic constants corresponding to these forces (we are thinking of an isotropic body, not a crystal which may possess 21), and can propagate two types of wave, a longitudinal corresponding to compression, and a transverse corresponding to shear. Green showed that when a transverse elastic wave passed from one medium to another it could not help giving rise to a longitudinal wave, and for this there is no room in the theory of light. Though his result was thus mainly negative, Green's calculus firmly established what conditions a valid theory must satisfy. Under the inspiration of Green's methods Stokes gave a rigorous solution of the problem of diffraction in place of Fresnel's approximate geometrical method.

A valid formulation for the dynamical theory of light was first made by MacCullagh, who assumed that the aether was a new kind of material which opposed no resistance to compression or shear, but which resisted rotation. Such a material satisfies all the necessary conditions, but it suffers from the objection that there is no known kind of matter which has the property, and for this reason it was regarded with great suspicion and its importance was not appreciated till long afterwards. During the middle of the 19th century there were many attempts, especially by Lord Kelvin (then W. Thomson), to invent a substance which should satisfy all the necessary conditions, but they were mostly very artificial. The modern theory was finally formulated by Clerk Maxwell, about 1860, who showed that electric oscillations must involve emitted waves which would have the same transverse character and would travel with the same velocity as light. He therefore identified light with electric waves, and gave the complete system of equations (then seen to be identical with MacCullagh's) which determine the behaviour of light. This theory has firmly held the field ever since, and Maxwell's name ranks as high as any among the contributors to optical theory. The completeness of his theory, and perhaps the familiarity that grows with the lapse of time, has overcome the objection that no known matter conforms to the same rules of vibration as the aether.

The Experimental Discoveries of the 19th Century.—During the period of these great theoretical investigations the experimental side had of course not been neglected, and many important discoveries had been made and instruments invented. Fraunhofer studied diffraction in a rather different way from Fresnel, and constructed gratings by winding wire between two fine screws and by ruling lines with a diamond on glass. With these he analysed the solar spectrum, and his work is thus the origin, both in subject matter and in method, of the modern science of spectroscopy. The invention of Nicol's prism (usually called the nicol) made it easy to produce polarized light, and this has ever since been the standard instrument in the study of polarization. Stokes began the study of ultra-violet light, rendering its effect visible by means of the property of fluorescence; it is now more usually investigated by photography. Faraday discovered the theoretically very important phenomenon of magnetic gyration,—that, when a transparent substance is in a strong magnetic field, a beam of polarized light passing through it along the direction of the field has its direction of polarization rotated. This was the earliest connection discovered between light and electricity. Fizeau and Foucault developed methods of measuring the velocity of light accurately, and among other things showed that light really does go slower in water than in air, as is demanded by the wave theory (*see* FLUORESCENCE AND PHOSPHORESCENCE).

We must also mention the slow development of the theory of dispersion, *i.e.*, the dependence of the refractive index on the wave length. Fresnel and Cauchy propounded a theory which attributed it to the coarse-grainedness of the refracting medium, from which it followed that the refractive index could be expanded in powers of the inverse square of the wave-length. This is often possible, but its inadequacy was seen when Leroux discovered the phenomenon of "anomalous dispersion" (which is not really at all anomalous), that substances exist which refract the red more than the blue. A hint of the modern theory was given by Maxwell, but its real development is due to Sellmeier who showed that dispersion was an example of the general phenomenon of resonance. At the end of the 19th century Lorentz revised the whole of Maxwell's theory, introducing the idea of electrons, and in the course of his work improved Sellmeier's dispersion formula.

During the closing decades of the 19th century an aspect of the wave theory which has had results of the most far reaching importance was much studied experimentally. Fresnel had successfully treated the optical theory of moving media up to a point, but many difficulties remained with regard to the movement of the earth as a whole. Stellar aberration suggested a fixed aether through which the earth moved, but then it seemed possible that for terrestrial experiments this motion ought to be detectable. On account of the great velocity of light none of these experiments were easy, but all gave negative results; particular mention may be made of the experiment of Michelson and Morley which was of such accuracy that, though it depended on the *square* of the ratio of the earth's velocity to that of light, it definitely established the negative. The mathematical theory was developed by Larmor and Lorentz to deal with this matter, and a very profound interpretation, given to it by Lorentz, led to the promulgation of the theory of relativity by Einstein (*see* RELATIVITY).

At the close of the 19th century optical theory had attained a completeness and perfection which left hardly room for further development, and it is with this classical theory that we shall here be concerned. During the 20th century one most important branch has been added to it by the discovery of the interference of X-rays, but for the most part the centre of interest has shifted. The study of the conditions under which light is emitted has revealed fundamental difficulties in all our mechanical conceptions. This has led to the body of doctrine called the quantum theory (*q.v.*) which is antagonistic to the older classical system. Each in its own field covers a large number of phenomena, but the reconciliation is not yet complete, though it is already possible to rewrite the theory of dispersion in the new language. We shall not do this here, but shall treat it together with the rest of the subject by purely classical methods.

WAVES AND INTERFERENCE

The most familiar form of waves is of course the surface waves of water, but the term is extended to cover any vibratory effect propagated through a medium. For example if we take a long stretched string and strike it near one end, a small hump will form and will travel without change of shape down the string. Though the portion of the string humped is changing all the time, the geometrical form is unchanging and so we can endow this form with individuality and say that the wave goes at a certain speed. If x denotes the distance of any point on the string from the point of reference, or the origin, and ϕ the displacement of the string at that point, the motion is described by the differential equation

$$\frac{\partial^2\phi}{\partial x^2}=\frac{1}{c^2}\,\frac{\partial^2\phi}{\partial t^2},$$

the solution of which is $\phi=f\,(x-ct)$. This expresses the fact that, whatever the initial form, the form at time t is the same with the origin shifted a distance ct.

General Characteristics of Waves.—The vibration of a string is specially simple, because the wave undergoes no change of form, but in most cases, such as water-waves, that is not so, for as the wave travels it alters shape, and so it is no longer possible to speak of a definite velocity. It is therefore necessary to analyse the waves into definite types which can be studied separately, and the type which is incomparably the most useful is the sine-curve. That such an analysis is useful is a consequence of the principle of superposition enunciated by Young; mathematically this principle follows from the fact that the differential equations of wave motion are linear, so that if we have two solutions of a wave problem we can derive a third by taking their sum. Thus any problem can be solved by expressing the initial state as a sum, or more usually an integral, of sine-curves of various wave-lengths, then solving the motion for each of these separately and finally recombining them. This is the only method available for water-waves; and though *plane* waves of light are propagated in free space without change of form, any obstacle or refractive medium destroys this simplicity and makes the analysis necessary.

In discussing the general characteristics of waves we may conveniently think of a stretched string, but when the appropriate name is given to the dependent variable ϕ everything we shall say applies equally well to water-waves, sound, or light. Thus, ϕ in the string means the displacement of the string sideways, in water-waves the elevation of the surface above its average height, and for sound it might mean the variable part of the air pressure; for light we shall later specialize it rather more and identify it with the electric force. In all these cases the typical solution is

$$\phi=A\cos[2\pi(\nu t-x/\lambda)-\epsilon]$$

First considering the motion of a particle of the string, we keep x constant and see how ϕ depends on t. It is a pure harmonic vibration of *amplitude* A and *frequency* ν, frequency meaning the total number of vibrations described in a second. The expression $2\pi(\nu t-x/\lambda)-\epsilon$, regarded as an angle, is the *phase* at the time t at the distance x from the origin. It can be interpreted very simply by the consideration that, when a point describes a circle at uniform speed, its projection on a diameter describes a harmonic motion; then the angle between this diameter and the radius through the point is the phase-angle. The term phase, though quite precise, is often used in a looser sense, because its absolute value does not matter, whereas differences in phase are of the very greatest importance in deciding the character of a wave. We next examine the shape of the string at any instant of time and see that it is a sine curve of *wave-length* λ. The amplitude, frequency, wave-length and phase are the four quantities characteristic of any wave.

The wave is progressive because of the phase relations between the various points of the string. If at any instant we compare the phases at x and $x+a$, we see that the latter is an angle $2\pi a/\lambda$ behind, and that at a time $a/\lambda\nu$ later it will have arrived at the phase which was at x initially. We therefore take $\lambda\nu = V$ as the *wave-velocity* or *phase-velocity*; it is the rate at which the crests move. Though phase velocity plays a most important part in wave theory it is misleading to think of it as a real velocity. For example, it is a general principle that no effect of any kind can be propagated with a speed greater than c, the velocity of light in vacuo, but it is not very rare to find substances in which the phase-velocity of light is considerably higher. When we say that no effect can travel quicker than c, we are thinking of the rate at which waves advance into a region previously undisturbed, but phase-velocity only has a meaning in connection with a sine-curve, and a sine-curve extends indefinitely in both directions, so that there is no undisturbed region to which the principle can apply.

In the case of water waves, and perhaps of electric waves of very long period, we can observe the crests and so can see directly the wave-velocity and measure the amplitude, but in general it is impossible to do this. Usually we only observe some dynamical effect, such as that which occurs when the rays of light impinge on the retina of the eye. The exact form of this effect is special to each type of wave, but it is a general principle that it depends on the energy of the waves and this is proportional to the average value of the square of the amplitude of the wave-variable ϕ. This quantity is the *intensity;* it is often quite unnecessary to know the factor of proportionality associated with it. It is important to observe that the amplitude can be deduced from the intensity, but that nothing can be said about the phase; this is a consequence of the dynamical fact that only by altering the phase can the wave medium do work on the observing instrument, so that only by spoiling the phase can we observe the wave.

The case of waves in three dimensions is of course more complicated than that of one. In thinking about them the most important idea is that of the *wave-front* which is any continuous surface over which the phases are all the same. For mathematical treatment such waves are sometimes resolved into sets of plane waves going in all directions, but it is more often convenient to make use of spherical waves. It can be shown that, if a three-dimensional medium propagates plane waves according to the rule

$$\phi = A\cos[2\pi(\nu t - x/\lambda) - \epsilon],$$

then it can propagate a spherical wave of the form

$$\phi = A\cos[2\pi(\nu t - r/\lambda) - \epsilon]/r,$$

where r is the distance from the origin. The wave-fronts are spheres round the origin as centre, and the wave represents an emission from a point source at the origin. The amplitude decreases as the wave spreads out, and is always proportional to the inverse distance. The intensity is therefore proportional to the inverse square of the distance and this is the fundamental law of photometry (*see* PHOTOMETRY). This type of wave suffices for the discussion of a great many phenomena in optics, but it may be mentioned that it will require some unessential modifications when we come to discuss polarization and electromagnetic waves.

The Velocity of a Group of Waves.—Much of optical theory can be developed by the consideration of pure monochromatic waves, and indeed it may be said that experimental methods have tended to move in directions for which these suffice. The monochromatic wave, however, gives a very incomplete account of events, because it ranges over an infinite extent of time and space, whereas we usually want to know about events in some limited region. We saw, for instance, in Huygens construction for double refraction, that the extraordinary wave has its front parallel to the ordinary, but yet that the *rays* go in a different direction. Even in the simpler case of plane waves of unlimited breadth there is a similar complication when the wave-velocity depends on the wave-length, as is the case in refracting media. Let us take a *group* of approximately monochromatic waves of limited length, and find the *group-velocity* with which it travels as a whole. To construct such a group we take a sine-curve multiplied by a factor such that the waves are not of uniform height, but fall away gradually to zero on both sides of the centre. The solution then shows that, though the crests travel forward with the wave-velocity appropriate to the wave-length, yet they alter in height as they go, so that after a time the crest which was highest at first will have become quite inconspicuous, while another wave originally quite small will have grown up and taken its place as highest crest. Thus the group as a whole moves with a different velocity from its component waves. The group-velocity U is derived from the wave-velocity V by the formula $d(kV)/dk$, where k is the reciprocal of the wave-length. The phenomenon of group-velocity is easily observed from the deck of a ship, for after a very short time a large wave under observation becomes quite small while another behind it has grown at its expense. For water the wave-velocity is proportional to the square root of the wave-length, and our formula then shows that the group-velocity is half the wave-velocity. For other types of waves it may be greater than the wave-velocity, and there is nothing to prevent it even being in the opposite direction, though no case of this is known. Only in the case where the wave-velocity is independent of the wave-length is it equal to the group-velocity; in this case any wave can be propagated without change of form.

The most important application of the idea of group-velocity to optics arises in the measurement of the velocity of light. Every type of measure depends in some way on interrupting the light and thus gives the group-velocity. In free space the wave-velocity of light does not depend on the wave-length and so is the same as the group-velocity, but this is not so in other cases. The superiority of the wave theory of light over the corpuscular theory was held proved when Foucault showed directly that light goes slower through water than air; but he did not in fact prove it, for the refractive index depends on wave-velocity, and his work dealt with group-velocity. However, since either can be deduced from the other, it is easy to verify the correctness of his result indirectly. In much of optics these considerations do not arise, and so they are frequently forgotten. Nevertheless they are indispensable for a full understanding of waves, and many difficulties have been caused in the past through neglecting them.

The Pressure of Light.—In the course of his theoretical investigations Maxwell discovered the pressure of light. He derived this from the electromagnetic theory, but as a matter of fact it can be shown to follow from any wave-theory, and was foreseen in the 18th century by Euler. If plane waves fall perpendicularly on a surface it may be shown that they exert a pressure on it of a magnitude equal to the density of energy in the waves. This result is exceedingly difficult to observe, as the pressure is very small in practical cases. The first attempt led to the invention of the radiometer by Crookes. In this instrument freely moving vanes are coated with black on one side and are polished on the other. The side which is black absorbs the radiation while the reflecting side sends it back; so there is more energy in the space in front of the reflecting side and therefore a greater pressure. When the radiometer is illuminated it does go round, but the wrong way! This is due to a rather complicated effect depending on the heating of the residual gas in the vessel, and in order to observe the pressure of radiation much more delicate means are required. It was eventually measured by Lebedev by so improving the radiometer that the effect of the gas was eliminated. There are also indirect methods by which the pressure of light can be verified, chief among which is the thermodynamic law for the emission of radiation (*see* HEAT). Light pressure plays scarcely any part in our common experience, but grows to enormous values in the hot interiors of stars and plays a dominating part in controlling their state.

The Doppler Effect.—When monochromatic light passes through any fixed optical system there is one property that is always conserved, the frequency of the vibrations; but this frequency can be changed if the light is reflected by a moving mirror, or if there is a difference in the motions of source and observer. This change of frequency is called the Doppler effect, after its discoverer, and is easily explained by the wave theory. Consider a fixed source emitting light of frequency ν, and sending it to an observer who is receding at velocity v. On account of his motion the successive crests of the light-waves will reach him at longer intervals than if he were at rest and a simple calculation shows that he will receive them with a frequency $\nu\ (1-v/c)$; the light will appear to him redder than it really is. If he is approaching, it will appear bluer, and if his motion is oblique to the direction of the source, the change of frequency will depend on the component of his velocity in the line of sight. In the case where light is reflected from a receding mirror it has to traverse the increasing distance twice over, and so the effect is doubled, and the frequency of the reflected light is $\nu\ (1-2v/c)$. It should be said that these values are not quite precise when v is large. The Doppler effect plays a very important practical part in astronomy, for by its means it is possible to discover the velocity of stars in the line of sight, and thus for example to calculate the motion of the components of a double star which are so close together that they cannot be seen separate. It is also vital in the theoretical investigation of the distribution of energy in the spectrum. A further consequence arises in practical spectroscopy. In a hot gas some of the atoms will be approaching the spectroscope and so will give light bluer than the average, while others will give a redder light in consequence of their recession, and thus the light will never be purely monochromatic. In some experiments it is necessary to minimise this effect by cooling the gas with liquid air.

The Colours of Thin Plates.—There is no essential difference between the phenomena of diffraction and interference, but only a difference in emphasis. Thus the term diffraction is used for phenomena connected with the spreading of waves on passing through a slit, shadow formation, etc., while interference arises, as in Young's experiment, when two waves from separate but coherent sources are superposed. We shall now discuss some important cases of interference, including the explanation of Newton's rings.

We have already described Huygens' construction for reflection and refraction. When a beam of light falls on a surface part is directly reflected and part is refracted. Consider now a thin plate, say a soap-film, under the action of an incident beam of monochromatic light (fig. 5). The beam refracted at the first surface comes to the second, and part emerges, while the rest is reflected back. This second part comes back to the first face and part of it emerges, while part is again reflected. Thus, if we want to know the total amount reflected, we have to consider the compounded effects of all the waves arising from direct reflection and any number of internal reflections. Now, in order to explain the process, fig. 5 has been drawn as though the rays AP, CQ, ER . . . were separate from one another, but they will not in fact be so, for the film is supposed thin, whereas the incident beam is fairly broad. The reflected beams will therefore overlie one another and this is a case like Young's experiment in which we have to consider the phases of the various waves. If these phases agree we shall have a brilliant reflection, otherwise it will be feeble. We shall see that the phases only agree for one colour at a time, and so the film looks coloured though it is illuminated by white light. In order to see the detail of this we must examine the process of refraction somewhat more closely.

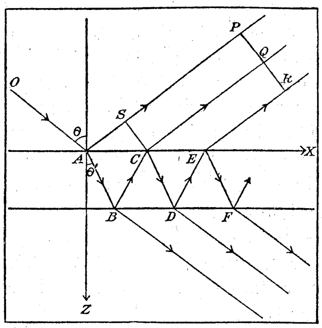


FIG. 5.—COLOURS OF THIN PLATES The total amount of light reflected will depend on the phase differences of AP, CQ, ER, and these will vary with the colour and inclination of the light

We first consider a single interface illuminated obliquely by a plane wave of light K (*see* fig. 6). This will be broken into a reflected wave L and a refracted wave M. The strengths of these can be calculated exactly in the detailed theory (they give Fresnel's sine and tangent formulae), but we do not require their values here. Let us say that, if K has unit amplitude, then L has amplitude r and M has amplitude t. We shall assume (from the more detailed theory) that there is no change of phase at the interface. We also require to consider the effect of a beam coming to the surface from the other side. Let us suppose that the reversed wave M would give a transmitted wave along K of amplitude t' and a reflected wave along N of amplitude r'. Now there is an important and very general mechanical principle, that, if all the parts of a system are simultaneously reversed in their motions, the system will retrace its course to the point from which it started. Thus, if we take a wave r along L reversed and simultaneously t along M reversed, they will give rise to unit amplitude along K reversed and no wave along N. The wave r from L gives r^2 along K and rt along N, while t from M gives tt' along K and tr' along N. We thus have the two equations $r^2+tt'=1$, $rt+tr'=0$. The last implies that r' must be equal to r, but that there is a change of phase of 180° at the interface; we can allow for it completely by simply writing $-r$ for r'.

We now return to the film of fig. 5. The reflected ray AP has amplitude r, the ray AB has t. Of this a fraction r' is reflected at B, so that tr' arrives at C and CQ has amplitude $tr't'$, while CD has tr'^2. Similarly ER will have tr'^3t' and so on. On the other side the waves emerging at B, D, F will have amplitudes tt', tr'^2t', tr'^4t', etc. We must now compare the various phases of the paths OAP, $OABCQ$, etc. Let us suppose that θ is the angle of incidence and θ' that of refraction, and that n is the refractive index. Allowing for the difference of the wave velocity in the film, the phase difference for a single pair of internal reflections will be $\frac{2\pi}{\lambda}(n.ABC-AS)$, where S is the foot of the perpendicular from C on AP. This is equal to $2\cdot\frac{2\pi}{\lambda}bn\cos\theta'$, if b is the thickness of the film; we shall denote it by 2δ. Thus if the phase at P is ϵ, that at Q is $\epsilon-2\delta$, and therefore that at R is $\epsilon-4\delta$ and so on. The whole reflected wave thus has amplitude

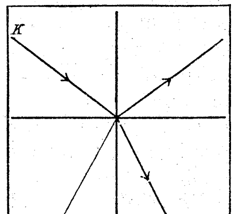


FIG. 6.—REFRACTION AT AN INTERFACE

$$r\cos\epsilon+tt'r'\cos(\epsilon-2\delta)+tt'r'^3\cos(\epsilon-4\delta)+\cdots.$$

This series is now summed and reduces, with the help of the relations between r, r', etc., to

$$\frac{2r\sin\delta}{1-2r^2\cos 2\delta+r^4}\left[-\sin(\epsilon-\delta)+r^2\sin(\epsilon+\delta)\right];$$

and the resulting intensity follows by squaring and averaging over all values of ϵ. The fraction of the incident wave reflected is

$$4r^2\sin^2\delta/[(1-r^2)^2+4r^2\sin^2\delta].$$

It can be shown similarly that the fraction transmitted is

$$(1-r^2)^2/[(1-r^2)^2+4r^2\sin^2\delta].$$

For a soap-film the coefficient r is not very large. The chief effect is when $\sin\delta$ vanishes, that is, when $bn\cos\theta'$ is any multiple of half a wave-length, for at such an angle of incidence there will be no reflection at all. Hence, when a film is lit by white light, some of the colours will be absent from the reflection, and the film will show the complementary colours. More detailed consideration than we can give here shows that these colours will not be seen well without the help of a telescope, unless the thickness of the film is very roughly of the order of twice the wave-length of ordinary light. The case of Newton's rings is very similar. The film is of air between the two glass surfaces, and the distance between these surfaces increases outwards from the point where the glasses touch, so that b passes progressively through values where there is no reflection for each colour in turn.

The Fabry and Pérot Interferometer.—The same principle of multiple reflection has been put to very important use in an instrument, the interferometer of Fabry and Pérot. Two sheets of very flat glass are set up accurately parallel, and from 1 to 5 cms. apart. The plate producing the interferences is the air between them. The characteristic of the instrument is a slight silvering of the inner surfaces of the glass, so that at each incidence nearly all the light is reflected. Now, if in our formula for reflection r is near unity, there is hardly any transmitted light at all, except when the light is very nearly incident at an angle such that $\sin\delta=0$. Divergent monochromatic light falls on one side of the plate, and only the component waves at certain definite angles can get through. A system of narrow brilliant rings will be seen with the aid of a telescope, and their radii can be used to determine the angles at which $\sin\delta=0$. An example is shown in Plate, fig. 3 and, if this is compared with Plate, figs. 1 and 2, it will be seen how much sharper the rings are in fig. 3.

The instrument has two different uses. Firstly, to measure wave-lengths absolutely, or rather to determine the length of the standard metre in terms of a more unvarying measure, the wave-length of a suitable spectral line. For this purpose the glass plates are set up several centimetres apart (it may be troublesome to get them parallel), and this distance is compared with that of the standard metre. Next it is necessary to measure the distance between the plates in terms of wave-length. The cadmium arc is the standard source of light as it gives three conveniently coloured monochromatic lines. The light from the arc traverses a prism, so that the lines are separated out, and one of them is allowed to fall on the interferometer. If the distances between the plates happens to be an exact multiple of half a wave-length, there will be a bright spot, in the middle of the telescope, surrounded by rings. More usually there will be a small ring in the middle, and, by measuring its angular radius, we can find directly the fractional part of the ratio of the plate distance to the wave-length. At first sight it would appear much more troublesome to determine the integral part as this may be as great as 100,000, but that is not so, for a relatively rough preliminary knowledge of the distance between the plates and of the wave-length can be made to yield it; and the final result is a determination of the absolute wave-length correct to 6 or 7 places of decimals.

The other use of the instrument is as a spectroscope. If a spectrum contains two lines very close together, each ring will appear doubled. The method is one of tremendous power but suffers from the disadvantage that if the two lines are not very close together one ring of the first line may fall near a different ring of the second, and it may not be easy to disentangle the meaning of what is observed. One ingenious use to which the instrument has been put is to fix the wave-length of the green "auroral" line which is given by the night sky. This is so faint that no ordinary spectroscope can be used, but its wave-length was determined with a very high degree of accuracy by means of an interferometer, the plates of which were covered with gold instead of silver, for gold specially favours the passage of green light, and so prevents the fogging of the photographic plate by the general illumination during the long exposure.

The Michelson interferometer is another instrument that can be used for the same purposes. Here a beam is divided into two by being half reflected in a slightly silvered glass plate at 45°. The two beams then go to mirrors, one of which is at an adjustable distance, and are then reflected straight back and reunited at the half-reflecting mirror. There is no multiple reflection and the fringes are therefore broad as in Newton's rings. The instrument was the first to be used in measuring the standard metre. It has another important use, for by its means it is possible to measure directly how nearly any spectral line is truly monochromatic. If the wave emitted by an atom were literally a sine-curve, this would imply that, like that curve, it started at minus infinity and continued to plus infinity (so the mere fact of switching off the light ensures that it is not one), but in fact the train of waves given out by each atom has a distinctly limited length and this can be measured by seeing how great may be the difference of paths in the two arms of the interferometer, before the interference fringes disappear. It is usually found impossible to see any fringes if this difference is more than about 70 cm., and this implies that after the atom has emitted about a million vibrations, it changes its phase arbitrarily before emitting again.

Another instrument of the same general character is the Lummer plate, in which light travels, being internally reflected, very obliquely, along the length of a glass plate silvered on both sides. All these instruments can be used for the most refined work in spectroscopy, but they all suffer from the difficulty that a single line produces a number of fringes rather close together, so that, when several spectral lines are photographed simultaneously, their fringes get mixed up in a way that is often hard to disentangle. There now exist diffraction gratings of nearly as high resolving power, which have not this complication, and the modern tendency is to use gratings for even the most accurate spectroscopic work, and to reserve the interferometer for the purposes for which it alone is suitable. (*See* INTERFEROMETER.)

DIFFRACTION

When we described Young's experiment, we regarded the two holes in the screen as themselves secondary sources of light emitting spherical waves. A similar construction was applied in Huygen's description of refraction, and may also be used in free space. We shall do this as a preliminary to describing the formation of shadows.

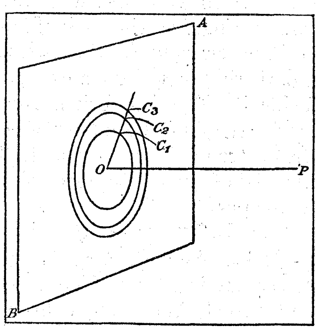


FIG. 7.—FRESNEL'S ZONES

A wave is advancing from plane AB to P. The circle round O is the first zone, and the rings outside, the succeeding ones. Zones give nearly the same effect at P, but with alternating signs

Fresnel's Construction.—In fig. 7 we have a plane wave with front at *AB* progressing towards *P*. We know of course that at *P* it will in fact be a plane wave too, with phase $\frac{2\pi}{\lambda}\cdot OP$ behind that at *O*, but we are now supposing that we can take every point in the plane *AB* as the source of secondary waves, and that the wave at *P* is due to the superposition of all these waves. In the plane *AB* describe circles round *O* of radii OC_1, OC_2 . . . etc., such that

$$PC_1-PO=\tfrac{1}{2}\lambda,\ PC_2-PO=\lambda,\ PC_3-PO=\tfrac{3}{2}\lambda,\ \text{etc.}$$

The central circle and the ring-spaces round it are called Fresnel zones, and are all of the same area. Each point is supposed to emit light, and this light will arrive at *P* with a phase depending on the distance to *P*. The phases of the waves arriving at *P* from a single Fresnel zone are all the same within half a wave-length. If we take the moment when the phase arriving from *O* is just 90°, then all the phases from points in the central zone will lie between 90° and −90°, and they will all make a positive contribution. Those from the second zone will all make a negative contribution, from the third positive and so on. We may represent the total effect as due to the sum of the effects of all the zones and write it as

$$m_1-m_2+m_3-m_4+\ .\ .\ .$$

Each of these quantities is nearly the same because the areas of the zones are equal, but they slowly diminish because the amplitude of a spherical wave varies inversely as the distance, and the outer zones are further from *P* than the central ones. To allow for this decrease we sum the zones in the form

$$\tfrac{1}{2}m_1+(\tfrac{1}{2}m_1-m_2+\tfrac{1}{2}m_3)+(\tfrac{1}{2}m_3-m_4+\tfrac{1}{2}m_5)+\ .\ .\ .\ ,$$

and then, the decrease in the *m*'s being at a constant rate, all the bracketed terms cancel, and the effect at *P* is equal to half that of the first zone. This argument is of course not a proof, but the full proof requires deeper mathematics than can be given here; for the same reason we shall not check what value must be assigned to the emission of a small area in order to give the amplitude of the reconstructed wave.

In spite of its incompleteness our argument brings out two very important facts. First, as each point of *AB* has been supposed to give out a complete spherical wave, we should expect the absurd result that there would be emission in the backwards direction towards the image point of *P* in the plane *AB*. The full solution shows that the amplitude of the secondary wave emitted at angle θ to the primary wave-front involves a factor $1+\cos\theta$, and this vanishes in the backwards direction. Secondly we should expect the phase of the wave at *P* to correspond to the average of all the phases in the first Fresnel zone, whereas we know that in fact it corresponds to that of the point *O*. To put this right (and the full theory of course proves it) we make the rule that the secondary waves are to have their phases advanced 90°, or a quarter wave-length, in front of the primary wave causing them. These rules may be regarded merely as artifices to avoid a deeper enquiry, but they have important consequences; for, when we have a thin sheet of matter in the plane *AB*, its particles will scatter the incident light in much the same way as we have been considering, but in this case neither of the two effects will come in. There will be light scattered backwards, which constitutes the reflected wave; and the light scattered forwards will be a quarter wave-length *behind* the primary wave, and this is the most primitive description of refraction.

The construction of the Fresnel zones explains the bright spot in the centre of the shadow of a circular disk. For, if the screen cuts out the first *n* zones, the wave at *P* will now be $m_{n+1}-m_{n+2}+\ .\ .\ .$, and the sum will be $\frac{1}{2}m_{n+1}$. In order to exhibit this effect the circle has to be cut with great accuracy, for if half of it is as little as a single zone wrong the amplitude at *P* will vanish. The same idea has been carried further in the construction of *zone-plates*. If we make a screen which cuts out every alternative zone, we shall get an effect proportional to $m_1+m_3+m_5+\ .\ .\ .$, which will be enormously greater than the effect without screen. Zone-plates have been made by drawing them in black on paper and then photographing down to a small scale. A brilliant spot will then be found at a point on the axis. The zone-plate illustrates wave principles admirably, but has not found any practical application.

The Formation of Shadows.—We may apply the same wave construction to explain the formation of shadows. In fig. 8, *AC* is a screen with straight edge at *C*, and we consider the light falling on different points of the screen *MN*. The wave front is supposed parallel to *ACB*, and the screen blocks out the part *AC*, so that we only have to consider the secondary waves emitted by the part *CB*. First take *P*, the geometrical edge of the shadow. If we draw the Fresnel zones for this point, they will consist of a semicircle, with C as centre, and half-rings surrounding it. Each will therefore give half the effect of the whole zone, and the resulting amplitude at P will be just half as great as if P were fully illuminated. The corresponding intensity is thus quarter as great. For a point Q we make the Fresnel construction starting at C; as Q moves away from P the sizes of the zones diminish steadily, and we therefore conclude that the intensity falls steadily from $\frac{1}{4}$ to zero. For a point R outside the shadow we make the construction in the way we did before for free space. There will then be a circle surrounded by rings, but the line through C cuts across them in such a way that some are incomplete. Suppose that R is just so far from P that the central circle is complete but is touched by the line C. Then the central zone gives its full contribution, but the second gives less than its full contribution, as do all the later ones. Consequently there is less to subtract than usual from the central zone and the light at R will be actually brighter than if there were no screen. Similarly if the circle and the first ring are complete, but the second ring is cut by the line C, the second ring will give a diminished positive contribution and the light will be fainter again. Thus outside the shadow there are a series of alternating maxima and minima of intensity gradually fading into uniform illumination at a distance from the shadow. These light and dark bands are known as diffraction fringes.

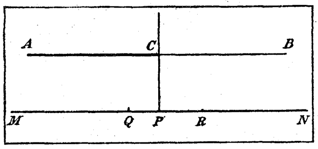
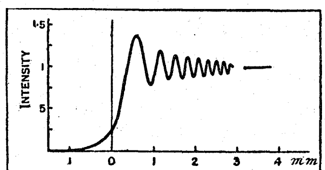


FIG. 8.—THE FORMATION OF SHADOWS
AC cuts off the light from part of the screen MN; P is the geometrical edge of the shadow, and the actual illumination in its neighbourhood is shown in fig. 9

The scale of the phenomenon depends on both the wave-length of the light λ and the distance CP. The intensity at a point R will depend on the numerical value of $PR\sqrt{\cdot CP}$. For example if CP is 1 metre and $\lambda = 5\times10^{-5}$ cm. for yellow light, the first maximum and first minimum will occur at distances 0·061 cm. and 0·094 cm. outside the geometrical edge, and will have 1·37 and 0·78 of the intensity of the incident wave. Fig. 9 shows how the intensity changes near the edge of the shadow. When the incident light is white the corresponding effect can be calculated by the superposition of all the colours; at the point of geometrical shadow the light will again be white and of quarter intensity and outside this there will first be a blue fringe. A similar process can be applied to work out the illumination due to a slit. If the slit is many wave-lengths wide it can be regarded merely as two straight edges, while if it is only a small fraction of a wave-length there wil be no shadow at all, but a uniform illumination. For intermediate cases there will be a rather complicated succession of fringes depending on the ratios of the three quantities, wave-length, breadth of slit and distance of screen. In any given case the results are easily calculable.



FROM SCHUSTER AND NICHOLSON, "THEORY OF OPTICS" (EDWARD ARNOLD & CO.)
FIG. 9.—THE EDGE OF A SHADOW
Showing how illuminative intensity rises from O inside to unity outside

The Fraunhofer Diffraction Phenomena.—There is another way, due to Fraunhofer, in which diffraction may be studied; this is in fact more important than Fresnel's in the theory of optical instruments. In this method parallel light again falls on a slit or hole, but, instead of observing the illumination on a screen, the light is now observed in a telescope focussed for infinity. The essential purpose of a telescope is that it brings all the rays going in a given *direction* into focus at a *point;* at this point a photographic plate may be placed, or alternatively the real image may be viewed with the help of a magnifying lens. The function of the telescope is thus to convert a direction into a point, and incidentally to magnify the scale. (Apart from this magnification it would be possible to see the Fraunhofer diffraction by looking at the slit with the naked eye; but the eye must be focussed for infinity and not for the slit, and this is not easy.) We must therefore find the intensities of the waves passing through a slit in various directions.

In fig. 10, AB is a slit, and we require to know what intensity goes at angle θ into the direction AM. We break up the wave at the slit into secondary waves. That arising at P has to go a distance $PR = AP\sin\theta$ further than that from A. If the phase of the wave from A is ϵ, that from P is $\epsilon - \frac{2\pi}{\lambda}x\sin\theta$, where $x = AP$. For a slit of breadth l the whole effect will be

$$\int_0^l \cos\left[\epsilon - \frac{2\pi}{\lambda}x\sin\theta\right]dx.$$

If this is integrated and then squared and averaged, we find the intensity proportional to

$$\left[\sin\left(\frac{\pi}{\lambda}l\sin\theta\right)\Big/\left(\frac{\pi}{\lambda}l\sin\theta\right)\right]^2.$$

The form of the curve $y = \sin^2 x/x^2$ is shown in fig. 11, so that to deduce what will be seen in the telescope we only require to equate x with $\pi l\sin\theta/\lambda$. Then if f is the focal length, the image corresponding to θ will be formed at a distance approximately $f\sin\theta$ from the axis of the telescope. From the curve we see there is a very strong maximum at $\theta = 0$, and that no light goes in the directions given by $\sin\theta = n\lambda/l$, that is, when BS, in fig. 10, is any multiple of the wave-length. About half way between these directions of no light there are secondary maxima, which are much weaker than the central one; even the first is less than $\frac{1}{20}$ of it. When the slit is broad the whole figure will be crowded close together. We must also consider narrow slits; *e.g.*, if the slit is exactly one wave-length broad the first zero will be at 90°; in any case nothing beyond that angle could be observed; if it is two wave-lengths broad, the first zero will fall at an angle of 30° and there will be a secondary feeble maximum at an angle of about 50°.

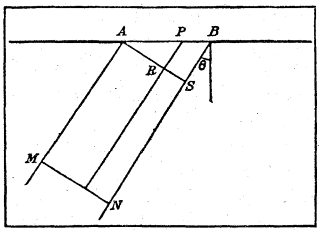


FIG. 10.—DIFFRACTION BY A SLIT

A similar construction can be applied for a hole as well as for a slit. Plate, fig. 5 shows the diffraction pattern given by a small rectangular hole. The pattern is broad in the direction in which the hole is narrow, and *vice versa.* In the case of a circular hole the pattern consists of a bright central circle surrounded by fainter rings, as shown in Plate, fig. 4. If the hole has radius R and the telescope focal length f, the bright centre is surrounded by a dark ring of radius $0{\cdot}61\times f\lambda/R$, and $\frac{5}{6}$ of the total light falls inside it. The first bright ring has radius $0{\cdot}82\times f\lambda/R$ and at its brightest point the intensity is only about one sixtieth of that at the centre of the central spot. The diffraction pattern of a circular hole is of great importance in connection with the theory of telescopes.

The Diffraction Grating.—A diffraction grating may be made by spacing a large number of slits parallel to one another at regular intervals. The general character of its action is easily understood. When monochromatic light falls on it each slit gives out a wave on the further side. For a certain direction the wave from the second slit will be exactly one wave-length behind that from the first and will reinforce it, as will all the waves from the other slits. If a is the distance between slits (measured from centre to centre), this reinforcing will occur at angle θ where $\sin\theta = \lambda/a$. This is called the spectrum of the first order. The spectrum of the second order arises when the wave from the second slit is two wave-lengths behind that from the first; its position is given by $\sin\theta = 2\lambda/a$. A similar process gives the higher orders also.

In order to discuss the grating in detail we take p slits each of breadth l. Their combined effect can be calculated in the same way as for a single slit by taking integrals from 0 to l, from a to $a+l$, $2a$ to $2a+l$, etc., and adding all together. When the expression has been summed, the intensity is formed from it and found to be as expressed in the formula on the opposite page.

$$I=\left[\frac{\sin\left(\frac{\pi l}{\lambda}\sin\theta\right)}{\frac{\pi l}{\lambda}\sin\theta}\right]^2\left[\frac{\sin\left(p\frac{\pi a}{\lambda}\sin\theta\right)}{\sin\left(\frac{\pi a}{\lambda}\sin\theta\right)}\right]^2$$

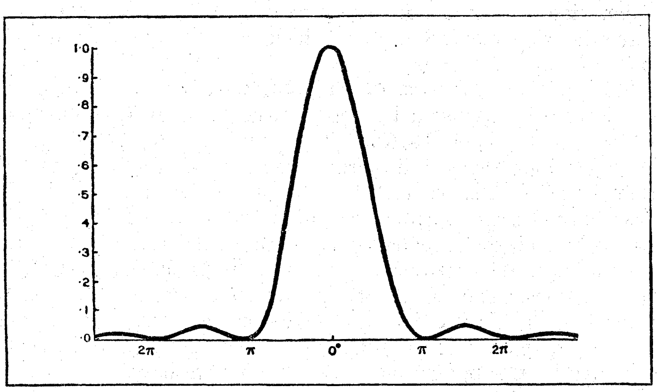
The first factor is exactly that which we found for a single slit. For a grating, l is usually small, so that this factor does not vary rapidly with the angle θ. The second factor is the important one, especially when p is a large number. The curve

$$y=\sin^2 px/\sin^2 x$$

has ordinate usually of the magnitude of about unity, but has very strong maxima of height p^2 at the values $x=0, \pm\pi, \pm 2\pi, \ldots$ etc. Thus the grating gives maxima at $\sin\theta=0, \pm\lambda/a, \pm 2\lambda/a, \ldots$ etc., the spectra of the various orders. In the neighbourhood of each of these the form of the curve is the same. Considering the case $x=0$, we can replace $\sin x$ in the denominator approximately by x and so have the curve of fig. 11. Thus each spectrum will give a pattern composed of a brilliant centre, and then feeble secondary maxima separated by darkness. The first darkness occurs when $x=\pi/p$, and this implies that in the spectrum of the nth order the first zero is at angular distance $\frac{1}{np}\tan\theta$ from the maximum. Since the second factor in I is the same for all orders the brilliancy of the different spectra will depend on the first factor. It may happen that this factor will entirely extinguish some orders; thus, if $l=\frac{1}{2}a$ there will be no even orders at all.

After the mirror and lens, the grating is the most important of optical instruments. In a transmission grating, lines are ruled on glass with a diamond. They are very fine and may be as close together as 5,000 to the centimetre. The cuts in the glass do not of course actually make it opaque, so that the grating is not really a set of slits, but they give it a periodic character which is all that is required. The second factor in I holds, but the first is invalid. Consequently the intensities in the different orders may vary greatly and in a way often unpredictable, as they depend on the shape of the cutting edge of the diamond. It has even been possible to prepare gratings in which nearly all the intensity goes into a single spectrum.

Let us suppose that we send a mixture of colours through the grating. Each colour in the light will produce its own set of spectra. In the zero order the rays are not bent, whatever the colour, and so, for $\theta=0$, the mixture will be unaltered. Turning to the side we shall first see the violet of the first order, then blue, green, yellow and red, and then darkness, for the second order of the violet (4,000 Å.U.) falls further out than the first order of the red (7,000 Å.U.). This isolation is true only of the first order (and even then only by not considering ultra-violet light); the second order red is overlapped considerably by the third order blue, and in the higher orders the spectra overlie one another completely. To eliminate this difficulty special devices have to be used, such as a rough preliminary sorting of the spectrum with a prism; or else a prism can be set with edge perpendicular to the grating lines so that it shifts the blue lines to a different level from the red. The overlapping of the spectra has been put to use in comparing wave-lengths with accuracy. Thus, if a spectrum contained a blue and a red line, such that the third order blue fell exactly on the second order of the red, we should know that the wave-lengths were exactly in the ratio 2:3. If they fall fairly close the ratio can still be fixed with accuracy, without a very precise knowledge of the grating constant. In this way a set of standard wave-lengths throughout the spectrum were first determined, but later the interferometer replaced the method.



FROM SCHUSTER AND NICHOLSON, "THEORY OF OPTICS" (EDWARD ARNOLD & CO.)

FIG. 11.—CHART SHOWING FRAUNHOFER DIFFRACTION BY A SLIT
The curve $y=\sin^2 x/x^2$. The y ordinate measures the intensity of light at angle O where sin O is proportional to x

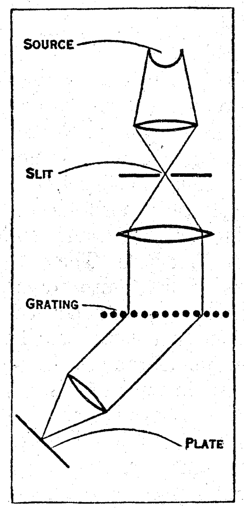


FIG. 12.—DIAGRAMMATIC VIEW OF A SIMPLE GRATING SPECTROSCOPE

For the installation of a grating spectroscope (*see* fig. 12) we require parallel light. Since most sources of light cover some area it is usual to focus the source on to a fine slit and use this slit as a secondary source. The light diverges from the slit and is passed through a collimating lens. Such a lens would turn the light from a point source into parallel light; for a slit the emergent rays will all lie in planes through the line of the slit, and, if the lines of the grating are parallel to the slit, the obliquity of the rays will not affect the diffraction. The parallel wave next comes to the grating and is diffracted. A lens is set at a suitable angle to catch the desired part of one of the spectra, and the wave is focussed on to a photographic plate. When monochromatic light is used a narrow line will appear, which will correspond in breadth to the breadth of the slit plus the breadth of the diffraction pattern that would be produced by an infinitely narrow slit.

In practical work of the highest class much complication is saved by having the grating ruled directly on a concave mirror, for this focusses the slit straight on the plate without the intervention of any lenses. It will readily be believed that the making of large gratings on this principle is a very difficult matter; it was most successfully overcome by Rowland who made a number which even now remain the most useful instruments in spectroscopy. The manufacture depends chiefly on the construction of a long screw of very regular pitch, to shift the diamond a definite distance after each line has been ruled. If the diamond should break, it is exceedingly difficult to recover the line with a new one, and all the work is wasted. A troublesome complication arises with some gratings if the screw has a systematic irregularity. Suppose for example that it rules every tenth line a little out of place. Then the true periodicity of the grating is the group of ten lines, and what we call the first order is really the tenth, though in view of the approximate regularity it will be far more brilliant than the first nine. Nevertheless in the study of a spectrum it may be that some of the strongest lines give a perceptible image corresponding to one of these lower orders and such an image might be mistaken for a real line. Images of this type are called "ghosts" and in accurate spectroscopic work it is very necessary to know what ghosts may be possessed by the grating in use.

The Nature of White Light.—It has been customary since the time of Newton to say that white light is compounded out of all the colours, but the diffraction grating suggests quite another point of view. Let us imagine that the incident light is a plane wave consisting of a single thin pulse. Each slit of the grating diffracts this pulse into all directions, and, if we observe from a given direction, we shall receive in turn the pulses which have come through each slit. They will be evenly spaced and further apart, the broader the angle from which we observe. At each position θ there will be something very like a monochromatic wave; more precisely it is a periodic wave composed of wave-lengths $a\sin\theta$ and all its submultiples; *i.e.,* out of the superposition of light of the first, second and higher orders appropriate to the angle θ. Regarding the matter in this way, we have a perfect right to say that the coloured light has been *created* by the spectroscope. This is a point of view well worth keeping in mind, for in many branches of physics we determine some property by an experiment and then attribute it to the system, even in cases where the experiment is not done, overlooking the fact that it may be the experiment itself that has evoked the property. In the present case the two points of view are reconciled by the fact that the pulse can be analysed mathematically into an integral composed of lights of all wave-lengths, and in this sense it is correct to say that white light contains all the colours, even though it is unnatural to attribute any periodic quality to a single pulse.

It may appear that the argument is special to the case of resolution by a grating, and that the spectrum of white light formed by a prism proves that the colours were there originally. Closer examination shows this to be wrong, though the argument is not so simple; by considering the property of group-velocity it can be shown that the prism will convert a single pulse into successions of pulses differently spaced for the different directions, but it would take too long to develop the idea further here. The outcome of the argument is that the analysis of light into wave-lengths is chiefly a matter of convenience, largely mathematical convenience; but this is enhanced by the fact that gases usually emit spectra consisting of very nearly pure monochromatic lines, so that it turns out to be also a practically important analysis.

The Resolving Power of Spectroscopes.—It is of great importance when working with any optical instrument to know its resolving power. If two spectral lines are sent simultaneously through a grating, the resolving power determines how close their wave-lengths may be without our confusing them. So too the resolving power of a telescope tells us what distance there must be between two stars in order that we may be sure that they are two and not one. Resolving power must be distinguished from magnification, for, as we shall see, it is possible to magnify the images indefinitely, but the only effect is to make a small indistinct image into a large indistinct image. Diffraction theory determines the resolving power of all instruments.

We will consider the resolving power of the grating, and must first distinguish it from the *dispersion*. If the lines are ruled very close together the spectra will be at wide angles, and so the spectral lines we try to resolve will be far apart; they will have a large dispersion, but, if the lines themselves are broad, it will not help the resolution. First we remember that the breadth of each line is affected by the breadth of the spectroscope slit, so that two lines may give overlapping images on this account. We need not consider this, as it may be obviated, by so narrowing the slit, that its breadth is less than the breadth of the diffraction pattern that would be given by an infinitely narrow slit. Let us suppose that we have two lines of wave length λ and $\lambda+\delta\lambda$, say the two D lines of sodium at 5,896 and 5,890 Å.U., and enquire under what conditions they can be

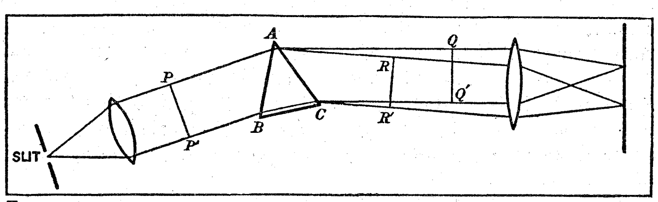


FIG. 13.—PRISM SPECTROSCOPE. THE POWER OF RESOLVING TWO SPECTRAL LINES DEPENDS ON THE LENGTH BC

separated. In the nth order spectrum they appear at positions $\sin\theta=n\lambda/a$ and $\sin(\theta+\delta\theta)=n(\lambda+\delta\lambda)/a$, so that, approximately,

$$\delta\theta=n\delta\lambda/a\cos\theta.$$

This is the dispersion of the lines, *i.e.*, the distance between the centres of the lines. Now, if the diffraction patterns of the lines are such that each main peak (of fig. 11) falls separate from the other, we can certainly distinguish that there are two lines. We could probably do so if they were a good deal closer and overlapping, but not if they were as little apart as one-tenth of the breadth of the peak. All that we require is a rough measure, and we shall take the condition that one peak falls on the first zero of the other. We saw that the first zero falls at a distance $\frac{1}{np}\tan\theta$ from the centre, and for limiting resolution this must be equal to the dispersion of the two lines, so that $\delta\lambda=\lambda/np$. The resolving power is usually defined as $\lambda/\delta\lambda$, where $\delta\lambda$ is the difference of wave-length of two lines that can just be resolved; we see that it is equal to np. The important point is that it in no way depends on the dispersion, but, for a given order of spectrum, only on the number of lines, no matter what their spacing. For example, if we want to separate the sodium lines in the first order we must have 1,000 lines, if in the second, 500. If the grating is coarse the lines may fall very close together, but a powerful telescope can still separate them; if there are fewer than 1,000 lines the telescope will merely magnify a blurred image.

We may compare this with the resolution of the Fabry-Pérot interferometer. The plate being of air, we take the refractive index as unity, and, as the incidence is nearly perpendicular, we can replace $\cos\theta'$ by $1-\frac{1}{2}\theta^2$. If $s\lambda=2b$ for one of the lines where s is a (large) integer, there will be a bright spot in the centre and the next ring will have angular radius $\sqrt{\lambda/b}$. If there is another line of wave-length $\lambda+\delta\lambda$, its innermost ring will have radius $\sqrt{s\cdot\delta\lambda/b}$. Though the fringes are fairly sharp, the opacity of the silvering of the plates sets a limit to their sharpness, and we shall not resolve the lines unless the radius of the inmost ring of the second line is a fairly large fraction, say a tenth, of that of the second ring of the first line. This shows that the resolving power should be about ten times as great as s; if the plates are 5 cm. apart it will be about 1,000,000 for visible light.

It is also interesting to consider the resolving power of a prism spectroscope (*see* fig. 13). This instrument separates lines by means of the difference in the refractive index of the glass for different colours. By an argument from geometrical optics, which we shall not give, it may be shown that the angular separation of the two lines is $dn.l/b$, where dn is the difference of their refractive indices, b is PP' the breadth of the beam, and l is BC the base of the prism. The lens will focus a beam of breadth $QQ'=b$ to a line of breadth λ/b, and the two lines will therefore be resolved if $l>\lambda/dn$. Thus, to obtain good resolution the most important factor is a great thickness of glass, and this severely limits the use of prism spectroscopes. Taking the value of dn for typical glass, we can calculate that 1 cm. will resolve the sodium lines, but if we require to resolve two lines for which $\lambda/\delta\lambda$ is half a million, as is possible with an interferometer or with a grating of half a million lines, we should require 5 metres of glass, and even if it were otherwise practicable such a thickness would be far too great to let any light through.

The Resolving Power of Telescopes.—The principal of the lens is usually discussed by geometrical methods (*see* OPTICS), but it is quite simple to work it out with the wave theory. In fig. 14 plane waves fall perpendicularly on the lens in the beam, PA,QC. The central ray through BE is retarded in the glass, but not so the extreme rays at A and C. The focus F is the point where all the secondary waves from AEC are in phase; the retardation of the central ray is balanced by the longer path of the extreme ones. The waves at AB are in phase, and the phase changes from there to F are given respectively by AF and $n{\cdot}BE+EF$, where n is the refractive index. Let BE be d, AB be r and EF be f, supposed much larger, then we have

$$d(n-1)+f=\sqrt{(f^2+r^2)},$$

whence, approximately, $f=\frac{r^2}{2d}\;\frac{1}{n-1}$, which determines the focal length of a plano-convex lens in terms of its curvature. If another set of waves at a small angle θ falls on the lens, their focus F' can be found by the consideration that the waves from A and C must be in phase, while F' is near F in a plane at right angles to the axis of the lens. We thus find that $FF'=f\sin\theta$, a familiar result in geometrical optics.

Supposing that the two waves are from stars, we enquire under what conditions they will be resolved. The image of the first star at F is of course not a point because of diffraction. We can roughly estimate its size by the consideration that there will be points near F for which the waves from A and C and all intermediate points, though not perfectly in phase, are so little out of phase, that there will be still a marked intensity. This is a question of the diffraction image of a circular hole and the radius of the central spot is $0{\cdot}61f\lambda/r$. If the centre of the image of the second star is much closer than this, we shall only have one bright spot and shall not distinguish that there were two stars. Thus the angular distance that can be resolved is $0{\cdot}61\lambda/r$. Taking visible light and measuring the radius of the telescope in millimetres this gives

$$\left(\frac{1{\cdot}17}{r}\right)'.$$

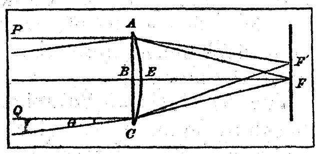


FIG. 14.—THE FOCUS OF A LENS
The power of resolving the images F and F′ depends on the size of the lens AC and not on the focal length BF

The important thing to notice is that the resolving power in no way depends on the magnification, but only on the diameter of the object glass. If the telescope has a short focal length the magnification will be small; but as long as the diameter is large the resolution will be good, and the small magnification can be overcome by the use of a stronger eye piece. This result requires one qualification, for we have assumed that the whole object glass is operative in bringing rays to the eye. When the magnification is not very great it may happen that the pupil of the eye is the effective limitation and not the object glass, and in such cases the resolving power will depend on the diameter of that part of the object glass from which light enters the pupil.

The tendency to make larger and larger telescopes is to be attributed partly to the fact that they collect more light, but much more to the increased resolving power. An extreme example is given by the measurement of the diameters of stars. Stars are all so distant that no existing telescope could hope to resolve the separate parts of their surface, and the disc seen is never perceptibly larger than that which would be produced by a geometrical point. But if we could have a telescope 50 ft. in diameter the resolving power should be sufficient to show the disc of a large star in the same way as an ordinary telescope does for a planet. It is not of course practicable to make such a telescope, but it is also not necessary; all that is required is two little pieces of such a telescope at the points A and C in fig. 14. In principle this is the way in which it has been found possible to measure the diameter of Betelgeuse and a few other stars.

The eye is an instrument similar to the telescope. Taking the pupil as 2 mm., the same calculation shows that its resolving power should be $0{\cdot}42'$. The actual limit, about $1'$, is not very different, and is no doubt affected by the structure of the retina. A similar limit would apply for any eye constructed on the same principle as man's; but insects' eyes are compound, being composed of a very large number of very small independent facets. There can be no phase relations between the separate facets, so that the resolving power can only depend on the size of each separately. It thus seems improbable that an insect can discriminate between objects less than some degrees apart.

The resolving power of the microscope presents a different problem from that of the telescope, because in the microscope we observe non-luminous objects illuminated usually by parallel or not very convergent light. The discussion of the theory will be found under MICROSCOPE, and we here only give the result. If the lens can receive light from the object over a range of 180° (and for a good microscope it very nearly does), then some rough impression of form can be detected for an object of the size of half a wave-length. By immersing the object in a refractive medium the wave-length is shortened and the resolution improved, and it may be further improved by the use of ultra-violet light.

POLARIZATION AND ELECTROMAGNETIC THEORY

In our review of the history of optics we described some of the earlier work on polarization, and we must now make its character clearer. The phenomena of interference and diffraction were all explained by regarding the light as a wave, leaving it entirely open what it is that vibrates and how it does it. In fact all that we have so far said would, with suitable changes of scale, be just as true for sound as for light. But when we come to the phenomena of double refraction, this is not so; they are only explicable if the vibrations are transverse. Though we saw that, in spite of many attempts, no material model could be found which would carry waves in the way that aether does light, still it is quite possible to visualize polarization. A string stretched horizontally may vibrate in a vertical or horizontal plane or simultaneously in both; at any instant a point of the string is displaced from its position of rest in a direction perpendicular to the line of the wire, and this position can be indicated by drawing a line in the direction and of the length of the displacement. When a light-wave is travelling through space, we can also represent it at any point and time by drawing a line in a definite direction and of a definite length. It should be explained that, unlike the case of the string, here the length is only diagrammatic and can be represented on any scale, as long as we are consistent and adopt the same scale for other points. This line is called the light-vector, and the wave is said to be transverse, because the light-vector is always found to be at right-angles to the direction of the wave, that is to say it lies somewhere in the plane of the wave-front. The reason for this will appear when we come to the electromagnetic theory; we shall first describe the main properties of polarization without justifying them.

Types of Polarized Light.—Suppose that we have a wave of plane monochromatic light advancing perpendicular to the paper. At any point in the paper we draw the light-vector, and it will go through a series of changes, returning to its original value in the period of the waves. We can represent any motion by giving the x, y co-ordinates of the end of the light-vector, and for monochromatic light these must be sine-functions of the time. If ν is the frequency we therefore take

$$X = A\cos(2\pi\nu t - \alpha), \quad Y = B\cos(2\pi\nu t - \beta)$$

as the general description of the light. We first consider a few special cases. If $B = 0$ we have a vibration in which the vector always lies in the direction of x and ranges between the values $\pm A$. This we call *plane polarized* in the direction x. Similarly if $A = 0$ we have light plane polarized in the direction y. If we have $\alpha = \beta$, we see that at any time $Y/X = B/A$, so that again we have plane polarized light, in direction arc $\tan B/A$ and with amplitude $\sqrt{(A^2+B^2)}$. Next consider the case $B = A$, $\beta = \alpha + \frac{\pi}{2}$. Then $X^2 + Y^2 = A^2$, so that the vector describes a circle; this is therefore called *circularly polarized* light. In the general case we can find the locus of the light-vector by eliminating t and get

$$\frac{X^2}{A^2} + \frac{Y^2}{B^2} - 2\frac{XY}{AB}\cos(\alpha - \beta) = \sin^2(\alpha - \beta).$$

This is an ellipse of which the axes are determined as to position and magnitude by A, B and $\alpha - \beta$. The most general type of light is therefore called *elliptically polarized*, and we recognize our previous types as degenerate ellipses.

We next consider the propagation of such waves, that is to say, the phase relations of the light-vectors for different positions of the wave-front. Our wave is now written as

$$X = A\cos[2\pi\nu(t - z/c) - \alpha], \quad Y = B\cos[2\pi\nu(t - z/c) - \beta],$$

and the character of the polarization is the same for all values of z, as it will depend on A, B and

$$(2\pi\nu z/c + \alpha) - (2\pi\nu z/c + \beta) = \alpha - \beta.$$

Next we take t as fixed and consider the way the light-vector is arranged for various values of z. We may liken it to the stretched string. If $B = 0$ it will be in the shape of a sine-curve in the plane of xz with wave-length c/ν, and similarly whenever $\alpha = \beta$, though for a different plane. If $\beta = \alpha + \frac{\pi}{2}$ and $B = A$, the locus is a screw, or helix, of radius A and pitch equal to the wave-length c/ν. If the axes are right-handed (so that a man standing with his head towards z has x to his right and y to his left), then the screw may be seen to be left-handed. This is therefore called *left-handed circularly polarized* light. If we take $\beta=\alpha-\frac{\pi}{2}$ instead, we should get a right-handed screw. The distinction between right and left-handed circularly polarized light is physically very important, as it plays a leading part in the phenomenon of gyration. In the case of elliptically polarized light the locus of light-vectors may be described as a flattened screw; it may be either right- or left-handed again, but the question is not so important physically. This suffices to describe the form of the waves, and it only remains to define the intensity. At any point this is given as the average value of the square of the light-vector; in the cases we have considered it is the average of X^2+Y^2. When the waves are travelling in an arbitrary direction instead of along z, we may have three components of the light-vector, and in such a case $X^2+Y^2+Z^2$ is to be averaged over the time.

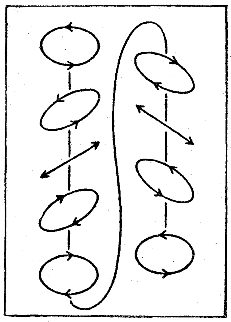


FIG. 15.—ELLIPTICALLY POLARIZED LIGHT

We must also consider the nature of ordinary unpolarized light. This has no "sides" and is symmetrical about the direction of propagation, and in this it is like circularly polarized light; but we shall see that circularly polarized light can easily be converted into plane polarized, whereas for ordinary light this is not possible, so the explanation of its symmetry must be found in another way. If the light is *rigorously* monochromatic, the phases of the components of the light-vector are maintained for ever, and such light must therefore be polarized, either plane, circularly or elliptically. In nature, however, no light is rigorously monochromatic, for the Michelson interferometer fails to show interference for path differences of more than a million wave-lengths, and this enables us to explain unpolarized light as being polarized light of which the direction is changed frequently. We suppose each atom to emit a polarized monochromatic wave which lasts for a time corresponding to a million wave-lengths, and then changes and emits one of a different polarization. The length of time of each separate type is so short that we cannot distinguish them, but merely get an average of all the different types and this average will be symmetrical about the direction of propagation.

In describing plane polarized light we have said that it is polarized in the direction x when the light-vector vibrates along x. Unhappily there is some confusion in the terminology used. When polarization was first discovered the convention was adopted that the light of the *ordinary* ray in double refraction is polarized *in the plane* through the axis of the crystal and the direction of propagation. It later appeared that the light-vector must be perpendicular to this plane, so that the old convention would have described the light as polarized in the plane of yz, which we call polarized in the direction x; and it was even sometimes loosely referred to the direction y alone. For most optical effects the behaviour is determined by the direction of the vector and not by the direction of propagation of the wave, so that it is practically inconvenient to mention two directions when one would do. The modern tendency, which we shall adopt, is to describe plane polarized light by the direction of the light-vector; thus, in double refraction we shall say that the ordinary ray is polarized at right angles to the crystal axis. Some confusion is unavoidable because the term plane polarized (instead of line polarized) is too deeply implanted to be changed, but we can avoid ambiguity by saying that light is plane polarized in some *direction,* instead of in some *plane,* and the direction is then the normal to the plane which was formerly used.

Double refraction is not the only way in which polarization is produced, and we shall discuss its other occurrences in detail later. Chief among them is reflection at a transparent surface set at a suitable angle. At other angles there is an incomplete polarization, which is sometimes very troublesome in experiments; for as light passes through any system of lenses or mirrors, it is almost impossible to prevent its becoming polarized, and this may easily obscure the study of its original polarization. We may also mention the polarization of scattered light, exemplified in the light of the sky. Again, in the diffraction of light by a slit, the two components behave rather differently, and so the light is slightly polarized; the theory we have given is sufficiently correct for small angles and we shall not consider the modification that is rigorously required. Perhaps the most interesting occurrence of all is in the Zeeman effect (*q.v.*). Here the spectral lines of an atom become displaced and split when the atom is in a strong magnetic field, and the split components are polarized in certain definite ways, from which much information can be obtained about the mechanics of the atom.

The Analysis of Polarized Light.—Polarization is chiefly, though by no means exclusively, studied by using the property of double refraction in crystals. We discuss this below, but it will here suffice to say that when a wave goes through a crystal its light-vector is resolved in two directions, mutually perpendicular and perpendicular to the direction of propagation, and the components in these directions have different wave-velocities. Suppose that we have a plate with parallel faces, and that the wave is going through it along z, while the two special directions are x and y. In such a plate the light-vector will be given by

$$X=A\cos[2\pi\nu(t-z/a)-\alpha],\quad Y=B\cos[2\pi\nu(t-z/b)-\beta],$$

where a and b are the wave-velocities for the directions x and y. If the incident light is plane polarized along x or y the wave will go through unchanged, but if it is polarized, say at angle γ on entering the plate at $z=0$, we shall have $\alpha=\beta$ and $A=C\cos\gamma$, $B=C\sin\gamma$. If the plate is of thickness l the light will emerge from the farther side as

$$X=C\cos\gamma\cos[2\pi\nu(t-l/a)-\alpha],\quad Y=C\sin\gamma\cos[2\pi\nu(t-l/b)-\alpha],$$

and so X and Y are no longer in the same phase, and the light is now elliptically polarized. Fig. 15 shows diagrammatically how this transformation comes about. If we had started with elliptically polarized light, the emergent light would in general be elliptically polarized, but in a new direction. In special cases it might become plane polarized, and this explains the principle of an important instrument used in the study of polarized light, the *quarter-wave plate.* A quarter-wave plate is made by taking l so that $2\pi\nu l/a-2\pi\nu l/b=90°$. If the incident light is elliptically polarized, with the axes of the ellipse along x and y, we may write it as

$$X=A\cos(2\pi\nu t-\alpha),\quad Y=B\sin(2\pi\nu t-\alpha).$$

After passing through the quarter-wave plate the emergent light will be

$$X=A\cos(2\pi\nu t-\alpha'),\quad Y=B\cos(2\pi\nu t-\alpha'),$$

and it is now plane polarized. As a case of special importance, if the incident light is circularly polarized, the emergent will be plane polarized at 45 degrees to the x direction, and its right- or left-handedness will be indicated according to whether the direction is between x and $+y$ or x and $-y$. Quarter-wave plates are usually made of mica, which is easily cleft into thin sheets. These sheets exhibit a rather weak double refraction, so that a quarter-wave plate is not inconveniently thin. As mica is rather soft, it is often mounted between two sheets of glass and scratches on these indicate the direction of the crystal axis.

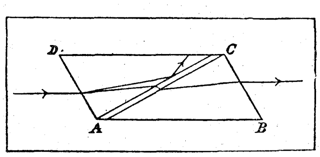


FIG. 16.—THE NICOL PRISM

We have seen how any type of polarized light can be turned into plane polarized, and it remains to consider how this can be investigated. The standard instrument is the nicol (*see* fig. 16). A rhomb of calcite, which is about 3 times as long as it is broad, is sawn across the line AC, and, after the cut has been polished, its two faces are cemented together with Canada balsam. The two ends AD and BC are also cut to a slightly different angle (68° instead of 72°). A wave, entering parallel to the prism, is doubly refracted, and, because of the slope of the face AD, the waves go in somewhat different directions, the ordinary wave being most bent. Canada balsam has refractive index intermediate between those of the ordinary and extraordinary waves, and, as the ordinary wave meets it very obliquely, it becomes totally reflected and so falls on the side *DC,* which is blackened so as to absorb it. The extraordinary wave passes freely through, and so the emergent light is plane polarized. A nicol will polarize light over a certain range of angles of incidence. The limits are set by the condition that on one side both rays are reflected at *AC* and lost, and on the other that both are transmitted; under favourable conditions the range of angles may be 25°. A typical experiment with polarized light involves the use of two nicols. The simplest example is the direct use of two "crossed" nicols. The first produces polarized light by absorbing one component; the second is placed with its axis in the same line as the first but is twisted round through 90°, so that the wave which was extraordinary wave in the first nicol is now the ordinary and so is absorbed. This device has been used for secret signalling. The signaller rotates his nicol through 90°, and though to the naked eye his lamp appears to burn steadily, if it is viewed through a fixed nicol it will go out.

When we want to study the polarization of elliptically polarized light, it must first be made into plane polarized light by some means, and then extinguished by a nicol. There will always be two adjustments to be made, because the light has two parameters, the ratio of the axes of the ellipse and their position. There are two chief methods used. A quarter-wave plate may be rotated until it lies along the principal axis, so that it renders the light plane polarized; the light can then be extinguished by a nicol. The position of the quarter-wave plate fixes the axes of the ellipse, and the angle it makes with the nicol gives the ratio of the axes. This method is specially convenient if we already know the axes of the ellipse, as is the case in some important experiments; in other cases the simultaneous making of two adjustments is troublesome. The alternative instrument is called the *compensator.* In this the analysis is in two fixed perpendicular directions, instead of along the axes of the ellipse, and we measure the relative lengths of the components of the light vector in those two directions and their phase-difference. The essential part of the compensator consists of two thin wedges of quartz, which is a rather weakly doubly refracting crystal. One wedge is cut so that the crystal axis lies in a line parallel to the edge, and the other so that it is at right angles to it and in the face; (*see* fig. 17, where the lines and dots indicate the directions of the axes). Incident light will be broken into two components in the first wedge, of which one will have a higher phase-velocity; but on entering the second this will change about, so that, if the thicknesses are exactly equal as at the centre *A,* there will be no changes of phase. Thus, incident plane polarized light will emerge as plane polarized at *A.* At any other point *B* this will not be so, because the light will have gone further through one crystal than through the other. If elliptically polarized light is incident, there will be places where it is plane polarized, and so, if we use an analyzing nicol set at the proper angle, we may observe the field crossed by dark bands. If one wedge is screwed over the other by means of the micrometer screw *M,* the bands will shift because of the changing differences in the thickness of the wedges. The reading consists in seeing how far the screw must be turned to bring one of the bands to the centre. This measures the phase-difference in the components of the light vector along and across the wedge, while the ratio of their amplitudes is given by the setting of the nicol.

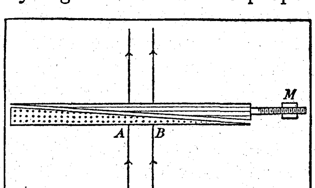


FIG. 17.—THE COMPENSATOR
The dots indicate the crystal axes of the two quartz wedges, and M is the micrometer screw

THE ELECTROMAGNETIC EQUATIONS

It was Maxwell who made the great discovery that the equations governing the behaviour of electric waves are equally applicable to light, and this provides a strict formulation for the whole theory, including of course polarization. For the derivation of the theory of electric waves *see* the article ELECTRICITY; we shall here take it as given and show how it applies for light.

Consider first the case of free space. At every point there may be an electric force $\mathbf{E}$ and a magnetic force $\mathbf{H}$. Each has both direction and magnitude and they can be most conveniently described by the components E_x, E_y, E_z and H_x, H_y, H_z along the directions x, y, z. The vector notation is well adapted to expressing their relations. In this notation

$$\frac{\partial E_x}{\partial x}+\frac{\partial E_y}{\partial y}+\frac{\partial E_z}{\partial z}$$

is written div $\mathbf{E}$ and called the divergence, while the three quantities

$$\frac{\partial E_z}{\partial y}-\frac{\partial E_y}{\partial z},\quad \frac{\partial E_x}{\partial z}-\frac{\partial E_z}{\partial x},\quad \frac{\partial E_y}{\partial x}-\frac{\partial E_x}{\partial y},$$

are the components of curl $\mathbf{E}$. A vector equation involving curl is thus three equations, when written in terms of the components.

The equations are

$$\frac{1}{c}\frac{\partial \mathbf{E}}{\partial t}=\text{curl } \mathbf{H},\ \text{div } \mathbf{E}=0;$$

$$-\frac{1}{c}\frac{\partial \mathbf{H}}{\partial t}=\text{curl } \mathbf{E},\ \text{div } \mathbf{H}=0.$$

In these equations c is originally a rather abstruse quantity, the ratio of the electromagnetic to the electrostatic units. It is a velocity, and one of the strongest evidences for the electromagnetic theory of light is that, when purely electric methods are used to determine the ratio, it is found to be the same as the velocity of light. We shall give a few examples of solutions, but before doing so must complete the theory by giving the rule for intensity. In our previous account of intensity we left a factor of proportionality undetermined, and this was right because we had then no other physical phenomenon to link with light, so that there was no way of fixing the absolute values. Now, however, we have a much more precise formulation, because we can imagine that we might measure (very ideally of course) the electric force in the light by means of an electrometer, and we can therefore make our definition absolute. Electrical theory assigns a value to the flux of energy, *i.e.,* to the rate at which energy is carried across unit area in unit time, and this is a suitable measure for intensity. It is called the "Poynting vector," after its discoverer, and is $\frac{c}{4\pi}[\mathbf{E},\mathbf{H}]$ where $[\mathbf{E},\mathbf{H}]$ is a *vector product* with component $E_y H_z - E_z H_y$, along x, etc.

We now consider some solutions of the electromagnetic equations. One such solution may be verified to be

$$E_x=A\cos\frac{2\pi}{\lambda}(ct-z),\ E_y=0,\ E_z=0;$$

$$H_x=0,\ H_y=A\cos\frac{2\pi}{\lambda}(ct-z),\ H_z=0.$$

We see in the first place that we have a wave travelling along z with velocity c, and purely electrical experiments have shown c to be equal to the velocity of light. Secondly we see that it is a transverse wave, but it is ambiguous whether the electric or magnetic force is the light-vector. A similar solution is

$$E_x=0,\ E_y=B\cos\frac{2\pi}{\lambda}(ct-z),\ E_z=0;$$

$$H_x=-B\cos\frac{2\pi}{\lambda}(ct-z),\ H_y=0,\ H_z=0;$$

and this evidently represents the other polarized component. A third solution can be formed by superposing these two, or by superposing them with a phase difference between E_x and E_y. The intensity in such a case would be $\frac{c}{8\pi}(A^2+B^2)$.

We must now consider whether the electric or magnetic force is the light-vector. Since both always occur in the wave, a theory could be constructed in which either was so taken, and it is a matter of convenience which we choose. A number of phenomena show that the electric force is the more important, primarily because matter is constructed out of electrons and not out of magnetic particles. We may give as one example the case of *standing* waves. When a plane wave of monochromatic light falls perpendicularly on a mirror and is reflected straight back, the incident and reflected waves interfere with one another and produce a system of stationary oscillations. These may be described by

$$E_x = A\cos\frac{2\pi}{\lambda}(ct-z) - A\cos\frac{2\pi}{\lambda}(ct+z)$$

$$= 2A\sin\frac{2\pi}{\lambda}ct\sin\frac{2\pi z}{\lambda};$$

$$H_y = A\cos\frac{2\pi}{\lambda}(ct-z) + A\cos\frac{2\pi}{\lambda}(ct+z)$$

$$= 2A\cos\frac{2\pi}{\lambda}ct\cos\frac{2\pi z}{\lambda}.$$

We see that at points where z is any multiple of half a wave-length E_x vanishes all the time, whereas H_y vanishes all the time at points where z is an odd multiple of quarter of a wave-length. Suppose that our mirror is coated with a nearly transparent photographic film, of some depth, which is afterwards developed and examined in section. Then we shall find places where it is fogged by the action of the light-vector, and others where it is unaffected and the positions of these tell us that it is the electric force that is effective and not the magnetic. From this and similar cases we conclude that it is best to take the electric force as the light-vector.

REFRACTION AND DOUBLE REFRACTION

We have already made much use of the idea that the optical effect of a transparent medium can be represented by a refractive index. This is not of course an explanation of refraction; for that we shall have to consider atomic processes, but without doing this we can discuss many of its features, and can describe the experiments which have been used in its investigation. We shall be content for the most part with the description of results; to work them out in detail would involve rather elaborate mathematics.

The Electromagnetic Equations for Refracting Media.—The natural starting point for the discussion is the extension of the electromagnetic theory to cover electrical waves propagated through matter. When a static electric force acts on matter it may produce two effects: If the matter is a conductor, a current will flow according to Ohm's law; this is expressed by defining a *current density* $\mathbf{j}$ (a vector with components $\mathbf{j}_x, \mathbf{j}_y, \mathbf{j}_z$) which is given by $\mathbf{j} = \sigma E$, where σ is the specific conductivity of the medium. If the matter is an insulator, the electric force displaces the electricity in the atoms in a way that may be compared to the compression of a spring, and a new quantity has to be introduced to express this, which is called the *dielectric displacement.* In isotropic media, such as water or glass, the dielectric displacement bears a constant ratio to the electric force. We write $\mathbf{D} = \epsilon\mathbf{E}$, and call ϵ the *dielectric constant.* General electromagnetic theory then shows that the equations for free space must be altered so as to accommodate either or both of these properties of matter. We now write

$$\frac{1}{c}\frac{\partial D}{\partial t} + \frac{4\pi}{c}\sigma\mathbf{j} = \text{curl } \mathbf{H}, \quad \text{div } \mathbf{D} = 0.$$

Matter also has magnetic properties, and this suggests that the other equations should be changed as well. It is found however to be unnecessary, for the alternations of force in light are so rapid that the magnetic properties have no time to take effect. So we adhere to the equations

$$-\frac{1}{c}\frac{\partial \mathbf{H}}{\partial t} = \text{curl } \mathbf{E}, \quad \text{div } \mathbf{H} = 0.$$

These equations together determine the behaviour of light in most types of matter, but we must remember that we always have to make observations outside, and therefore require to know how the light will pass from one medium to another. Electric theory again provides the answer; when light goes through a boundary between two media, at every point of the surface and at every instant of time, the tangential components of electric and magnetic force just on one side of the boundary must each be equal to the tangential components of the corresponding forces just on the other side. (*See* ELECTRICITY.)

Refraction in Transparent Media.—In a non-conducting isotropic medium, the equations assume the form

$$\frac{\epsilon}{c}\frac{\partial \mathbf{E}}{\partial t} = \text{curl } \mathbf{H}, \quad -\frac{1}{c}\frac{\partial \mathbf{H}}{\partial t} = \text{curl } \mathbf{E}.$$

It is easy to verify that these are satisfied by

$$E_x = A\cos\frac{2\pi}{\lambda}\left(\frac{c}{\sqrt{\epsilon}}t - z\right), \; E_y = 0, \; E_z = 0;$$

$$H_x = 0, \; H_y = A\sqrt{\epsilon}\cos\frac{2\pi}{\lambda}\left(\frac{c}{\sqrt{\epsilon}}t - z\right), \quad H_z = 0.$$

The electric force is transverse to the waves and the wave-velocity is $c/\sqrt{\epsilon}$, so that the medium has refractive index $\sqrt{\epsilon}$. An apparent difficulty at once arises, for our result seems to imply that the refractive index should not depend on the colour of the light. This will be explained when we come to the atomic theory, where it will appear that the dielectric constant depends on the frequency of the inducing electric force.

We next consider the passage of light from one medium to another. Suppose that they have refractive indices n and n', and first suppose n to be the lesser; in the case of free space it will be unity. To find the formulae for refraction and reflection we take a given incident wave, and assume that there are reflected and refracted waves, but without making any assumptions about their wave-lengths or directions. The boundary conditions then require that the sum of the tangential components of incident and reflected forces at the boundary in the first medium, are everywhere and at every time equal to the corresponding forces in the refracted wave on the other side of the boundary. These conditions lead in the first place to the law that the frequencies of all three waves must be equal, so that the wave-length of the refracted wave is $\lambda n/n'$, and then to the law that the angle of reflection is equal to the angle of incidence θ, while the angle of refraction θ' is given by $n\sin\theta = n'\sin\theta'$. These rules can be deduced merely from the fact that there are boundary conditions and would be the same whatever the form of those conditions. Next, with the special conditions of the electrical theory, we can find the amplitudes of the reflected and refracted waves. Taking the component in which the electric force is polarized perpendicular to the plane of incidence we find as amplitude of the reflected wave $\sin(\theta-\theta')/\sin(\theta+\theta')$, while the component polarized in the plane of incidence gives $\tan(\theta-\theta')/\tan(\theta+\theta')$. These are Fresnel's sine and tangent formulae; their squares give the intensities of reflection. The intensities of the refracted wave may also be given, but are not so important.

We may now consider how the reflection varies with the angle of incidence. Take the sine formula first. For perpendicular incidence the formula becomes ambiguous, but may be replaced by $(n'-n)/(n'+n)$. For water the refractive index is about $1\frac{1}{3}$, and so, when light falls perpendicularly on water the amplitude of the reflected wave is $\frac{1}{7}$ of that of the incident, and therefore the intensity is only about 2 per cent. With increasing angle of incidence, the reflection increases somewhat (for incidence on water at 45° it becomes about 5 per cent), and, as the incidence approaches grazing, it increases rapidly up to unity, which means perfect reflection. The phase of the reflected light is always the same as that of the incident. The tangent formula behaves quite differently. For perpendicular incidence it has the same value, but it starts diminishing, and finally vanishes at the polarizing angle, when $\tan\theta = n'/n$, at which angle the reflected and refracted waves are perpendicular to one another. For water the angle of incidence is about 54°. After this it increases again and reaches unity at grazing incidence. The phase is the same as that of the incident light up to the polarizing angle, and from there onwards differs from it by 180°.

These phenomena have been much studied experimentally. The behaviour of a transparent medium depends only on its refractive index, which is most accurately determined by the refractometer (essentially, a prism of the substance); so that experiments on reflection do not provide new information, but serve as a very valuable check on the theory. Suppose, for example, that we illuminate a glass surface obliquely with light polarized in some direction neither in nor perpendicular to the plane of incidence. To find the reflection this light must be resolved into two components, one of which obeys the sine and the other the tangent formula. They will be unequally reflected, but in neither case is the phase changed at the reflection (or only through 180°, which does not matter); and so the reflected light will again be plane polarized, but in a new direction. If the light is incident at the polarizing angle the reflected light will contain only the component polarized in the direction at right-angles to the plane of incidence. If ordinary light is incident the same is true, and this process is often used for obtaining polarized light. The most refined experiments have revealed the fact that the polarization is never perfect, but the unwanted component can usually be attributed to the presence of grease on the surface. If elaborate precautions are taken to remove this grease the effect becomes very small, but it never quite vanishes. This is probably to be attributed to the fact that the surface atoms are necessarily in a different state from those inside, so that it is not possible for a medium to remain truly homogeneous up to the boundary.

We have described what happens when the incident light is in the medium of lower refractive index. In the contrary case the intensity of reflection follows similar rules for the two components, but with one very important difference. In this case the angle of refraction is larger than the angle of incidence, and the reflection becomes complete for both polarized components when the refracted ray is at 90°, at which point the inclination of the incident ray is given by $\sin\theta = n'/n$. For greater angles of incidence the phenomenon of total internal reflection supervenes, and this we must now consider.

When $\sin\theta > n'/n$ there is no angle θ' for which the equation $n\sin\theta = n'\sin\theta'$ can be satisfied, and so there can be no progressive wave in the second medium. The appropriate solution involves instead a real exponential factor. If the boundary is the z plane, and if the incident wave is at angle θ, its phase will be given by $\cos\frac{2\pi}{\lambda}\left(\frac{ct}{n} - x\sin\theta - z\cos\theta\right)$, and the appropriate solution in the second medium is $e^{-(2\pi/\lambda)z\sqrt{(\sin^2\theta - n'^2/n^2)}}\cos\frac{2\pi}{\lambda}\left(\frac{c}{n}t - x\sin\theta - \epsilon\right)$, which evidently fits the boundary condition and may be verified to satisfy the wave equations. The real exponential implies that the disturbance only penetrates a very short distance into the second medium, roughly not much more than a wave-length. When the amplitudes are worked out, the reflected wave is found to have amplitude equal to the incident, but with a changed phase, and the change is unequal for the two polarizations. Thus, if incident plane polarized light is totally reflected, the emergent light is polarized elliptically. Working on this principle Fresnel devised an instrument which turns plane into circularly polarized light.

For water and air the angle of total reflection is about 49°. Thus, when the surface of a glass of water is viewed obliquely from below, it looks like mercury. Total reflection has a curious effect on the field of view of a fish, for however close it is to the surface, everything outside the water must be crowded into a cone of angle 49°, the edge of which will represent the horizon; while, on account of the total reflection, the fish will be able to see the bottom, except for parts nearly underneath, quite as well reflected in the surface as directly. Total internal reflection is much used in optical instruments, as it provides more perfect reflection than any silvering. In many types of binocular the rays are internally reflected no less than four times between the two lenses of each telescope (*see* BINOCULAR INSTRUMENT).

Refraction in Absorbing Media.—To discuss the passage of light through metals, we take both a dielectric constant and a conduction current and, by Ohm's law, the latter will be proportional to the electric force. The first electromagnetic equation is now

$$\frac{\epsilon}{c}\frac{\partial \mathbf{E}}{\partial t} + \frac{4\pi\sigma}{c}\mathbf{E} = \operatorname{curl}\mathbf{H},$$

while the remainder are unchanged. The presence of the conduction term has an effect something like what we found in total internal reflection, for it compels us to introduce a real exponential. For a wave of frequency ν going along z a solution can be found in which

$$E_x = e^{-2\pi\nu\kappa z/c}\cos 2\pi\nu(t - nz/c),$$

provided that n and κ satisfy the equations

$$n^2 - \kappa^2 = \epsilon, \quad n\kappa = \sigma/\nu;$$

n is the refractive index, and κ is called the absorption coefficient. Considered at a given instant of time, the wave is a damped sine-curve of wave-length $c/n\nu$ and the amplitude decreases to a fraction $e^{-\kappa/n}$ of itself for each successive crest. For actual metals κ/n is quite large, so that the light can only penetrate a very short distance. The value of n could be determined experimentally from the deflection of light by a prism, if one could be made so thin as to transmit light, and κ could be determined by finding how much the light is attenuated in passing through a plate; but in view of the extreme opacity of metals such methods are very troublesome, and it is more convenient to deduce n and κ from experiments on reflection.

The principle of reflection is just the same as for transparent media, but the details are very different on account of the real exponential in the internal wave. There is a change of phase in the reflected wave, and it is different for the two polarizations. Consequently, if plane polarized light is reflected, it becomes elliptic, and the study of this ellipticity is the most powerful method of evaluating n and κ. In the case of perpendicular incidence it can be shown that the intensity reflected is $(n^2+\kappa^2+1-2n)/(n^2+\kappa^2+1+2n)$. For all metals κ is considerably larger than n, and so the reflection is not far from complete. We see how it comes about that strong absorption, or large κ, means strong reflection. The refractive indices of metals vary over a much wider range than those of transparent substances. Thus, while the latter range roughly speaking between 1 and 2·4, silver has refractive index 0·18, associated with absorption coefficient 3·67. More remarkable still is sodium, which, if it can be used untarnished, is an even better reflector than silver. Here $n = 0{\cdot}005$ and $\kappa = 2{\cdot}61$, and 99·7 per cent of the light is reflected at perpendicular incidence. In so far as wave-velocity has a meaning in such a substance, the wave-velocity is two hundred times the velocity of light.

It is hardly too much to say that there is no theory of the optics of metals. There is a general resemblance between their optical and electrical qualities in that the best conductors are the best absorbers, and therefore the best reflectors. But in all cases κ is greater than n, and this implies that the dielectric constant ϵ is negative, which has no meaning in electrical theory.

Other substances are opaque besides metals, quite apart from the opacity due to the repeated scattering of light. Indeed ordinary transparent substances are always opaque for light of some part of the spectrum, and for such light they behave much like metals. In particular, light which is strongly absorbed will be strongly reflected. Rubens took advantage of this fact in his study of "rest-rays," which consist of light in the extreme infrared. For example rock-salt absorbs light of wave-lengths round 50 μ, and so reflects it strongly, although it is transparent to other wave-lengths. If then the light from a lamp emitting all wave-lengths is reflected to and fro several times by rock-salt mirrors, the other wave-lengths will be eliminated, and the reflected light will be nearly pure. After the last reflection its wave-length is determined by means of a grating. Unlike the case of metals, here the process of absorption has been fairly completely explained with important consequences for the theory of the solid state.

Double Refraction.—In crystals the atoms are packed together in a regular manner, and this packing implies that they will fall into rows in certain directions. Consequently the physical characters of the crystal will differ for different directions, and it is said to be anisotropic. The geometrical theory of crystallography only permits of certain definite types of packing, and these are classified according to the types of symmetry they possess. For purposes of electricity and optics we need to know the way in which the anisotropy will affect the relation between electric force and dielectric displacement. It can be shown that in general the displacement need not be in the same direction as the force, but that there must always be three mutually perpendicular directions in the crystal for which they are in the same direction. We take these directions for our axes, and have

$$D_x=\epsilon_1 E_x,\quad D_y=\epsilon_2 E_y,\quad D_z=\epsilon_3 E_z.$$

But the crystal symmetry may make a further restriction. Thus in the regular system of crystals, the three mutually perpendicular axes are equivalent to one another, so that all physical properties in these three directions must be the same and therefore ϵ_1, ϵ_2, ϵ_3 must be equal. For electrical and optical purposes therefore, though not for others, the regular system is isotropic. In the hexagonal, tetragonal and trigonal systems there is an axis of 6-, 4- or 3-fold symmetry, and, if this is taken as the z-axis, it follows that $\epsilon_1=\epsilon_2$, though they need not equal ϵ_3. Calcite and quartz both belong to this type. In all other crystal classes all three ϵ's may be different. We thus have three types of crystal, the regular, the uniaxial and the biaxial. The regular behaves for light as though it were isotropic and we shall deal with the uniaxial as a special case of the biaxial (*see* CRYSTALLOGRAPHY).

For a transparent crystal the electromagnetic equations assume the form

$$\frac{1}{c}\frac{\partial \mathbf{D}}{\partial t}=\operatorname{curl}\mathbf{H},\quad \operatorname{div}\mathbf{D}=0;$$

$$-\frac{1}{c}\frac{\partial \mathbf{H}}{\partial t}=\operatorname{curl}\mathbf{E},\quad \operatorname{div}\mathbf{H}=0;$$

together with $D_x=\epsilon_1 E_x$, $D_y=\epsilon_2 E_y$, $D_z=\epsilon_3 E_z$.
The whole question can be discussed with either E, H or D as the primitive quantity, and of course exactly the same results would emerge, but it is most convenient to take D. This is the light-vector used by Fresnel in his original theory, before it was given an electrical meaning. The process of solution consists first in eliminating E and H in terms of D, and then fitting a plane wave of arbitrary direction so as to satisfy the equations for D. If $l:m:n$ are the direction cosines of the wave front and $L:M:N$ those of the light-vector, and if the wave-velocity is V, the wave will be of the form

$$D_x=LS,\quad D_y=MS,\quad D_z=NS,$$

where $$S=A\cos\frac{2\pi}{\lambda}(Vt-lx-my-nz).$$

In giving the results of the substitution we shall write α^2, β^2, γ^2 for c^2/ϵ_1, c^2/ϵ_2, c^2/ϵ_3. Then it is found that the wave-velocity V must satisfy the equation

$$\frac{l^2}{V^2-\alpha^2}+\frac{m^2}{V^2-\beta^2}+\frac{n^2}{V^2-\gamma^2}=0.$$

This is a quadratic equation in V^2, and we conclude that for a given direction of the wave-front there are two wave-velocities. Associated with each of these values there are definite values of $L:M:N$, and these determine the polarizations of the two waves. They are at right-angles to one another and to the direction of the wave. A simple example is given by a wave going along the direction of z, where the two velocities are α and β and the directions of polarization x and y. Another example is given by a uniaxial crystal where $\alpha=\beta$. The wave-velocities are then given by

$$V=\alpha \text{ and } V^2=\alpha^2n^2+\gamma^2(l^2+m^2).$$

Thus one wave has velocity independent of the direction; this is the ordinary wave, and its light-vector lies in the plane perpendicular to the axis. The other, the extraordinary wave, is polarized in a direction contained by the axis and the wave direction, and its velocity depends on the wave direction and ranges between γ and α.

The values of the wave velocities for different directions can be best appreciated by constructing the *normal surface.* This is a two-sheeted surface constructed by laying off in every direction from an origin two radii proportional to the two wave velocities. Its general form can be seen from fig. 18 which shows a perspective drawing of a portion of it, which is repeated by reflection in the principal planes. The figure is drawn on the assumption that $\alpha>\beta>\gamma$, and it will be seen that the two sheets meet in four conical points one in each quadrant of the plane of xz, that is in the plane perpendicular to the intermediate axis. Waves going in the directions of these conical points will have the same velocity whatever their polarization, and so for these directions light will not be polarized. These are the two *optic axes* which give rise to the name biaxial. Uniaxial crystals may be regarded as a degenerate case in which the two optic axes have approached one another; the normal surface becomes a sphere and an oval surface, which touch along the direction of the axis. The normal surface does not show how the waves corresponding to the two sheets are polarized, and for this Fresnel gave a very convenient construction. The ovaloid is an oval surface obtained by laying off a radius in each direction $l:m:n$ according to the rule

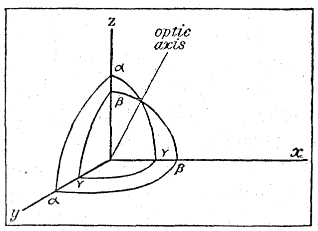


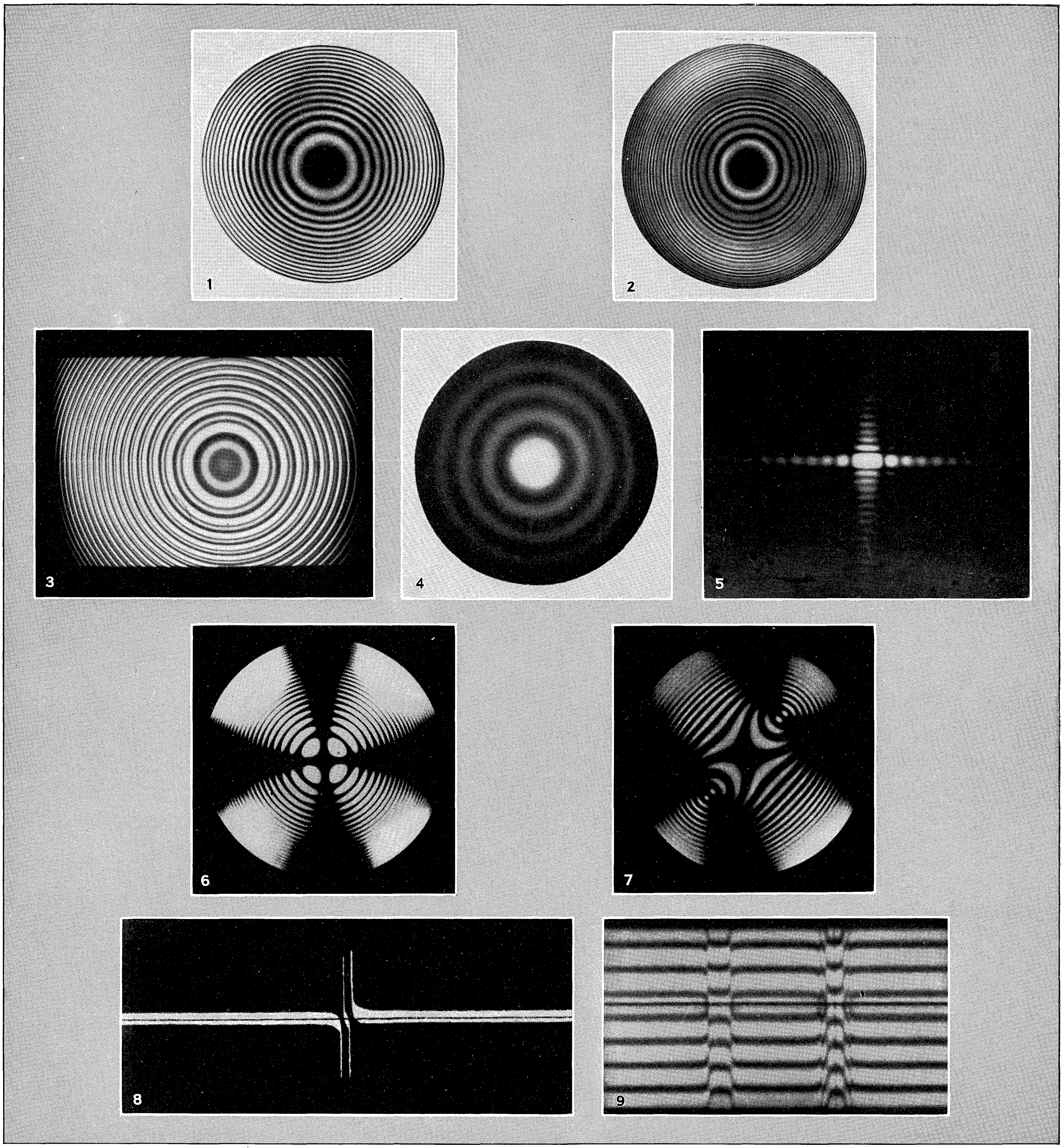
FIG. 18.—NORMAL SURFACE REPEATED BY REFLECTION IN THE OTHER QUADRANTS

$$r^2=\alpha^2l^2+\beta^2m^2+\lambda_2n^2.$$

When this surface is cut by a plane parallel to the wave front, the longest and shortest radii of the section give the two values of the wave-velocity, and their directions give the polarizations. This construction shows among other things that the wave-velocity is fixed when the polarization is given, without reference to the direction of the wave-front.

The phenomena we have so far described suffice to explain many of the features of crystal optics, in particular they are all that is required to understand the action of quarter-wave plates, nicols and other polarizing instruments, but they do not explain the fundamental fact that things seen through a crystal look double. To understand this we have to consider rays, not plane waves of indefinite breadth. In making Huygens' construction it would be wrong to draw the normal surface round each point and base the construction of fig. 3 on this, for the normal surface is only a diagram describing how plane waves can go, and does not represent the front of a wave emitted from a point. To find the form of this wave-front, we imagine that at every point of the normal surface a plane is drawn perpendicular to the radius-vector. All these planes will envelop a surface of two sheets, and this we call the ray surface. In general shape it resembles the normal surface, and has four conical points lying in the same plane, but now at different angles; these are called the ray axes. Huygens' construction is done with the ray surface, not the normal surface. For uniaxial crystals the ray surface degenerates to a sphere and a spheroid touching the sphere at the ends of the axis.

It will be readily believed that double refraction involves much complicated geometry, and the complete conquest of the subject by Fresnel is one of the greatest feats ever performed in physics. Effects can be obtained by illuminating crystals with suitably polarized light. Plate fig. 4 shows the effect obtained in the case of a uniaxial crystal, cut at right angles to the crystal axis; and fig. 5 that in the case of a biaxial crystal, cut at right angles to the bisector of the angle between the optic axes. We must omit their explanation, which requires a detailed discussion. We can only refer to the curious phenomenon of cônical refraction which was discovered theoretically by Hamilton and after-



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DISPERSION OF LIGHT

1. Newton's Rings in light of one colour
2. Newton's Rings in light of two colours. The two sets of rings fall together in some places and alternately in others
3. Fabry Perot Interferometer rings in green light of mercury. The two sets of rings show that there are two lines very close together in the spectrum
4. Diffraction pattern for circular aperture
5. Fraunhofer Diffraction pattern for rectangular hole. Inset is shape of hole. It is broad in the direction where the figure is narrow
6. Uniaxial crystal illuminated between crossed nicols
7. Biaxial crystal illuminated between crossed nicols
8. Anomalous dispersion of sodium vapour. The vapour is in the form of a prism. The two breaks in the horizontal line correspond to the two D-lines, where light is absorbed. For each the light on the red side (left) is strongly refracted downwards, and on the blue side upwards. At greater distance, refraction is too small to be perceptible
9. Magnetic gyration of sodium vapour. The line on the left has one pair of components, whereas that on the right has two pairs

wards verified. When a narrow beam is sent along the axis of a biaxial crystal, the direction for the ray becomes indeterminate so that it can be anywhere on a certain cone. On emergence at the other side this cone is made into a cylinder by the surface refraction, and if this falls on a screen we get a ring of light.

Double refraction is invariably present in crystals which are not of the regular system, but is often quite small. Even in a strongly doubly refracting crystal like calcite the two principal indices are 1·66 and 1·49 so that their difference is considerably less than the refractive effect of either (which may be represented by its difference from unity). In uniaxial crystals and in biaxial of the orthorhombic system the axes are fixed by the crystal symmetry, though the principal wave-velocities may vary with the colour. In biaxial crystals of the monoclinic and triclinic systems the principal axes may vary in position as well, and the most complicated colour patterns may be produced. Some crystals, such as tourmaline, show a selective absorption, so that one of the two polarized waves cannot penetrate far into the crystal, and the light emerges from the other side plane polarized.

Double refraction also occurs when an isotropic solid is in a state of strain, and indeed the chance strains in badly annealed glass are sometimes a cause of trouble in experiments with polarized light. On the other hand advantage has been taken of the effect, for by making a transparent model, say of a girder, it is possible to find the strains set up in it by the appropriate forces in cases where the shape is too complicated for direct calculation. Another occurrence of double refraction is the Kerr effect,—an ambiguous name, as there is a second effect of magnetic type, also named after this investigator. When light is sent through the glass of a charged electric condenser, double refraction occurs, so that the component polarized in the direction of the electric force has wave-velocity slightly different from that transversely polarized; the effect is proportional to the square of the electric force across the condenser. Yet another case, predicted and discovered by Voigt is a very small double refraction when light traverses matter placed in a strong magnetic field at right angles; this is associated with magnetic gyration which we shall discuss later.

Natural Optical Gyration.—Double refraction is not the only optical effect exerted by crystals. The symmetrical properties of a crystal are of two different kinds, corresponding to rotation and reflection respectively. Most crystals have some symmetry elements of both types, but there are some which only have rotations, so that the crystal is not identical with its mirror image. The simplest geometrical form possessing this peculiarity is the screw, which cannot be superposed on its mirror image, and we therefore liken this type of crystal to a screw. Quartz is such a substance, and there exist two types of quartz crystals, which we may call right- and left-handed. Now circularly polarized light has the same quality of a screw, and we should therefore expect that a right-handed quartz crystal would react differently to right- and left-handed circularly polarized light respectively. It is in fact found that the wave-velocities are different, and this is the basis of the theory of optical gyration.

Let us suppose that n_r and n_l are the refractive indices for the two types of circularly polarized light of frequency ν. Then the right-handed wave will be

$$E_x = A\cos 2\pi\nu(t - n_r z/c), \quad E_y = -A\sin 2\pi\nu(t - n_r z/c),$$

and the left-handed

$$E_x = A\cos 2\pi\nu(t - n_l z/c), \quad E_y = +A\sin 2\pi\nu(t - n_l z/c).$$

Suppose that at the plane $z=0$ we have light polarized along the direction x. This is given by simply adding these two solutions together, and then at any value of z we shall have

$$E_x = 2A\cos 2\pi\nu\left[t - \frac{n_r+n_l}{2}\frac{z}{c}\right]\cos\pi\nu(n_l - n_r)z/c,$$

$$E_y = 2A\cos 2\pi\nu\left[t - \frac{n_r+n_l}{2}\frac{z}{c}\right]\sin\pi\nu(n_l - n_r)z/c.$$

This means that at the point z we can regard the light as plane polarized in a direction inclined to x at angle $\pi\nu(n_l - n_r)z/c$. The phenomenon is actually observed by sending plane polarized light through the medium and seeing how an analyzing nicol must be placed in order to extinguish the light. The gyrational constant is the rotation produced by a thickness of 1 cm. of the substance.

In quartz the gyration is very strong, being 217° per cm. for yellow light, but is complicated by double refraction of the uniaxial type, and it is only for light going very nearly along the crystal axis that it can be observed. There are also crystals of the regular system which exhibit the effect, for example sodium chlorate, and here it is present for all directions. It is also shown by liquids when their molecules contain a chemically asymmetric atom; such a liquid is isotropic in that all directions are equivalent, but is not, molecularly speaking, identical with its mirror image, and so it can and does refract the two types of circularly polarized light differently. Since many sugars contain an asymmetric carbon atom, measurement of the gyration is a very convenient method of estimating the strength of a sugar solution, and great practical use is made of it.

THE ATOMIC THEORY OF REFRACTION

We have so far treated refraction as an effect of matter in bulk without enquiry as to how it comes about. The gross effect must be a superposition of the effects of the separate atoms and molecules, and we shall now consider how this superposition takes place. The light arising from an atom may have a great variety of characters, but whatever these are it must have one feature, that the wave is a spherical wave with the atom in its centre. We shall therefore first investigate what types of spherical wave are possible. In discussing diffraction we described a spherical wave emerging from a point source with amplitude inversely proportional to the distance. Though that sufficed to give the outline of the theory, it took no account of polarization, and it must be further refined for our present purpose. We naturally build the complete theory by considering what types of electromagnetic waves can emerge from a point.

Types of Spherical Waves.—The transverse nature of light makes it impossible to have a wave going out uniformly in all directions. We give the mathematical form of the simplest possible wave. Let

$$S = A\cos\frac{2\pi}{\lambda}(ct - r)/r, \text{ where } r = \sqrt{(x^2+y^2+z^2)}$$

and A is a constant. Then the electric and magnetic forces are given by

$$E_x = \left(\frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \frac{\partial^2}{\partial x^2}\right)S, \quad E_y = -\frac{\partial^2}{\partial x\partial y}S, \quad E_z = -\frac{\partial^2}{\partial x\partial z}S,$$

$$H_x = 0, \quad H_y = -\frac{1}{c}\frac{\partial^2}{\partial t\,\partial z}S, \quad H_z = \frac{1}{c}\frac{\partial^2}{\partial t\,\partial y}S.$$

If these are worked out they lead to expressions which are rather complicated in general, but simpler for points at a great distance from the source, and it will suffice to discuss the latter case. Consider a large globe, surrounding the source, marked with circles of latitude and longitude, the pole being the axis of x. The observer is on this sphere at angular distance θ from the pole. Then the wave that reaches him will have its electric force polarized so as to vibrate in the north and south direction, and the magnetic force will be east and west and equal in magnitude. The electric force is inversely proportional to the radius of the globe and to the square of the wave-length, but, most important of all, it varies as $\sin\theta$, vanishing at the pole and having its maximum at the equator. The actual value is

$$E = \left(\frac{2\pi}{\lambda}\right)^2 A\sin\theta\cos\frac{2\pi}{\lambda}(ct - r)/r.$$

In fig. 19 (a) the observer takes up various positions on the globe (marked by his co-latitude), and looks towards the centre; then the diagram shows the vibration of the electric force that will reach him.

In the classical electromagnetic theory this is the wave which would be emitted by an electron of charge e vibrating with frequency c/λ and small amplitude a along the x-axis at the origin, provided that $A=ea$. If the observer were to watch this motion, he would see it in perspective, and the electric force at the observer is proportional to and in the same direction as the apparent motion of the electron. It is very convenient to have a name for this type of wave, including the complete distribution in all directions round the source, and in view of the motion of the emitting electron we shall call it a *line-wave.*

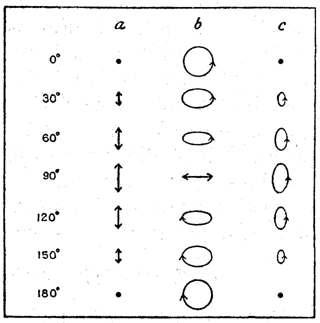

FIG. 19.—SPHERICAL WAVES
The observer, on a sphere in co-latitude on the left, looks toward the centre. The amplitude and polarization of light received are shown. (a) Line-wave, (b) circle-wave, (c) screw-wave

If the emitting electron describes a small circle instead of a line we have what we may call a *circle-wave.* This can be regarded as two superposed line-waves with their poles at right angles and phases differing by a quarter wave-length. The pole of the circle is perpendicular to the poles of both lines. Fig. 19 (b) shows the electric force as seen by the observer for various positions on the globe. Its form again resembles the perspective view he would have of the electron. At either of the poles he receives circularly polarized light, and it is important to notice that they will be of opposite types, one right-handed and the other left-handed. For other directions the light is elliptically polarized and becomes plane polarized at the equator. The intensity is twice as great at the poles as at the equator.

We must also consider a third type of wave which is not so simple. In the electromagnetic equations there is a mathematical symmetry between the electric and magnetic forces, so that we can obtain a solution by interchanging their roles. If we construct a wave by adding to the ordinary line-wave a small "magnetic" line-wave with the same pole and same frequency, we obtain a wave in which the light is everywhere of the same intensity as for a line-wave, but is elliptically polarized with axes in constant ratio and lying in the directions of the circles of latitude and longitude. Such a wave is illustrated in fig. 19 (c). It is important to notice that in this case, unlike the circle-wave, the light-vector turns in the same direction in both hemispheres. Thus the whole wave has the same screw character and we shall call it a *screw-wave.* The screw-wave cannot be emitted by any motion of an electron. It would be emitted if there were a single magnetic pole moving with the electron, but such a thing does not exist and in fact the wave can only arise from a system itself having the screw character, such as a molecule with a chemically asymmetric atom in it.

The Scattering of Light.—When light falls on an atom it sets the electrons in motion and they therefore re-emit light, and the character of this scattered light will depend on the nature of the atom as well as the incident light. But the effect of a single atom is too small to be observable, so that we always have to use a large number and the compounding of their effects produces complications. In fact the scattering of light by matter is a more primitive quality than is refraction, and it is therefore best to reduce everything into terms of scattering before we approach the theory of the behaviour of the single atom. There are several different ways in which an atom may emit light under the stimulus of light, but we can exclude some of them from consideration. Thus certain substances respond by *fluorescing,* that is to say emitting light of a different wave-length, and again there is the important phenomenon of *resonance radiation* (*q.v.*) where the wave-length of the light is unaltered, but where it appears that there is no phase relation between the incident and the scattered light. (*See* FLUORESCENCE AND PHOSPHORESCENCE.) Both these phenomena are extremely interesting, but from the present point of view they may be regarded as an absorption and simultaneous re-emission of the light, and so they belong to the theory of the emission of light and are outside our scope.

The most universal way in which atoms react to light is by the emission of waves of the same frequency and having a definite phase relation to the incident light, and this process, to which we shall limit the name of scattering, is responsible for refraction, both ordinary and double, and for gyration. In order that all these effects may be explained, we can see one property which the scattered waves must always have. The various refractive effects are all due to an interference between the original and the scattered waves, and, since the refraction is independent of the brightness of the light, it follows that the wave scattered by an atom, whatever its other characters, must be proportional in amplitude to the incident force. Another of its properties depends on the fact that for ordinary light the wave-length of the light is always far greater than the size of the atom; hence at any instant the atom is practically in a uniform field of force, and so the scattered wave will depend only on the polarization and frequency of the incident wave, but not at all on the direction of its wave-front. These conditions must hold for any atom, but apart from them there is great liberty of choice for the form of the scattered spherical wave. We shall see that for some purposes we have to assume circle-waves and screw-waves, but both ordinary and double refraction are fully accounted for by means of ordinary line-waves; moreover for transparent substances the line-wave is exactly in phase with the incident. All these results can be deduced by assuming completely general types of spherical waves and then seeing what limitations will give rise to the various refractive effects, but here we shall pursue the opposite course and shall assume the form of the scattered wave and show that our assumption is verified. For the most important case, that of the refraction of a transparent medium, we can summarize our assumptions in the form that under incident light of amplitude E_0 the wave scattered by an atom is a line-wave of the form we gave with ρE_0 written for A, and with pole along the direction of E_0. Then ρ, which depends only on the nature of the atom and on the frequency of the incident light, is the *scattering constant* of the atom.

The Light of the Sky.—The most primitive exhibition of scattering is not found in refraction, but in such phenomena as the light of the sky (*q.v.*), and it is therefore appropriate to discuss this first. Supposing that the observer looks at a point not very near the sun, the light that he sees will have been scattered through a broad angle, and the phase of the light-path, sun—atom—observer, will be different for each atom. Consequently the waves from the separate atoms do not reinforce one another. If the atoms were arranged with perfect regularity their waves would arrive at the eye with regular differences of phase and would destroy one another so that the sky would look black; however the uniform density of gases is not due to systematic regularity, but to the unsystematic regularity produced by the enormous number of atoms. The atoms of a gas have no ordered positions, as they have in a crystal, hence the brightness of sky light will depend on compounding a large number of similar waves of quite arbitrary phases and taking the average value of the result. Consider a set of n atoms each of which is giving a wave of the same magnitude, but with phases $\epsilon_1, \epsilon_2, \ldots \epsilon_n$. The resultant amplitude will be proportional to $\cos\epsilon_1+\cos\epsilon_2+\ldots+\cos\epsilon_n$, and the intensity is the square of this. Now the square will consist of terms like $\cos^2\epsilon_1$ and others like $2\cos\epsilon_1\cos\epsilon_2$. The latter of these are as likely to be negative as positive, so that they will average out, but the former has average value $\frac{1}{2}$ for each separate term. Thus the average intensity scattered by the n atoms is just n times that scattered by one. If then we want to know the brightness of the sky we only require to calculate the intensity scattered by a single atom and multiply by the number of atoms in the field of view.

We will suppose that N is the total number of atoms in a small solid angle, the illumination from which is to be found. Then, from the formula for line-waves, we shall have an intensity proportional to $NE_0^2\ \rho/\lambda^4$, and here E_0^2 is the intensity of the direct sunlight. Now in fact ρ, the scattering constant of the atom, does not depend very much on the wave-length, as long as we only consider visible light and we can therefore say that the light scattered is inversely proportional to the fourth power of the wave-length. This explains why the sky is blue even though sunlight is rather weaker in the blue part of the spectrum than the red, for the wave-length of red light is about 1·8 times that of blue, and so factor λ^{-4} is about 10 times as large for blue light as for red.

Another property of the sky-light is its polarization. Consider a point of the sky at right-angles to the sun. The unpolarized light from the sun may be broken into two polarized components, one of which has electric force pointing at the observer. The line-waves induced by this component will have the observer at their poles, and so will give no light towards him. He will therefore only receive the light of the other component, and this will be polarized in the direction perpendicular to the line joining the sun to the point observed. At other angles both polarized components are present, one in constant intensity and the other proportional to the squared cosine of the distance from the sun. If the sky is actually observed at right-angles to the sun with a nicol, it will be found that the polarization is not complete. This is partly to be attributed to rays that have been scattered several times on their way to the eye, and also to the fact that, though we have spoken only of atoms, the air is mostly composed of diatomic molecules, and for these the line-wave need not have its pole exactly coincident with the direction of the incident force. There is also usually a complication due to dust, which acts by direct reflection and makes the sky much brighter near the sun than at broad angles.

A most interesting application of the theory of sky-light was made by Lord Rayleigh (3rd baron). The barometer shows the mass of the atmosphere, and so, by a direct comparison between the brightness of the sky and that of the sun, it is possible to deduce how much light is scattered by one cubic centimetre of air at ground level. In fact, if N is the number of atoms in 1 cu.cm., we can evaluate $N\rho^2$. Now, as we shall see, we can also find $N\rho$ by a study of refraction, and hence we can estimate N. The process led to one of the earliest good determinations of the fundamental constant of Avogadro, the number of molecules in a gram molecule. Similar processes have since been applied in the laboratory, with the advantage that the incident light can be itself polarized, and similar results are obtained.

Scattering As the Cause of Refraction.—When we deduce refraction from scattering we are dealing with an incomparably greater effect than in sky-light, because here there will be phase relations between the original and the scattered waves, so that we compound the effects of the separate atoms by amplitudes instead of by intensities. We suppose that light-waves as they traverse matter have the same velocity as light in free space, but that they set up secondary waves from the atoms which, also proceeding with the velocity of light, interfere with one another and with the original wave. When the compound effect has been calculated, it is found that it can be expressed by altering the wave-velocity of the original wave and disregarding altogether the scattered waves, and in this way refraction is explained.

Take a thin sheet of atoms spread over a plane on which monochromatic light falls perpendicularly. The diagram of fig. 7 will describe the process, provided that we now regard the plane as composed of matter. Each atom will emit a line-wave, and the effect at P will consist of the superposition of these waves on the original beam, which is supposed to arrive at P undisturbed. The process is very like Fresnel's discussion of diffraction, though there we imagined that the original wave was suppressed at the plane AB. Suppose that there are N atoms per unit volume, in a thin sheet of thickness l spread over the z plane, and let the incident wave be

$$E_x = F\cos\frac{2\pi}{\lambda}(ct-z).$$

The effects that all the atoms produce at P can be summed just as in Fresnel's construction, and the result is an amplitude

$$-2\pi FNl\rho\frac{2\pi}{\lambda}\sin\frac{2\pi}{\lambda}(ct-z).$$

The important point to notice is that the phase differs by a quarter wave-length from that of the original wave; this is due to the fact that the scattered waves are in phase with the incident, and is in contrast with Fresnel's construction, in which, in order to get the right result, the phase had to be advanced by a quarter wave-length. We now add the two waves together, and, taking advantage of the smallness of the scattered wave, we find

$$F\cos\frac{2\pi}{\lambda}[ct-z+2\pi Nl\rho].$$

If we adopt the ordinary process of refraction and attribute the change of phase to the changed wave-velocity during the passage through the thickness l of the sheet of matter, we should say the emergent wave was

$$F\cos\frac{2\pi}{\lambda}[ct-z+(n-1)l],$$

and so we may identify $n-1$ with $2\pi N\rho$. This is the physical origin of refraction. We see also how the reflected wave arises, for the line-wave from each atom will be exactly the same at the point which is image of P in the plane AB as it is at P, and so the total amplitudes of the scattered waves will be the same at the two points; but for the reflected wave there is no interference with the incident light. It is easy to verify that the actual reflected intensity is that which should arise from a thin sheet of refractive index n and thickness l.

We have only treated of the small effect of a thin film, and this contains the essence of the process, but it is of course necessary to discuss matter in bulk. Here the scattered wave from every atom acts on every other atom and so complicates the wave scattered by it. Nevertheless the problem proves soluble and leads to a result not very different from the simpler case. The main difference is that we now have $\frac{n^2-1}{n^2+2}=\frac{4}{3}\pi N\rho$; in the special case when $N\rho$ is small, n is near unity, and this reduces to $n-1=2\pi N\rho$ as before. The general solution for oblique incidence verifies all the formulae that are given by the ordinary bulk theory, but the idea of scattering is helpful in seeing directly how reflection and refraction come about. When light falls on a thick slab, the atoms are set in motion and their scattered waves are all in definite phase relations to one another. If we consider a point outside the face of the slab, it will receive all these waves, but those from the interior will have phases spread uniformly round the 360° and so will cancel out. Thus the reflected wave will arise from the atoms in the face where this uniformity ceases to hold. The existence of the polarizing angle becomes immediately obvious, as it is nothing but the rule that in a line-wave there is no emission towards its pole, which is perpendicular to the direction of the refracted wave.

The formula $\frac{n^2-1}{n^2+2}=\frac{4}{3}\pi N\rho$ was discovered by Lorentz (by a rather different method) and becomes the foundation of the theory of dispersion. He deduced an important consequence from it. When a substance can exist in two states, ρ will be nearly the same for both and N will be proportional to the density, so that, if d is the density of either state, $\frac{n^2-1}{n^2+2}\frac{1}{d}$ should be the same for the two. This is verified by comparing the refractive index of a liquid and its vapour. Since their densities often differ by a factor of some hundreds, it is a very stringent test and is often fulfilled to within one or two per cent. We should hardly expect perfect agreement, because the liquid molecules are being perpetually disturbed by one another, so that there may be a small change in the value of ρ attached to each molecule.

The explanation of double refraction follows a very similar course. The sheet of matter must now be supposed to react differently under the stimulus of light according as it is polarized along x or along y. In each case there is a line wave emitted with pole along the direction of the incident force, but the amplitudes are different and so the phase changes in the two components of the transmitted wave will be different. The detailed consideration of the effect for matter in bulk is of course more complicated, but leads to Fresnel's normal surface and all its consequences. This part of the theory is complete, but there are difficulties in giving an atomic meaning to ρ, because the adjacent atoms in a crystal are not arranged isotropically and will perturb one another in a complicated manner. As a consequence, the expression $(n^2-1)/(n^2+2)$ ceases to apply; but the full discussion can only be made by a detailed study of the theory of the solid state. With the help of this theory and a knowledge of the arrangement of the atoms in calcite it has been found possible to explain its high double refraction with fair numerical accuracy.

The Scattering from Absorbing Substances.—A similar process of scattering can be used to explain the action of absorbing substances, but here it is necessary to take the scattered wave in a different phase from the incident. Supposing this phase change to be η, the scattered wave from the thin sheet of atoms will now be

$$-2\pi FNl\rho\sin\frac{2\pi}{\lambda}(ct-z-\eta).$$

If this is added on to the original wave we get

$$F(1-2\pi Nl\rho\sin\eta)\cos\frac{2\pi}{\lambda}(ct-z+2\pi Nl\rho\cos\eta).$$

The first factor means a reduction in amplitude, *i.e.*, absorption, and there is also refraction just as before. Thus by a suitable choice of ρ and η we can describe the observed behaviour of any absorbing substance. The full theory is best expressed in terms of complex quantities and leads to the equation

$$\frac{(n-i\kappa)^2-1}{(n-i\kappa)^2+2}=\frac{4\pi}{3}N\rho e^{-i\eta},\ (\text{ where } i=\sqrt{-1}),$$

so that we can deduce ρ and η from a knowledge of n and κ.

It has been mentioned that transparent substances are usually opaque for light in some parts of the spectrum, and the theory of this is fairly well understood. In these regions the phase η can take any value between 0° and 180°. This theory however does not apply to metals, and it is a very interesting fact that, if we use the observed values of n and κ to calculate ρ and η for metals, the phase change η is in all cases quite small. For the very highly reflecting sodium it is only 7′, and for silver little more than 1°, while, even for such a poor reflector as steel (58% at perpendicular incidence), the phase change is not 10°. These facts are quite unexplained; they suggest however that the phase change is not the typical characteristic of metals, but that their high reflection is rather to be attributed to a large scattering power; for, if we consider a transparent substance in which $\frac{4\pi}{3}N\rho$ is greater than unity, we find that n^2 must be negative and therefore n is imaginary, and this means that the waves in the medium are strongly damped. From this point of view metallic reflection is more like total internal reflection than like the reflection from an absorbing substance.

Natural Gyration.—We have seen how gyration arises from the difference between the wave-velocities of right- and left-handed circularly polarized light. It is a screw property and can only be exhibited by molecules containing a chemically asymmetric atom. The condition is exactly that which permits of the emission of what we have called a screw-wave, and to explain gyration it is only necessary to suppose that, under the influence of plane polarized incident light, the molecule scatters a screw-wave. We take as before a thin sheet in the xy plane illuminated by plane polarized light,

$$E_x=F\cos\frac{2\pi}{\lambda}(ct-z).$$

Each molecule emits a screw-wave which has axis along x. In any direction a screw-wave can be resolved into a main component which is like that of a line-wave and a weaker component at right-angles and a quarter period behind. Take ρ for the scattering constant of the line-wave and σ for the other component. Then, when we sum all the waves scattered by the molecules, the line-waves will compound as before into

$$-2\pi FNl\rho\frac{2\pi}{\lambda}\sin\frac{2\pi}{\lambda}(ct-z)$$

along x, but there will now be a component along y of magnitude

$$-2\pi FNl\sigma\frac{2\pi}{\lambda}\cos\frac{2\pi}{\lambda}(ct-z).$$

If we add these small quantities on to the original wave we find approximately

$$E_x=F\cos\frac{2\pi}{\lambda}(ct-z+2\pi N\rho l),$$

$$E_y=-2\pi N\sigma l\cdot\frac{2\pi}{\lambda}\cdot F\cos\frac{2\pi}{\lambda}(ct-z+2\pi N\rho l);$$

and this means that the light is now plane polarized at angle $-2\pi N\sigma l\cdot 2\pi/\lambda$ to the x direction. The rotation is proportional to l, the thickness of the sheet, and the other factors express the gyrational constant. The theory for matter in bulk gives a similar result, but presents it by showing that there are different refractive indices for right- and left-handed circularly polarized light.

Magnetic Gyration.—In our discussion of the refraction of isotropic bodies, we saw that plane polarized light might be supposed to stimulate the emission by the atom of a line-wave. Now circularly polarized light can be constructed out of two plane polarized components at right angles and differing by a quarter wave-length in phase, and what we have called a circle-wave can be constructed out of two line-waves with perpendicular poles and phases differing by a quarter period. Consequently we could have worked out the theory of refraction just as well using circularly polarized light and circle-waves, and in discussing magnetic gyration it makes a convenient starting point to do so. When an atom is in the presence of a magnetic field it behaves in a sense as though it were in rotation, about an axis along the field's direction, with velocity proportional to the field strength. We shall see how this comes about when we discuss dispersion, but can explain the gyration without reference to the detailed theory. If then the atom is illuminated by circularly polarized light, it will react differently according as its magnetic rotation is with or against the rotation of the light-vector. We may describe what happens by saying that the atom's scattering constant will no longer be ρ, but $\rho+\tau$ and $\rho-\tau$ for the two types of circularly polarized light. Here τ will be proportional to the strength of the field, and it is usually to be regarded as much smaller than ρ.

Suppose that the incident light is

$$E_x=F\cos\frac{2\pi}{\lambda}(ct-z),\quad E_y=F\sin\frac{2\pi}{\lambda}(ct-z).$$

When the scattered wave from a thin sheet is superposed on this, we have, by the same construction as before,

$$E_x=F\cos\frac{2\pi}{\lambda}[ct-z+2\pi N(\rho+\tau)l],$$

$$E_y=F\sin\frac{2\pi}{\lambda}[ct-z+2\pi N(\rho+\tau)l].$$

But if the incident light is of the opposite type it will be

$$E_x=F\cos\frac{2\pi}{\lambda}(ct-z),\quad E_y=-F\sin\frac{2\pi}{\lambda}(ct-z);$$

and the resultant wave will be

$$E_x=F\cos\frac{2\pi}{\lambda}[ct-z+2\pi N(\rho-\tau)l],$$

$$E_y=-F\sin\frac{2\pi}{\lambda}[ct-z+2\pi N(\rho-\tau)l].$$

If we add these two solutions together the incident light is

$$E_x=2F\cos\frac{2\pi}{\lambda}(ct-z),\quad E_y=0,$$

and the transmitted light is

$$E_x = 2F\cos\frac{2\pi}{\lambda}(ct-z+2\pi N\rho l)\cos\frac{2\pi}{\lambda}(2\pi N\tau l),$$

$$E_y = 2F\cos\frac{2\pi}{\lambda}(ct-z+2\pi N\rho l)\sin\frac{2\pi}{\lambda}(2\pi N\tau l);$$

so that the plane of polarization has turned through an angle $\frac{2\pi}{\lambda}(2\pi N\tau l)$. This is proportional to the thickness of the sheet and, through τ, to the strength of the magnetic field. The remaining factors are individual to the substance of which the sheet is made. The constant is often called the Verdet constant after one of the earlier investigators who measured it for a number of substances.

The magnetic gyration is usually very small for practicable magnetic fields. It occurs in all transparent isotropic substances and for light going along the axis of uniaxial doubly refracting crystals; for other directions it is masked by the double refraction. There is a very remarkable similar effect, when polarized light is reflected from the polished pole of a magnet. For perpendicular incidence the plane of polarization rotates, and for other directions there are similar more complicated changes in the rule of reflection. The Kerr effect, as it is called from its discoverer, is evidently like the magnetic gyration in transparent substances, but its theory is very incomplete.

The two types of gyration, natural and magnetic, are radically different in character, as is shown by the fact that one depends on a screw-wave, the other on a circle-wave. The consequence is that in natural gyration, if the light is reflected back so as to traverse the sheet again, its direction of polarization turns in each passage like a screw of the same type and so it comes back to its original polarization. On the other hand magnetic gyration is due to a rotation, not a screw, so that if the light is reflected back again it rotates in the same direction as before and the angle of turning is doubled.

DISPERSION

We have traced the optical effects of matter in bulk to their source in the atoms, and in doing so have only found it necessary to use the ordinary conceptions of the classical theory of dynamics, but as soon as we begin to consider the atoms themselves we get into difficulties, because in fact the atom obeys quite different dynamical rules. These rules, which are the principal subject of the quantum theory (*q.v.*), are fairly well understood, but since our whole practical experience is based on classical dynamics, they are very hard to apprehend in anything but mathematical form; regarded physically they appear to contain an unsatisfying element of irrationality, which is really to be attributed to limitations in our habits of thought. For the purposes of the present subject it is fortunately possible to some extent to avoid these difficulties. The quantum theory gives certain rules, very unlike those of ordinary dynamics, for the intensities and frequencies of the spectral lines emitted by an atom or molecule, and it also predicts how such an atom will behave under the influence of light. Though both these aspects of the theory are quite different from ordinary dynamics, they have this in common with the classical theory, that if we make up a purely classical model to imitate the emission (though in many other properties it will be quite wrong), it will react correctly for the scattering of light. For convenience of calculation we thus imagine that associated with each atom is a phantom *virtual atom,* which will suffice to work out the optical effects. An actual atom contains only a few electrons, but the virtual atom contains a *virtual electron* for each line of its spectrum, and the charges on the virtual electrons are usually much smaller than the known charge of an electron. Since the spectrum is composed of nearly monochromatic lines, we suppose that each virtual electron is free to execute approximately harmonic vibrations. The relation between the emission and the scattering of light by the atom is then akin to the relation of free to forced vibrations in a harmonic vibrator.

Free Vibrations of the Atom.—Let us suppose that we have a virtual electron of mass m vibrating along the axis of x, under a force Kx towards the origin. It will obey the equation

$$m\frac{d^2x}{dt^2}+Kx=0, \text{ or } \frac{d^2x}{dt^2}+(2\pi\nu_1)^2x=0 \text{ if } K=m(2\pi\nu_1)^2.$$

If left entirely to itself such an electron would vibrate with constant amplitude and frequency ν_1 for ever; but it cannot be regarded as left alone, because the moving electricity will be perpetually changing the electric forces everywhere in the manner that we have described as a line-wave. This wave will carry away energy, which is supplied at the expense of the electron, so that its amplitude must decrease. The electron is always linked with the aether, and it may be shown that the reaction of the aether on it can be represented by introducing a damping term so that the vibration is expressed by

$$m\frac{d^2x}{dt^2}+m(2\pi\nu_1)^2x=\frac{2}{3}\frac{e^2}{c^3}\frac{d^3x}{dt^3},$$

where e is the charge and c as usual the velocity of light. The new term is very small (except for penetrating X-ray frequencies), and the equation may be solved by approximation, and gives

$$x=Ae^{-\frac{1}{3}(e^2/mc^3)(2\pi\nu)^2t}\cos 2\pi\nu t.$$

This represents a vibration which decreases during each vibration by a fraction $\frac{1}{3}\frac{e^2}{mc^3}4\pi^2\nu$, or l/λ where l is $\frac{4\pi^2}{3}\frac{e^2}{mc^2}$; for an ordinary electron it is $3{\cdot}7\times10^{-12}$cm., and, as the charge of a virtual electron is usually smaller, the approximation is evidently justifiable for ordinary light of wave-lengths about 10^{-5} cm. The line-wave emitted by this electron will also be damped with the consequence that, in Michelson's interferometer, when the two light-paths differ by a considerable amount the interference will become imperfect. This is in fact observed, but usually for path differences somewhat shorter than might be expected. If we imagine the light to be passed through a grating we observe the same phenomenon in a slightly different way; the damping factor gives the line a finite breadth, and in fact spectral lines are nearly always somewhat broader than is indicated by the theory of pure electromagnetic damping. A variety of causes contribute to this broadening; such as the frequent collisions between the radiating atoms and air molecules, for these collisions will change the phases of the emitted waves, and the Doppler effect of the motion of the atoms, which slightly alters the frequency. These effects can both be observed directly by alterations of pressure and temperature, but it is uncertain whether they are sufficient causes of the broadening. The whole question is getting very near to the point where the classical conception of a virtual atom fails, and also to the limits of experimental technique, and all that can be said is that under the most favourable conditions it seems that the damping is not far from the value predicted by electromagnetic theory. We can avoid raising the question by introducing a fictitious damping factor which replaces the electromagnetic and may write as our equation:—

$$\frac{d^2x}{dt^2}+\sigma\frac{dx}{dt}+(2\pi\nu_1)^2x=0,$$

so that the electron's motion is resisted by a small force $m\sigma\frac{dx}{dt}$, and as long as σ is small we do not need to enquire into its origin.

It is necessary next to suppose that the atom contains a number of virtual electrons with different frequencies, and so to adjust their properties that the spectrum lines will occur in the correct relative strengths. Suppose that the first electron, with charge e_1, frequency ν_1, etc., is vibrating with amplitude a_1. Then it emits a line-wave, and, at distance r in the equator, we have seen that the intensity will be proportional to $\nu_1^4e_1^2a_1^2/r^2$. In order to compare this intensity with that given by the second electron e_2 we have to consider what their respective amplitudes will be. This requires an assumption, and the appropriate assumption to make (subject to some conditions which we shall not discuss) is the equiparation of energy, that on the average each virtual electron has the same energy. Now the energy of the first electron is $\frac{1}{2}m_1\left(\frac{dx_1}{dt}\right)^2+\frac{1}{2}m_1(2\pi\nu_1)^2x_1^2$, and this is proportional to $m_1a_1^2\nu_1^2$. We therefore conclude that the intensity of the first line will depend on $e_1^2\nu_1^2/m_1$. It happens that the quantity which is most important in spectrum theory is not the intensity itself, but the intensity divided by the fourth power of the frequency. This quantity has no name, but is always referred to as "Einstein's B" by which letter we shall therefore denote it. Then, for the line of frequency ν_s, we so choose e_s and m_s that $e_s^2/m_s\nu_s^2$ is proportional to B_s, and the intensity is proportional to $B_s\nu_s^4$.

Forced Vibrations of the Atom.—When the virtual atom is exposed to light there will be an additional force acting on it. The equation of motion of the first electron will now be

$$m_1\frac{d^2x_1}{dt^2}+m_1\sigma_1\frac{dx_1}{dt}+m_1(2\pi\nu_1)^2x_1=e_1F\cos 2\pi\nu t,$$

where F is the amplitude of the incident electric force E and ν is its frequency; the direction of the wave-front does not matter. This is the equation which gives the ordinary phenomenon of resonance, and we must consider the form that its solution takes for different frequencies of the incident light. In the first place, σ plays practically no part in the solution when it is small, unless ν is very near ν_1. Excluding that case we have

$$x_1=\frac{e_1}{m_1}\frac{F}{4\pi^2(\nu_1^2-\nu^2)}\cos 2\pi\nu t.$$

If $\nu<\nu_1$, x_1 is in phase with the electric force E and its amplitude increases strongly as ν approaches ν_1. If $\nu>\nu_1$ the phases are opposite; the amplitude is small for large values of ν, but as ν_1 is approached from above it becomes large (*see* fig. 20). There is thus a transitional stage when ν passes through ν_1, and in this stage the amplitude of x_1 has to pass from a large positive to a large negative value. In order to see how it does so we must include the damping term in our equation. There is now a phase difference between x_1 and E, and the solution is

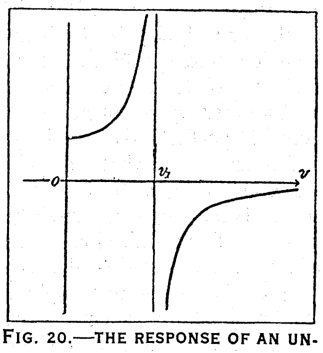

FIG. 20.—THE RESPONSE OF AN UNDAMPED RESONATOR
A periodic force throws a resonator into vibration, and for any frequency of the force the ordinate shows the amplitude of the resonator

$$x_1=\frac{e_1}{m_1}\frac{F}{2\pi\sqrt{\{4\pi^2(\nu_1^2-\nu^2)^2+\sigma^2\nu^2\}}}\cos(2\pi\nu t-\gamma),$$

where $\tan\gamma=\frac{\sigma\nu}{2\pi(\nu_1^2-\nu^2)}$. If ν is much less than ν_1 the phase angle γ is practically zero, and continues so up to values differing from ν_1 by a not very large multiple of σ. From this point on the phase grows rapidly and becomes 90° at $\nu=\nu_1$ and then increases further, so that, at an equal distance on the other side of ν_1 it is practically 180°. The amplitude follows the course of fig. 20 nearly up to ν_1, but instead of becoming infinite it attains a very large maximum at $\nu=\nu_1$ of amount $\frac{e_1}{m_1}\frac{F}{2\pi\sigma\nu}$, and then decreases. When well beyond ν_1 it has the same course as in fig. 20, but with changed sign now because the negative value is allowed for by the phase. Fig. 21 shows the general features, but it has been necessary to take a comparatively large value of σ in order to show the form clearly. In the figure σ is $2\pi\nu_1/5$, whereas for actual spectra it is of the order of $V_1\times10^{-7}$, so that in any diagram which showed the maximum the rest of the figure would be quite invisible. It thus appears that, except for frequencies very near ν_1, the damping can be disregarded, and we shall for the most part take advantage of this simplification and so make use of the curve of fig. 20 instead of fig. 21.

The Dispersion Formula.—The motion of the electron, forced in this way, will cause a line-wave to be emitted of which the magnitude is given by multiplying the amplitude of the electron's motion by its charge. Omitting the damping factor, we thus say that the electron has a scattering constant

$$e_1\cdot\frac{e_1}{m_1}\frac{1}{4\pi^2(\nu_1^2-\nu^2)}$$

which is proportional to $B_1\nu_1^2/(\nu_1^2-\nu^2)$. The other virtual electrons will give similar effects and they are all to be superposed. Thus the virtual atom will have *scattering constant* proportional to

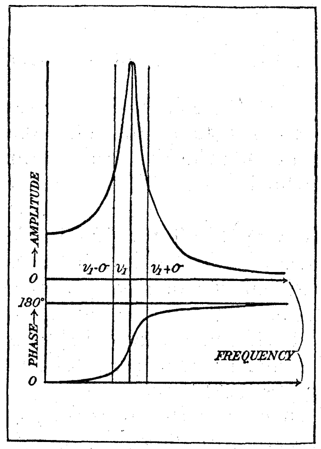

FIG. 21.—THE RESPONSE OF A DAMPED RESONATOR, THE ORDINATE OF THE UPPER CURVE SHOWING THE AMPLITUDE, THE LOWER, THE PHASE, OF THE RESONATOR

$$\rho=\frac{B_1\nu_1^2}{\nu_1^2-\nu^2}+\frac{B_2\nu_2^2}{\nu_2^2-\nu_2^2}+\cdots.$$

This is the best form for theoretical purposes, but experimental work more frequently makes use of wave-lengths. Re-writing the equation we have

$$\rho=\frac{B_1\lambda^2}{\lambda^2-\lambda_1^2}+\frac{B_2\lambda^2}{\lambda^2-\lambda_2^2}+\cdots$$

as the dispersion formula, which should apply for any wave-length not too close to λ_1, λ_2, etc. The relative magnitudes of the terms are derivable from the intensities of the associated lines in emission spectra. Their absolute values can also be given by carrying the theory somewhat deeper, and we shall touch on this below.

We may now consider the march of events when a substance is illuminated by light of increasingly shorter wave-length. We will suppose $\lambda_1>\lambda_2>\lambda_3\cdots$. We saw that the refractive index depends on the product of ρ and the number of atoms in a cubic centimetre, but, as we have omitted a factor of proportionality already, we may also omit the factor for the number of atoms, and may equate ρ above to $(n^2-1)/(n^2+2)$. For very long waves we shall have practically $(n^2-1)/(n^2+2)=B_1+B_2+\cdots$. If n^2 is deduced from this it should agree with the dielectric constant determined by purely electrical means. Though there is little doubt that this would be verified, optical observations are usually lacking for sufficiently long waves. As λ decreases the first term grows in comparison to the others, because $\lambda^2-\lambda_1^2$ gets more rapidly smaller, and just before λ_1 this term entirely dominates the refraction. At λ_1 there will be a region of absorption and on the other side the first term will be negative, the rest still positive. As λ decreases further the first term, still negative, shrinks in importance and the second grows until near λ_2 when it becomes dominant. Passing beyond λ_2 it changes sign and later shrinks in importance, its place being taken by λ_3 and so on. Finally when all the lines have been passed, $(n^2-1)/(n^2+2)$ will be negative and proportional to the square of the wave-length. For a strict test of the theoretical dispersion against experiment, we should have to work out the value of n from that of $(n^2-1)/(n^2-2)$; but for a rough comparison this is not necessary. Where $(n^2-1)/(n^2+2)$ is large so is n, when the former is negative n is less than unity, and, if n is plotted against frequency, the curve will have the same general characteristics as has $(n^2-1)/(n^2+2)$. An example of the general course of the dependence of n on frequency is given without any numerical accuracy in fig. 22. There are supposed to be three lines of which the middle one is the strongest. In the neighbourhood of each line the refraction cannot be observed on account of absorption. As each line is passed there is a strong decrease in the refractive

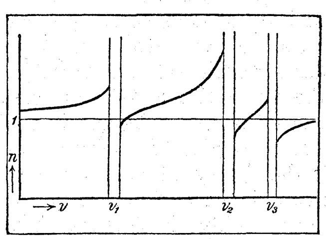

FIG. 22.—A DISPERSION CURVE SHOWING THE WAY REFRACTIVE INDEX DEPENDS ON LIGHT FREQUENCY
At ν_1, ν_2, ν_3 there will be absorption

index, associated with the change of phase of the corresponding virtual electron by 180°. Whether the refractive index actually becomes less than unity will depend on the breadth of the unobservable region and on the strength of this line compared to the others. At frequencies higher than the highest frequency of the atom the refractive index will always be less than unity, and such values have been found for X-rays, though, strictly speaking, even here the atom has higher frequencies still.

Much the most striking example of dispersion is the phenomenon called anomalous dispersion, though in fact it is not at all anomalous. There are dyes which strongly absorb certain colours in the spectrum while being transparent to the others; thus if the green is absorbed, the dye will look purple by transmitted light. In consequence of the very strong green absorption there is a reversal in the usual order of refraction. The blue light, which lies on the short wave-length side of the green, is much less refracted than the yellow which lies on the side of long wave-lengths. Fig. 23 shows with some exaggeration the way in which a prism made of such a colour would fold the spectrum back on itself. A similar effect is shown in Plate, fig. 8 for sodium vapour. Sodium has two very strong lines close together in the yellow, and both of them show anomalous dispersion. A flame containing the vapour is given the form of a prism, and white light is sent through it. This light is then sent through a spectroscope so as to spread out the colours in a direction at right angles to the dispersion of the prism. The colours on opposite sides of either of the sodium lines will be deflected in opposite directions by the prism, so that their images on the photographic plate are shifted up and down in Plate, fig. 8. The form of the dispersion curve is thus made directly evident.

On account of the brilliance and fineness of the sodium lines, sodium vapour has been used with more success than any other medium in the study of dispersion, and several important results have emerged. It has been found possible to make direct measures of the absorption of light in the immediate neighbourhood of the two lines and so to evaluate the damping factor σ; this was found to be in quite good agreement with the electromagnetic damping factor. Another important experiment consists in finding the absolute value of the scattering constants for these two lines of the sodium atom. The theory of this depends on quantum principles, and cannot be given in detail; but, loosely speaking, the two virtual electrons together correspond to a single actual electron, so that, if we can make experiments in which the two lines are indistinguishable, the scattering constant should be given by the use of the ordinary values of e and m. The straightforward way of doing this would be to observe the refraction with light of a very different colour, because then the difference between the influences of two such close lines would be insensible, but this is useless because the refraction itself becomes too small. Indirect means depending on magnetic gyration have been used, and have entirely supported the theoretical prediction that both lines are due to a single electron.

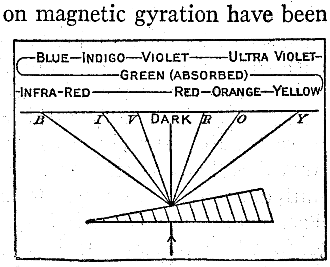

FIG. 23.—ANOMALOUS DISPERSION
The absorption in the green makes the yellow more refracted than the blue

The most accurate measures of refractive index have been made with transparent substances, substances in which the absorption only occurs far in the infra-red or ultra-violet. To analyze the dispersion the usual procedure is based on the fact that for the infra-red terms, $\lambda^2/(\lambda^2-\lambda_1^2)$, can be expanded in powers of λ^2, while for the ultra-violet terms it can be expanded in inverse powers of λ^2. A formula is therefore constructed of the type $A+C\lambda^2+\cdots+E\lambda^{-2}+F\lambda^{-4}+\cdots$, and A, C, $E\cdots$ are fitted to the observed values of $(n^2-1)/(n^2+2)$. The term in C corresponds to the infra-red lines, and A, E, F to the ultra-violet. The actual positions of the lines are then found by trial. The infra-red lines, or, more usually, bands, can often be fixed with fair accuracy, both by experiments with rest-rays and by observing the refraction near them; but the ultra-violet are more troublesome, because it is often not possible to get observations very close to the lines. Indeed it is usually found that wave-lengths and B's can be chosen with considerable latitude, and can yet give all the observed results with a high degree of accuracy. The whole process is very laborious and has only been carried out for a few substances, such as rock-salt and potassium chloride. It is found possible to represent the refraction by one term for the infra-red and perhaps two in the ultra-violet, together with a third constant term which must correspond to wave-lengths so short that $B_s\lambda^2/(\lambda^2-\lambda_s^2)$ does not change perceptibly in value in the whole region accessible to observation. The ultra-violet lines are attributed to electron vibrations of some kind, but those in the infra-red arise through the motions of whole atoms, and have been fitted satisfactorily into the general dynamical theory of the crystalline state.

The theory of the refractive indices of gases is distinctly more advanced, because their emission spectra can be studied without the radical change of state that would be necessary for solids. In the case of metallic vapours, such as sodium, the theory may be considered complete, though its practical verification is somewhat difficult. The spectrum of helium is known, and the measurement of its refraction has led to an interesting result. The lines of all atomic spectra fall into series which converge towards a finite limit λ_h, but beyond this limit there is a region in which there is emission over a continuous range of wave-lengths. Corresponding to this it is found that the refraction of helium requires an expression

$$\frac{n^2-1}{n^2+2}=\frac{B_1\lambda^2}{\lambda^2-\lambda_1^2}+\cdots+\int_0^{\lambda_h}\frac{B_x\lambda^2}{\lambda^2-x^2}\,dx.$$

In the case of the ordinary permanent diatomic gases the spectrum is not so well-known, for an electric discharge is required in order that the gas should be luminous, and this breaks the molecules into atoms. Even without this knowledge, however, one feature can be predicted for a molecule composed of two identical atoms; the atomic vibrations which are of infra-red frequency will have no optical effects at all. This is confirmed by the dispersion formulae which for the permanent gases have only ultra-violet terms.

The Dispersion of Magnetic Gyration.—The dispersion of doubly refracting and naturally gyrating substances has been studied, and fits into the same general type of formula, but the theory is very complicated. On the other hand magnetic gyration is fairly completely understood, and, as it has thrown much light on the behaviour of atoms, we may consider it in more detail. We first take the simplest case, which is not in fact exhibited by many types of atom. In a magnetic field an electron experiences a force proportional to the field and to its own velocity, in a direction perpendicular to both, and we cannot therefore now limit the electron's motion to a single line. Taking the field along z (and omitting the damping factor by the exclusion of cases where it would be important), the motion will be

$$m_1\frac{d^2x}{dt^2}+m_1(2\pi\nu_1)^2x-\frac{e_1}{c}H\frac{dx}{dt}=e_1E_x,$$

$$m_1\frac{d^2y}{dt^2}+m_1(2\pi\nu_1)^2y+\frac{e_1}{c}H\frac{dx}{dt}=e_1E_y.$$

Take the incident light to be circularly polarized, so that

$$E_x=F\cos 2\pi\nu t,\quad E_y=F\sin 2\pi\nu t.$$

Then the solution is

$$x=\frac{e_1}{m_1}\;\frac{F\cos 2\pi\nu t}{4\pi^2(\nu_1^2-\nu^2)-\dfrac{e_1H}{m_1c}\,2\pi\nu},$$

$$y=\frac{e_1}{m_1}\;\frac{F\sin 2\pi\nu t}{4\pi^2(\nu_1^2-\nu^2)-\dfrac{e_1H}{m_1c}\,2\pi\nu}.$$

But if the incident light is polarized the other way, so that

$$E_x = F\cos 2\pi\nu t,\quad E_y = -F\sin 2\pi\nu t,$$

we have

$$x = \frac{e_1}{m_1}\,\frac{F\cos 2\pi\nu t}{4\pi^2(\nu_1^2-\nu^2)+\dfrac{e_1 H}{m_1 c}2\pi\nu},$$

$$y = -\frac{e_1}{m_1}\,\frac{F\sin 2\pi\nu t}{4\pi^2(\nu_1^2-\nu^2)+\dfrac{e_1 H}{m_1 c}2\pi\nu}.$$

The change in the denominators of these shows that there is a different magnitude of response to the two types of circular polarization, and this we saw would explain the gyration.

It is of some interest to see how the gyration behaves in the immediate neighbourhood of ν_1. To simplify we will write $e_1H/4\pi m_1 c=\omega$, and it will be justifiable to write the denominator of the first solution as $4\pi^2[\nu_1^2-(\nu+\omega)^2]$, since for practicable fields ω^2 is always negligible. In the second type of motion the denominator will be $4\pi^2[\nu_1^2-(\nu-\omega)^2]$. Considering the first solution we see that for values of ν on opposite sides of $\nu_1-\omega$ there will be a phase difference of 180°. On the other hand the second solution will not show this change at the same point, but at $\nu_1+\omega$ instead. This suffices to outline the behaviour of the gyration (*see* fig. 24). As ν increases towards the value $\nu_1-\omega$ the gyration rapidly increases. At $\nu_1-\omega$ the light is absorbed, but on the other side, where it is again observable, it gyrates strongly the opposite way. As ν increases farther the gyration becomes less, though always negative, and then again increases as ν approaches $\nu_1+\omega$. After passing this it is positive and large, and rapidly decreases as ν recedes from $\nu_1+\omega$. By seeing which way the plane of polarization rotates, it is possible to find the sign of the electric charge e; this is negative as is that of the actual electron. It will be seen that our calculation indicates the presence of two regions of absorption, which implies that the original line ν_1 has been split into two by the magnetic field. The phenomenon can also be observed in emission, and is then called the Zeeman effect (*q.v.*). This effect is much more complicated than our explanation would suggest, but, with the help of the quantum theory, it has been more or less completely elucidated. Most spectral lines do not split into only two members, but into a pattern composed partly of line-waves and partly of circle-waves, and the circle-waves control the gyration. In the case of the two sodium lines, there are two pairs for one and one pair for the second.

The theory of the gyration of solids and liquids is less complete than that of metallic vapours, in just the same way as is that of refraction; but it is known to bear a very similar relationship. We can imagine that each virtual electron has an appropriate eH/mc which determines its response to the two types of circularly polarized light. If the incident light has frequency far from any of the natural frequencies of the substance, it is found that the gyration depends on terms of the form $\nu^2/(\nu_1^2-\nu^2)^2$; this means that for ordinary substances it increases much more rapidly than does the refractive index, as the colour changes from red to blue. By a comparison of the gyration of any substance with its refraction, the values of e/m for its virtual electrons can be estimated, and they are usually a fraction (mostly between ½ and 1) of the accepted value for an actual electron. The discrepancy has not been explained, but it is to be attributed to a complication rather like that of the Zeeman effect which occurs in vapours.

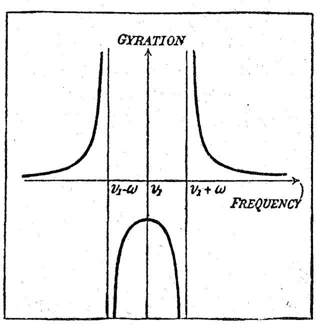

FIG. 24.—THE DISPERSION OF MAGNETIC GYRATION

ν_1 is the spectral line of frequency split by the magnetic field into $\nu_1-\omega$

In this account the principles of optics have been presented as a completed body of knowledge. Only where we leave the consideration of matter in bulk and come to atoms do we encounter more dubious questions. Since the beginning of the 20th century atomic theories have been in a state of flux, and it is necessary that we should radically revise our conception of particles, and probably of time and space as well; but, however great the changes, and however new the language, we may be sure that the older work will stand, and that the new theory will accommodate within itself the wave-theory of light.

BIBLIOGRAPHY.—There are several excellent books on the theory of light, for example: *The Theory of Optics* by P. Drude, or *The Theory of Optics* by A. Schuster (the last edition by Schuster and Nicholson includes an account of modern spectrum theory). *Physical Optics* by R. W. Wood covers the same ground from a rather more experimental point of view. An admirable account of the history of the subject is given in *History of the Theories of Aether and Electricity* by E. T. Whittaker. *The Theory of Electrons* by H. A. Lorentz is concerned especially with refraction, including the refraction of moving media. *See* also Rayleigh's *Collected Works*. (C. G. D.)

LIGHT AND RADIATION IN RELATION TO HEALTH. The phenomena of life result from the reactions of living substance to radiant energy, and depend primarily on the sun. The application of this principle in the treatment of disease by exposing the body to light is known as actinotherapy.

All radiations are conceived of as electro-magnetic waves conducted in a hypothetical medium, aether, and travelling with the velocity of light, 186,000m. a second. According to theory each of the atoms (*see* ATOM) of which a chemical element is composed consists of a central nucleus positively charged (protons and electrons densely packed, and electrons negatively charged, revolving round the nucleus in a variety of orbits with enormous speed, comparable to the planets revolving round the sun). The more complex the atom the greater the number of its electrons. When an electron is displaced from an outer to an inner orbit, radiant energy is given off. When an electron jumps from an inner to an outer orbit, energy is absorbed. Only a certain variety of orbits are possible for an electron to revolve in; a certain quantum of energy is required to effect each jump.

To have any effect on matter radiant energy must be absorbed. There then takes place a change of energy, *e.g.*, into electrical effect, heat, fluorescence, chemical action. All radiations when absorbed by a perfect black body are transformed into heat. A thermopile coated with lamp black is used for measuring in calories per sq.cm. per second, or in ergs per sq.cm. per second, intensity of radiant energy emitted by a source or received by a surface. This is the final standard of measurement. The body is composed of an infinite number of living cells. The living cell is the seat of an infinitely intricate play of energy, containing millions upon millions of molecules. We have to conceive of electrons being displaced by radiations in the atoms of these molecules, of molecular change enhanced thereby, provoking reactions which manifest themselves as signs of life, of the spirit of man evolving out of such transformations of energy.

Radiations are classified by frequency of vibration, and by wave length; they include first, the Hertzian waves used in radio with wave lengths extending to a thousand metres or more; to these waves the body is transparent; to be heard, they must be transmitted, received and transformed by suitable electrical apparatus. Then come the infra-red rays with wave lengths from 600,000 to 7,000 A.U. (Angstrom Unit = one ten-millionth of a millimetre). Absorbed largely by water and converted into heat, these rays are caught as they pass to, or come off, the earth, by the vapour-charged atmosphere. Thus is the earth kept warm to a temperate degree and life made possible. (*See* RADIATION, RAYS.)

Absorbed by the wet substance of the skin, these rays heat particularly the outer layers, whence heat is conducted to deeper parts and distributed by the blood circulating through the skin. Acting on the cool dry skin, these rays when intense provoke a dry prickling and not very agreeable sensation of heat. Next to the infra-red come the visible rays, a very narrow part of the vast radiation spectrum, with wave lengths from 8,000 to 4,000 A.U. The media of the eyes have been evolved transparent to these rays. The skin is much less transparent; while a part is reflected, a part of these rays penetrates to the cutaneous blood vessels, and absorbed therein, is changed into heat; in a cool dry skin these rays provoke transudation of water, and give thus a more agreeable sensation of heat.

The transformation of energy of visible rays taking place in the blood may have important effects as yet unknown. It is in this respect that sources of visible radiation have a superiority over infra-red rays as means of providing artificial heat; infra-red rays from hot water pipes heat rather the surface of the skin, while visible rays from sun, fire or lamp penetrate and heat the blood and tissues below the surface. Red rays are not wholly absorbed by the blood in the skin and so penetrate deeper still. By means of powerful incandescent lamps and red glass screens an agreeable and easily controlled method of applying heat to the body and provoking hyperaemia is obtained.

In the case of the eye, the parts of the visible spectrum evoke different sensations of colour, viz., red, orange, yellow, blue, violet, as the wave lengths shorten from 8,000 to 4,000 A.U. The living substance of the retina has evolved so as to react differently to the different groups of wave lengths. The living cells of the skin and the blood in the skin also react differently to infra-red, visible and ultra-violet rays, but little is yet known about this subject.

The U.V. rays are shorter than violet ones, and they, therefore, lie beyond the violet of the spectrum and are invisible, but may be made visible by fluorescent screens.

The horny layer of the skin fluoresces faintly; it can be made to fluoresce strongly by a coat of vaseline or solution of quinine. Fluorescence is produced by electrons displaced from atoms by the rays jumping back into inner orbits. A part of the energy of the rays is thus spent; fluorescence of the surface of the skin is then a means of protection against U.V. rays.

For study of the U.V. rays a quartz spectroscope is required, as glass absorbs most of these rays. They are classified by wave length as "near," 4,000 to 3,000 A.U., and "far," 3,000–2,000 A.U. The region about 3,100–2,900 A.U. is sometimes called the middle U.V., or "Dorno region," and has the most powerful sunburn action on the skin. These middle U.V. rays are so completely absorbed by living substance that they have very little power of penetration; thus, only some $\frac{1}{100}$ of rays, about 3,000 A.U., penetrates as far as the capillaries beneath the epidermis.

The main action of these rays is then, on the living cells of the epidermis. The U.V. rays shorter than 2,500 A.U. are so completely absorbed by the outer horny layer of the epidermis that they have very little action on the living cells beneath; the very far U.V. rays less than 1,800 A.U. do not penetrate air. A powerful source of U.V. has a bluish white light, and produces a pricking sensation in the conjunctiva of the eyes. To prevent conjunctivitis the eyes must be protected by glasses from such sources.

The skin is insensitive to these rays on exposure, but after sufficient exposure and a latent period of a few hours, there follow inflammatory reactions of the skin; these are pricking, flushing and slight swelling, followed later by peeling and browning. The reaction is caused primarily by the rays displacing electrons in the atoms of certain substances in the living cells, and so inducing molecular changes which after a latent period result in coagulation and death of the living substance. The dead cells desquamate and are replaced by new ones. Products of the damaged cells, by exciting the nerve endings in the epidermis, cause flushing of the blood vessels of the skin, and transudation of lymph and leucocytes. These local reactions in the irradiated skin provoke secondary reactions in the blood and body generally.

The effect of U.V. rays on living cells can be studied under the microscope, *e.g.*, on infusoria enclosed in a suitable quartz chamber. With the help of a quartz microscope and photography the effect of U.V. rays on microbes has been studied. Such a method shows up structures in living micro-organisms previously unknown. The remarkable discovery has been made that a substance, ergosterol, which is present in foods and in the skin, is activated by middle U.V. rays and becomes vitamin D required for bone formation. The want of this vitamin causes rickets and softening of the bones. Rickets can be prevented by adequate exposure of the skin to the U.V. rays of the sun or arc lamps, or by taking enough vitamin D in the food.

This one fact by itself shows the immense importance of getting rid of smoke pollution of the air, and having sun baths. Walls, glass, smoke, fogs and clothes cut off people from these beneficent rays. Irradiation of rickety children with U.V. rays increases the percentage of inorganic phosphorus and calcium in the blood, which is in them abnormally low. While provoking the formation of the brown pigment (melanin) in the skin, the U.V. rays lessen at the same time the percentage of the amino-acid tyrosin in the blood, the probable precursor of melanin. The inflammatory reaction set up by the U.V. rays provokes an increase of the power of the blood to destroy microbes as tested *in vitro,* a sign that these rays may possibly increase resistance to infection. It must be borne in mind that an over-dose has the opposite effect.

Right dosage with U.V. rays increases the sense of well-being and alertness of mind, and acts as a tonic in the winter months. Much of the stimulating effect of a visit to the Alps can be imitated by arc-light baths, combined with car rides and exercise in the open air. The fact must not be lost sight of that exposure to cool open air is as important as exposure to light. Such exposure stimulates the heat production of the body and appetite and tones up the muscles; breathing cool open air provokes blood flow through, and secretion from, the respiratory membranes; these are excellent effects. Open air is clean compared with house air which is contaminated with dust, mould and microbes.

Protection of the skin from U.V. rays is brought about mainly by swelling and thickening of the horny layer of the epidermis. The pigment which results from sunburn chiefly protects the blood from over-heating by visible rays. By absorbing of visible rays, nerve endings in the epidermis are excited, and this provokes sweating which cools the skin by evaporation. The naked pigmented races have a thin skin, and, sweating readily in the sun, lose heat easily in the shade. The pigmented skin of such races can be inflamed by U.V. rays. So long as the skin is kept cool by a flow of water, visible rays, even when concentrated by a lens (burning glass), have no sunburn effect on the skin.

The U.V. rays, on the other hand, sunburn the cold skin. Glacial burns are often very severe. It is possible to sensitize the skin to visible rays by injection of various dyes, eosin, erythrosin, and by a derivative of haemoglobin, viz., haematoporphyrin. The white skin thus sensitized, reacts to visible rays as it does to U.V. rays. Black skins are immune. Certain foods may have this sensitizing effect. Thus, only black pigs can be kept in tropical America, where the red mangold grows. There are rare cases of unfortunate people sensitive to visible rays. Exposed to light, their skin becomes inflamed and necrosed. They have to live like night animals. In some of these, haematoporphyrin is found in the urine.

Ultra-violet rays have great power to kill microbes, but as their penetrating power is very small, they only sterilize surfaces. In a skin disease such as lupus, these rays effect cure, not by directly killing the infecting tubercle bacilli, but by provoking an inflammatory reaction of the tissues which results in killing of the microbes and repair of the damage. Ultra-violet rays benefit the health of chicks and provoke egg-laying and fertility of fowls kept indoors under glass. They also, in suitable dosage, benefit growth of vegetables and fruits under ordinary glass. A particular kind of glass, called vitaglass, is transparent to the U.V. rays of the sun, and this is used for skylights with advantage. At the new monkey house at the London Zoo, the animals are given warm shelves, incandescent lamps, vitaglass skylights, louvres always open in the roof, and free access to open air playgrounds through openings closed by hinged flaps. Bathing pools are set in the playgrounds. Food rich in vitamins, with plenty of fruit and raw vegetable, is provided. These are conditions which, if provided in crêches in cities, would raise an A1 population.

Light-baths are very useful for treatment of rickets and tuberculosis, particularly tuberculosis of the skin (lupus), glands and joints; also many skin and eye diseases, and some forms of baldness. They may benefit chronic infections, *e.g.,* chronic bronchitis and asthma. Combined with visible and infra-red rays, or red rays, they may benefit forms of chronic rheumatism. Used in winter months, light-baths act as a tonic, and prevent rickets and debility of children.

The sources of U.V. rays are the sun and arc lamps. The U.V. of the sun is limited to rays longer than about 300 $\mu\mu$ owing to absorption of shorter rays by a layer of ozone placed miles high in the sky.

The artificial sources of U.V. rays are:—(1) The mercury vapour lamp; (2) the short flame arc; (3) the long flame arc. The last two may have plain carbon, or metal-cored carbon poles. Metal poles, such as tungsten or iron may be used with a short flame arc. The mercury vapour lamp is a powerful but relatively cold source of U.V. rays. A ring of incandescent lamps added to this source affords visible and infra-red rays for heating. The short flame arc, with plain carbon poles, gives much visible and infra-red and some U.V. rays as the sun does. The long flame arc, with metal-cored carbon poles gives plenty of visible and infra-red, and is at the same time a powerful source of U.V. rays. Given equal energy, the U.V. from the long flame arc may at right angles to the flame be 14 times that of the short flame arc. Much of the U.V. rays come from the flame, and to effect the best output, the positive pole must be placed below and be metal-cored (iron). The negative pole, placed above, can be plain carbon.

Half a dozen people can sit round a long flame arc, taking 2,500 Watts; at two feet distance, a dose of five minutes suffices. One half of the body can be bathed at a time, and two baths a week given. For intense local treatment, *e.g.,* required for lupus, the Kromayer, or water-cooled mercury vapour-lamp is most valuable, the dose given being five minutes, with the quartz glass of the lamp pressed on the skin—a dose sufficient to produce strong reaction and desquamation. The dose is repeated when the desquamation has passed away and the skin is again susceptible. The mercury vapour lamp or the short flamed arc with metal poles can be run off the ordinary house circuit and afford efficient sources. By means of a frosted Vitreosil screen the powerful mercury vapour lamp can be reduced to an intensity safe for domestic use.

With a screen of Chance's dark glass which transmits almost only long U.V. rays the fluorescence of substances can be studied in a dark room. This is a most useful method of identification. Thus, hair affected with ring-worm can be identified.

The far U.V. rays merge into the soft X-rays. The penetration of the skin increases again with the shortening of wave length. The X-rays produce inflammatory reaction after a long latent period, *e.g.,* two to three weeks. They are used to check the growth of cancer cells and to produce sterility. Acting on embryoes, deformities in growth and monsters may be produced by their means. Owing to the great penetration of the soft tissues by X-rays in comparison with bones, photographs of fractures and disease of bones can be obtained. The shorter the X-ray the greater is the penetration. General mild doses of X-rays have been used in treatment of asthma, and to prevent recurrence of cancer after removal of the primary growth.

X-rays are used for cure of skin diseases such as ring-worm. Great care must be used, for X-ray burns have a tendency to turn into cancer. The gamma rays of radium resemble very short ("hard") X-rays, and have the same effect as these. Tubes containing radium emanation are buried in cancers which cannot be removed with the knife, with the view of stopping growth. In certain accessible sites this treatment may be successful.

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(L. E. H.)

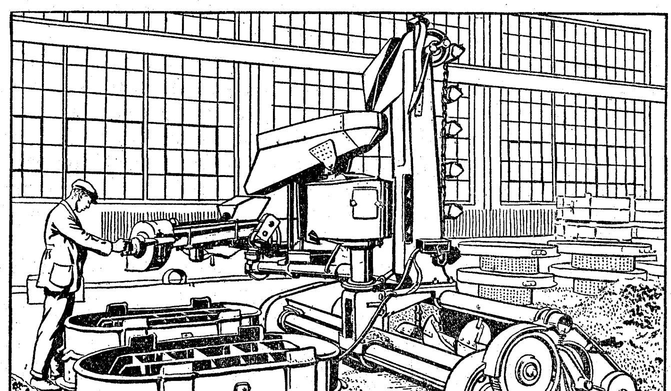
LIGHT BRIGADE. The brigade of light cavalry under the command of Lord Cardigan which carried out the famous charge at Balaklava on October 25, 1854, during the Crimean War. The charge has been immortalized by Tennyson in his poem "The Charge of the Light Brigade." The titles of the regiments which comprised the light brigade are 4th, 8th, 11th and 13th Hussars and 17th Lancers.

LIGHT (THIN) CASTINGS INDUSTRY. A highly specialized development of the ironfounding industry. Its products are designed almost exclusively for use in connection with the building trades, domestic purposes, and municipal and architectural requirements. Its development has depended on, and kept pace with, development in municipal enterprise and a rising standard in both public and private hygienic habits. Its product is cast in thin section and to this end requires an iron of high phosphorus content, giving the necessary fluidity. The actual process is quite similar in principle to that applied to any other branch of founding, but it has become so highly specialized a trade that the average ironfounder not so specializing cannot produce castings of such fine section or finish.

Classification.—For purposes of the trade light castings are classified under the following main heads:—

1. *Unfitted Goods,* including such articles as rain water and soil pipes, hot water pipes, gutters or rhones, drain pipes, gas and water pipes and the various connecting pieces required therewith, electric and gas pillars, roof lights, school desk and stable fittings, manhole covers and frames, etc.
2. *Fitted Goods,* including such articles as coal, gas, electric, and steam cooking ranges, grates, stoves, boilers, etc.
3. *Baths and Sanitary Ware,* including cisterns, sinks, etc.
4. *Hollow-ware,* including kettles, pots, pans, coppers or furnace pans, etc.
5. *Light Structural and Ornamental Castings,* including spiral stairs, fire escape stairs, verandahs, railings, gates, bandstands, shop fronts, etc.

The development of the industry as a distinct and separate branch of ironfounding may be said to date from the beginning of the 19th century, and it was with the setting up of the Board



BY COURTESY OF FOUNDRY PLANT AND MACHINERY, LTD.

TRACTOR SAND SLINGER MACHINE RAMMING MOULDS FOR LIGHT CASTINGS

This machine rams any size of box, at speeds varying from five to ten cubic feet per minute. Other models can be used in a stationary position by bolting to the floor of the moulding shop

of Health under the Act of 1848 and the powers conferred and duties devolved on local authorities thereunder that the demand for light casting sanitary products became really substantial. With the awakening of public interest in sanitation as a preventive measure against disease, individual requirements in the way of hygienic appliances also grew, and the tendency has since been for what were first deemed luxuries in the way of sanitary equipment to become necessities, with an ever advancing standard. The light castings industry set itself to cope with these demands and a real appreciation of what it has done and is doing in that direction can best be gained from a consideration of what light castings articles are included in the structure of a modern dwelling house, and of the various functions which they perform.

Gutters, etc.—The outside requirements are gutters or rhones, rain water pipes and soil pipes cast in 6ft. lengths and varying from $1\frac{1}{2}$ to 6in. diameter. The gutters, which are made to many patterns, intercept rain water from the roof and conduct it to an outlet hole to which is attached the rain water pipe which leads the water down the outside of the house to an earth drain at the foot and thence to the public sewage system. The ordinary rain water pipe and gutter are round and half round respectively, but for buildings more pretentious in design, rectangular rain water pipes and ornamental gutters are frequently required and supplied. All waste matter from the house is taken away by an outside pipe of heavier make than the rain water pipe, known as a soil pipe, which connects the lavatory, bath, and sinks with the earth drain and main sewer. It projects up to the roof of the house, the upper part acting as a ventilating pipe.

As regards the inside structure of the house, light castings requirements comprise the bath, range, interior grates for living rooms, mantel registers for bedrooms, lavatory cistern, and portable wash boiler.

Baths.—At first baths were merely painted inside. Demand for higher quality and better finish led to the introduction of what is known as the metallic enamelled bath, which was grained on the inside to give a marble effect; but this type has been almost entirely superseded by what is known as the porcelain enamelled bath, which may be either in green or white. Baths are made either parallel or taper, generally with a square end and a scoop end, although in some patterns both ends are square. The popular sizes are 5 and $5\frac{1}{2}$ft. long, of varying widths and depths. Better quality baths are made with wide rolls or rims and in some cases are cast or fitted with outside panels reaching to the floor. The normal bath type, however, stands on feet which are cast separately and bolted to snugs on the bath casting. A modern development to suit the small modern house where bathroom space is limited is the combined bath and basin, the basin being either cast in one piece with the bath or cast separately and fitted on at the square end. The whole is fitted with swivel taps for hot and cold water serving bath and basin. Better class baths are also, if required, fitted with canopies for douches, sprays, etc. These canopies are generally of plate glass.

Ranges.—Ranges are made in various types and fitted with one or more ovens which may be placed level with or to one side above the fireplace. As a general rule ranges are fitted with a hot water boiler at the back of the fire. This boiler is supplied from the cold water cistern and feeds an intermediate tank which is connected directly to the bath, basin, and sink taps. A modern labour-saving device is to substitute for the range a combination article consisting of an ordinary sitting-room fireplace with an oven attached. The oven may be either at the side or on top, and in such cases the hot water boiler is placed at the back of and heated from the interior.

Interior Grates and Mantel Registers.—An interior grate is simply a framework with a bottom grate fitted into tiles which are cemented to bricks built in between the fireplace and the wall of the house. It may be entirely open or fitted with a fixed or movable canopy of plain or ornamental design. The cheaper types are finished in ordinary black, but interior grates are supplied in oxidized copper or silver, in armour bright which gives the interior a steel appearance, and in steel itself.

The mantel register is a combined casting designed to supply both fireplace and mantelpiece. This may be supplied plain or with ornamental tiles set into the sides.

In addition to the foregoing, which may be classified as structural requirements, light castings foundries produce what may be termed furnishings in the shape of kerbs or fenders for fireplaces, kettles, pots and pans for cooking purposes, and smoothing or sad irons (ordinary, gas, and electric). The kerbs or fenders may, as in other cases, be finished in plain black or in some better quality finish.

There is also that branch of the industry which supplies the service requirements of municipalities and local authorities in connection with their gas, water, and sewage systems. The requirements in such cases are pipes which are made in 6 and 9ft. lengths, with bores of varying diameters. In the trade the water pipe is known as the underground pipe. The drain pipe is of high inside finish and tested under high pressure. Hot water pipes, which are usually made in 9ft. lengths and varying diameters, are mainly used for the heating of greenhouses, outbuildings, and public buildings such as churches, halls, etc.

Making the Patterns.—The first step in the process, which is common to all classes of castings, takes place in the drawing office where a drawing of the pattern is made. This is passed to the pattern shop where the pattern is made in wood, stucco, or an amalgam of tin and lead. It is then passed to the moulding shop, where an iron or aluminium working pattern is cast.

Unfitted Goods.—This category consists mainly of pipes and gutters and their connections. They are made in boxes of two parts, top and bottom, or in trade language, top part or "cope" and drag. The pattern is placed on a board on the floor and the bottom or drag part of the box is placed over it. The drag is rammed with damp sand, technically called "greensand," until it is absolutely firm. It is then turned over and the top part of the box is placed on it. The top part is rammed firm, and holes or gates leading down to the pattern are made in the sand. These holes or gates are for the running of the molten metal. The top part is then lifted off, the pattern drawn out, and the mould dusted and sleeked to make it absolutely smooth. A core which consists of a cylinder of the requisite length of hard sand made in a core box round a metal bar which projects at both ends is inserted in the hollow left by the pattern. The ends of the core when in place rest on two prints or bearings in the mould left by the pattern. The top part is put on and the box closed by hooking the two parts together. The mould is then ready to receive the metal. In the case of the lighter pipes, *e.g.*, rain water and soil, the gates are made on the top and the casting is run horizontally, while in the case of the heavier pipes, *e.g.*, drain and underground, the pipes are made and cast on a slope technically known as "the bank." The gates are placed at the top end of the mould and the casting is run on the slant. Still larger and heavier pipes are cast in a vertical position.

The metal is brought from the cupola in large bogies and is poured into the mould by means of hand ladles through the gates. Before the box is opened, and before even the metal has cooled, the gates are knocked off. When the iron has cooled the top part is lifted off and the pipe lifted out. The pipes are then collected and taken to the dressing shop, where any fins or raw edges are taken off them and they are brushed with steel brushes. All pipes then go before a man known as the passer for acceptance or rejection, and, if passed, are taken to be painted or coated with a tar preparation before despatch.

Fitted Goods.—The moulding process for fitted goods is in principle exactly similar to that for unfitted goods except that in the case of a perfectly flat casting a core is not required.

From the moulding shop these castings are sent, like the others, to the dressing shop, where the rough edges are taken off. Thence after inspection they pass to the grinding mill, where they are ground and buffed to give the necessary polished surfaces. They are then taken first to the fitting shop, where they are given a preliminary fitting and slight inequalities are remedied, and secondly to the finishing shop, where the individual parts are blacked, oxidized, or nickel plated, according to requirements. Thereafter they are returned to the fitting shop for final assembly. The article is then ready for the showroom or for despatch.

Baths and Sanitary Ware.—After a moulding process similar to that previously described, the bath is annealed or burned, *i.e.*, heated in a furnace known as a muffle. The purpose of annealing is to soften the metal and in particular to remove or drive out all of the various gases which may remain imprisoned in it. The bath is then dressed, sand blasted, and coated, to give a suitable ground to which the enamel can adhere. It next passes to the enamelling shop, where it is again put into the muffle and kept there until it is at the requisite heat. It is then taken out and the enamel, which is in powder form, is dusted on by means of automatic dusters or fine mesh sieves. Generally each bath receives two coats of enamel, each coat being preceded by the heating process. The bath is then laid aside for the enamel to harden, and thereafter the feet are bolted on and the outside painted. The bath is then ready for the warehouse or for despatch.

Cisterns are simply moulded, dressed, fitted, and painted, while sinks are enamelled by a process similar to that followed in the case of baths. The cast-iron porcelain enamelled sink has, however, been largely superseded by the earthenware sink.

With regard to hollow-ware and structural and ornamental castings, the process, apart from moulding, follows the lines described on p. 85, namely, dressing, tinning or enamelling, in the case of pots and pans, and in the case of spiral stairs, verandahs, shop fronts, etc., dressing and fitting.

Plate Moulding.—A development in the moulding process is the use of plate patterns. Instead of working with a loose pattern, one, two, or more articles, where the size and nature of the casting lend themselves to it, are put on what is known as a plate. At first these plates were made of cast-iron, but they have since been made, where possible, of aluminium, so as to lighten the handling of the job. There is, however, no difference in the actual moulding process, and successive processes follow, as before described, according to the nature of the article.

Machine Moulding.—For a considerable time machines have been employed to assist in the ramming of the moulds, but formerly these were chiefly used for smaller classes of work, *e.g.,* connections and certain types of flat castings. They are variously operated—by electricity, by compressed air, by hydraulic power, or by hand. In all cases the moulding box has to be filled by hand, the machine doing only the ramming. Since the World War, however, there has been put on the market a machine called the Sand Slinger which is being operated in foundries throughout the world. This machine not only fills the boxes with sand but, in the act of doing so, rams it hard. It is made to different designs for different purposes and can ram practically any size of box at speeds varying from five to ten cubic feet of sand per minute. The type most commonly in use in light castings shops is known as the Tractor machine. This takes the sand from the floor, riddles it and passes it on by means of a moving belt to the ramming head, whence it is discharged into the moulding box. The ramming head is attached to the end of a swivelling arm which has a radius of from 9 to 11ft. on either side of the machine. The machine is also made to work in a stationary position, in which case it is bolted to the floor of the moulding shop. It is also supplied in portable form so that it can be moved to any job in any part of the moulding shop. In the case of the stationary and portable types the sand has to be fed to the machine. Another type is the Motive type to which is attached a large tank with a sand carrying capacity of from eight to ten tons. This can conveniently be filled by means of an overhead conveyor.

As the ramming of the boxes in the moulding shop is one of the heaviest and most tiring jobs in the foundry, it would appear to be only a question of time before practically all classes of work are automatically rammed by the Sand Slinger or some similar type of machine. (J. K.)

LIGHTER, a barge employed in ports in loading or unloading the cargoes of ships, the name being derived from the verb "to light"; *i.e.,* to relieve of a burden. The men employed on them are termed lightermen. (*See* BARGES AND CANAL CRAFT.) Also a small mechanism, used instead of matches, in which a small wheel is twirled against a piece of ferro-cerium, throwing off sparks which ignite petrol fed through a cotton wick.

LIGHTFOOT, JOHN (1602–1675), English divine and Hebrew scholar, was born at Stoke-upon-Trent on March 29, 1602, and studied at Christ's college, Cambridge. He was a supporter of the parliament, and an original member of the Westminster Assembly (*see* his *Journal of the Proceedings,* vol. xiii. of his works). In 1643 he was made master of Catherine hall, Cambridge, and rector of Much Munden, Herts, preferments in which he was confirmed after the Restoration. In 1654 he became vice-chancellor of the university. He wrote various learned exegetical works. His later years were devoted to helping Brian Walton with the *Polyglot Bible* (1657) and to the preparation of his own best known work, *Horae Hebricae et Talmudicae* (5 vols., 1658–74). He died at Ely on Dec. 6, 1675.

See his *Whole Works,* in 13 vols., edited, with a life, by R. Pitman (1822–25) and D. M. Welton, *John Lightfoot, the Hebraist* (Leipzig, 1878).

LIGHTFOOT, JOSEPH BARBER (1828–1889), English theologian and bishop of Durham, was born at Liverpool on April 13, 1828. He was educated at King Edward's school, Birmingham, and Trinity college, Cambridge. He graduated senior classic and 30th wrangler, and was elected a fellow of his college. From 1854 to 1859 he edited the *Journal of Classical and Sacred Philology.* He became tutor of his college (1857), Hulsean professor (1861), chaplain to the prince consort and honorary chaplain to the queen, Whitehall preacher (1866) and canon of St. Paul's (1871). In 1875 he became Lady Margaret professor of divinity in succession to William Selwyn. He had previously written his commentaries on the epistles to the Galatians (1865), Philippians (1868) and Colossians (1875), which mark a new departure in New Testament exegesis in England. Lightfoot was a great grammarian and textual critic; he endeavoured to make his author interpret himself, and by considering the general drift of his argument to discover his meaning where it appeared doubtful. Thus he was able often to recover the meaning of a passage which had long been buried under a heap of contradictory glosses, and he founded a school in which sobriety and common sense were added to the industry and ingenuity of former commentators. In 1879 Lightfoot was consecrated bishop of Durham. He continued to work on his editions of the Apostolic Fathers, and in 1885 published an edition of the Epistles of Ignatius and Polycarp, collecting also much valuable material for a second edition of Clement of Rome, which was published after his death (1st ed., 1869). His defence of the authenticity of the Epistles of Ignatius is an important contribution to that very difficult controversy. He died at Bournemouth on Dec. 21, 1889, and was succeeded in the episcopate by Westcott, his schoolfellow and lifelong friend who published a sketch of his *Life* (1894).

LIGHTHOUSES. Under the general heading of Lighthouses this article includes, in addition to a description of marine lighthouse structures and apparatus, some reference to Unattended lights, Light-vessels, Lighted buoys, Aerial lighthouses and Acoustic and wireless fog signals. (*See* the following section, *Lighthouses of the United States,* for similar information concerning America.)

A lighthouse is a structure erected to carry a light for the purpose of warning or guidance, in connection with marine and aerial navigation.

Early History.—The earliest lighthouses, of which records exist, were the towers built by the Libyans and Cushites in Lower Egypt, beacon fires being maintained in some of them by the priests. Lesches, a Greek poet (*c.* 660 B.C.) mentions a lighthouse at Sigeum (now Cape Incihisari), in the Troad, which appears to have been the first light regularly maintained for the guidance of mariners. The famous Pharos of Alexandria, built by Sostratus of Cnidus in the reign of Ptolemy II. (283–247 B.C.) was regarded as one of the wonders of the world. A full account of it is given in Hermann Thiersch's *Pharos Antike, Islam und Occident* (1909). The tower, which took its name from that of the small island on which it was built, is stated to have been 600 ft. in height, but the evidence in support of this is doubtful. It was destroyed by an earthquake in the 13th century, but remains are said to have been visible as late as 1350. The name Pharos became the general term for all lighthouses, and the term "pharology" has been used for the science of lighthouse construction. The tower at Ostia was built by the emperor Claudius (A.D. 50). Other famous Roman lighthouses were those at Ravenna, Pozzuoli and Messina. The ancient Pharos at Dover and that at Boulogne, later known as *la Tour d'Ordre,* were built by the Romans and were probably the earliest lighthouses erected in western Europe. Both are now demolished.

The light of Cordouan, on a rock in the sea at the mouth of the Gironde, provides the first example now existing of a wave-swept tower. Two earlier towers on the same rock are supposed to have been built, the first by Louis le Debonnaire (*c.* A.D. 805) and the second by Edward the Black Prince. The existing structure was begun in 1584 during the reign of Henry II. of France and completed in 1611. The upper part of the beautiful Renaissance building was removed towards the end of the 18th century, and replaced by a loftier cylindrical structure rising to a height of 207 ft. above the rock (fig. 1). Until the 18th century the light was exhibited by means of an oak-log fire, and subsequently a coal fire was in use for many years. The ancient tower at Corunna, known as the Pillar of Hercules, is supposed to have been a Roman Pharos. The Torre del Capo at Genoa originally stood on the promontory of San Berrique. It was built in 1139 and first used as a lighthouse in 1326. It was rebuilt on its present site in 1643 and rises 236 ft. above the cliff. The Pharos of Meloria was constructed by the Pisans in 1154 and was several times rebuilt until it was finally destroyed in 1290. On the abandonment of Meloria by the Pisans, they erected the still existing tower at Leghorn in 1304, which has well borne the brunt of time.

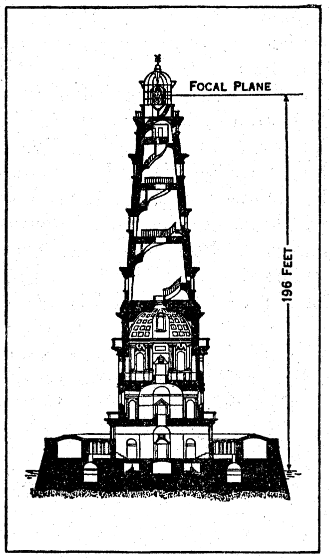


FIG. 1.—CORDOUAN LIGHTHOUSE, EARLIEST EXTANT WAVE-SWEPT TOWER

The lighthouse was begun in 1584 and stands on a rock in the Bay of Biscay near the mouth of the river Gironde

In the 17th and 18th centuries numerous towers, on which were erected braziers or grates containing wood or coal fires, were established in various positions on the coasts of Europe. Among such stations in the United Kingdom were Tynemouth (*c.* 1608), the Isle of May (1636), St. Agnes (1680), St. Bees (1718) and the Lizard (1751). The oldest lighthouse in the United States is believed to be the Boston light situated on Little Brewster island on the south side of the main entrance to Boston Harbour, Mass. It was established in 1716, the present structure dating from 1859. Other early lighthouses on the New England coast were those at Beaver Tail, near the entrance to Newport Harbour (1740), and the Brant at the entrance to Nantucket Harbour (1754). A watch-house and beacon appear to have been erected on Beacon or Lighthouse Island as well as on Point Allerton Hill near Boston, prior to 1673, but these structures would seem to have been in the nature of look-out stations in time of war rather than light-houses for the guidance of mariners.

LIGHTHOUSE STRUCTURES

The structures of lighthouses may be divided into two classes, (a) those on rocks, shoals or in other situations exposed to the force of the sea, and (b) the more numerous class of land structures.

Wave-swept Towers.—In determining the design of a lighthouse tower to be erected in a wave-swept position consideration must be given to the physical features of the site and its surroundings. Towers of this description are classified as follows: (1) Masonry and concrete structures; (2) Openwork steel and iron-framed erections on pile or other foundations; (3) Cast-iron plated towers; (4) Structures erected on caisson foundations.

(1) Masonry towers are generally preferred for erection on wave-swept rocks affording good foundation, and have also been constructed in other situations where adequate foundations have been made by sinking caissons into a soft sea bed. Smeaton's tower on the Eddystone rock is the model upon which most later designs of masonry towers have been based, although many improvements in detail have since been made. In situations of great exposure the following principles in design should be observed: (a) The centre of gravity of the tower structure should be as low as possible. (b) The mass of the structure superimposed at any horizontal section must be sufficient to prevent its displacement

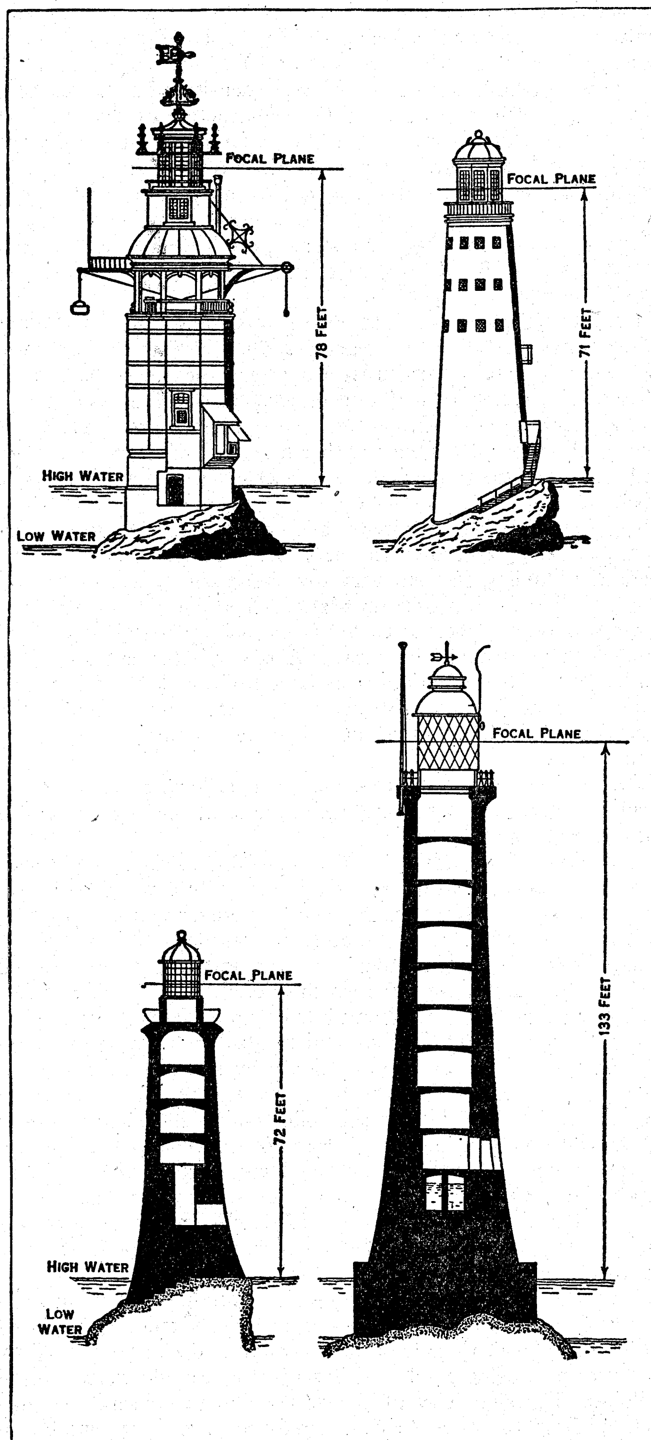


FIG. 2.—THE FOUR LIGHTHOUSES ON THE EDDYSTONE ROCKS

The towers are drawn to the same scale. The first tower was destroyed in the great storm of 1703, and the present tower was completed in 1882

by the combined forces of wind and waves without dependence on the adhesion at horizontal joint-faces or on the dove-tailing of stones introduced as an additional safeguard. (c) The structure should be circular in plan throughout, this form affording the least resistance to wave stroke and wind pressure in any direction. (d) The lower portion of the tower exposed to the direct horizontal stroke of the waves should, for preference, be constructed with a vertical face. The upper portion should be either straight with uniform batter or continuously curved in the vertical plane. External projections from the face of the tower, except in the case of a gallery under the lantern, should be avoided, the surface throughout being smooth. (e) The height from sea-level to the top of the tower should be sufficient to avoid the obscuration of the light by broken water or dense spray driving over the lantern. (f) The foundation of the tower should be carried well into the solid rock and secured to it. (g) The materials of which the tower is built should be of high density and of resistant nature. (h) The stones used in the construction of the tower, at any rate those on the outer face, should be dove-tailed or joggled one to the other in order to prevent their being dislodged by the sea during the process of construction and to afford additional stability. Of late years, cement concrete has been used to a considerable extent for maritime structures, including lighthouses, either alone or faced with masonry. Reinforced concrete has also been employed.

(2) Many examples of openwork steel and iron lighthouses exist. Some typical examples are described hereafter. This form of design is suitable for situations where the tower has to be carried on a foundation of iron or steel piles driven or screwed into an insecure or sandy bottom, *e.g.*, on shoals, coral reefs and sand banks or in places where other materials of construction are exceptionally costly and where facility of erection is a considerable advantage.

(3) Cast-iron plated towers have been erected in many situations where the cost of stone or scarcity of labour would have made the building of a masonry tower excessively expensive.

(4) Cylinder or caisson foundations have been used for lighthouse towers in numerous cases where such structures have been erected on sand banks or shoals. A remarkable instance is the Rothersand tower. Two attempts have been made to sink a caisson in the outer Diamond Shoal off Cape Hatteras on the Atlantic coast of the United States, but these endeavours have proved to be futile.

Famous Wave-swept Towers.—The following are brief descriptions of some of the more important wave-swept towers in various parts of the world.

Eddystone (*Winstanley's Tower*).—The Eddystone rocks, which lie about 14 m. off Plymouth, are fully exposed to south-western seas. Four towers have been constructed on the reef which is submerged at high-water spring tides. The first lighthouse (fig. 2a) was polygonal in plan and highly ornamented with galleries and projections which offered considerable obstruction to the sea stroke. The work was begun by Henry Winstanley, a gentleman of Essex, in 1695 and finished in 1698. In the following year, in consequence of damage by storms, the tower was increased in diameter from 16 ft. to 24 ft. by the addition of an outer ring of masonry and made solid to a height of 20 ft. above the rock, the tower being raised from 80 ft. to nearly 120 ft. This work was completed in 1700. The lower part of the structure appears to have been of stone, the upper part and lantern of timber. During the great storm of Nov. 20, 1703, the tower was swept away, those in it at the time, including the builder, being drowned.

Eddystone (*Rudyerd's Tower*).—This lighthouse was begun in 1706 and completed in 1709 (*see* fig. 2b). The structure consisted principally of oak timbers securely bolted and clamped together, the lower part being filled in solid with stone to add weight to the building. The simplicity of the design and the absence of projections from the outer face rendered the tower very suitable to withstand the onslaught of the waves, but the lighthouse was destroyed by fire in 1755.

Eddystone (*Smeaton's Tower*).—This famous work, which consisted entirely of stone, was begun in 1756, the light being first exhibited in 1759 (*see* fig. 2c). John Smeaton was the first engineer to use dove-tailed joints for the stones in a lighthouse structure. The stones, which averaged 1 ton in weight, were fastened to each other by means of dove-tailed vertical joint faces, oak key wedges, and by oak tree-nails wedged top and bottom, extending vertically from every course into the stones beneath it. During the 19th century the tower was strengthened on two occasions until in 1877, owing partly to the undermining of the rock on which the tower was built and the insufficient height of the structure, the Corporation of Trinity House determined on the erection of a new lighthouse in place of it.

Eddystone (*J. N. Douglass' Tower*).—The site selected for the new Eddystone tower (fig. 2d) is 120 ft. S.S.E. from Smeaton's lighthouse, where a suitable foundation was found, although a considerable section of the lower courses had to be laid below the level of low water. The base is vertical, 44 ft. in diameter, and all the stones are dove-tailed, both horizontally and vertically, on all joint faces, those of the foundation course being secured to the rock by Muntz metal bolts. The lantern is a cylindrical helically-framed structure with domed roof, gun-metal astragals and cast-iron pedestal. The optical apparatus in this lighthouse consists of two superimposed tiers of refracting lens panels. The burners originally fitted in Eddystone tower were of 6-wick pattern, but these were replaced in 1904 by incandescent oil-vapour burners. At the time of the completion of the lighthouse two bells, weighing 2 tons each and struck by mechanical power, were installed for fog-signalling purposes; these have since been replaced by an explosive gun-cotton fog signal. The work of preparing the foundation was begun on July 17, 1878, and the light was first exhibited on May 18, 1882.[1] The upper portion of Smeaton's tower was removed on completion of the new lighthouse and re-erected on Plymouth Hoe, where it replaced an old Trinity House sea mark. One of the principal features in the design of the new Eddystone lighthouse tower is the solid vertical base. Heavy seas are immediately broken up or reflected by it, spray alone rising to the height of the lantern gallery. The shock to which the gallery cornice of the old tower was exposed was so great that stones were sometimes lifted from their beds. Its successor presents another point of dissimilarity from Smeaton's structure, in that the stones forming the floors consist of single corbels built into the wall instead of stone arches the thrust of which, in the earlier tower, was taken by the walls strengthened by building in chains in the form of hoops. The system of constructing corbelled stone floors was first adopted by R. Stevenson in the Bell Rock lighthouse.

Bell Rock.—The Bell Rock tower (fig. 3a), which lies 12 m. off the coast of Forfarshire, stands on an exposed reef, dry at

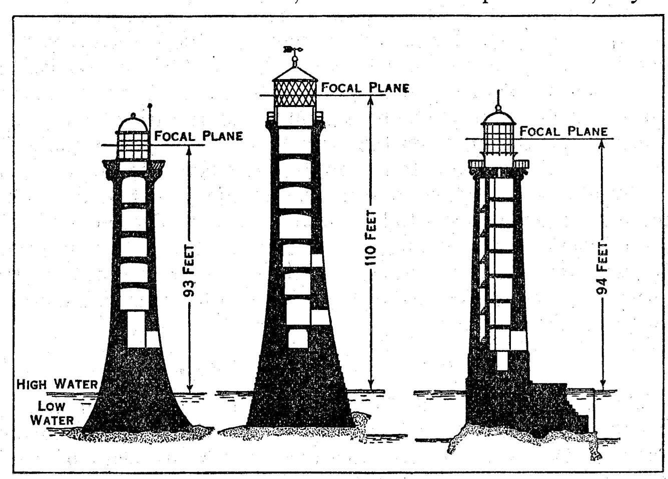


FIG. 3.—SECTIONS OF ROCK LIGHTHOUSES DRAWN TO SAME SCALE
a, Bell Rock, off the east coast of Scotland; b, Wolf Rock, off coast of Cornwall; c, Ar'men, off the coast of Finistère

low water and submerged to a depth of about 16 ft. at high water of spring tides. The rock is of hard sandstone. The lighthouse was constructed by R. Stevenson in 1807–11.

Skerryvore.—The Skerryvore Rocks, 12 m. off the island of Tyree in Argyllshire, are wholly open to the Atlantic. The tower, 150 ft. in height and designed by Alan Stevenson, was begun in 1838 and finished in 1844.

Bishop Rock.—The lighthouse on the Bishop Rock,[2] the westernmost landfall rock of the Scilly Islands, occupies perhaps

[1] *Proc.* Inst. C.E. vol. LXXV. (1883).
[2] *Proc.* Inst. C.E. vol. CVIII. (1892).

a more exposed situation than any other in the world. The first lighthouse erected there was begun in 1847 under the direction of N. Douglass. The tower consisted of a cast and wrought-iron openwork structure having the columns deeply sunk into the rock. On Feb. 5, 1850, when the tower was ready to receive the lantern, a heavy storm swept away the whole structure. In 1851 the erection of a granite tower was begun and the light was first exhibited in 1858. This structure also proved insufficient to withstand the very heavy seas to which it was exposed. Soon after its completion the 5-cwt. fog bell, fixed to the lantern gallery 100 ft. above high-water mark, was washed away and the tower vibrated considerably during storms. In 1874 it was strengthened by bolting continuous iron ties to the internal surfaces of the walls. In 1881 further signs of damage appeared and the structure was encased from its base upwards with granite blocks dove-tailed to each other and to the existing work. At the same time the elevation of the light was increased. The work was begun in 1883 and completed in 1887. Profiting by the experience gained after the construction of the new Eddystone tower, Sir J. N. Douglass decided to build the lower portion of the improved Bishop Rock tower in the form of a cylinder, but with considerably increased elevation (fig. 4).

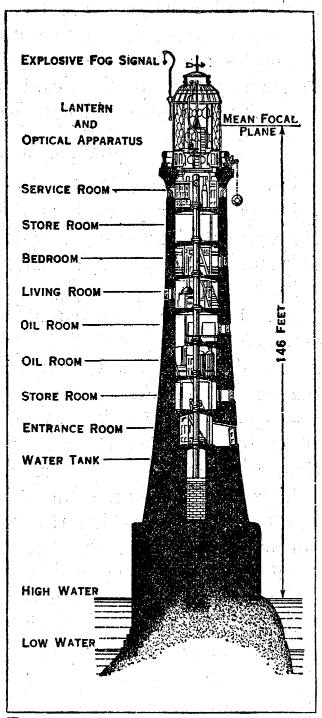


FIG. 4.—BISHOP ROCK LIGHTHOUSE, SCILLY ISLANDS
This is the second granite tower. The first granite tower was encased and raised in height in 1883–87

Minot's Ledge (Plate I.). The tower, 89 ft. in height, is built of granite upon a reef off Boston Harbour, Mass., and occupied five years in construction, being completed in 1860. The rock just bares at low water. The stones are dovetailed vertically, but not on their horizontal beds, bonding bolts being substituted for the horizontal dovetailed joints in the lower 40 ft., or solid portion of the tower.

Wolf Rock.—This much-exposed rock lies midway between the Scilly isles and the Lizard point, and is submerged to the depth of about 6 ft. at high water. The tower was erected in 1862–9 (fig. 3b). The lower part of the base has projecting steps or scarcements in order to break up the sea[1].

Dhu Heartach Rock.—The Dhu Heartach Rock, 35 ft. above high water, is 14 m. south-west of the island of Mull. The tower occupied six years in erection, and was completed in 1872. The focal plane is at a level of 145 ft. above high-water.

Ar'men.—The masonry tower, erected by the French Lighthouse Service, on the Ar'men rock off the western extremity of the Île de Sein, Finistère, occupied fifteen years in construction (1867–81). The rock is barely uncovered at low water and of small area, which made it impossible to construct a tower having a base diameter greater than 30 ft. (fig. 3c).

St. George's Reef, California.—This structure, completed in 1891, consists of a square pyramidal stone tower rising from the easterly end of an oval masonry pier, built on a rock to a height of 60 ft. above the water. The focal plane is at an elevation of 146 ft. above high water. The site is one of great exposure.

Fastnet.—The first lighthouse on the Fastnet rock, off the south-west coast of Ireland, was a circular cast-iron tower 86 ft. in height completed in 1854. It was erected on the summit of the rock which in 1895 was found to be considerably undermined. In 1899 a granite structure of increased height and founded upon a sound ledge of rock on one side of the higher, but undermined, portion of the reef, with its foundation laid near high water, was commenced and completed in 1904 (Plate II.). The focal plane is at a level of 158 ft. above high-water mark.

Maplin.—The screw-pile lighthouse erected on the Maplin Sand in the estuary of the Thames in 1838 is the earliest of its kind and served as a model for numerous similar structures in various parts of the world The piles, nine in number, are of solid wrought-iron with screws 4 ft. in diameter.

American Shoal, Florida.—This tower is typical of the openwork pile structures on the Florida reefs, and was completed in 1880. The focal plane is 109 ft. above high water.

Wolf Trap.—This lighthouse was erected during the years 1893–94 on Wolf Trap Spit in Chesapeake bay, near the site of an old openwork structure which was swept away by ice early in 1893. The tower is built upon a cast-iron caisson 30 ft. in diameter sunk 18 ft. into the sandy bottom. The depth of water on the shoal is 16 ft. at low water. The caisson was filled with concrete, and is surmounted by a brick superstructure 52 ft. in height from low water to the focal plane of the light. A somewhat similar structure was erected in 1885–87 on the Fourteen-Foot Bank in Delaware Bay. The foundation in this case was, however, shifting sand, and the caisson was carried to a greater depth.

Rothersand.—This lighthouse, off the entrance to the river Weser, in Germany, is a structure of great interest on account of the difficulties met with in its construction. The tower had to be founded on a bottom of shifting sand 20 ft. below low water and in an exposed situation. Work was begun in May 1881, when attempts were made to sink an iron caisson under pneumatic pressure. Owing to the fact that scour removed the sand from one side of the caisson it tilted to an alarming angle, but eventually it was sunk to a depth of 70 ft. below low-water. In October of the same year the whole structure collapsed. Another attempt, made in May 1883, to sink a caisson of bi-convex shape, in plan 47 ft. long, 37 ft. wide and 62 ft. in height, met with success, and after many difficulties the structure was sunk to a depth of 73 ft. below low-water, the sides being raised by the addition of iron plating as the caisson sank. The sand was removed from the interior by suction. Around the caisson foundation were placed 74,000 cu.yd. of mattress-work and stones, the interior being filled with concrete. The lighthouse (fig. 5) was completed in 1885.

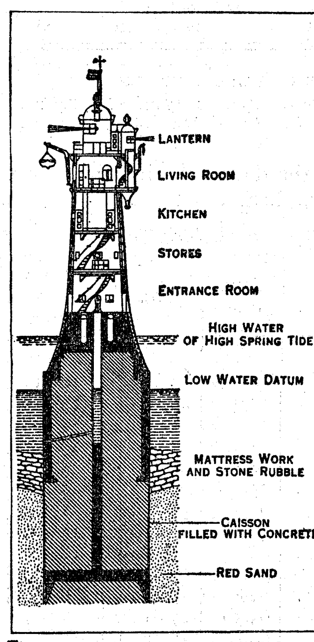


FIG. 5.—ROTHERSAND LIGHTHOUSE, NEAR THE MOUTH OF THE WESER ESTUARY, GERMANY

Other well-known wave-swept towers are those at Haulbowline Rock (Carlingford Lough, Ireland, 1823); Héaux de Brehat (Brittany, 1839); Horsburgh (Singapore, 1851); Bayes d'-Olonne (Bay of Biscay, 1861); Smalls (Pembrokeshire, 1861); Hanois (Guernsey, 1862); Daedalus reef, iron tower (Red sea, 1863); Alguada reef (Bay of Bengal, 1865); Longships (Land's End, 1872); Great Basses (Ceylon, 1873); the Prongs (Bombay, 1874); Spectacle reef (Lake Huron, 1874); Chicken rock (Isle of Man, 1874); Fowey Rocks (Florida, 1878); Rattray Head (Aberdeenshire, 1895); Beachy Head (Eastbourne, 1902); the Graves (Boston, U.S.A., 1905); and Jument d'Ouessant (Brittany, 1911).

Jointing of Stones in Rock Towers.—Various methods of jointing the stones in rock towers are employed in building. The great distinction between the towers, built by successive engineers to the Trinity House, and other rock lighthouses is that, in the former the stones of each course are dove-tailed together both laterally and vertically and are not connected by metal or

[1]*Proc.* Inst. C.E. Vol. XXX.

wooden pins and wedges and doweled as in most other cases. This dove-tail method was first adopted at the Hanois rock at the suggestion of Nicholas Douglass. The cement mortar in the joint

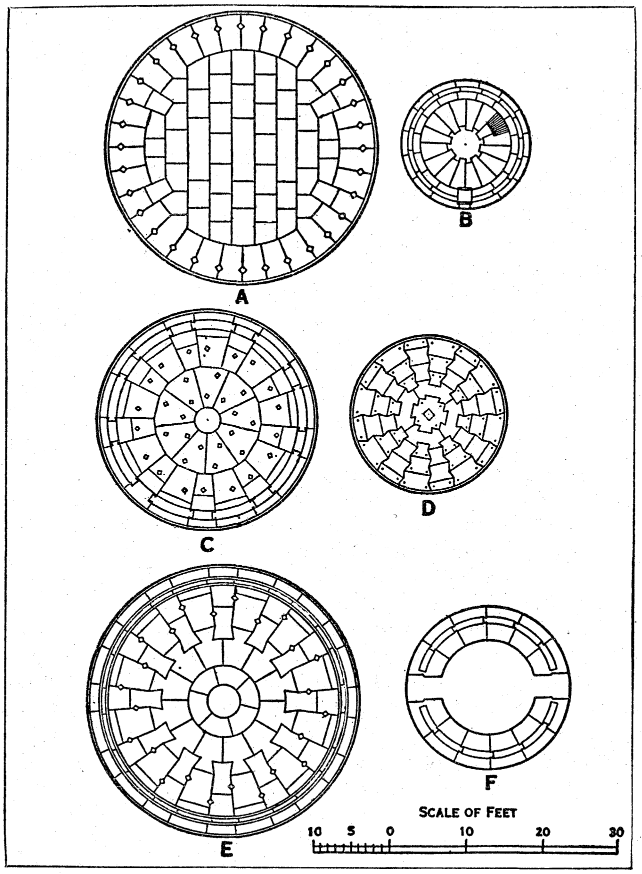


FIG. 6.—COURSES OF STONES OF VARIOUS TOWERS
A. Dhu Heartach, 1st Course. B. Bell Rock Floor. C. Wolf, 12th Course. D. Eddystone, 12th Course, Smeaton's Tower. E. Chickens, 6th Course. F. Eddystone, 48th Course, Douglass Tower

formed between the faces so locks the dove-tails that the stones cannot be separated without being broken.

TABLE I. *Comparative Cost of Exposed Rock Towers*

Name of structure	Total cost	Cu.ft.	Cost per cu.ft. of masonry		
	£		£	s.	d.
Eddystone (*Smeaton*) (1759) . . .	40,000	13,343	2	19	11
Bell rock, Firth of Forth (1811) . .	55,620	28,530	1	19	0
Skerryvore, Scotland (1844) . . .	72,200	58,580	1	4	8
Bishop rock, first granite tower (1858)	34,560	35,209		19	7
Smalls, Bristol Channel (1861) . .	50,124	46,386	1	1	7
Hanois, Alderney (1862)	25,296	24,542	1	0	7
Wolf rock, Land's End (1869) . .	62,726	59,070	1	1	3
Dhu Heartach, Scotland (1872) . .	72,584	42,050	1	14	6
Longships, Land's End (1872) . .	43,869	47,610		18	5
Eddystone (*Douglass*) (1882) . . .	59,255	65,198		18	2
Bishop rock, reconstruction (1887) .	64,889	45,080	1	8	9
Great Basses, Ceylon (1873) . . .	63,560	47,819	1	6	7
Minot's Ledge, Boston, Mass. (1860) .	62,500	36,322	1	17	2
Spectacle reef, Lake Huron (1874) .	78,125	42,742	1	16	2
Ar'men, France (1881)	37,692	32,400	1	3	3
Fastnet, Ireland (1904)	79,000	62,600	1	5	5

Effect of Waves.—The wave stroke to which rock lighthouse towers are exposed is often considerable. During the erection of the tower at Dhu Heartach, 14 joggled stones, each of 2-tons weight, were washed away after having been set in cement at a height of 37 ft. above high water, and similar damage was done during the construction of the Bell rock tower. The effect of waves on the Bishop rock and Eddystone towers has been noted above.

Land Structures for Lighthouses.—The erection of lighthouse towers and other buildings on land presents no serious difficulties of construction; such buildings are usually of simple architectural character. Besides being built of stone, brick or reinforced concrete, land towers are frequently constructed of cast-iron plates or open steel-work with a view to economy. Fine examples of the former are to be found in many British colonies and elsewhere, that on Dassen Island (Cape of Good Hope), being typical. A cast-iron tower erected at Kijkduin, near Helder, in Holland, in 1875 is 197 ft. in height to the focal plane. Many openwork structures up to 200 ft. in height have been built. Examples are the towers erected at Cape São Thomé (Brazil) in 1882, 148 ft. to the focal plane; Mocha (Red sea) in 1903, 180 ft.; and Sanganeb Reef (Red sea) 1906, 165 ft.

OPTICAL APPARATUS

Optical apparatus in marine lighthouses is employed for concentrating the rays of light derived from a light source: (1) in the vertical plane only, to show a fixed belt of light all round the horizon, which can be made either flashing or occulting by eclipsing the light or by interposing mechanically a screen; (2) in both the vertical and horizontal planes simultaneously to produce a high-powered beam or cone of light which can be revolved, to show a flashing light, or fixed, to mark an isolated danger or narrow channel where a limited azimuth suffices; and (3) in the vertical plane and afterwards in the horizontal plane for diverting or condensing a portion of the fixed belt of light to strengthen a sector.

Three types of apparatus are used to effect these concentrations: (a) *Catoptric* in which the rays undergo reflection only at the surface of a mirror; (b) *Dioptric* in which the rays pass through a glass medium and are bent or refracted as they enter and emerge from it (fig. 8); and (c) *Catadioptric* in which the rays after entering the glass medium suffer total internal reflection be-

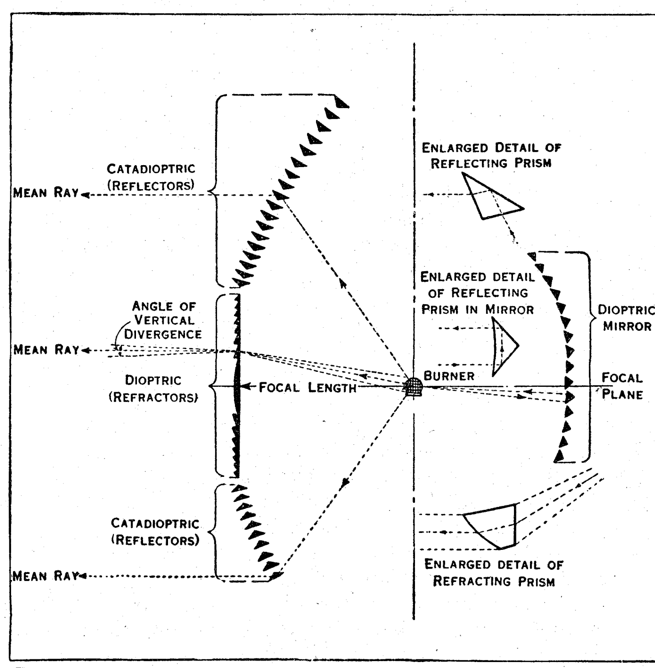
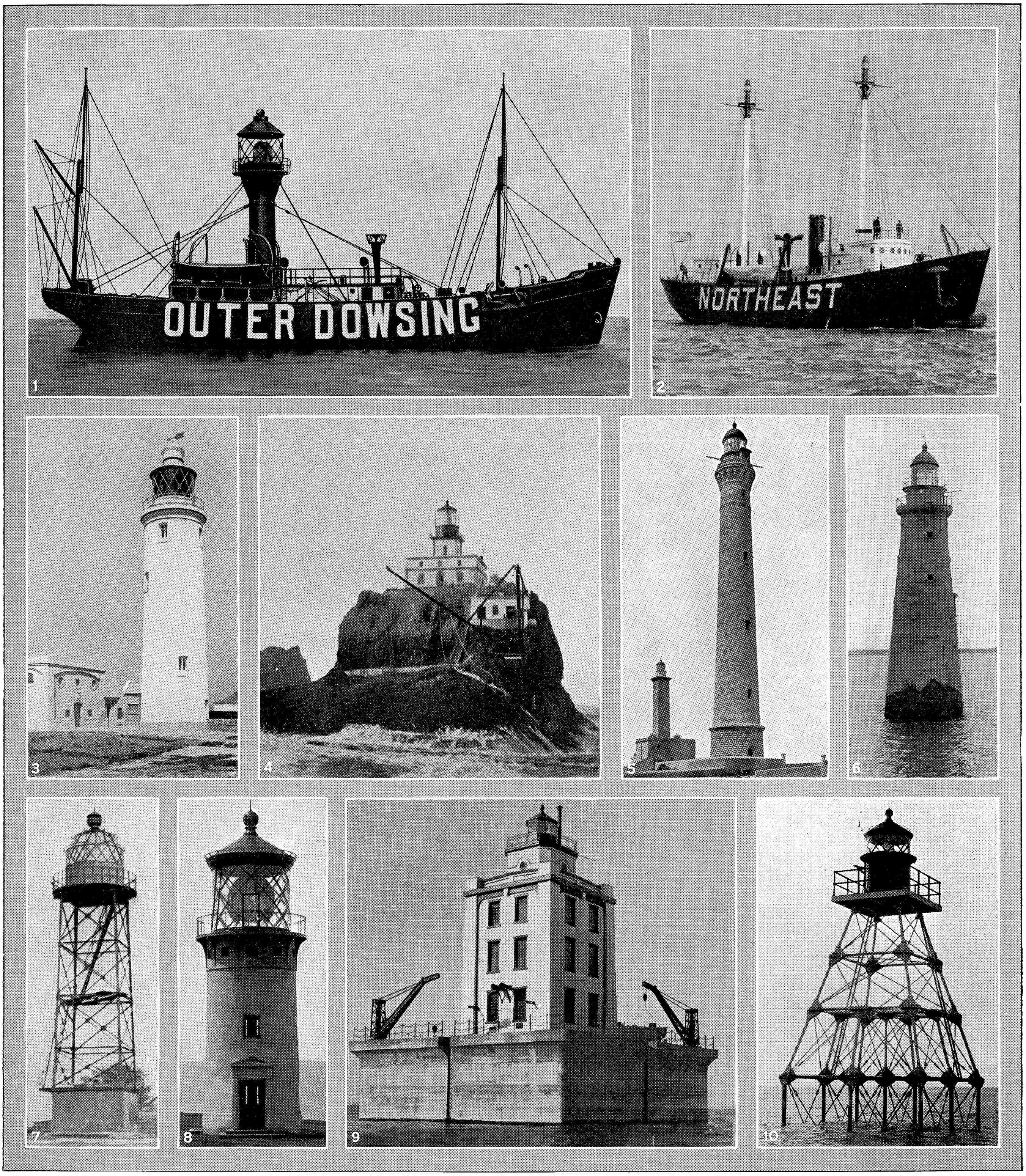


FIG. 7.—DIAGRAM SHOWING THE GLASS ELEMENTS COMMONLY USED IN LIGHTHOUSE OPTICAL APPARATUS. ELEMENTS ARE IN VERTICAL SECTION

fore emerging from it (fig. 7). The object of these several forms of optical apparatus is not only to produce characteristics or distinctions in lights to enable them to be recognized readily by mariners, but to utilize the light rays to the best advantage by their condensation. This is accomplished more effectively by the use of revolving annular lenses than by fixed belts, as greater intensities are thereby attained. Fig. 7 shows in diagrammatic form the various sections and dispositions of glass elements commonly used in lighthouse optical apparatus.

Catoptric System.—Paraboloidal reflectors, consisting of small facets of silvered glass set in plaster of Paris, were first



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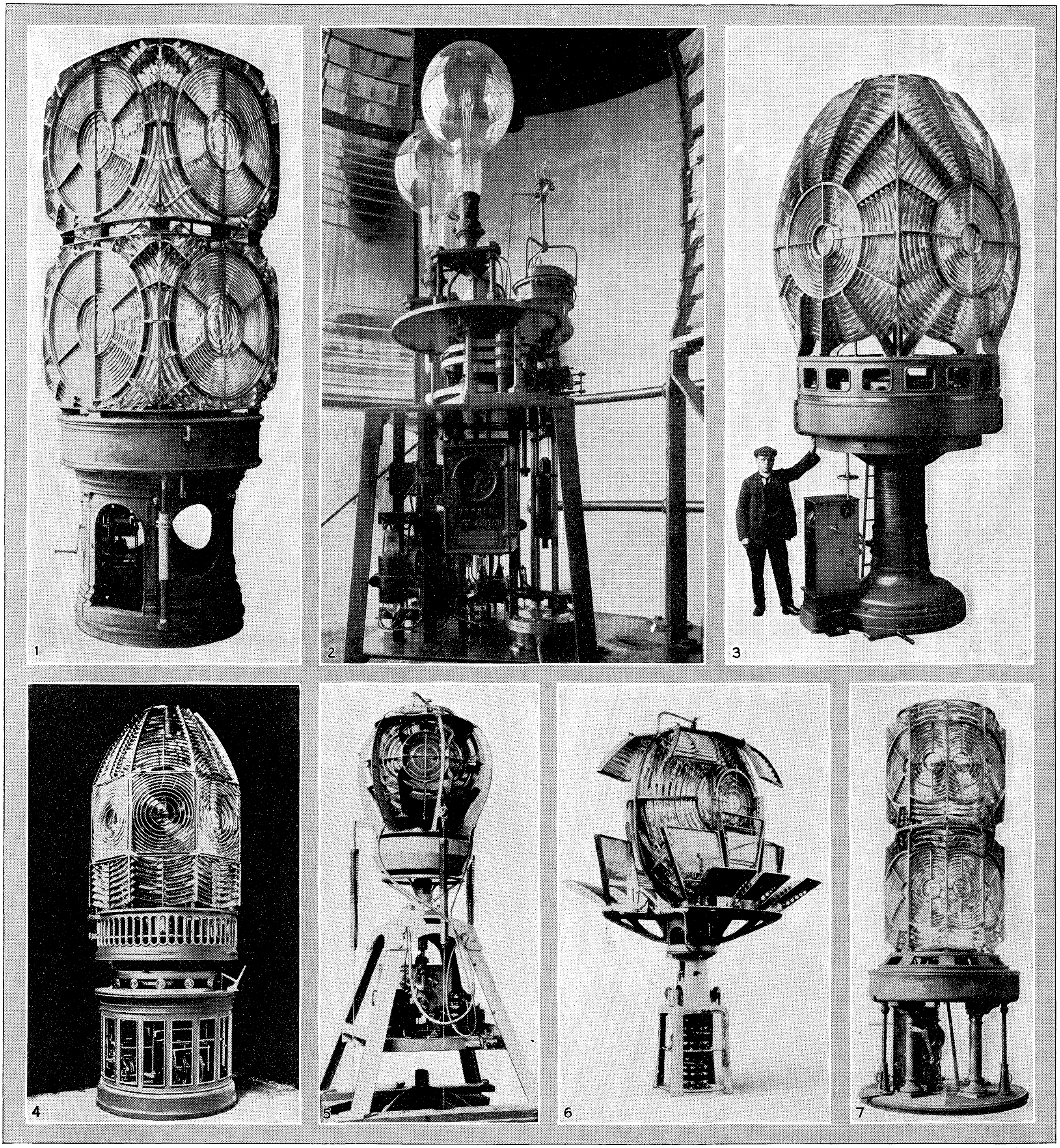
LIGHTSHIPS AND LIGHTHOUSES OFF THE COASTS OF ENGLAND, FRANCE AND AMERICA

1. Light vessel moored at Outer Dowsing shoal in the North sea, about 50 mi. east of the mouth of the Humber. This light vessel is equipped with dioptric apparatus balanced on a constant-level table. The illuminant is a high power electric gas-filled lamp. The vessel has a diaphone fog signal and also a submarine oscillator. **2.** Northeast End lightship, stationed north-east of Delaware bay entrance; a modern vessel with diesel engine for propulsion. Main signal light is electric, on foremast, with reserve light on mainmast. **3.** The High lighthouse, Hurst, one of two leading lights near the sea entrance to the Solent, opposite the Isle of Wight. These are now unattended lights with automatic acetylene plant (building at left). **4.** Tillamook Rock light station, off the Oregon coast; a stone structure on exposed rock. Light is 133ft. above the sea. **5.** Ile Vierge lighthouse. Finistère, Brittany, France; completed 1902. Tower is 247ft. from base to focal plane of the light. The old lighthouse tower on the left is preserved as a seamark. **6.** Minots Ledge lighthouse, about 14mi. south-east of Boston; a granite tower, built in an exposed position in the Atlantic. **7.** Aerial lighthouse, Cranbrook, Kent, off south-east coast of England. Glazing of lantern is extended over the dome, permitting the optical apparatus to direct beams of light from the horizontal up to zenith. **8.** Kilauea Point lighthouse, Hawaii, a reinforced concrete tower 52ft. high, standing on a cliff. The lens, enclosed in the lantern, has two double panels, and shows a double flashing light of 1,100,000 candlepower every 10 seconds. **9.** Martin Reef light station, on a reef in the northern part of Lake Huron. It stands in 6ft. of water, in a position exposed to heavy ice action. The light is electric, 70ft. above the water. **10.** Pacific Reef light, standing in 7ft. of water, on the outer edge of the coral reefs off the Florida coast. It is supported by iron piles driven 9 ft. into the coral reef. It is an unattended station, with an automatic acetylene light



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OPTICAL APPARATUS FOR LIGHTHOUSE ILLUMINATION

1. Biform apparatus of first order, Fastnet Lighthouse, Ireland (1904), which shows a single flash every 5 secs. An incandescent oil mantle-burner is at the focus of each of the two superimposed optics
2. Burnham Leading Lights, Somerset (1928). An incandescent gas-filled electric lamp is seen at the focus of one of the fixed optical apparatus, with a reserve lamp behind it and stand-by acetylene burner (right). The automatic features include a flashing device. At left are fixed lens belt and upper prisms; right, portion of dioptric mirror. Since automatic equipment was installed in 1928 the two lighthouses are unwatched at night
3. North Saddle Lighthouse, China, a first-order apparatus of four panels, single flashing. The annular trough containing mercury, in which the float carrying the rotating apparatus is immersed, can be lowered for examination by rotating it on the central screwed column
4. Great Basses Rock Lighthouse, Ceylon. This first-order apparatus, rotated on a roller carriage, made in 1872, is an example of the slow-revolving lights employed before the introduction of mercury floats and wide lens-panels. Rotating mechanism seen in base
5. Optical apparatus in Spurn Lightvessel, with constant level table
6. Apparatus for aerial lighthouse at Cranbrook, Kent (*see* Pl. I. fig. 7)
7. Third-order biform apparatus of 6 panels and mirror, Hartland Point Lighthouse, North Devon (1927), which shows 6 flashes every 15 secs. At focus of each optic is gas-filled incandescent electric lamp of 3 K.W.

used about the year 1763 in some of the Mersey lights by William Hutchinson, who was then dock master at Liverpool. Spheroidal metallic reflectors were introduced in France in 1781, followed by paraboloidal reflectors of silvered copper in 1790 in England and France, and in Scotland in 1803. The earlier lights were of the fixed type, a number of reflectors being arranged on a frame or stand in such a manner that the emergent rays overlapped and thus illuminated the whole horizon continuously. In 1783 the first revolving light was erected at Marstrand in Sweden. Similar apparatus were installed at Cordouan (1790), Flamborough Head (1806) and at the Bell rock (1811). To produce a revolving or flashing light the reflectors were fixed on a rotating carriage having several faces. A type of paraboloidal reflector is still used for light-vessel illumination.

About the year 1900 reflecting mirrors were used in the Heligoland lighthouse in combination with electric-arc lamps. The French lighthouse service installed (1919) a quadruple-flashing light at Galite in Tunisia, which has large gilded and burnished paraboloidal reflectors and incandescent oil burners. It is, however, unlikely that such reflectors will take the place of dioptric lenses. Paraboloidal reflectors have also been used in some aerial lighthouses including that at Mount Valérien, near Paris.

Dioptric System.—The first adaptation of dioptric lenses to lighthouses is probably due to T. Rogers, who used lenses at one of the Portland lighthouses between 1786 and 1790. Count Buffon had in 1748 proposed to grind out of a solid piece of glass a lens in steps or concentric zones, in order to reduce the thickness to a minimum (fig. 8a). Condorcet in 1773 and Sir D. Brewster in 1811 designed built-up lenses consisting of stepped annular rings. Neither of these designs, however, was intended to apply to lighthouse illumination. In 1822 Augustin Fresnel constructed a built-up annular lens in which the centres of curvature of the different rings receded from the axis according to their distances from the centre, so as practically to eliminate spherical aberration; the only spherical surface being the small central part or "bull's eye" (fig. 8). These lenses were intended for revolving lights only. Fresnel next produced his cylindric refractor or lens belt, consisting of a zone of glass generated by the revolution round a vertical axis of a medial section of the annular lens (fig. 8). The lens belt condenses and parallelizes the light rays in the vertical plane only, while the annular lens does so in both planes. The first revolving light constructed from Fresnel's designs was erected at the Cordouan lighthouse in 1823. It consisted of 8 panels of annular lenses of 45° vertical aperture and having a focal distance of 920 mm. To utilize the light, which would otherwise escape above the lenses, Fresnel

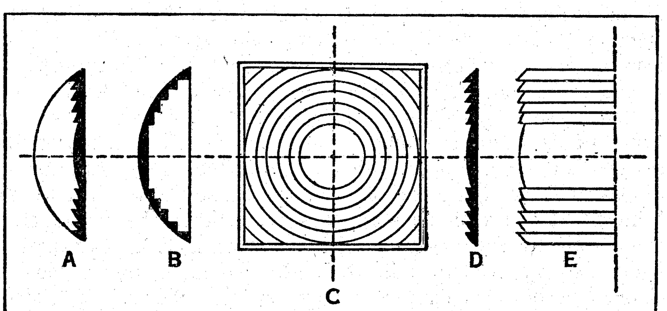


FIG. 8.—THE DEVELOPMENT OF FRESNEL'S LENSES

a, Buffon's lens; b, derivation of Fresnel's lens; c, d, elevation and section of Fresnel's annular lens; d, e, section and half elevation of Fresnel's lens belt

introduced a series of eight plain silvered mirrors, on which the light was thrown by a system of lenses. At a subsequent period mirrors were also placed in the lower part of the optic. The apparatus was mounted on rollers and revolved by clockwork. This optic embodied the first combination of dioptric and catoptric elements in one design (fig. 9). Fresnel also designed for the Chassiron lighthouse a dioptric lens with catoptric mirrors for giving a fixed light, which was the first of its kind installed (1827) in a lighthouse. This combination is geometrically perfect, but not practically so, on account of the great loss of light by metallic reflection; this is 25% greater than that resulting from the use of glass elements. Shortly before his death in 1827 Fresnel devised his totally reflecting or catadioptric prisms (fig. 7) to take the place of the silvered reflectors previously used above and below the lens elements. In these the principle of internal reflection from the face of a glass prism is made use of as well as the principle of refraction. Thus a ray of light falling on the prismoidal ring is refracted as shown in the enlarged detail of the reflecting prism and then is totally reflected emerging after a second refraction in a horizontal direction. Fresnel devised these prisms for use in fixed-light apparatus, but the principle was applied to flashing lights by T. Stevenson in 1850. Both the dioptric lens and catadioptric prism invented by Fresnel are still in general use, the mathematical calculations of the great French designer still forming the basis upon which lighthouse opticians work.

Fresnel also designed a form of fixed and flashing light in which a fixed light, varied by flashes, was produced by placing panels of straight refracting prisms in a vertical position on a revolving carriage outside the fixed light apparatus. The revolution of the upright prisms periodically increased the power of the beam by condensation of the rays, emergent from the fixed apparatus, in the horizontal plane.

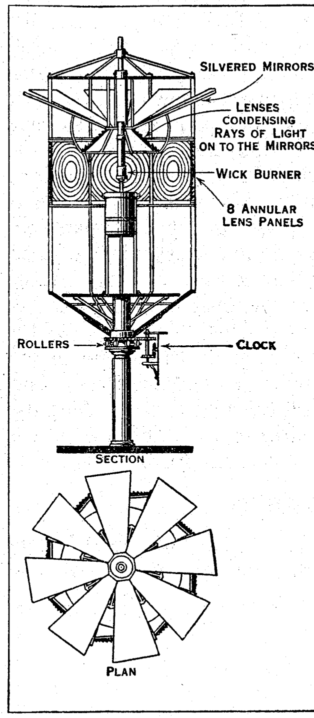


FIG. 9.—FRESNEL'S FIRST REVOLVING LIGHT, ERECTED IN 1823

This apparatus of 920 mm. focal distance, formerly at Cordouan lighthouse (river Gironde), was the first dioptric revolving light to be established

The lens segments in Fresnel's early apparatus were of polygonal form instead of cylindrical, but subsequently manufacturers succeeded in grinding glass in cylindrical rings of the form now used. The first apparatus of this description was made by the Cooksons of Newcastle in 1836 at the suggestion of Alan Stevenson, and erected at Inchkeith, Fifeshire. The first dioptric apparatus erected by the Trinity House to show a fixed light was the one formerly at Start Point in Devonshire. It was constructed in 1836.

Azimuthal Condensing Prisms.—To condense the rays from a fixed-light apparatus in certain azimuths, T. Stevenson devised in 1850 his azimuthal condensing prisms which have been variously applied in the construction of optical apparatus as, for instance, for the strengthening of coloured sectors. Applications of this system will be referred to subsequently (*see* fig. 10).

Dioptric Mirror.—An important improvement in lighthouse optical work was the invention of the dioptric mirror by (Sir) J. T. Chance in 1862. This mirror is a modification of a spherical mirror devised by T. Stevenson in 1850, in which double reflection from the internal surfaces of a catadioptric prism was employed. Chance generated the zones of prisms round the vertical axis, separated the elements and set them at increasing radii, thus producing an instrument of practical utility. By the use of the dioptric mirror rays of light which would otherwise be lost are reflected back through the focus of the source of light and are refracted or reflected with the main rays. This form of mirror is still in general use and is constructed for vertical angles up to 100°.

Spherical Lens.—Mr. C. A. Stevenson devised in 1888 annular lens panels consisting of lens elements spherical in the horizontal and vertical planes, and these, with equiangular prisms, have been used in a number of apparatus for Scottish lighthouses.

Optical Glass for Lighthouses.—In the early days of lens lights the only glass used for the prisms was made in France at the St. Gobain and Premontré works, which have long been celebrated for the high quality of optical glass they produce. The early dioptric lights erected in the United Kingdom, some 13 in all, were made by the Cooksons, who were instructed by Léonor Fresnel, the brother of Augustin. At first they tried to mould the lens and then to grind it out of one thick sheet of glass. The manufacture of lenses was abandoned by Cooksons' successors in 1845 and in 1850 Chance Bros. and Co., of Birmingham began to make optical glass, assisted by M. Tabouret, a French expert who had been a colleague of Augustin Fresnel himself. The first light made by the firm was shown at the Great Exhibition of 1851, since when numerous dioptric apparatus have been constructed by Messrs. Chance, who are, at this time, the only manufacturers of lighthouse glass in the United Kingdom. Most of the glass used for apparatus constructed in France is manufactured at St. Gobain. Some glass used by German constructors is made at Rathenau in Prussia and Goslar in the Harz.

The glass generally employed for lighthouse optics has a mean refractive index of $\mu = 1{\cdot}51$, the corresponding critical angle being $41° 30'$. Messrs. Chance have used dense flint glass for the upper and lower refracting rings of high-angle lenses (up to 97° vertical angle) and for dioptric mirrors in certain cases. This glass has a value of $\mu = 1{\cdot}62$ with critical angle $38° 5'$. The use of refracting elements for an angle greater than 60° aperture is not attended by any advantage over reflecting prisms.[1]

TYPES OF LIGHTS

Occulting Lights.—During the last quarter of the 19th century the disadvantages of fixed lights became more and more

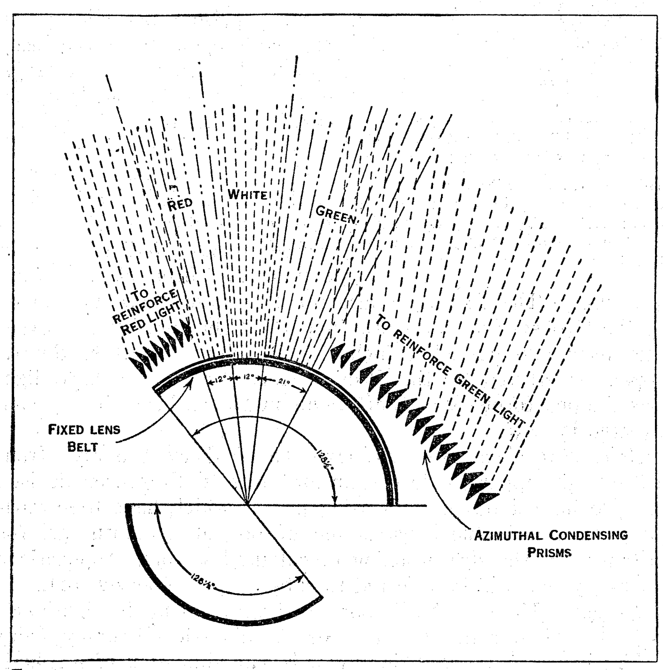


FIG. 10.—WOODMAN POINT DIRECTION-LIGHT, FREMANTLE, WEST AUSTRALIA
The diagram is a plan of the optical apparatus at the level of the focal plane. The light is condensed and directed over the channel, the dangers at the sides of which are covered by the red and green lights

apparent and they have fallen into disuse except in the case of the less important harbour and river lights. The necessity of providing a distinctive characteristic has led to the conversion of many of the fixed-light apparatus of earlier years into occulting lights, or to their supersession by more modern and powerful flashing-apparatus. The occultation of a light is produced either by a cylindrical screen lowered and raised around the burner; or by a revolving screen; or, when some form of gas burner is used, by intermittently extinguishing the light itself. Varying characteristics, comprising one or more occultations, may be procured by means of such contrivances. "Otter" screens are sometimes employed in cases where it is desired to produce different periods of occultations in two or more positions in azimuth, in order to differentiate sectors marking shoals, etc. The screens are of sheet metal blacked and arranged vertically, somewhat in the manner of the laths of a venetian blind, and operated by mechanical means.

[1] *See* W. M. Hampton, *Trans. Optical Soc.*, vol. XXIX (1928).

Leading Lights.—In the case of lights designed to act as a

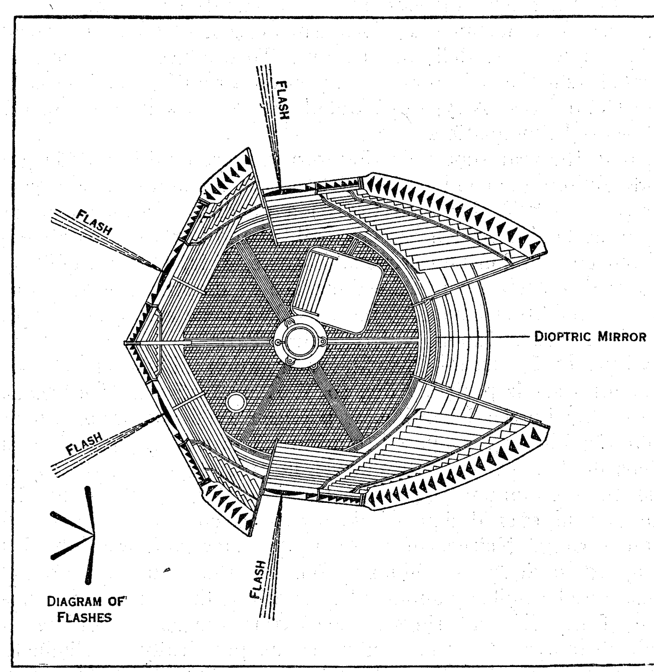


FIG. 11.—FLAMBOROUGH LIGHTHOUSE, YORKSHIRE
Sectional plan of the first-order optical apparatus at focal plane. The light shows 4 flashes every 15 seconds

lead through a narrow channel or as direction lights, it is undesirable to employ a revolving apparatus. Fixed-light optics are used in such cases, generally fitted with an eclipsing mechanism. A typical apparatus of this description is that at Woodman Point, Fremantle, West Australia (fig. 10). The occulting white-light covers the fairway, and is flanked by sectors of occulting red and green-light marking dangers and intensified by vertical condensing prisms. A good example of a holophotal direction-light is that at Suzac lighthouse (France). The apparatus consists of an annular lens 500 mm. focal distance, of 180° horizontal angle and 157° vertical, with a reinforcing mirror of 180°. The lens throws a red beam, of about $4\frac{1}{2}°$ amplitude in azimuth and 50,000 candle-power, over a narrow channel. The illuminant is an incandescent petroleum-vapour burner. Holophotal direction lenses of this type can only be applied where the sector to be marked is of comparatively small angle. Silvered metallic mirrors of parabolic section are also used for the purpose. The establishment of a direction light frequently renders the construction of separate towers for leading lights unnecessary. If two distinct lights are employed to indicate the line of navigation through a channel or between dangers they must be sufficiently far apart to afford a good lead, the front or seaward light being situated at a lower elevation than the rear or landward one.

Coloured Lights.—Colour is used as seldom as possible as a distinction, entailing as it does a considerable reduction in the power of the light. It is however necessary in some instances for differentiating sectors over dangers and for harbour lighting purposes. Alternating colours for flashing lights are not to be commended on account of the unequal absorption of the coloured and bright rays by the atmosphere. Where such a combination has been employed, as in the Wolf rock apparatus, the red and white beams have been approximately equalized in initial intensity by constructing the lens and prism panels for the red light of larger angle than those for the white beams. Owing to absorption by the red colouring of the glass screen the power of the red beam is only 40% of the intensity of the corresponding white light. The corresponding intensity of green light is 25%. When red or green sectors are employed, in conjunction with a white light from a fixed apparatus, they should if it is practicable be reinforced by mirrors, azimuthal condensing prisms, or other means, to raise the coloured beam to approximately the same intensity as the white light. With the introduction of group-flashing characteristics the necessity for using colour as a means of distinction for landfall lights disappeared. In situations such as a river fairway where a large number of buoy or beacon lights have to be provided with distinguishing characteristics, coloured lights are, however, frequently employed.

Group-flashing Lights.—One of the most useful distinctions consists in the grouping of two or more flashes separated by short intervals of darkness, the group being succeeded by a longer

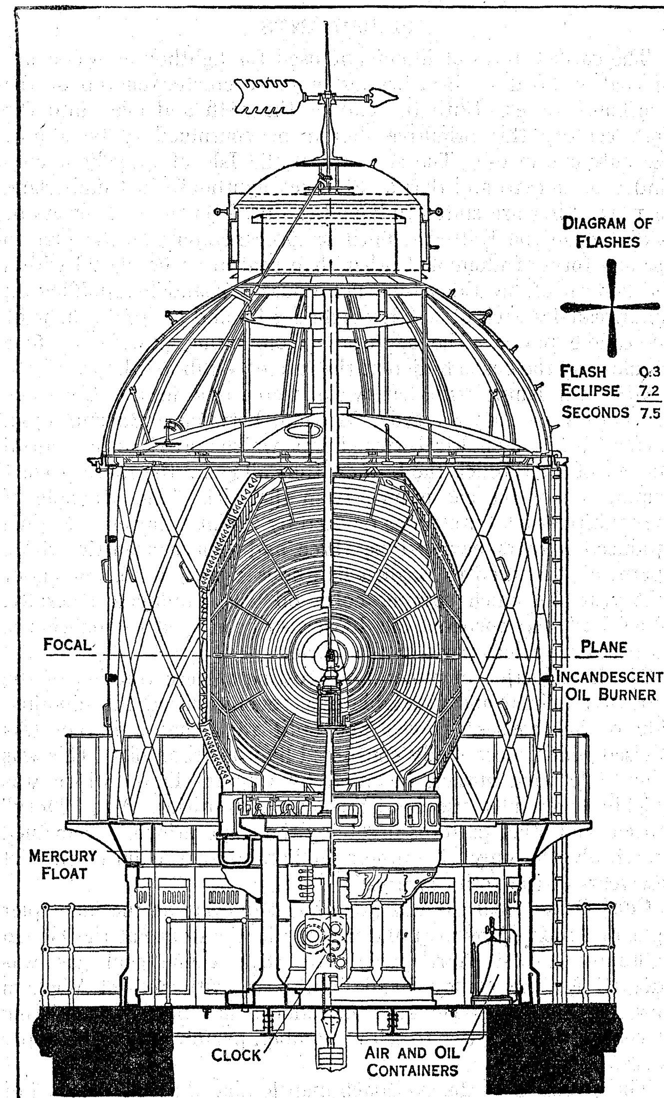


FIG. 12.—MANORA POINT (KARACHI) APPARATUS AND LANTERN
The apparatus is of 1,330 mm. focal distance; it is rotated on a mercury float and has an incandescent oil burner at its focus. The right hand half is shown in elevation and the left hand as a vertical section

eclipse. Thus two, three or more flashes of, say, half-second duration or less follow each other at intervals of about 2 seconds and are succeeded by an eclipse of, say, 10 seconds. In 1874 Dr. John Hopkinson introduced the improvement of arranging the lenses of a dioptric revolving light, together with their panels of reflecting prisms, asymetrically, setting them at an angle to produce the group-flashing characteristic. The first apparatus of this type constructed were those now in use at Tampico, Mexico (triple-flashing), and the Little Basses light-house, Ceylon (double-flashing). A modification of the system consists in grouping two or more lenses together and filling the remaining angle in azimuth by a reinforcing mirror. A sectional plan of the quadruple-flashing first-order apparatus at Flamborough, Yorkshire, is shown in fig. 11 on page 92.

Hyper-radial Apparatus.—In 1885 Messrs. Barbier of Paris constructed the first hyper-radial apparatus (1,330 mm. focal distance) to the design of D. and C. Stevenson. Apparatus of similar focal distance were subsequently established at a number of other lighthouses. That at Manora Point, Karachi, India (1908) is illustrated in fig. 12. The introduction of incandescent oil burners and electric lamps of focal compactness and high intrinsic brightness has rendered unnecessary the provision of optics of such large dimensions.

Fixed and Flashing Lights.—The use of these lights, which show a fixed beam varied at intervals by more powerful flashes, is undesirable, though a large number were constructed in the earlier years of dioptric illumination and some are still in existence. In certain conditions of the atmosphere it is possible for the fixed-light of low power to be entirely obscured while the flashes are visible, thus the true characteristic of the light is vitiated.

Screens and Cuts.—Screens of coloured glass, intended to distinguish the light in particular azimuths, and of sheet iron, when it is desired to "cut off" the light sharply on any angle, should be fixed as far from the centre of the light as possible, in order to reduce commingling, in the first case, and the escape, in the second case, of the light rays due to divergence. These screens are usually attached to the lantern framing.

Divergence.—A dioptric apparatus designed to bend all incident rays of light from the light source in a horizontal direction would, if the flame could be a point, have the effect of projecting a band or zone of light (in the case of a fixed apparatus) and a cylinder of light rays (in the case of a flashing light) towards the horizon. Under such conditions the mariner in the near distance would receive no light as the rays would pass above the level of his eye and be visible only on the horizon. In practice this does not occur, sufficient natural divergence being produced ordinarily owing to the magnitude of the flame. When the electric-arc or an incandescent electric-lamp of small focal diameter is employed it is sometimes necessary to design the prisms so as to produce artificial divergence. The measure of the natural horizontal divergence for any point of the lens is twice the angle whose tangent is the ratio of the radius of the illuminating source to the distance of the point from the geometrical centre of the lens and for calculating the vertical divergence the vertical dimensions of the light source, above and below the focal plane, must in turn be substituted for the radius, and the sum of the angles thus obtained is the total divergence. In fixed dioptric-lights there is, of course, no divergence in the horizontal plane. In revolving lights the horizontal divergence is a matter of considerable importance, determining as it does the duration of flash, *i.e.,* the length of time the flash is visible to the mariner.

Feux-Éclairs or Quick-flashing Lights.—One of the most important developments in lighthouse illuminating apparatus was in the direction of reducing the length of flash, initiated by the French lighthouse authorities about 1891, and shortly afterwards followed in other parts of the world. The early *feux-éclairs,* designed by the French engineers and others, had usually a flash of $\frac{1}{10}$ to $\frac{1}{3}$ sec. duration. As a result of experiments carried out in France in 1903–04, $\frac{3}{10}$ sec. is now generally adopted as the minimum duration for white flashing lights. If shorter flashes are used it is found that the reduction in duration is attended by a corresponding, but not proportionate, diminution in effective intensity. In the case of many electric flashing-lights the duration is of necessity reduced but the greater initial intensity of the flash permits this loss without serious detriment to efficiency. Red or green requires a considerably greater duration than do white flashes. The intervals between the flashes in single-flashing lights of this character are also small, usually $2\frac{1}{2}$ to 5 seconds. In group-flashing lights the intervals between the flashes are about 2 sec. or even less, with periods of 7 to 15 sec. between the groups, which may be arranged to show any number up to six flashes, as in the older forms of apparatus. The *feu-éclair* type of apparatus enables a higher intensity of beam to be obtained by reason of the greater ratio of condensation of light, the employment of panels of greater angular breadth than those formerly used being possible with a higher rotatory velocity. It has been urged that short flashes are insufficient for taking bearings, but the utility of a light in this respect does not seem to depend so much upon the actual length of the flash as upon its frequent recurrence at short intervals.

It was soon found impracticable to revolve an optical apparatus with its mountings, sometimes weighing as much as 7 tons, at the higher rate of speed required for *feux-éclairs* by means of the old system of roller carriages, though for a certain number of small quick-revolving lights ball bearings have been successfully adopted. It has therefore become almost the universal practice to carry the rotating portions of the apparatus upon a mercury float. This application of mercury rotation was the invention of O. Bourdelles. The arrangement consists of an annular cast-iron trough containing mercury with a similar but slightly smaller annular float immersed in it and displacing a volume of the liquid metal whose weight is equal to that of the apparatus supported. In all cases provision is made for lowering the mercury bath or raising the float and apparatus for examination. An example of a mercury float is shown in Plate II., fig. 3.

Multiform and Twin Apparatus.—In order to double the power to be obtained from a single apparatus at stations where lights of exceptionally high intensity are desired, the expedient of superimposing one complete lens apparatus on another has sometimes been adopted, as at the Bishop rock (fig. 4), Hartland point (Plate II.) and at the Fastnet lighthouse in Ireland (Plate II.). Triform and quadriform apparatus have also been erected in Ireland. The adoption of the multiform system involves the use of lanterns of increased height. Another method of doubling the power of a light is by mounting two complete and distinct optics side by side on the same revolving table. This expedient has been frequently adopted by French designers.

"Orders" of Apparatus.—Augustin Fresnel divided his dioptric lenses into "orders" or sizes depending on their focal distance. This division is still used, although two additional "orders" known as "small third order" and "hyper-radial" respectively are in ordinary use. The following table gives the focal distance of the several sizes:—

TABLE II.

Order	Focal distance, mm.
Hyper-radial	1,330
1st order	920
2nd "	700
3rd "	500
Small 3rd order	375
4th order	250
5th "	187·5
6th "	150

Lenses of smaller focal distance are also made for buoy and beacon lights.

Light Intensities.—The powers of lighthouse lights given in the Admiralty *Lists of Lights* are expressed in terms of "lighthouse units" (one lighthouse unit = 1,000 pentane candles). In France the "*bougie decimale*" and in America the "American candle" are identical with the standard pentane candle. The Hefner unit used in Germany, Holland, etc., is 0·9 of the pentane candle. The intensity of a beam of light emitted from a dioptric apparatus depends upon the brilliancy or intrinsic brightness of the source of light and the projected area of the optical panel, in the case of a revolving light, or of the pillar of light in the case of an optic of fixed section. The theoretical value of the intensity can be computed from the formula $I = iA$. Where I is the total intensity of the emergent beam; i is the mean intrinsic brightness obtained by dividing the total light intensity of the source by the area of its projected image in various planes and A the projected area of the optical panel (for revolving apparatus) or the height of glass multiplied by the breadth of the illuminating source (for optics of fixed section).

In practice, owing to the inequalities of the illuminating source and the losses due to refraction, reflection and absorption experienced by the rays in their passage through the optical elements and the lantern glazing, the actual value is found to be about 50% of the theoretical value. By the addition of a mirror the intensity of that part of the panel reinforced by it is increased by about 30%. Deductions must be made in the case of coloured lights (*see* paragraph on "coloured lights," p. 92).

The mathematical theory of optical apparatus for lighthouses and formulae for the calculations of profiles will be found in the works of the Stevensons, Chance, Allard, Reynaud, Hopkinson, Ribière and others.

ILLUMINANTS

The earliest form of illuminant used for lighthouses was a fire of coal or wood set in a brazier or grate erected on top of the lighthouse tower. Until the end of the 18th and even into the 19th century this primitive illuminant continued to be almost the only one in use. The coal fire at the Isle of May light continued until 1810 and that at St. Bees lighthouse in Cumberland to 1823. Fires are stated to have been used on the two towers of Nidingen, in the Kattegat, until 1846. Smeaton was the first to use any form of illuminant other than coal fires; he placed within the lantern of his Eddystone lighthouse a chandelier holding 24 tallow candles each of which weighed ⅖ lb. and emitted a light of 2·8 candle power. The aggregate illuminating power was 67·2 candles and the consumption at the rate of 3·4 lb. per hour.

Oil.—Oil lamps with flat wicks were used in the Liverpool lighthouses as early as 1763. Argand, between 1780 and 1783, perfected his cylindrical-wick lamp which provides a central current of air through the burner, thus allowing the more perfect combustion of the gas issuing from the wick. The principle of the multiple-wick burner was devised by Count Rumford. Fresnel produced burners having two, three and four concentric wicks. Sperm oil was used in English lighthouses until 1846, but about that year the much cheaper colza oil was employed generally. Olive, lard, and cocoanut oils have also been used for lighthouse purposes in various parts of the world.

The introduction of mineral oil, costing a mere fraction of the expensive animal and vegetable oils, revolutionised the illumination of lighthouses. It was not until 1868 that a burner was devised which successfully consumed hydro-carbon oils. This was a multiple wick burner, invented by Captain Doty, which was quickly taken into use by lighthouse authorities. The "Doty" burner, and other patterns involving the same principle, remained practically the only oil burners in lighthouse use until the last few years of the 19th century.

Coal Gas.—Coal gas was introduced in 1837 at the inner pier light of Troon (Ayrshire) and in 1847 it was in use at the Heugh lighthouse (West Hartlepool). In 1878 cannel-coal gas was adopted for the Galley Head lighthouse, with 108-jet Wigham burners. Sir James Douglass introduced gas burners consisting of concentric rings, two to ten in number, perforated on the upper edges.

The invention of the Welsbach mantle placed at the disposal of the lighthouse authorities the means of producing a light of high intensity combined with focal compactness. For lighthouse purposes gaseous illuminants other than coal-gas are as a rule more convenient and economical, and give better results with incandescent mantles. Mantles have, however, been used with ordinary coal-gas in instances where a local supply of suitable types is available.

Incandescent Mineral-oil Burners.—Incandescent lighting with high-flash mineral oil was first introduced by the French lighthouse service in 1898 at L'Ile Penfret lighthouse. The incandescent burners now in use in lighthouse services all the world over are all made on the same principle, but differ in details. The principle consists in injecting the liquid petroleum under pressure into a vapourizer where it is heated by subsidiary jets and converted into vapour. This vapour issues from a nozzle and, drawing in air, passes into a chamber in the head of the burner where it mixes to form a combustible gas for the incandescence of the mantle; at the same time a small proportion of the gas is diverted to the subsidiary jets. A small reservoir of compressed air—charged by means of a hand-pump—is used for providing the

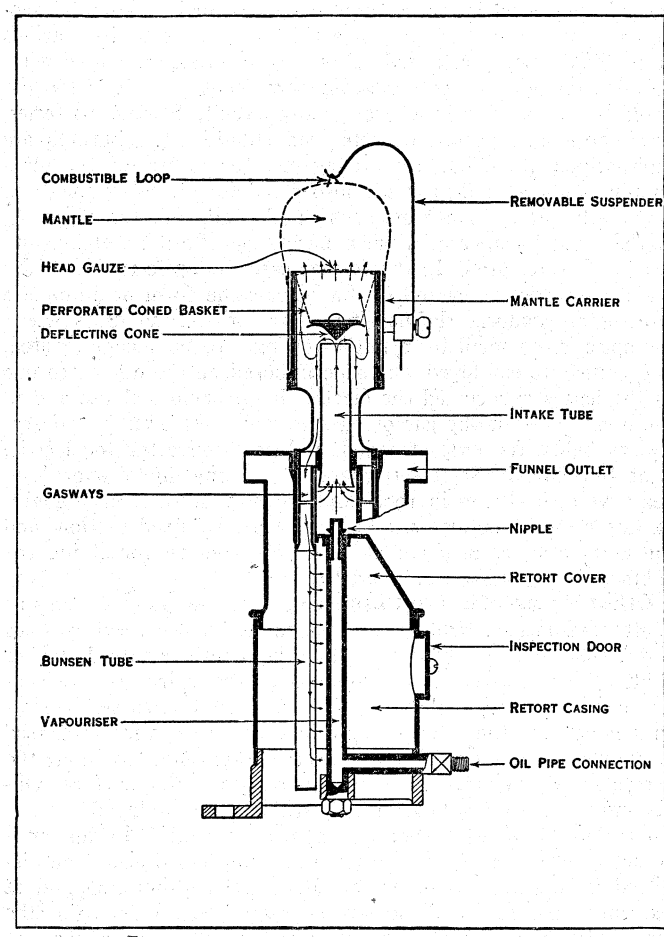


FIG. 13.—"HOOD" PETROLEUM-VAPOUR BURNER

necessary pressure for injection. On first ignition the vapourizer is heated by a spirit flame to the required temperature.

The candle-power of apparatus in which ordinary multiple-wick burners were formerly employed is increased more than six times by the substitution of suitable incandescent-oil burners. In 1902 incandescent-oil burners were adopted by the general lighthouse authorities in the United Kingdom. The "Hood" burner used in the Trinity House service is illustrated in fig. 13 and the "Chance" type in Plate II. The mantles are of the soft autoform (or self-forming) type which has taken the place of the collodin mantles employed in the older forms of burner. Particulars of the burners in ordinary use are as follows:—

Mantle diameter, mm.	Service intensity—standard candles	Intrinsic brightness per sq.cm. of projected area in standard candles	Consumption of oil—pints per hour
35	660	53	0·75
50	1,150	52	1·25
75	2,200	50	2·25
100	3,300	48	3·25

Oil Gas.—Pintsch's oil-gas system introduced in the '70s of the last century is the prototype of the several methods of gas lighting now employed for the majority of buoy and other unattended lights and, before the end of the 19th century was in general use in many countries. Incandescent oil-gas burners were introduced both for buoy and beacon lighting as well as for a few attended lights early in the 20th century. The use of ordinary oil-gas necessitates its periodical supply by means of large transport containers in which it is stored at a pressure of from 9 to 10 atmospheres, a disadvantage which has led to its gradual supersession by acetylene or other forms of oil-gas (*see* below).

An oil-gas, known by the name of its inventor, Blau, of Augsburg, has been employed to some extent, particularly in Germany and Holland, since about 1906 as a substitute for ordinary oil-gas. It is produced in retorts in much the same manner as the older variety but at a lower temperature (550°–600° C) and can be compressed to 100 atmospheres, at which pressure the hydrocarbons are liquefied. This liquid gas is stored and transported in cylinders weighing about 130 lb. and is expanded from them at about 9 atmospheres pressure into the body of the buoy or the receivers at the beacon or lighthouse. When it is used with an incandescent mantle of large size an intrinsic brightness of about 25 candle-power per sq.cm., or about 40% more than ordinary oil-gas, is obtainable.

Another variety of compressed oil-gas known as B.B.T., introduced in France about 1924, has also been used for buoy and beacon lighting. It does not liquefy at 140 atmospheres, at which pressure it is transported in containers each weighing about 2 cwt. It is burnt only in conjunction with an incandescent mantle and the intrinsic brightness obtained is slightly higher than that realized with Blau gas.

Acetylene.—Acetylene (*q.v.*) was first experimented with for buoy and beacon lighting about 1896, open-flame burners being used. An incandescent-mantle burner consuming acetylene was used at the Chassiron lighthouse (France) in 1902. Oil-gas, enriched by the addition of 20% of acetylene, was for a time used in Germany and Holland for buoy and beacon lighting. It was not, however, until about 1906, when the difficulties associated with its employment had been overcome by the introduction of dissolved acetylene, that the gas came into general use for coast lighting. Acetylene in this form is stored at a pressure of 10 to 15 atmospheres in cylinders, usually weighing about 2 cwt., filled with a porous material and charged with acetone in the presence of which the gas is dissolved. Owing to the higher intrinsic brightness of the flame and the convenient transport of the gas it is now in common use throughout the world not only for buoy and beacon lighting but also for many coast lights of secondary importance and unattended revolving lights, mantle burners being sometimes employed.

Acetylene generated on the spot on the carbide-to-water principle is nevertheless still used by some lighthouse authorities, for unattended lights. Comparatively frequent attention in renewing the charge is, however, required in these cases. The intrinsic brightness obtained in some incandescent-acetylene burners is about equal to that of autoform-mantle petroleum-vapour burners.

Electricity.—Electricity for lighthouse illumination was first experimented with in England in 1858 at South Foreland by Trinity House. This was followed by its adoption at Dungeness in 1862, and at Souter point on the coast of Durham in 1871. Both these installations were later abandoned, the former in 1874 and the latter in 1923 when a first-order biform flashing-light with incandescent oil-burner replaced it. Electricity was installed at St. Catherines in the Isle of Wight in 1888 and was also in use at the Isle of May lighthouse at the mouth of the Firth of Forth from 1886 to 1924. Arc lamps formerly provided the illuminant in all large apparatus, but the development of high power, gas-filled, electric-filament lamps has caused their supersession for lighthouse use. A special type of lamp with highly concentrated filament was evolved by the Dutch lighthouse service in 1918 and has been made in sizes up to 4 kw. (Some experimental 4 kw. lamps under trial in Holland [1928] have an intrinsic brightness of about 1,800 candles/cm^2. Lamps of 20 kw. have been used experimentally for aerodrome lighting.)

Economies have been effected by the introduction of these lamps combined with automatic electric equipment, and where in addition a local supply of current is available the reduction of maintenance charges at electric stations is considerable. For instance at the South Foreland, which has been a permanent electric station since 1872, an engineer and four keepers were formerly required to maintain the establishment, which included a steam electric-generating plant. With the introduction of the filament lamp and automatic equipment in 1926 the establishment was reduced to one keeper. High-tension cables were brought from Dover to the lighthouse; the clock machine revolving the lens is wound electrically; and a lamp-changer automatically replaces a lamp when the filament of the one in service burns out or brings a stand-by acetylene burner into focus if the electric supply fails. A tell-tale device in the keeper's quarters warns him if any derangement takes place. The filament lamp is 8,000 c.p., 80 v. and 50 amp., and has a mean intrinsic brightness of 1,000 candles/cm^2. A somewhat similar installation has been substituted for the arc lamp at the Lizard (1926), but in this case the current is generated at the lighthouse, the personnel being reduced from five to three. At other important coast lighthouses including Pendeen, Skerries and Hartland point (Plate II.), in order to obviate a watch being kept during fog both in the engine room and the lantern, electric light has been introduced in place of the petroleum-vapour lamps and the apparatus in the lantern made automatic. The electric current is generated by semi-diesel engines direct-coupled to the dynamos. Similar installations have been put into four new Trinity House light-vessels (1926–27).

Electricity was used at the old south lighthouse at La Hève (France) in 1863, and in 1910 there were 13 important electric lights on the French coast. Arc lamps were employed and generating plant, usually steam driven, was provided at each station. The high cost of maintaining such stations prevented any extension of their use on a large scale in France as in other countries; but since 1920 the conversion of some of the then existing electric stations to incandescent-filament lighting has been effected. At other stations too, where current from public supplies is available, electricity has been introduced. Blau gas is commonly employed for the stand-by burners in French electric lighthouses. In Holland several electric-arc and petroleum-vapour lights have been superseded by electric filament lamps since 1919. At Ameland, a generating set is provided and at Kijkduin, current is taken from the public supply.

MISCELLANEOUS LIGHTHOUSE EQUIPMENT

Modern lighthouse lanterns usually consist of a cast-iron or steel pedestal, cylindrical in plan, on which is erected the lantern glazing, surmounted by a domed roof and ventilator (fig. 12). Adequate ventilation is of great importance, and is provided by means of ventilators in the pedestal and a large ventilating dome or cowl in the roof. The astragals carrying the glazing are of wrought steel or gun-metal. They are frequently arranged helically or diagonally, thus causing a minimum of obstruction to the light rays in any vertical section and affording greater rigidity to the structure. The glazing is usually $\frac{1}{4}$ in. thick plate-glass curved to the radius of the lantern. In situations of great exposure the thickness is increased. Lantern roofs are of sheet steel or copper secured to steel, gunmetal or cast-iron rafter frames. At certain lighthouses it is found necessary to erect a grille or network outside the lantern to prevent the numerous sea birds, attracted by the light, from breaking the glazing by impact. Lanterns vary in diameter from 5 to 16 ft. or more, according to the size of the optical apparatus. For first-order apparatus a diameter of 14 ft. is usual and 12 ft. for second-order.

The lantern, gallery handrails and principal metallic structures in a lighthouse should be connected to a copper lightning conductor (*q.v.*) carried to a point below low water or terminating in an earth plate embedded in wet ground.

Revolving-light apparatus are rotated by clockwork mechanism actuated by weights or spring driven. The clocks are fitted with speed governors and also warning apparatus to indicate when re-winding is required. Where current is available small electric motors are often employed either for automatic re-winding of the clockwork or for driving the rotating mechanism direct. In modern gas-lit apparatus the pressure of the gas is sometimes made use of to revolve the lens table.

At rock and other isolated stations, accommodation for the keepers is usually contained in the towers. In the case of land lighthouses, dwellings are provided in close proximity to the tower. The watch room should be situated immediately under the lantern floor. Oil is generally stored in galvanized steel tanks.

UNWATCHED AND UNATTENDED LIGHTS

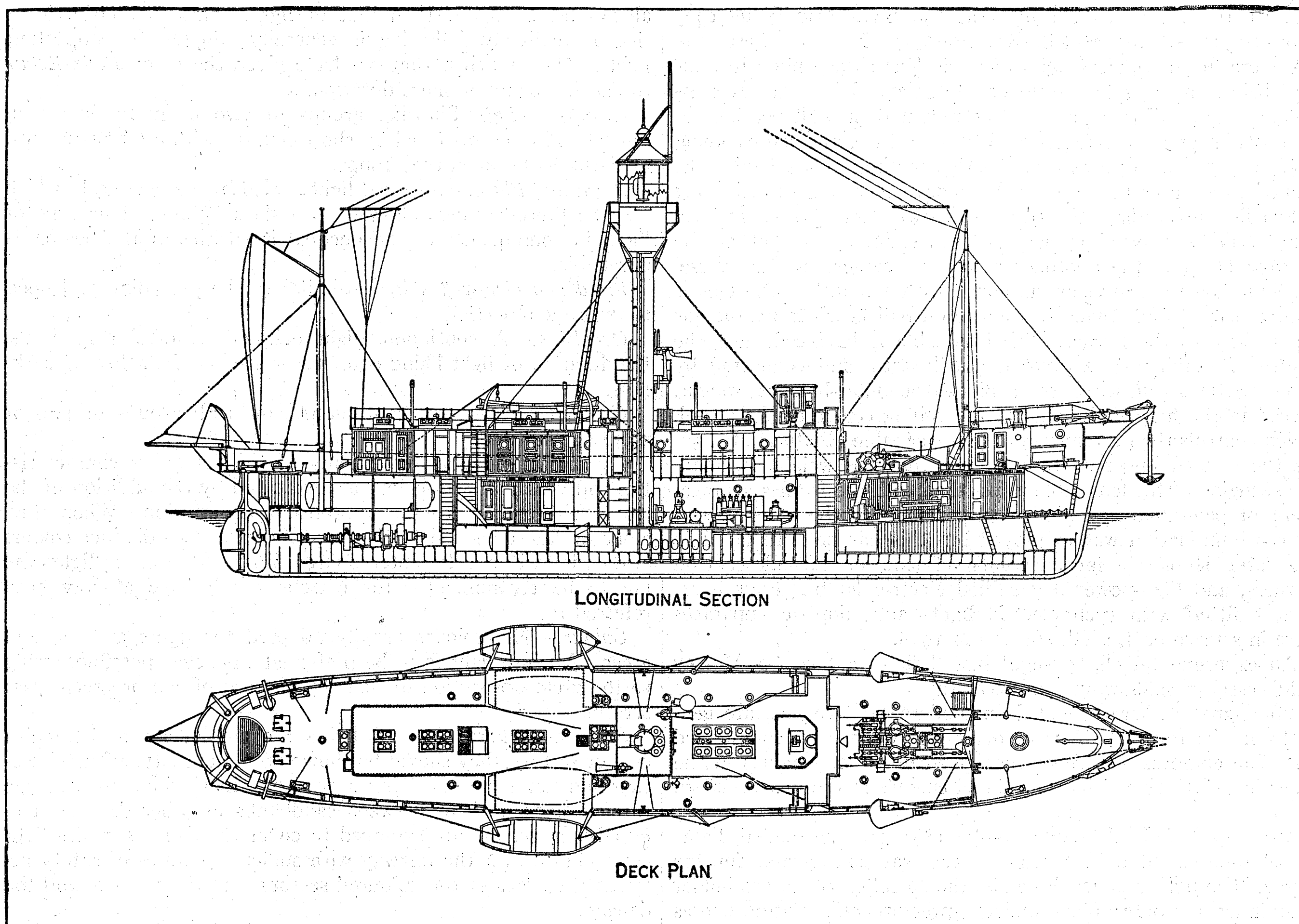
Electric.—Since 1884, when an iron beacon lighted by an incandescent-electric lamp supplied with current from a secondary battery was erected on a tidal rock near Cadiz, various forms of electric unattended lights have been experimented with. In 1928 many such lights were in permanent use where current could be obtained from a local supply circuit. Storage batteries, small automatic generating sets, and stand-by gas burners are alternatively provided to guard against the failure of the main supply. Automatic devices are also fitted for changing one lamp for another if the lamp in focus should fail, and for switching in the stand-by apparatus when necessary. Both revolving and fixed optics are used. In the former case the optic is rotated by a small electric motor and in the latter some form of automatic interrupter produces the flashing characteristic. In cases where the optic is too small for a burner changer to be accommodated, two lenses are employed, one superimposed on the other. In one of the lenses is focussed the electric lamp in normal use and in the other the stand-by gas or electric lamp. An example of secondary lights, formerly attended, and now converted to electric, is at Burnham in Somerset where two leading lights over $\frac{1}{4}$ m. apart were so altered in 1928, and are now unwatched at night. In this case the optics (*see* Plate II.) are of fixed section, and the automatic features include a flashing device for giving the lights their respective characteristics.

Other Forms of Beacon Lighting.—Among other systems of unattended beacon lighting adopted in lighthouse services since about 1880, but now little used, may be mentioned the Lindberg light, a Swedish invention employing a volatile spirit; the Benson-Lee lamp having a carbon-tipped wick; the French permanent-wick lamp; and the Wigham lamp in which a flat wick immersed in petroleum travelled over a horizontal roller so that the petroleum was volatilised from a constantly renewed surface. Oil-gas, mostly in its modified forms is still largely employed.

Acetylene Lights.—The gas is provided either by an automatic generator or else in the form of compressed acetylene dissolved in acetone. In order to reduce the consumption and at the same time give a distinctive characteristic to the light, the gas is usually passed through an automatic flashing mechanism which works continuously until the supply is exhausted. Waste of gas during daylight is sometimes obviated by using a sun-valve, which is a device to turn off the gas at daybreak and turn it on at dusk. Sun-valves depend for their automatic action on the differential expansion of two distinct metals under the influence of light rays or on the difference in the absorption of light rays by black and bright bodies respectively. The movement of a lever arm, brought about by a small movement of the light-sensitive element, actuates a valve which opens and closes the gas supply. Acetylene in unattended lights is burnt either as an open flame or in conjunction with a mantle.

The "Aga" system of acetylene lighting, developed in Sweden about 1904, has been extensively used both in that and other countries for all classes of unattended lights, including buoys. It was first adopted in England in 1913. Other systems embodying similar principles are also in use. The "Dalen" incandescent mantle burner embodies a mix-flasher which automatically controls the character of the light and regulates the mixing of air and gas for consumption in an inverted soft-mantle burner.

In some unattended lights with acetylene illumination the lenses are rotated by a gas pump as the gas passes to the mixer and burner, the lens table moving on ball bearings or a mercury float; the sun-valve automatically controls the duration of lighting; a pilot jet serves to re-ignite the main burner at sunset; and an automatic changer provides for the replacement of a broken mantle. Incandescent mantle burners and acetylene equipment have also been installed in a number of lighthouses of secondary importance, formerly attended by keepers, and now converted to unwatched or semi-watched lights. Among such in



BY COURTESY OF THE CHIEF ENGINEER, NETHERLANDS LIGHT SERVICE

FIG. 14.—THE MAAS LIGHT-VESSEL (NETHERLANDS LIGHT SERVICE), A SELF-PROPELLED LIGHT-VESSEL MOORED IN THE NORTH SEA ABOUT EIGHT MILES FROM THE HOOK OF HOLLAND. THE LIGHT IS ELECTRIC, OF ABOUT 270,000 C.P. THE SHIP HAS THREE FOG-SIGNALS; VIZ., A COMPRESSED-AIR SIREN, A SUBMARINE OSCILLATOR AND A WIRELESS FOG-SIGNAL, THE TWO LAST BEING SYNCHRONISED

England are the lights at the Rock (Liverpool); Great Orme Head and St. Tudwall (Carnarvonshire); Berry Head (S. Devon); Peninnis Head (Scilly Isles); East Usk (Mon.); and Great Castle Head (Pembrokeshire). The Menai lighthouse has been fitted with an open-flame acetylene equipment. In some cases, where the consumption of gas is large, acetylene generators on the carbide-to-water system have been installed, as at the Inner Fern and Bamburgh lights on the coast of Northumberland, and the two first-order leading lights at Hurst (Plate I., fig. 3), on the mainland opposite the Isle of Wight.

Acetylene in the dissolved form is at present the best and most economical illuminant for entirely unwatched lights when electric current is not available. Its use has enabled many unattended lights to be established and maintained at a comparatively small cost in positions where a light attended by keepers would be impracticable as, for example, on some parts of the Australian coast.

LIGHT-VESSELS

The earliest light-vessel established in English waters was that placed at the Nore in 1732. The early lightships were of small size and carried lanterns of primitive construction suspended from the yard-arms. Modern light-vessels are usually of steel construction and are of various dimensions. The following may be taken as the limits in the Trinity House service:

Length	80 to 114 ft.
Beam	20 „ 26 „
Depth moulded	13 „ 15½ „
Displacement	200 „ 500 tons

The larger vessels are employed at outside and exposed stations, the smaller ships being stationed in sheltered positions and in estuaries. The moorings usually consist of 3-ton mushroom anchors and 1¾″ or 1⅝″ open-link cables. The lanterns used in some of the older vessels are 8 ft. in diameter surrounding the mast upon which they are hoisted at night and lowered to the deck level during the day. Fixed lanterns mounted on hollow steel masts are now gradually displacing the older type. The first English light-vessel so equipped was constructed in 1904.

Self-propelled light-vessels, some of which are of much larger dimensions than any British light-vessel, are employed at the majority of stations in the United States, and there are a few in exposed situations in other countries including France, Sweden, Holland (fig. 14) and Germany.

Until about 1895 the illuminating apparatus used in light-vessels was almost exclusively of catoptric form, consisting for the most part of 21 in. silvered paraboloidal reflectors, having mineral-oil burners in focus, hung in gimbals to preserve the horizontal direction of the beam. In a few cases incandescent-mantle burners or electric-filament lamps have been substituted for the old wick-burners in catoptric apparatus. Dioptric apparatus is now usually provided in new lightships, not only in Britain but in other countries also. The French lighthouse service in 1896 devised the first dioptric revolving light for a light-vessel. This ship, the Talais,[1] was lit by an incandescent oil-gas burner. A much larger vessel, the Sandettié, of 342 tons displacement, was completed in 1902. The new type of floating light was afterwards adopted by other lighthouse authorities, and many vessels constructed on the lines of the Sandettié were built during the first decade of the 20th century. In England the

[1]The Talais and another similar vessel constructed in 1899 were later converted into unattended light-vessels.

first of the class was stationed at the Swin Middle in 1905 (now—1929—at the Mid-Barrow Station). Most of these vessels were fitted with revolving dioptric lenses suspended in gimbals below the lens table and counterbalanced by a heavy pendulum weight. The apparatus was mounted on ball bearings in some cases and on a mercury float in others, the lenses being revolved by clockwork or gas. Another method of suspending the dioptric apparatus has recently been developed, the design being a Swedish invention. This device, known as the constant-level table, has been fitted in several vessels, including that at the Barrow Deep in the approaches to the Thames. In this vessel the illuminant is acetylene employed with a mantle. The lens is mounted on a table made to revolve on ball bearings by the gas on its way to the burner. The lens table is balanced, near the centre of gravity, on a pivot in the lantern, and connected by three vertical pull-wires to a pivoted counter-balance weight, placed in the hull of the ship at the rolling centre of the vessel, which controls the movement of the upper table (Plate II., fig. 5). As the motion imparted to the lower balance weight is small, the swinging of the lens table is less than with the former arrangement of pendulum and gimbal suspension. In the older vessels oil-gas illumination was employed but this has been replaced in the later ships by incandescent-acetylene or incandescent-oil burners, and high-powered gas-filled electric lamps. Four light-vessels fitted with such electric lights and dioptric apparatus were in service on English stations in 1928.

An experimental electric-light installation on board a Mersey light-vessel in 1886 proved unsuccessful.

Fog signals, where provided on modern light-vessels, are generally in the form of sirens or diaphones worked by compressed air. The compressors are driven by steam or oil engines in the older installations and by semi-diesel engines in the more modern vessels.

Unattended Light-vessels.—In 1881 an unattended light-vessel illuminated by Pintsch's oil-gas was constructed for the Clyde. The light was occulting and the vessel carried a gas-holder containing a supply of gas under a pressure of six atmospheres sufficient to maintain the light for three months. Bells are often fitted on this class of light-vessel, the clappers being swung by the roll of the ship or worked by a gas-operated machine.

The improvements made in recent years in the design and construction of unwatched lights and their proved reliability have made it possible for many attended light-ships in positions of secondary importance to be replaced by unwatched vessels. Large economies, both in the cost of construction and of maintenance, have thereby been effected. These unattended vessels range in size from small boats to large vessels, and are fitted with dioptric apparatus and acetylene or Blau-gas lighting.

Communication Between Light-vessels and the Shore.—As far back as 1886 experiments were instituted at the Sunk light-vessel, off the coast of Essex, with the object of providing telephonic communication with the shore by means of a submarine cable. In spite of great difficulties experienced in maintaining the cables several light-vessels were ultimately equipped with this means of communication, and cables were also laid to many pile lighthouses and isolated rock and island stations. Wireless telephone installations have now (1929) superseded all the cable communications with light-vessels.

DISTINCTION AND DISTRIBUTION OF LIGHTS, ETC.

The following are the various light characteristics which may be exhibited to the mariner:—

Fixed.—Showing a continuous or steady light. Seldom used in modern lighthouses and generally restricted to small port or harbour lights. A fixed light is liable to be confused with lights of shipping or neighbouring shore lights.

Flashing.[1]—Showing a single flash, the duration of darkness always being greater than that of light. This characteristic or that immediately following is generally adopted for important lights. The French authorities have given the name *Feux-Éclair* to flashing lights of short duration.

Group-flashing.—Showing groups of two or more flashes in quick succession separated by short eclipses with a larger interval of darkness between the groups.

Fixed and Flashing.—Fixed light varied by a single flash, which may be preceded and followed by a short eclipse. This type of light, in consequence of the unequal intensities of the beams, is unreliable.

Fixed and Group-flashing.—Similar to the preceding and open to the same objections.

Occulting.—A continuous light eclipsed at regular intervals, the duration of light being equal to or greater than that of darkness.

Group Occulting.—A continuous light with groups of two or more occultations.

Alternating.—Lights having any of the foregoing characteristics and which alter in colour are indicated by the addition of the word "alternating" to the appropriate description. When used alone in describing a light the word indicates two distinct colours alternating without any intervening eclipse. Alternating lights are not to be recommended for reasons which have already been referred to.

Colour.—The colours usually adopted for lights are red and green. A white light is to be preferred whenever possible, owing to the great absorption of light by the use of red or green glass screens.

Sectors.—Where coloured lights are employed to distinguish cuts or sectors, they should be shown from apparatus of fixed section and not from revolving apparatus. In marking the passage through a channel, or between sandbanks or other dangers, coloured-light sectors are arranged to cover the dangers, white light being shown over the fairway with sufficient margin of safety between the edges of the coloured sectors next the fairway and the dangers.

Choice of Characteristic and Description of Apparatus.—In determining the choice of characteristic for a light, due regard must be paid to existing lights in the vicinity. No light should be placed on a coast line having a characteristic the same as, or similar to, another in its neighbourhood unless one or more lights of dissimilar characteristic, and at least as high power and range, intervene. In the case of landfall lights the characteristic should differ from any other within a range of 100 m. In narrow seas the distance between lights of similar characteristic may be less. Landfall lights are the most important of all and the most powerful apparatus available should be installed at such stations. The distinctive characteristic of a light should be such that it may readily be recognized by a mariner without the necessity of accurately timing the period or duration of flashes. For landfall and other important coast stations flashing dioptric-apparatus of the first-order (920 mm. focal distance), or its equivalent in power, with powerful burners are required. In countries where the atmosphere is generally clear and fogs are less prevalent than on the coasts of Britain, second- or third-order lights suffice for landfalls, having regard to the high intensities available by the use of improved illuminants. Secondary coast lights may be of second-, third- or fourth-order of flashing character, and important harbour lights of third- or fourth-order. Less important harbours and places where considerable range is not required, as in estuaries and narrow seas, may be lighted by flashing lights of fourth-order or smaller size. Where sectors are requisite, occulting apparatus should be adopted for the main light: or subsidiary lights, fixed or occulting, may be exhibited from the same tower as the main light but at a lower level. In such cases the vertical distance between the high and the low light must be sufficient to avoid commingling of the two beams at any range at which both lights are visible. Such commingling or blending is due to atmospheric aberration.

Range of Lights.—The range of a light depends first on its elevation above sea-level and secondly on its intensity. Most

[1]For the purposes of the mariner a light is classed as flashing or occulting solely according to the duration of light and darkness and without any reference to the apparatus employed. Thus the light shown by a fixed apparatus, in which the light source is mechanically eclipsed but yet the period of darkness is greater than that of light, is classed in the Admiralty *List of Lights* as a "flashing" light.

important lights are of sufficient power to render them visible at their full geographical range in clear weather. On the other hand there are many harbour and other lights which do not meet this condition.

The distances from which lights are visible, given in lists of lights—except in the cases of lights of low power for the reason given above—are usually calculated in nautical miles as seen from a height of 15 ft. above sea-level, the elevation of the lights being taken as above high water. Under certain atmospheric conditions, and especially with the more powerful lights, the glare of the light (by reflection from the clouds) may be visible considerably beyond the calculated range.

TABLE III.

DISTANCES AT WHICH OBJECTS CAN BE SEEN AT SEA, ACCORDING TO THEIR RESPECTIVE ELEVATIONS AND THE ELEVATION OF THE EYE OF THE OBSERVER.* (A. STEVENSON)

Heights in feet	Distances in nautical miles	Heights in feet	Distances in nautical miles
5	2·565	120	12·56
10	3·628	150	14·02
15	4·443	200	16·22
20	5·130	250	18·14
30	6·283	300	19·87
40	7·255	400	22·94
50	8·112	500	25·65
60	8·886	600	28·10
70	9·598	700	30·28
80	10·26	800	32·45
100	11·47	900	34·54
		1000	36·28

**Example:* A light 200 ft. high will be visible 22.50 nautical miles to an observer, whose eye is elevated 30 ft. above the water; thus, from the table:

30 ft. elevation, distance visible 6·28 nautical miles
200 ,, ,, ,, ,, 16·22 ,, ,,
22·50 ,, ,,

Elevation of Lights.—The elevation of the light above sea-level need not, in the case of landfall lights, exceed 200 ft., which is sufficient to give a range of over 20 nautical miles. One hundred and fifty feet is usually sufficient for coast lights. Lights placed on high headlands are liable to be enveloped in banks of fog at times when at a lower level the atmosphere is comparatively clear (*e.g.*, the old Beachy Head light). No definite rule can, however, be laid down, and local circumstances, such as configuration of the coast line, must be taken into consideration in every case.

Choice of Site.—Landfall stations should receive first consideration and the choice of location for such a light ought never to be made subservient to the lighting of the approaches to a port. Subsidiary lights are available for the latter purpose. Lights installed to guard shoals, reefs, or other dangers should, when practicable, be placed seaward of the danger itself, as it is desirable that seamen should be able to "make" the light with confidence. Sectors marking dangers seaward of the light should not be employed except when the danger is in the near vicinity of the light. Outlying dangers require marking by a light placed on the danger or by a floating light in its vicinity.

LIGHTED BUOYS

Pintsch's oil-gas was first used for a light carried on a buoy in 1878. An automatic occulter, worked by the gas passing from the reservoir to the burner, was introduced in 1883. The majority of buoy lights lit by oil-gas are fitted with multiple-jet or Argand burners, but incandescent mantles are also employed. Ordinary oil-gas has been largely superseded by other forms of gas illumination (*see* p. 96). Gas buoy-lights are usually provided with sufficient storage capacity to run the light unattended for three months or longer. The lanterns used for all forms of buoy lighting are self-contained with cylindrical dioptric lenses of fixed-light section usually 150 to 375 mm. diameter. Some of the largest types of gas buoy in use have an elevation from water level to the focal plane of over 26 ft., and a beam intensity of more than 1,000 candle-power. One buoy placed at the entrance to the Gironde in 1907, has an elevation to the focal plane of 34 feet. Spar buoys may be adopted for situation where strong tides or currents prevail.

Acetylene Gas Buoys.—Although some experimental work was done as early as 1896, acetylene gas was first regularly used for buoy lighting early in the 20th century when automatic water-to-carbide generators were employed in Canada for producing the gas, the generators being placed in the body of the buoy. This system never gave entirely satisfactory results and its use is attended by danger of explosion. It has almost everywhere been superseded by the dissolved acetylene system first applied to buoy lighting in Sweden. The normal acetylene buoy equipment maintains the light without recharging up to 12 months (fig. 15).

Electric Buoys.—Buoys have been fitted with electric light both fixed and occulting. Six spar buoys were laid down in the Gedney channel, New York Lower Bay, in 1888. The wear and tear of the cables, by which current was supplied from a shore station, caused considerable trouble and expense, and the lights were replaced by gas-lighted apparatus in 1904. Electric buoys were also used extensively in Germany early in the present century; but in 1929, very few, if any, examples of this method of buoy lighting remain in service.

Bell and Whistling Buoys.—Bells or whistles are frequently fitted to gas buoys as well as to unlighted marking buoys. An acetylene lighted whistle-buoy is illustrated in fig. 15. Submarine bells have also been fitted to buoys but their functioning in such positions is unreliable.

AERIAL LIGHTS

Light signals are needed by air craft in night flying, just as they are required by the mariner. Air craft travel in three dimensions and also at higher velocities than a ship. Light signals for the guidance of an airman must therefore be at short intervals and must be visible from the horizon up to the zenith. One form of optical apparatus for an aerial lighthouse comprises a lower section similar to the portion below the focal plane of a marine revolving light; above this is a section of a fixed-light optic with its axis horizontal instead of vertical as in a marine fixed-light. The lower revolving lens emits a high-power beam of light of small angle with its axis just above the horizontal while the upper segment throws a narrow band of light of lower power from the horizontal to the vertical. Although an airman would pick up the main beam emitted by such an apparatus at, say, 30 m., he would be above it (if flying at a height of about 6,000 ft.), when at a distance of about 20 m. and not near enough to pick up the weaker beam. To compensate for this the lower lens and the illuminant are made of such dimensions and power that the main beam is stronger than is actually required in the direction of its axis and a portion of the rays from this beam is bent upwards by means of refracting prisms placed in front of the panel, thus reinforcing the light in the direction where additional power is required (fig. 16). The effect of this adjustment is shown by the range curve. The optical apparatus is rotated on a mercury float or on ball bearings as in a marine lighthouse.

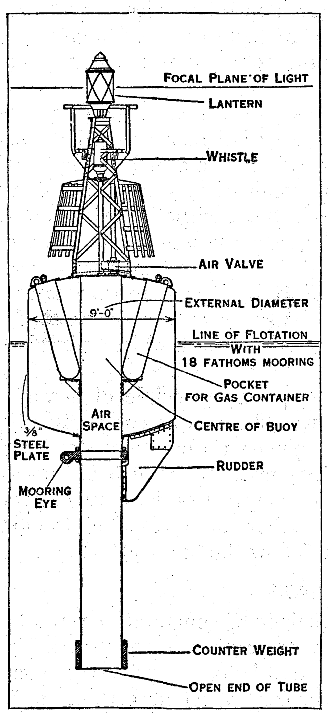
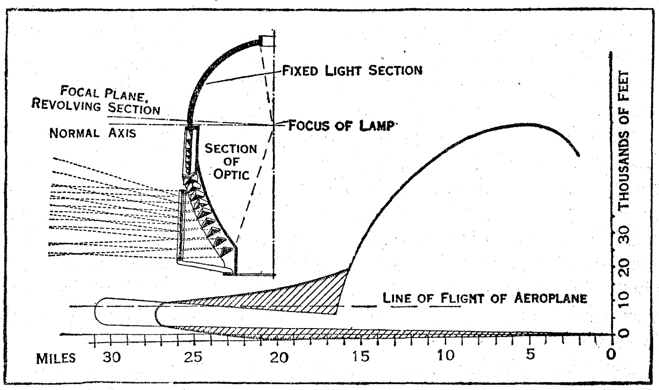


FIG. 15.—ACETYLENE-LIGHTED WHISTLING BUOY (TRINITY HOUSE) The body is welded steel; the whistle is sounded by the motion of the buoy compressing air in the central tube

In some aerial apparatus, as at Cranbrook (Kent), reflecting mirrors are used as well as refractors in front of the lower part of the lens, and refracting prisms are employed instead of the fixed-light lens in the upper part of the apparatus.

Both catoptric and dioptric apparatus have been employed in France in the construction of aerial lighthouses, and in some of them powerful electric-arc lights have been used. The aerial light at Dijon (1925) is of great power and is made up of four sets of double dioptric lenses (8 in all) of 500 mm. focal distance, having an arc lamp at the focus of each lens, projecting parallel beams



BY COURTESY OF MESSRS. CHANCE BROTHERS

FIG. 16.—VERTICAL SECTION OF A PANEL OF AN OPTIC FOR AN AERIAL LIGHTHOUSE AND THE RELATIVE RANGE-CURVE

of light in groups of four. The lighthouse at Mont Valérien, near Paris (1926) is provided with catoptric projectors of gilded metal, a portion of the series of mirrors being arranged to direct the light rays in directions between the margins of the main beams and the zenith. The electric arc is also employed in this case. At Le Bourget a fourth-order dioptric apparatus is installed with a gas-filled electric lamp of 8,000 c.p. in focus. Lanterns containing the apparatus of aerial light have glazed roofs as well as the side glazing usual in marine lighthouses.

Neon tubes emitting a red light have been used at the Croydon aerodrome since 1924 for the guidance of airmen in fog because of the large percentage of red rays which have a higher power of penetration in fog. The Croydon beacon is of 13,500 c.p. and consists of clusters of Neon tubes, 16 ft. long, without lenses or reflectors of any description. A flashing characteristic is given to the signal by interrupting the current. Many of these lamps are in use in the United States, Germany and France. It is doubtful whether the Neon tube under fog conditions is superior to other methods of aerial lighting by means of which beams—both white and red—of much higher total intensity can be projected.

In Great Britain and France the guiding principle of airways lighting is (in 1929) to provide powerful lights at comparatively long distances apart, which can be picked up by airmen at long range flying either low down or at comparatively high altitudes. In the United States and in Germany the practice is to lay a series of comparatively low-power lamps at short intervals along the air route, the airmen being expected to follow the line marked out.

FOG-SIGNALS

The introduction of coast fog-signals is of comparatively recent date. They were, until the middle of the 19th century, practically unknown except so far as a few isolated bells and guns were concerned. In times of fog the mariner can expect no certain assistance from even the most efficient system of coast lighting, since beams of light of high power are frequently entirely dispersed and absorbed by the particles of moisture, forming a sea fog of even moderate density at relatively short distances from the shore. The careful experiments and scientific research which have been devoted to the subject of aerial-acoustic fog-signalling have produced much that is useful and valuable to the mariner, but unfortunately the practical results thus far obtained have not been so satisfactory as might be desired owing to (1) the very short range of the most powerful signals yet produced under certain unfavourable acoustic conditions of the atmosphere, (2) the difficulty experienced by the mariner in judging at any time how far the atmospheric conditions are against him in listening for the expected signal, and (3) the difficulty in locating the position of a sound signal by phonic observations. The future of marine fog signalling may lie in the direction of wireless signals, but it is unlikely that acoustic signals will be dispensed with even if reduced in number.

Bells and Gongs are the oldest and, generally speaking, the least efficient forms of fog signals. Under very favourable acoustic conditions the sounds are audible at considerable ranges. On the other hand, 2-ton bells have been inaudible at distances of a few hundred yards. Bells are frequently used for beacon and buoy signals. When employed in conjunction with a lighted beacon they are sometimes rung mechanically either by clockwork or by compressed CO_2 gas. Electric striking mechanism has also been employed where current is available.

Explosive Signals.—Guns were long used at many lighthouse and light-vessel stations in Great Britain, and are still found at some foreign stations. In 1878 sound rockets charged with gun-cotton were first employed at Flamborough Head and were afterwards supplied to many other stations.[1] The nitrated gun-cotton or tonite signals now in general use at rock and other lighthouses where accommodation is limited are hung at the end of an iron jib or pole attached to the lantern or other structure, and fired by means of a detonator and electric battery. An example will be noticed in the illustration of the Bishop rock lighthouse, the jib being attached to the lantern (fig. 4). Sometimes the explosive is combined with aluminium in the charge to give a brilliant flash in addition to the detonation.

The acetylene fog-gun is an automatic or semi-automatic signal in which a mixture of air and acetylene is exploded at short intervals in a gun chamber. It is economical in working cost and occupies little space; but its power cannot be compared with that of a compressed-air siren. The admission of air and acetylene is controlled by an automatic gas-valve and the charge is fired by a spark. Signals can be sounded as frequently as every ten seconds.

An acetylene gun was established at the Dhu Heartach rock lighthouse (west coast of Scotland) in 1912. The gun continues in action without attention from the time when it is started until it is stopped by the keeper. The gas is generated automatically on the carbide-to-water principle.

On the Clyde there are two isolated beacon structures which are equipped with automatic guns started and stopped by wireless control from Gourock pier. Several other stations in Scotland and elsewhere are provided with these guns.

Whistles and Reed Horns.—Whistles, whether sounded by air or steam, are not used in Great Britain although they are still employed as fog signals in the United States, Canada and Sweden. It has been objected that their sound bears too great a resemblance to steamers' whistles; and they are wasteful of power.

Reed horns, in their original form, were the invention of C. L. Daboll, an experimental one, of his manufacture, being tried in 1851 by the United States Lighthouse Board. The reed horn was adopted by Trinity House in 1862 after being improved by W. Holmes and many examples from his designs are now in use at secondary stations in Britain and America. Normally they are sounded at a pressure of 15 lb. per in. with air furnished by power-driven compressors, semi-diesel engines being commonly used in modern installations. When operated by hand the working pressure is 5 lb. per square inch.

Sirens and Diaphones.—These are considered to be the most efficient aerial sound-signals which can be obtained for lighthouse purposes. One or other of them is usually employed when first-class signals are required and space is available for the accommodation of the necessary plant. Both are compressed-air instruments, but differ somewhat in operation. The diaphone, in its modern form the more powerful instrument, was invented in Canada by J. P. Northey, about 1903, and consists of a piston reciprocating in a cylinder, around both of which are cut circumferential slots or ports. The piston is fitted with an operating head to which air is admitted, first on one side and then on the other, for giving to it the reciprocating motion. As the slots in the two units pass and repass one another, air is being admitted through them to produce the impulses or sound waves, and upon the number of times these ports open and close each second de-

[1]The Flamborough Head rocket was superseded by a siren fog signal in 1908.

pends the note. In the case of the siren the piston revolves in the cylinder instead of having a reciprocating motion, but otherwise the principle of air admission is the same in both instruments. Each is fitted with a trumpet-horn or resonator and the working air-pressure is 30 lb. per sq.in. for the diaphone and 25 lb. per sq.in. for the siren. The diaphone note is usually about 180 vibrations per sec. or F sharp in the tenor clef; it terminates with a quick descending note termed the "grunt" at the end of each blast. This grunt is a valuable distinctive feature as it can sometimes be heard when the remainder of the signal is inaudible.

To provide the air for these instruments compressing machinery and large capacity air storage receivers are required. In recent Trinity House installations two instruments with their axes approximately 120° apart horizontally are fitted for distributing the sound over a wide arc. In the diaphone installations at Flamborough, Hartland and Skerries (1927) the mouths of the two trumpets are placed on a common vertical axis with their centres half a wave-length apart, to give effect to the theory propounded by the third Lord Rayleigh that vertical dispersion of sound was by this means avoided. A similar arrangement has also been introduced at some French stations.

The siren in a primitive form was invented by John Robison (1739–1805). Cagniard de la Tour evolved the disc form and gave it the name of siren. The first steam siren was patented by Brown of New York. The cylindrical form and the centrifugal governor now commonly used are due to G. H. Slight.

Nautophones.—A form of aerial-acoustic instrument called the Nautophone has recently been devised which consists of an electrically vibrated diaphragm sounding a high note. In its present state of development (1929) it compares, as regards intensity, with a reed horn.

Submarine Bell and Oscillator Signals.—As early as 1841 J. D. Colladon conducted experiments on the lake of Geneva to test the suitability of water as a medium for transmission of sound-signals and was able to convey distinctly audible sounds through water for a distance of over 21 m.; but it was not until 1904 that any successful practical application of this means of signalling was made. Submerged bells are used principally in connection with light-vessels and are struck by clappers actuated by pneumatic or electrical mechanism. They have also been fitted to buoys and beacon structures, and placed on the sea bed. In the first case the bell is actuated by the motion of the buoy and in the others by electric current, transmitted by cable from the shore.

The oscillator or electro-magnetic submarine fog-signal is actuated electrically from the lightship to which it is attached or from the light station with which it is connected. The instrument, which came into use during the World War, comprises a vibrating diaphragm of large dimensions, and its principle of operation is similar to the working of a telephone. It sends out a high note to which can be given a characteristic code notation. The instrument has been fitted in several light-vessels in European and American waters. The underwater range of the oscillator has been known to exceed 50 m. as compared with 10 m. for the bell.

To take full advantage of the signals thus provided it is necessary for ships approaching them to be fitted with special receiving microphones installed below the water line and in contact with the hull plating. The signals are audible by the aid of ear-pieces similar to ordinary telephone receivers. Not only can they be heard at considerable distances and in all conditions of weather, but their direction in reference to the moving ship can be determined approximately. When they are established in conjunction with a wireless-beacon fog-signal and when the acoustic and radio-signals are made to synchronize, as at the Nantucket Shoals light-vessel (U.S.A.), they provide in combination a valuable means of determining distance by observing the interval of time between the reception of the two signals (*see* below).

Wireless Fog Signals.—Wireless fog signals,[1] designed for continuous transmission from light stations, provide a means by which a navigator may obtain a direct bearing on the transmitting station. They are of three types: (1) a stationary wireless-beacon transmitter from which a characteristic signal is sent out in all directions, so that it can be picked up by a ship fitted with a direction-finder or wireless-compass[1]; (2) a rotating short-wave directional wireless-beam transmitter, which sends out a different characteristic signal on all points of the compass as it revolves; these signals are received on a special aerial, and as the wireless beam is directional and as each signal represents a definite bearing, the particular signal heard gives the bearing of the ship from the station; (3) a rotating wireless-loop transmitter, which is revolved at a pre-arranged constant speed and sends out on north and east zero points a characteristic signal, followed during the remainder of its revolution by a continuous dash. The bearing in this case is taken by means of a stop-watch, in conjunction with an ordinary wireless receiver, and is obtained by noting the time which elapses between the hearing of one or other of the zero-point signals and the total extinction of the continuous dash. As the loop makes so many revolutions in a definite period, the determination of the bearing is merely a matter of computation between the speed of rotation and the time recorded by the stop-watch.

(1) *Wireless-beacon.*—Each system has its particular merits, but the first, that is, the beacon station, is probably the most effective of the three. It is comparatively cheap to install and easy to maintain, while the system is applicable either on shore or on board a light-vessel. Moreover, this form of wireless fog-signal necessitates a ship being fitted with a direction-finder which enables a bearing to be obtained not only of the beacon-station but also of other ships at sea during fog; or, as has frequently been proved with advantage, of a ship in distress. When the wireless-signal is combined with a submarine-signal and made to synchronize with it, distance from, as well as direction of, the station can be obtained.

A beacon-station of this type was established at Round island in the Scilly islands in 1927. In the beacon, a simple valve transmitter of ½ kw. power generating interrupted continuous waves is employed working on an open twin L aerial. The wave-length is 1,000 metres. Good bearings are obtainable from it at a distance of over 100 m. The whole equipment is automatically controlled, even to the replacement of transmitting valves in case of failure, by a master-clock which sends out signals every half hour by Greenwich mean time. During foggy weather the time interval is reduced. Little attention is required and it has been found practicable to run the station without addition to the lighthouse staff. Similar signals were established in 1928 at 12 other British stations, including two light-vessels and others were in course of erection. Wireless fog-signals of the same general type have been installed by other lighthouse services, notably those of the United States (where 57 stations were in operation in 1928), Holland, France, Sweden and Canada. An experimental station was established in France in 1912 but the first permanent wireless fog-signals were put into service in the United States in 1921 on light-vessels in the approaches to New York harbour.

(2) *Rotating-beam.*—A wireless fog-signal in the class of the second type has been established at Inchkeith in the Firth of Forth (1922). It works on a 6·2-metre wave-length and though the receiving apparatus is simple and inexpensive, the transmitter in its present state of development has disadvantages in that the range is small, and a large rotating structure is required for producing the beam. In addition, as the bearings must be given relative to a fixed zero, the system is inapplicable for use on a light-vessel.

(3) *Rotating-loop.*—The third system, which was developed by the Royal Air Force, possesses an advantage in that an ordinary receiving apparatus and stop-watch only are required for taking bearings, but the power employed is over ten times that of the beacon-transmitter for less range, while the cost is considerably greater. The cost of maintenance too is high, as

[1]Other designations are:—*Radio beacons, Radio fog-signals, Wireless beacons* and, in France, *Radiophares.*

[1]Synonyms are:—*Radio-compass* and *Goniometer.*

a careful watch must be kept on the timing of the rotation of the loop and the large power-plant requires constant attention. The transmitter is delicate and must be free from local interference if accuracy of bearing is to be assured; so that sites for this type of station have to be carefully selected. Like the second system, it cannot be applied on a lightship because of the necessity of having fixed zero-points. Loop stations have been established experimentally at Gosport and Farnborough and further trials of the system are being carried out at Orfordness.

Wireless fog-signalling and position-finding are (1929) still in the state of active experiment and development.[1] They are undoubtedly destined to be one of the most important navigational aids in the future. The desideratum appears to be a system, applicable to stations both ashore and afloat, which employs a wireless signal whose bearing is quickly and directly ascertainable by the navigator himself and which, when combined with submarine acoustic-signals, can be used for ascertaining distance.

LIGHTHOUSE ADMINISTRATION

The principal countries of the world possess organized and central authorities responsible for the installation and maintenance of coast lights and fog-signals, buoys and beacons.

British Isles.—In England Trinity House is the general lighthouse authority. The Corporation of Trinity House, or according to its original charter, "The Master Wardens and Assistants of the Guild Fraternity or Brotherhood of the most glorious and undivided Trinity and of St. Clement, in the Parish of Deptford Strond, in the county of Kent," existed in the reign of Henry VII. as a religious house with certain duties connected with pilotage, and was incorporated during the reign of Henry VIII. In 1565 it was given certain rights to maintain beacons, etc., but not until 1680 did it own any lighthouses. Since that date it has gradually purchased most of the ancient privately-owned lighthouses and has erected many new ones. The act of 1836 gave the corporation control of English coast-lights with certain supervisory powers over the numerous local lighting authorities, including the Irish and Scottish boards. The corporation now consists of a Master, Deputy-master, and 22 Elder Brethren (ten of whom are honorary), together with an unlimited number of Younger Brethren, who, however, perform no executive duties. In Scotland and the Isle of Man the lights are under the control of the commissioners of northern lighthouses, constituted in 1786 and incorporated in 1798. The lighting of the Irish coast is in the hands of the commissioners of Irish lights formed in 1867 in succession to the old Dublin Ballast board. The principal local light authorities in the United Kingdom are the Mersey Docks and Harbour board and the Clyde Lighthouse trustees. The three general lighthouse boards of the United Kingdom, by the provisions of the Mercantile Marine Act of 1854, are subordinate to the Board of Trade, which controls all finances.

On Jan. 1, 1928, the lights and fog-signals in service under the control of the several authorities in the British Isles were as follows:—

TABLE IV.

Authority	Light-houses	Minor lights	Light-vessels		Aerial-acoustic fog signals			Submarine fog signals	Wireless fog signals
			Manned	Unat-tended	Explosive	Sirens, diaphones, reed horns, etc.	Bells, etc.		
Trinity House	87	8	45	2	13	75	11	19	8
Commissioners of Northern Lighthouses	151	7	1	4	11	40	3	..	2
Irish Lights Commissioners	82	4	10	..	14	23	4	5	1
Mersey Docks and Harbour Board	14	17	3	..	..	5	7	1	1
Admiralty	3	31	..	..	..	4	1	..	..
Clyde Lighthouse Trust	5	12	..	..	2	3	2	..	..
Humber Conservancy	6	4	2	1	..	3	1	1	1
Other local lighting authorities	192	940	2	2	4	43	69	1	..
Totals	540	1023*	63	9	44	196	98	27	13†

*Lighted buoys and some harbour and river lights of minor character are not included in the above list.
†Including some signals established during 1928.

In the Trinity House service at shore lighthouse stations where there is no fog-signal there are usually two keepers, and at rock stations four, one being ashore on leave. At a shore fog-signal station there is an additional keeper. The crews of light-vessels as a rule consist of 11 men, three of them and the master or mate going on shore in rotation. The average annual cost of maintenance (excluding repairs) of an English shore lighthouse, with two keepers, is £477. For shore lighthouses with three keepers and a siren fog-signal the average cost is £811. The maintenance of a rock lighthouse with four keepers and an explosive fog-signal is about £1,310, and an electric-light station with a diaphone fog-signal costs about £1,200 annually to maintain. A light-vessel of the average type with a power-driven fog-signal entails in England an annual expenditure on maintenance of approximately £2,500, excluding the cost of periodical overhaul.

Other Countries.—The lighthouse board of France is known as the Commission des Phares, dating from 1792 and remodelled in 1811, and is under the direction of the minister of public works. The chief executive officers are an *Inspecteur Général des Ponts et Chaussées*, who is the director of the service, and another engineer of the same corps, who is engineer-in-chief and secretary. The board has control of about 770 lights, including those of Corsica, Algeria, etc. In Denmark, Austria, Holland, Italy, Sweden, Norway and many other countries the minister of marine has charge of the lighting and buoying of coasts; in Belgium the public works department controls the service, and in Spain the lighthouse service is established on lines similar to that of France.

In Canada the coast lighting is in the hands of the minister of marine, and in most of the other British dominions and colonies the public works departments have control of lighthouse matters. For the lighthouse service of the U.S.A. *see* following article.

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[1]*See* G. R. Putnam, *Radio Fog-Signals* (Washington, Government Press, 1924, and supplements *seq.*); also *Proc.* Inst. El. Engrs. (*passim*) and Admiralty *List of Wireless Signals* (London, annually).

Chaussées; Mémoires de la Société des Ingénieurs Civils de France, and the *Proceedings* of the International Navigation Congresses contain many valuable papers. The official publications of the French Lighthouse service, the Admiralty *Lists of Lights,* and similar issues should be consulted by those specially interested. *See* also *Passim* technical journals such as *The Engineer, Engineering,* and *Le Génie Civil.*

(N. G. G.; J. P. Bo.)

THE UNITED STATES

The first lighthouse in America, a tall masonry tower, was built in 1716 by Massachusetts at the entrance to Boston harbour. The original Colonies on the Atlantic, largely dependent on water traffic, gave early attention to lighthouses. Congress, in 1789, immediately after the national government's organization, provided for lighthouses and buoys, 12 having been built by the colonial governments. In 1852 Congress established the Lighthouse Board, substituting for it in 1910 the Lighthouse Service. On July 1, 1939 the Lighthouse Service was consolidated with the U.S. Coast Guard, in the Treasury Department.

The problems of lighthouse construction are similar everywhere in the world, but the Great Lakes and north Atlantic ice action, southern coast hurricanes, and some earthquake areas need particular attention. This country has about 30 important lighthouses on submarine or unusually exposed sites, some involving difficult engineering; only a few of these are wave-swept lighthouses of primary significance. The following are important or typical wave-swept U.S. lighthouses:

Minots Ledge (1860), south of Boston harbour, the most notable, built on a reef, bare only at low water, exposed to the Atlantic's sweep; its construction lasted over 5 years. Steps were cut to receive the foundation. The conical-shaped tower is of granite, the first 40 ft. solid, base 30 ft. diameter, the light elevated 85 ft. The stones are dove-tailed in each course, connected vertically by bonding bolts, and eight long iron posts pass through the lower courses into holes in the ledge.

White Shoal (1910), marking a shoal in northern Lake Michigan. A timber crib 72 ft. square towed to the site, filled with stone, was sunk in 22 feet of water; this supports concrete pier, tower and light 125 feet above water. *Martin Reef* (1927), northern Lake Huron, has a similar substructure.

On the Great Lakes important structures on submarine foundations mark shoals, usually replacing the original lightships. Timber crib foundations, economical, satisfactory in fresh water, are favoured. Other types are: Concrete caissons towed to site, sunk on bottoms previously levelled, and filled with stone, i.e., *Lansing Shoal* (1928), Lake Michigan. *Spectacle Reef* (1874), Lake Huron and *Stannard Rock* (1882), Lake Superior have coffer-dams in protecting piers, the former for a stone tower on rock, the latter for a wrought iron cylinder foundation pier fitted to rock and concrete-filled.

Sabine Bank (1906), marking a sand bank about 14 m. off the Gulf coast, is a cast iron tower and substructure, standing in 18 feet of water. The iron caisson was towed to the site and sunk 20 ft. in sand by pneumatic process, the only U.S. lighthouse foundation so placed in the open sea. There are others in protected waters.

Pacific Reef (1921), marking the outer edge of coral reefs off the Florida southern coast. It is supported by nine iron piles, each driven 9 ft. into the coral reef, the piles pass through, and are partially supported by, iron discs 4 ft. in diameter resting on the coral surface. In 7 ft. of water, it supports an iron open work structure. Although only an automatic acetylene light, 45 ft. high, it illustrates recent practice, at moderate cost. Six other lights, along the Florida reefs, on similar foundations, are notable structures, the tallest being *Sombrero Key* (1858), 160 feet.

Tillamook Rock (1881), a stone structure on a small rock islet 1 m. off the Pacific coast, south of the Columbia river's mouth, the most notable lighthouse on the United States western coast due to its position on extremely exposed rock, in deep water and open to the Pacific sweep. Landing is impossible directly on the rock, and can be made only by hoisting from a boat. Seas break sometimes over the lantern 145 ft. elevation. *St. George Reef* (1891) off the California coast is in a similarly difficult position.

Many lighthouses in water were built on screw-pile foundations, but none recently; one, *Sand Key Light* (1853), Florida, is 120 ft. high. Of many handsome masonry lighthouses along the coast, especially the low-lying Atlantic seaboard, *Cape Hatteras* is the highest, 193 feet though not now used for lighthouse purposes. Reinforced concrete has been extensively used recently to construct light towers, wharves and buildings.

The most notable is *Navassa Island Light* (1917), on a desert West Indian island, tower 162 ft., cylindrical shaft 15 ft. diameter. Another primary light of reinforced concrete is *Kilauea Point* (1913), Hawaiian islands; tower 52 ft. high, on a cliff.

Apparatus, Illuminants and Characteristics of American lights are similar to standard world practice, but have some diverging developments. Concentrating light by using rapidly revolving lenses with few panels, and superior illuminants, gives beams of sufficient power with smaller lenses; no lenses larger than third order (500 mm., 20 in. radius) have been installed since 1913; numerous large lenses, have been replaced by more efficient optical apparatus.

The primary light standard, the electric incandescent lamp, using commercial current or current generated at the station, has replaced the older kerosene oil vapour apparatus. Incandescent electricity is most satisfactory because of its power, convenience and adaptability. It is efficient to electrify certain stations for illuminant, operating sound fog signal and radio-beacon, and lighting buildings.

Electricity is very convenient for signals controlled remotely, as those near jetty ends. Small plants or primary cells generate electric energy for minor lights. The principal difficulty in putting incandescent electric lamps in old lenses is the too concentrated light source, and insufficient divergence of beam; this is being overcome by various methods.

Acetylene gas compressed in cylinders is increasingly used for unwatched or semi-watched lights of medium importance. Acetylene under incandescent mantles, or more elaborate acetylene apparatus is not used. Electric and dissolved acetylene equipment has advanced automatic apparatus installation and conversion to unattended stations. About 60% of lights, including buoys and excluding rivers, are now automatic.

Automatic apparatus extends lighthouse facilities to remote regions like Alaska.

Distinguishing principal coast lights by flashing or occulting characteristics, and eliminating fixed lights, progresses steadily. Characteristics are simple, quickly and easily recognized without timing. Preferred limitations are: that a single important light flash be not less than 0·3 sec. in duration, a minor light not less than 0·1 sec., that the characteristic be repeated preferably twice a minute, and one light of a range, or two lights in line, be fixed. Colour is valuable in distinguishing but illumination is reduced to about 30%—a serious drawback. Red and green are used for secondary lights.

Uniformity of Buoyage.—The United States of America has long had a fairly standardized system to show the relation of buoys to channels, by colours, shapes and numbers, this system having in part been prescribed by law in 1850. International uniformity in buoyage and lights would add safety and convenience to navigation. Limited but important action on this at the International Marine Conference, Washington, 1889, resulted in considerable uniformity.

The United States system, based largely on the 1889 conference, is, for vessels coming from sea: red buoys, conical-shaped ("nun"), even numbers, on right side of channel; cylindrical black buoys, flat tops ("can"), odd numbers on left side; horizontal red and black-banded buoys mean shoals or dangers; vertical black and white stripes show clear channels; with coloured lights, red on right and green on left of entrances or channels, but white may be on either side.

Colour and shape to mark the relations of buoys to channels are in nearly world-wide use; shape alone is not enough, because not readily applicable to important classes of buoys, such as gas, whistle, bell and spar. Moreover, experience shows that both colour and shape do not differentiate too much the respective channel sides. Colour is the most obvious, readily applied characteristic, and there is far greater world colour uniformity than in other buoy characteristics. The Washington Conference recommendations now embrace about 80% of world buoyage, including France, Germany, Scotland, Ireland, Argentina, United States, Canada, Japan, India, China, Philippines, Australia, New Zealand. The American buoyage system, light characteristics and apparatus are as simple as may be, so as to avoid confusion, and to be more definite and reliable.

Lightships are placed, on foggy coasts, to mark outstanding dangers, or port approaches. The first was placed in Chesapeake bay (1820).

Fixed structures on shoals, or gas buoys, have replaced many originally placed in inland waters; Great Lakes lightships are thus being gradually retired. There are 31 lightships stations, with 10 relief ships. Of the stations 25 are outside on the Atlantic and Pacific coasts, where it is impracticable to build lighthouses, yet where they are vital to traffic, *i.e.,* Nantucket lightship moored in 30 fathoms, 41 m. from land, guards shoals to the north and most trans-ocean vessels approaching the United States Atlantic coast steer for this vessel, one of the world's most important seamarks.

A full-powered vessel, 132 ft. long, crew of 16, it has a flashing incandescent electric light of 22,000 candle-power, compressed air fog whistle, radio-beacon and synchronized submarine oscillator. It is an oil-burning steam vessel, No. 112 (1936). Several lightships have Diesel engines, and 3 ships have Diesel-electric propulsion.

Lightships moored in the sea off the Atlantic coast, exposed to tropical hurricanes and other severe storms, receive special attention as to vessel design and moorings to ensure station permanency. For years attempts to keep lightships off New York and Cape Hatteras failed.

Severe storms have sometimes torn lightships from their moorings. Cast steel chain is being used for moorings, so as to better retain lightships on station. Mushroom anchors up to 4 tons are being used.

Buoys.—The American coast's great length and intricacies require 15,000 buoys. The increase in lighted buoys is a notable advance. In 1939, 1,881 lighted buoys were on station. Nearly all lighted buoys use acetylene gas compressed in tanks, set in buoy pockets, but electric lighted buoys are increasing in number. Steel buoys of various sizes are extensively used to mark channels and shoals. Wooden spars are being replaced advantageously by small inexpensive steel buoys. Though not very effective fog signals, there are 226 whistle buoys and 811 bell buoys, some of the latter provided with chimes having 4 different notes, to distinguish from the bells.

All buoys and moorings are relieved at least once a year, old buoys brought to depots, cleaned and repainted. Their great number makes this an important and time-consuming task. (*See* article on Buoy.)

Sound Fog Signals.—Radio-beacons, described later, are the most effective fog signal. Various types of sound signals, using compressed air or electricity, are employed, but their value is limited, due to short and undependable range, and the impracticability of taking accurate bearing on them. But, so far as may be foreseen, sound fog signals will remain indispensable. Steam whistles formerly used extensively, are being replaced by more efficient apparatus. Variously actuated electric sirens, reed horns and bells serve for minor sound signals.

The United States uses no explosive fog signals and but few signals (bells) operated by hand.

Though automatic sound fog signals would be of great value, there are, besides the bell and whistle buoys, only 29 bells actuated by carbon dioxide gas; these are useful where a moderate signal suffices that can readily be reached, but are not dependable otherwise.

Nearly all fog signal machinery and apparatus is installed in duplicate for greater reliability.

Radio-beacons.—These stations emit radio signals on distinctive codes. Allied with the radio direction finder on shipboard, they are considered the most important addition to navigational apparatus since the mariner's compass. They furnish the first generally available means ever provided of taking accurate bearings on invisible objects at considerable distances.

The first successful radio-beacons were placed at three stations near New York in 1921; the system has now grown in the United States and outlying territories to 141 stations, about one-third the number in the world. The transmitting apparatus is generally timed to sound one out of each three minutes, during fog or low visibility; also at certain half or quarter hours in clear weather. Each station sends a characteristic code signal differing from any other within range. Signals are of interrupted continuous wave type, sent with tube transmitters; tests are being made with continuous wave signals; standard wave length is 1,000 metres (300 kilocycles per second), but to lessen interference between adjacent stations in congested localities, wave lengths have been staggered somewhat, between 952 and 1,052 metres (315 and 285 kilocycles).

A few important stations, *i.e.,* Nantucket lightship, are operated with 500 watts; the standard power for other coast stations, and on the Great Lakes, is 200 watts; for inland waterways as low as $7\frac{1}{2}$ watts are being tried. This system is extending rapidly. If conditions favour, bearings correct to 1° or 2° up to 200 m. away are obtained. Rotating radio-beacons have not been introduced here, as they can not be placed on lightships, the most important radio-beacon stations.

The above system with the radio direction finder on board ship is the only possible general navigational system through radio bearings. The systematic operation of radio-beacons during clear weather is being extended; correct bearings may be taken far beyond the range of any other aids. (R. R. W.)

Airways Lighting in the United States.—The installation, operation and maintenance of the Federal Airways System, including the lighting of the various airways comprising the whole network, are under the jurisdiction of the Administrator of the Civil Aeronautics Authority. Prior to the creation of the Authority in 1938, these tasks had since 1926 been the responsibility of the Department of Commerce, administered successively by the Lighthouse Service and the Bureau of Air Commerce. With the completion of a $7,000,000 two-year airways modernization program in 1939, there were in operation 24,249 miles of lighted airways equipped with 2,016 beacon lights, 238 radio range stations providing directional guidance, 68 radio position markers, 95 scheduled weather broadcasting stations, 23,658 miles of weather reporting teletypewriter circuits and an additional 10,676 miles of traffic control circuits, both with a total of 332 teletypewriter stations, and 273 intermediate fields for emergency use.

Standard light equipment consists of 36-in. and 24-in. revolving beacons with parabolic mirror and 1,000 or 500 watt electric lamps developing approximately 2,000,000 beam candle-power and course light projectors flashing code numbers identifying the beacon along the airway and showing the course. Commercial electric power operates the apparatus mounted on steel skeleton towers. Engine-driven (gasoline or Diesel) generators in a small power house at the tower's foot furnish electricity if commercial power is unavailable. Astronomic clocks turn lights on and off. Boundary lights and cone markers 300ft. apart outline intermediate fields, green range lights mark best runways and red lights mark air navigation obstructions. Internally lighted fabric wind cone on beacon towers at landing fields indicates wind direction and force (*see* also Aerodrome; Aviation, Civil). (X.)

Administration.—The maintenance of aids to marine navigation is a function of the United States Coast Guard, having been placed under that organization on July 1, 1939, and consists of the maintenance of lighthouses, lightships, radio-beacons, fog signals, buoys, and beacons upon all navigable waters of the United States and its possessions; including Atlantic and Pacific coasts of continental United States, the Great Lakes, the Mississippi river and its tributaries, Puerto Rico, the approaches to the Panama canal, the Hawaiian islands, and Alaska.

The chief administrative officer is the Commandant of the

Coast Guard, with headquarters at Washington, D.C. Under his direction the functions of establishment, construction, maintenance, and operation of aids to navigation are carried on through administrative and engineering divisions in Washington, and by the various district offices. Because of the wide geographic distribution of aids to navigation on the sea coasts, the Great Lakes, and navigable rivers of the United States, with an aggregate coast line of over 40,000 miles, the field work of the service is carried on by district organizations. There are 13 Coast Guard districts, carrying on lighthouse work, as well as other functions of the Coast Guard. Each district is under the supervision of a commander, assisted by a suitable engineering and administrative force, and equipped with the necessary supply and buoy depots, and with suitable vessels for the maintenance of the navigational aids.

The total cost of maintaining the aids to marine navigation for 1938 was $13,340,659, of which $2,847,809 was for new works, repairs and improvements. Average costs for that year are: primary seacoast light station, $5,592; river post light, $122; sea-going tender (Atlantic), $70,332; exposed lightship, $28,300. Total aids in 1939, 29,606, of which 9,862 are lighted. The Philippines have 440 local aids, the Panama Canal 715, making a grand total for U.S. Territories of 30,761.

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LIGHTING AND ARTIFICIAL ILLUMINATION.

Man, in his social and economic development, has been engaged in continuous effort to utilize the hours of darkness through the application of artificial illumination to human needs. The respect in which light has been held throughout the ages suggests that proficiency in its use could be regarded as a criterion of the degree of civilization which a people has attained. New methods of providing artificial illumination, although invariably opposed by proponents of the method in current use, aided other contemporary developments in raising the standard of living.

Methods of producing light remained primitive and crude in design over long periods of time, and when new and improved methods were introduced, the use of the earlier forms continued so that at no time has one method completely replaced another. In the middle of the 20th century there were parts of the world in which the resinous wood torch, the oil lamp, the candle and various forms of the kerosene lamp were used.

Artificial illumination is obtained as a result of combustion, incandescence or electric discharge with or without fluorescence, and its development has been the efficient production of light without heat. Sources of light may be divided into three classes: (1) vegetable and animal fatty substances; (2) carbonaceous matters, gases and oils; and (3) electrical (*see* fig. 1).

HISTORICAL DEVELOPMENT

The earliest form of artificial illumination was the fire used by primitive man for warmth and for protection against wild beasts, and burning pieces of resinous wood plucked from the campfire were the first torches. From this beginning, which antedates written history by thousands of centuries, the torch as a source of illumination has continued in use throughout the world. It has assumed various forms, bundles of thin splinters bound together by rushes and dipped in pitch or wax being used by the ancient Greeks and Egyptians, by natives of the East Indies, and at different periods by the Indians of North and South America.

The flambeau of the middle ages, carried by pedestrians at night, was a torch consisting of twisted fibre coated with some inflammable substance. These torches provided the earliest form of street lighting, being fastened in metal holders to the outside walls of houses. Pieces of resinous wood, stuck between the stones of the fireplace, gave forth bright but smoky flames for lighting homes of early New England. This type of illumination was being used in rural homes of the poorer type as late as 1928.

Unusual sources of artificial illumination are the "animal lights" used in tropical countries. Glow-worms, beetles and fireflies are described as being confined in lanterns in the West Indies, and in Java they are stuck in wax in shallow saucers, the light given off by them being sufficient for performing night tasks within a small area. Early accounts from tropical America describe a great beetle which furnished enough light for a traveller to find his way at night.

Oily carcasses of various animals with a wick drawn through them have been used; records of use of the penguin in this manner being most common.

Oil Lamps.—The earliest prehistoric lamp dates to the Mousterian age. This was a hollowed piece of stone, very crude, found at Le Moustier, France, in 1928. On the Mesopotamian plains terra-cotta lamps of 7000–8000 B.C. have been found and copper and bronze lamps of Egypt and Persia of the year 2700 B.C. have been found by archaeologists at various times.

By 1000 B.C. an advancement in lighting efficiency was provided by a wick of vegetable fibre burning in a saucer type vessel holding olive or nut oil. About 950 B.C. Homer spoke of the "Festival of Lamps," these lamps being flat saucers filled with castor oil and salt, with a wick floating on the surface. By 500–400 B.C. lamps burning oil had come into general domestic use. The Romans made lamps of unglazed and glazed terra-cotta, having two or more spouts. Later bronze and iron lamps were introduced and designs became more elaborate although the principle of producing light remained the same. About 100 B.C. the Romans also developed the first true lantern of horn, cylindrical in form, with a perforated top. Lamps were in general use among the early Jews, Greeks and Romans; the "seven-branched candlestick" of Biblical times and the lamps of the vestal virgins were of the vegetable oil type.

Pliny, in about A.D. 50, mentioned oil found on the shores of the Adriatic as being used for lamps, this being the first record of the use of mineral oil in illumination. Japanese history of the year A.D. 615 mentions "burning water" and Marco Polo, in his 13th century writings, speaks of the oil springs of Baku as furnishing oil satisfactory for lighting purposes.

Improving the efficiency of oil-burning lamps became a matter of interest to scientists at a very early period. Hero of Alexandria, who lived during the latter half of the first century, A.D., devised a lamp in which the raising of the oil to the wick was effected by pressure of a liquid of greater specific gravity (brine) acting through a column of air.

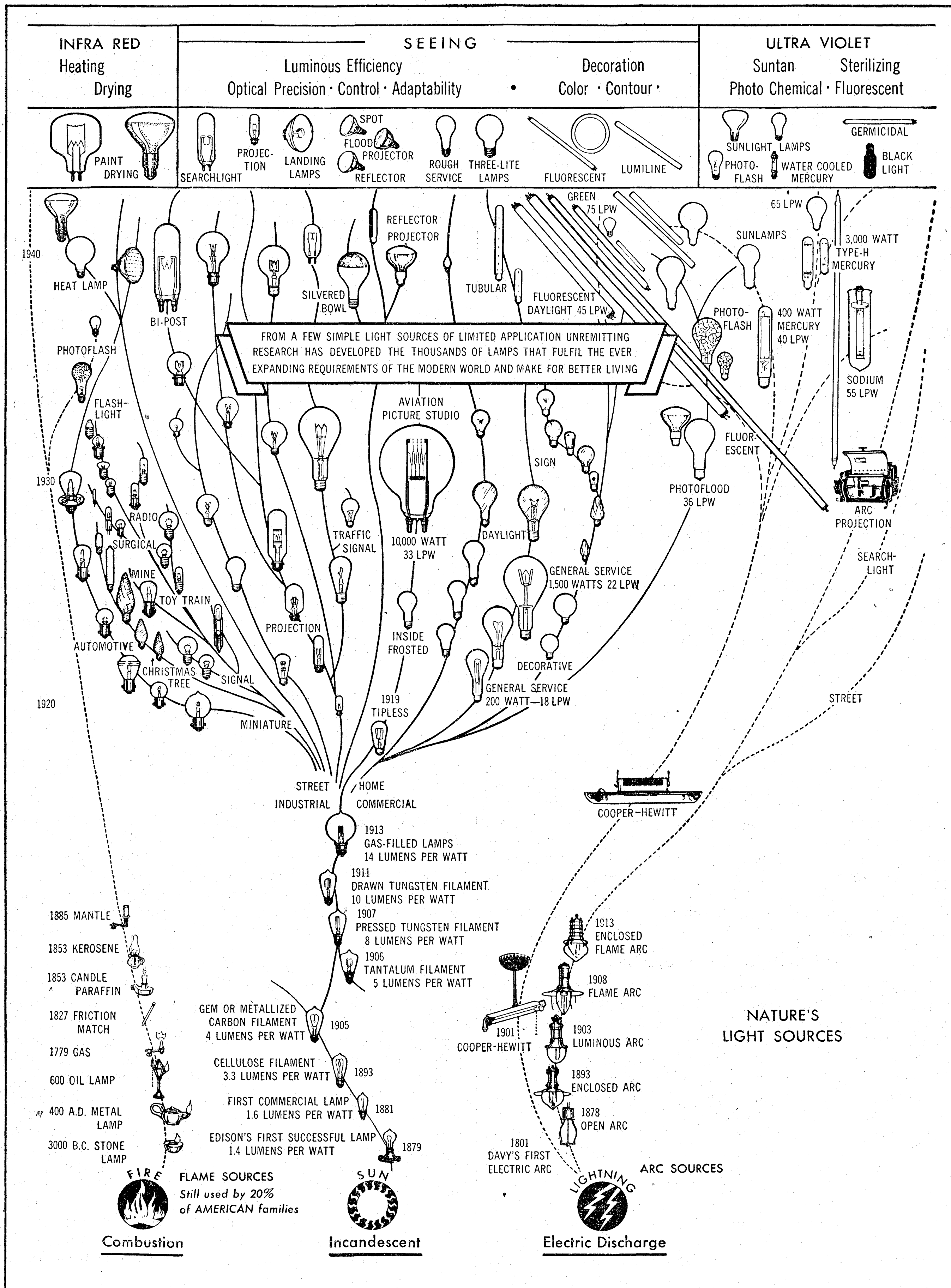
Leonardo da Vinci, in 1490, dissatisfied with the meagre quantity of light afforded by the oil lamp and flickering of the flame, added a chimney in the form of a glass cylinder fitted into a glass globe filled with water. The light burned steadily and through lens action the work surface was brightly lighted for night study. Da Vinci recognized the components of "seeing" as shown by the fact that he also devised water lenses for correcting near vision; the first recorded analysis that "seeing" is a combination of light and vision.

Various types of oil lamps were used through the 14th to 17th centuries, but there was little improvement in their efficiency during that period. The "Betty lamp" of the Pilgrims (1620), the name of which was derived from the German *besser* meaning "better," was a metal receptacle with a wick lying in a slot and protruding from one side. This lamp was equipped for hanging from mantlepieces or shelves, fish oil being the chief illuminant.

Toward the end of the 18th century Ami Argand, physicist of Geneva, introduced a lamp, patented in 1784, furnished with a round burner and tubular wick, and a chimney for directing and regulating the flow of air to the flame. An accident led to the discovery that a round glass chimney reduced flickering, thereby improving the quality of the light, and the Argand lamp marked the greatest advancement in artificial illumination to that date.

In 1800, B. G. Carcel added a clockwork pump to the Argand lamp for raising and feeding oil to the wick, and because of the steadiness of the light produced, the lamp in this form became a photometric standard.

In 1847, James Young produced distilled oils from coal, which was an improvement over previous illuminants, but the discovery



COURTESY LAMP DEPARTMENT OF GENERAL ELECTRIC COMPANY

FIG. 1.—PICTORIAL SUMMARY OF LIGHT

of petroleum by E. L. Drake in 1859 provided an inexpensive illuminant with such a high degree of lighting efficiency that the crude oil lamp was practically superseded.

From 1859 to 1879 an average of 80 patents a year were granted for various types of improved lamps for burning oil, one of the most important being the duplex burner lamp introduced in 1865 by Joseph Hinks. In 1868, the "Wells light" introduced a process of combining an oil spray with vaporized oil through the use of pressure. This process gave a highly luminous flame and the principle is used in modern flare lamps. The Kitson lamp of 1885 was a pressure type lamp using platinum mantles, replaced later by Welsbach mantles.

During the latter half of the 19th century oil lamps underwent many changes and improvements in an effort to make them more attractive for domestic use and more efficient for industrial purposes. They were mounted on elaborate bases, the oil reservoirs were decorated, some were designed for suspension from ceilings and others were portable. These latter designs carried over into the 20th century and the kerosene lamp with a flat wick in a perforated metallic holder, and a plain glass chimney is used extensively in outlying districts and poorer homes.

Candles.—The invention of the candle may be regarded as contemporaneous with the need for a portable means of artificial illumination, and candlemaking is probably one of the oldest industries of mankind. The candle is defined as a porous, combustible core surrounded or saturated with an inflammable solid. Therefore, the primitive man who first selected a highly resinous bit of wood to use as a torch was the original chandler. Among aboriginal races in Africa, oily nuts were burned in saucers of clay, and some more ingenious individuals strung these nuts on twigs, thereby obtaining continuous illumination.

The true candle dates from the days of the Romans. In A.D. 100 Greek and Roman candles were made of flax threads coated with pitch or wax, although the Phoenicians are credited with the first use of wax candles about A.D. 400. The candle was not in as common use as the oil lamp for several centuries, but returned during the middle ages, and the 16th to 18th centuries marked its greatest use. Throughout this period and until the discovery of petroleum, candles provided the only method of artificial illumination available to people of average means. The use of candles has been closely related to religion throughout history, and the supplying of candles appears as a large item in expense accounts of the early church. Various materials have been used in the manufacture of candles, the earliest being rush piths dipped in tallow. Later, splinters of wood, also dipped in tallow or beeswax and called "kindle lights" were used. Home-made candles of Pilgrim days were of tallow. With the opening of the whaling industry in the 18th century, spermaceti, a crystalline substance from the head of the sperm whale, came into use and spermaceti candlemaking was an important industry of the time. The spermaceti candle, because of its clear, steady flame, was used as a standard of measure for artificial light, the term "one candle-power" being based on the light given by a pure spermaceti candle weighing one-sixth pound and burning at the rate of 120 grains an hour. The development of stearine in 1823 and of paraffin in 1850 furnished improved materials for candles.

Candleholders have assumed various forms, much attention being given to more elaborate designs for those holding single candles for portable use, and multiple holders for mounting on walls or suspension from ceilings. In Italy in 1492, the Prickett chandelier was introduced, being a multiple-spiked holder mounted in groups around a decorative figure on the wall. Mutton-fat candles were forced on the spikes. In the 15th century crystal chandeliers equipped with small cups for holding candles of refined wax were used for lighting homes, ballrooms and public gathering places. One hundred twenty of these candles would have been required to equal one 100-watt lamp, and the number required to illuminate a large room produced considerable heat.

As late as 1834 candles in elaborate chandeliers were used for illumination of the house of commons in England, and their replacement by gas was strongly opposed by members. With the advent of gas as an illuminant, use of candles was gradually confined to church ceremonies, decorative domestic purposes and festive occasions.

Gas.—The development of gas as an illuminant provides a striking example of the length of time that elapses before a scientific idea is developed into useful application. Ancient records of Egypt and Persia prove numerous instances of spontaneous discharge of combustible gases from fissures in the earth. That natural gas was employed as an illuminant by the Chinese centuries before the Christian era is shown by records of great antiquity telling of gas brought to the surface from beds of rock salt 1,500 to 1,600 ft. deep, conveyed through bamboo pipes and used for lighting salt mines and homes in Szechwan province.

In 1664, near Wigan, Lancashire, England, Dr. John Clayton discovered a pool of natural gas while draining water from a ditch, and suspected a nearby coal mine as its source. Probably the earliest record of the possibility of extracting inflammable material from coal by distillation was in 1739 when Dr. Clayton published an extract from a letter written to the Hon. Robert Boyle, who died in 1691, describing experiments along this line as satisfactory. In 1726, Dr. Stephen Hales stated in a paper before the Royal Society of London that 158 grams of Newcastle coal would yield 180 cu.in. of "inflammable air," and in 1733 Sir James Lowther sent specimens of distilled coal gas to the Royal society for experimentation.

No attempt was made to use gas for illuminating purposes, however, until 1784 when Jean Pierre Minckelers used it for lighting his lecture room at the University of Louvain. Contemporaneously, in Paris, France, Philippe Lebon experimented with distillation of gas from various materials for domestic use, and in 1799 Lebon patented a "thermo-lampe," using gas distilled from wood.

First use of gas as an illuminating agent on a large scale is ascribed to William Murdoch, a Scotchman, living at Redruth, Cornwall, England. In 1792, Murdoch lighted his home with gas produced in large iron retorts and conveyed a distance of 70 ft. through metal pipes. In 1798 he installed a gaslighting system in the engineering works of Boulton and Watts, Soho, near Birmingham, England, this installation being exhibited to the public in 1802. Shortly thereafter Murdoch was providing gas commercially for several shops in the vicinity, the cotton mill of Phillips and Lee in Manchester and Stonyhurst college.

Public prejudice against the new illuminant, denounced as dangerous and impractical, caused its adoption to be slow. Credit for dispelling this prejudice is given to F. A. Winsor, a German, who worked with great zeal and patience on the improvement of illuminating gas for a number of years. Through his efforts the first public installation of gaslights was made in London in 1807, and the Chartered Gas Light and Coke Co. was founded by him in 1810. For this reason, Winsor is referred to as the "father of gaslighting."

In 1813 Westminster bridge, London, was illuminated by gas, and Paris adopted gas for street lighting in 1818, but by 1829 there were only 40 public gas lamps in that city, while 3,000 oil lamps were still in use. However, within a few years most of the cities in England and Europe had installed gaslighting systems.

The first domestic use of gas in the United States was in 1806, when David Melville, of Newport, R.I., lighted his home and the street directly in front of it with gas generated on the premises. First interior commercial use was in 1816 when gaslights were installed in the New theatre in Philadelphia, Pa.

Between 1820–80, interest centred about purification of gas for obtaining higher illuminating power, and in the improvement of burners. Burners of many types were developed, those of the "batwing" or "fishtail" type, so-called because of their shape, being most commonly used. In 1879 William Sugg developed the Sugg-Argand burner, consisting of perforated concentric metal rings. This burner, designed to compete with the electric lamp in illuminating power, created a light of high intensity with great economy through use of an increased air draught produced by pressure.

Because of increasing interest in electricity as an illuminant during the latter part of the 19th century, much effort was directed toward improvement of gaslighting. Dr. Carl Auer von Welsbach experimented for ten years on production of the Welsbach mantle, considered the most important development in the history of incandescent gaslighting. First public exhibition of the Welsbach system of lighting was in London in Feb. 1887, and by 1900 incandescent gaslighting was permanently established.

The Welsbach mantle consisted of a cylinder woven of Sea Island and Egyptian cotton soaked in a solution of 99% thoria and 1% ceria, this ratio giving maximum illuminating efficiency. The top of the mantle was then soaked in solutions of various other rare earths for shrinking, and after being dried the mantle was ignited, burning out the organic matter and leaving a skeleton of the cotton form composed of metallic oxides. Stiffening for shipping purposes was obtained by dipping in a solution of collodion and camphor. In use the mantle was suspended in a special holder, over a Bunsen burner in which gas and air combined before reaching the point of ignition, so that in place of the ordinary gas flame, the metallic oxides composing the mantle were heated to incandescence, emitting a brilliant light. Experiments made to improve the colour of the light, which had a decided greenish cast, determined that by using varying combinations of rare earths in solution for impregnating the mantles, different colours of light could be obtained.

Bunsen burners of all types, inverted and upright, were used and the mantles were adapted for use with high pressure gas systems, high pressure oil lamps, kerosene lamps and acetylene lamps. Welsbach mantles have continued in use with various types of lamps.

Acetylene Gas.—Edmund Davy, nephew of Sir Humphry Davy, knew of the existence of this gas in 1835, and in 1866 M. P. E. Berthelot, a French chemist, performed experiments in its production, but not until 1892 was its manufacture and use as an illuminant described by Henri Moissan. Simultaneously, in the U.S., Thomas L. Willson discovered the electrochemical production of calcium carbide and demonstrated that acetylene gas obtained by immersion of calcium carbide in water produced an intense white light. A report issued in 1909 indicated that 290 towns in the U.S. were lighted by acetylene gas. Later its use was confined to emergency lighting in remote areas, for military purposes and for lighting buoys and beacons; its advantage for the latter purpose being that an acetylene light can be charged, lighted and then left unattended for six months or more.

Pintsch Gas.—Originally developed for lighting of railroad cars, and named after its inventor Julius Pintsch of Germany, this gas was produced by destructive distillation of petroleum and compressed to facilitate storage and transportation. Used in Europe for many years, it was brought to the U.S. in 1866, and in 1910 there were 93 Pintsch gas works in the U.S., Canada and Mexico supplying compressed gas to nearly 400 railroad stations. It was used extensively on steamships and for lighthouses.

Similar to Pintsch gas were the numerous "bottled gases" developed in subsequent years, and in use under various trade names (1945). These provide illumination in areas where electricity is not available, being used with lamps equipped with the Welsbach type mantles.

By 1911 conversion of gas fixtures for use with electricity had begun. While 50% of the gas manufactured in the U.S. in 1916 was used for lighting, and the Welsbach mantle had so cheapened gaslighting that in cost per unit of illumination it had no competitor, electricity was rapidly replacing gas for general illuminating purposes. However, in England and Europe gas enjoyed wide use for a number of years longer, since in 1926 when Buffalo, N.Y., was making plans to replace all existing gas lamps with electric arc and incandescent lamps for street lighting, the earlier electric street lighting of almost all boulevards and parks in Paris had been replaced by high-pressure gas lamps, automatically lighted and controlled.

Electric Lamps.—In 1650 Otto von Guericke of Magdeburg, Germany, discovered that light was produced by electricity, or by electrical excitation. He demonstrated that when a globe of sulphur was rotated rapidly and friction was produced by pressure of the hand during rotation, a luminous glow could be observed. About 1700 Francis Hawksbee used this discovery, together with a glass globe exhausted by means of a vacuum pump, also invented by Von Guericke, to produce the first "electric light." When the globe was rotated at high speed, then rubbed with the hand, it emitted a faint glow of light.

Following this demonstration, which created much excitement among scientists of England, numerous physicists experimented with production of light by electrical excitation, but without marked success until 1802. In that year Sir Humphry Davy demonstrated that strips of platinum or other metals could be heated to incandescence electrically and would give off light for some time. In 1809, Davy, using a battery of 2,000 cells to pass a current through charcoal terminals, produced the arc light, so called because of the shape of the luminous flame created when an electrical current passed across the gap between the carbon points.

Throughout the 19th century, development of the arc lamp and the incandescent lamp were parallel. In 1840 Sir William Robert Grove demonstrated the Grove system of lighting before the Royal Institution of England, lighting the auditorium in which he lectured with lamps using platinum coils heated to incandescence by means of the Grove battery. The lamps gave only feeble light and the system proved impractical, being complicated and expensive. It has been estimated that cost of the current produced by the Grove battery was several hundred dollars a kilowatt hour.

In 1841 Frederick de Moleyns of Cheltenham, England, obtained the first patent granted for an incandescent lamp. His lamp was unique, consisting of a glass sphere from which the air had been exhausted, and containing powdered charcoal bridging the gap between two platinum wires or filaments. Light was produced by passage of current through the platinum filaments, heating the charcoal to incandescence. However, the globe blackened quickly and the lamp was short-lived.

In 1845 Thomas Wright of London obtained the first patent for an arc lamp, and in the same year an American, J. W. Starr of Cincinnati, Ohio, obtained a British patent for two electric lamps of the incandescent type. Starr invented the first true metallic filament lamp and a magnetoelectric generator with which to produce current for lighting purposes. He died at the age of 25, before he could put his original ideas to practical use.

During the latter part of the 19th century many scientists endeavoured to find a practical method of producing artificial illumination by electricity on a commercial basis, and there are records of occasional use of electric lamps throughout the period. In 1849 a scene in Giacomo Meyerbeer's opera, *Le Prophet,* at the Paris opera house was illuminated by electric light; an old print shows Mons. Ch. de Chagny demonstrating incandescent lighting for collieries, and in 1857 the first commercial installation of an electric arc light was made in the lighthouse at Dungeness, England.

In 1872 Alexandre de Lodyguine, Russian physicist, made a lamp having a V-shaped piece of graphite for a filament, operating in a glass globe filled with nitrogen gas. Two hundred of these lamps were installed about the Admiralty dock, in St. Petersburg (Leningrad), and a company was formed to exploit the lamp but unreliability of operation and cost made it impractical for general use and the company failed. During the following ten years Russian scientists developed various lamps using the same principle, but none was of practical value.

In 1876 Paul Jablochkov, a Russian electrical engineer, announced that within a few months he would introduce an illuminating agent which would entirely supersede gas, the popular illuminant of that period; and in 1876 the "Jablochkov candle" marked an epoch in artificial illumination toward which the previous 30 years of laboratory experiment had led. The Jablochkov candle was an arc lamp having parallel carbon rods separated by a thin wall of clay, or a mixture of sand and glass, which vaporized during burning of the arc. Alternating current was used to ensure equal rates of consumption of the two points of the rods. This lamp was widely used commercially, first public demonstration being given at the Paris exposition in 1878, and it was used for lighting the boulevards of Paris for a number of years.

First installation of arc lamps for public lighting in the U.S.

was in 1879 when the public square in Cleveland, Ohio, was lighted by 12 Brush carbon arc lamps, the system developed by Charles F. Brush.

Before the Edison incandescent carbon filament lamp was patented in 1880, numerous scientists directed their efforts toward production of a satisfactory incandescent lighting system, outstanding among them being Sir Joseph Wilson Swan, English physicist. In 1850 Swan had devised carbon filaments of paper; later he used cotton thread treated with sulphuric acid and mounted in glass vacuum bulbs. Utilizing this lamp, called the "electric glow lamp" he gave the first public exhibition of electric lighting on a large scale at Newcastle, England, in 1880.

A demand for a smaller electric lamp for domestic purposes, and operating with greater efficiency than any produced to that time, led to consideration of the problem of "subdividing the electric light." Outstanding work was done in the U.S. by Moses G. Farmer, Hiram S. Maxim and William E. Sawyer.

Final development of the incandescent lamp was the result of concurrent work by Joseph Swan and Thomas A. Edison. Edison had recognized early in his experiments along this line that improved methods of distribution of electricity were necessary before the incandescent lamp could be generally adopted for commercial use, and much of his effort was directed to that end. However, in 1878 he established a well-equipped laboratory at Menlo Park, N.J., and after much experimentation produced the first satisfactory incandescent lamp. This lamp consisted of a high-resistance carbon filament operating in a vacuum, having platinum wires imbedded in the glass for carrying the current through the glass to the filament. He obtained a patent on this lamp in Jan. 1880, after having given a public demonstration of his first complete incandescent lighting system at Menlo Park on Dec. 21, 1879.

First commercial installation of Edison's lamp was made in May 1880, on a steamship operated by the Oregon Railway and Navigation company. This installation, consisting of 115 lamps, was operated successfully for 15 years.

The arrival of the incandescent electric light, from an industrial standpoint, may be said to date from the year 1881. In 1882 the Pearl St. station in New York city was put into service, and is considered the forerunner of the great central stations subsequently developed. In England, in 1882 an exhibition of electric lighting was held at the Crystal palace and by this time incandescent lamps had been installed in numerous public buildings.

When the incandescent lamp was introduced as a public illuminant, fear was expressed that it might be injurious to the eyesight, particularly when used for long periods by indoor workers. In 1898 the oculists of London petitioned parliament to pass laws against the use of unshaded lights, claiming danger to the eyes from exposure to high intensity lights in shops, offices and on the street. As a result research was instituted on various types of shades and reflectors. One of the earliest reflectors used commercially was the one-piece silvered glass reflector developed by E. L. Haines, and installed in show windows in Chicago, Ill., and other cities in the U.S.

Closely related to the incandescent gas mantle and suggested by it, was the Nernst glower, unique among illuminants of its time as the first practical attempt to substitute some other incandescent substance for carbon filaments. Patented in 1901 by H. W. Nernst of Germany, it utilized a filament composed of oxides of rare earths heated to incandescence by passage of electrical current. Mixtures of two or more oxides were found to be most satisfactory, and in 1905 the commercial Nernst glower consisted of 85% zirconia and 15% vitria. The Nernst lamp did not achieve wide use, but investigations carried out to improve this lamp had considerable effect on the development of the incandescent lamp.

Werner von Bolton discovered the possibility of using tantalum for lamp filaments about 1902, and in 1906 the tantalum lamp was put on the market in the U.S., but disappeared from use about 1913.

In 1904 Willis R. Whitney of Schenectady, N.Y., produced the heat-treated or metallized carbon filament lamp, with a higher degree of efficiency than any previous incandescent lamp. This was the last new development to make use of the carbon filament, for work had begun on the application of tungsten for lighting purposes.

From the beginning of the development of the incandescent lamp, scientists were concerned with the problem of the conversion of electrical energy into light in the most efficient manner possible, and with the discovery of tungsten as a material for filaments this seemed to have been achieved. The tungsten filament lamp represented the greatest advancement ever made in the quality and efficiency of incandescent lighting, and quickly replaced carbon, tantalum and metallized carbon filaments for commercial use.

First tungsten filament lamps, introduced in the U.S. in 1907, made use of "pressed" tungsten, manufactured by a process perfected by Alexander Just and Franz Hanaman of Vienna. William D. Coolidge of Schenectady, N.Y., discovered a process for producing drawn tungsten filaments, greatly improving the strength of tungsten lamps. This process was patented in 1913 and lamps of this type were immediately adopted for general use.

Tungsten filament lamps were developed in a variety of sizes and shapes, for domestic and commercial use and for some highly specialized purposes. In 1935 they were available in shapes varying from the common pear-shaped or round bulb type to tubular forms several feet long. A very small lamp, known as the "grain o' wheat" lamp, having a bulb only 2 mm. in diameter and 8.7 mm. long, became valuable to the medical profession, providing a light source for internal investigation and surgical work. Other lamps as large as 10,000 watts were being used in 1937 for airport lighting and in the motion picture industry. The largest incandescent lamp built up to 1945 was a 50,000 watt lamp for display purposes which found some use in a special application.

In 1913 Irving Langmuir discovered that use of inert gases inside the incandescent lamp bulb would permit higher filament temperature without rapid disintegration, with increased efficiency. Nitrogen alone was first used, but research determined that other gases were more satisfactory, and in 1937 gas-filled lamps contained an atmosphere of 80% argon and 20% nitrogen. Low first cost, ease of maintenance and adaptability gave this lamp such importance in the lighting field that other incandescent lamps practically disappeared. A further improvement introduced in 1937 was the coiled-coil type of filament for general service lamps, adopted by most manufacturers and by 1945 the gas-filled coiled-coil filament lamp was the most efficient incandescent lamp in use.

The history of the incandescent lamp between 1920 and 1935 was also concerned with improving the quality of lighting, including introduction of inside frosted bulbs and bulbs of various colours for domestic purposes. Development of lighting from concealed sources, or "indirect lighting" made rapid strides, increasing the level and quality of illumination in homes, schools and offices.

Electric Discharge Lamps.—At the beginning of the 20th century interest became centred in artificial illumination by means of gaseous conductor lamps, later called "electric discharge" lamps. Early research in the field was done by Heinrich Geissler, German physicist, about 1850, who invented the Geissler tube by means of which was demonstrated the phenomenon of luminosity accompanying the discharge of electricity through rarified gases. In 1887, Geissler tubes were used largely for laboratory demonstrations, but in 1897 tubes of various colours were used successfully for a display commemorating the Diamond Jubilee of Queen Victoria of England. This use of Geissler tubes was made possible through the discovery, by John W. S. Rayleigh and Sir William Ramsay, of the rare gases argon, neon, xenon and krypton, in 1895. Argon had been discovered originally by Henry Cavendish in 1785, but was not recognized as having any practical value until the experiments by Rayleigh and Ramsay.

The Moore tube, developed by D. McFarlan Moore, between 1891 and 1904, along the principle of the Geissler tube, made use of nitrogen and carbon dioxide. Nitrogen was found to produce a yellow light, while carbon dioxide gas furnished light of a pinkish-white colour, closely approximating daylight, making this light invaluable for colour matching. It was for this purpose that Moore tube lights were most widely used. First commercial installation was made in a store in Newark, N.J., in 1904. Principal objections to the Moore tube for general lighting purposes were difficulty of installation and repair, and the complicated valve mechanism required to maintain the gas in the tube at the correct pressure.

The mercury vapour lamp, originated by L. Arons of Germany, in 1892, was not manufactured on a commercial basis until taken over by the Cooper-Hewitt Co. Peter Cooper-Hewitt introduced the mercury arc lamp in 1901, its efficiency proving to be two or three times that of the contemporary incandescent lamp. Chief limitation to its use was the peculiar spectral quality, caused by concentration of the light rays produced in three restricted regions of the spectrum, and the complete absence of red. Research designed to improve this by introduction of other gases into the tube failed to produce satisfactory results until Cooper-Hewitt devised a fluorescent screen which converted some of the excess of blue and green light and a little of the yellow into red, thereby materially improving the colour. First practical installation of the Cooper-Hewitt lamp was in the composing room of the New York *Evening Post* in 1903. Creating a shadow-free light, without glare, the lamp was immediately given wide use for industrial lighting in the U.S. In Europe in 1937 use of the mercury arc lamp was about equally divided between interior and street lighting.

Cooper-Hewitt also developed the quartz tube mercury lamp, used extensively in biological research. A later form of the quartz tube lamp, based on research carried on in the laboratories of the Phillips company in Eindhoven, Neth., led to exploitation in Europe of a small water-cooled or capillary type of mercury arc lamp, developed in 1935. Subsequently the U.S. type of this lamp was used primarily for photographic work and for searchlights.

Research had been continuous in the use of rare gases for illumination purposes. In 1910 Georges Claude experimented with electric discharge tubes containing neon, argon, helium, krypton and xenon and within a decade the neon sign industry had developed. The novel effects obtainable with neon tubes gave them wide use for advertising purposes, their extreme adaptability, high luminosity and brilliant colours making them particularly suitable in this field. Efficiency of light production by use of neon tubes was too low for general illumination, and none of the colours was satisfactory for interior lighting.

During 1933 the most promising source of illumination among electric discharge lamps was the high intensity sodium vapour lamp. Not satisfactory for commercial or domestic use because of characteristic yellow colour, reports from an experimental installation of sodium vapour lamps along a highway in the Netherlands were very favourable. Subsequent major applications were for highway lighting and general outdoor lighting where colour discrimination was not required; and by 1945 sodium vapour lamps were being used for highway lighting and illumination of bridges and vehicular tunnels all over the world.

In 1936 the fluorescent lamp was in process of development. Offering a highly efficient low power source in various colours, the fluorescent lamp afforded the nearest approach to "cold light" ever devised in practical form. Fluorescent lighting differed from incandescent lighting in that the light was produced not by heating a tungsten filament to incandescence, but by fluorescence of certain chemicals under radiation of ultra-violet light. The fluorescent lamp in 1936 consisted of a low pressure mercury arc of about 15 watts, enclosed in a glass tube, the inside of which was coated with mineral salts (phosphors) having fluorescent qualities. The efficiency and colour of the light were determined by the particular salt used. Practical application of the fluorescent lamp on a large scale in 1938 marked a major development in the field of artificial illumination. Until that time fluorescent lighting had been the object of laboratory experiment, but in 1939 numerous permanent installations of fluorescent lighting were made and general lighting by these lamps was completed in two large factories in the U.S. In that year also, fluorescent lighting was an integral part of the decorative scheme of the New York world's fair.

During the ensuing six years research designed to improve fluorescent sources was carried on extensively, and low and high voltage fluorescent lighting found many new applications in interior lighting and luminous decorative design. Fluorescent light was gradually adopted for industrial lighting, for store lighting and for show windows, but not until 1942 was it used to any extent for home lighting, although many specialized applications had been made. In 1944, experimental installations of fluorescent lamps for street lighting were made, but they were not in general use for that purpose. The period of World War II found fluorescent lighting being adopted for many specialized uses, for naval and military purposes, aviation lighting, railway lighting and for increasing use in the industrial field.

World-wide interest in artificial illumination gathered momentum with the beginning of the 20th century. Great expositions held in many parts of the world featured spectacular lighting using the latest developments. "Festivals of Light" were held in many cities, and in 1937 Sweden celebrated the tenth anniversary of its "Association for the Culture of Light" with an electric week.

Wide-spread interest was shown in the psychological and physiological aspects of higher levels of illumination as related to human welfare, one evidence of this being the adoption in 1937 of a factories bill in England containing provisions for compulsory adoption of standards of lighting in all factories and workshops.

Artificial illumination has been accepted as an architectural medium, and lighting is no longer a thing of utility alone, but an intrinsic part of the architectural design of buildings. Specialized types of lighting for various industrial, agricultural and domestic fields have been investigated and adopted.

Street Lighting.—Street lighting during the ancient Egyptian civilization was more advanced than during any subsequent period until A.D. 1500. In A.D. 400 Antioch in Syria was lighted at night by lamps suspended on ropes, this being the first recorded attempt at organized street lighting. However, it is not probable that streets of that period were generally lighted since the Romans considered the use of flambeaux and lanterns necessary for travelling through the cities at night, as shown in numerous early writings.

Compulsory street lighting came into effect as early as 1367, when Charles V ordered the placing of lamps at stated intervals in the streets of Paris for crime prevention. In 1415 Sir Henry Burton, lord mayor of London, ordered all householders to hang out lanterns on winter evenings between All Hallows and Candlemas, this practice being followed for 300 years in London.

Street lights of this early period were oil-burning lamps, torches fastened in holders to outside walls of houses, or open wire or iron baskets containing pieces of burning wood. This latter form was used in Paris as late as 1729, when there were nearly 6,000 lanterns of this type in use. In the United States during this period street lighting was accomplished by placing candles in house windows, but in 1769 a law was passed in New York compelling householders to display a lantern outside every seventh house, thereby illuminating the street.

In 1662 the first commercial street lighting enterprise was enfranchised in Paris, consisting of a corps of public lantern bearers, who for a small fee would accompany wayfarers to their homes. In 1694 Edward Heming, in London, obtained the exclusive rights for placing lights outside every tenth door, for a modest remuneration from houseowners, who were required by law to provide lighting for the streets. However, in 1735, contracting for street lighting was taken out of private hands and passed into the jurisdiction of the common council, and a small tax was levied to cover the cost.

Oil lamps for street lighting came into use in London in 1736, and about the same time in Paris. In 1745 a marked improvement was introduced by the addition of polished metal reflectors, called *reverbere.* Oil lamps equipped with these reflectors created a brilliant light found objectionable by many citizens, and in 1736 further improvement was made by a modified form of reflector considered highly satisfactory, and adopted for general use throughout Paris. General highway lighting was introduced for the first time with the use of these lamps along the road from Paris to Versailles in 1777. Lamps of this type remained in use in France until replaced by public gaslighting.

In 1762, wooden lamp posts supporting oil lamps provided the first municipal street lighting system installed in New York city, and street lighting as a public service was not installed in Boston, Mass., until 1792. By the end of the 18th century, although most cities of England and Europe had adopted general street lighting systems, very few U.S. cities were lighted by more than candles or oil lamps placed in house windows, and in small towns the streets remained unlighted until the advent of kerosene lighting.

First public street lighting by gas was in 1807, when one side of Pall Mall in London was illuminated by clusters of gas lamps, and in 1813 Westminster bridge was also lighted by gas. Paris adopted gas for street lighting in 1818, Berlin in 1827 and other European cities followed in quick succession.

Baltimore, Md., in 1821, was the first city in the U.S. to adopt gas for street lighting. In 1827 gas conveyed through mains made of wooden logs supplied the first public system of gaslighting for New York city, and by 1836 gas was in general use for public lighting in the larger cities throughout the U.S. With the development of high pressure gas in 1897, improved systems of gaslighting came into general use.

Development of the electric arc lamp in 1878 gave impetus to street lighting, about two-thirds of a mile of the Avenue de L'Opéra being lighted by Jablochkov candles, an early form of the arc lamp, during the universal exhibition in Paris in that year. First public street lighting by arc lamps was introduced in Cleveland, Ohio, in 1879, and the arc lamp in its various forms held first place for public street lighting until well into the 20th century. Incandescent lamps were given limited use for street lighting throughout their development, the first incandescent lamp to achieve use in this field being the gas-filled lamp with coiled tungsten filament, in 1915.

Increased use of the automobile, about 1920, with attendant higher traffic speeds on highways and congested traffic conditions in cities, brought a demand for higher levels of illumination for streets and highways. More improvements in street lighting were reported during 1922 than during any previous year of electric lighting. While gas lamps were still in use in many U.S. cities, and some installations of gas street lighting were made during that year, electric lighting for streets and highways was receiving much attention in an effort to reduce traffic accidents. Lighting from electric signs and store windows contributed largely to general illumination in the business district, but outlying districts were felt to be inadequately lighted.

Development of electric discharge lamps provided highly satisfactory sources of light for street and highway illumination. Sodium vapour lamps were widely adopted for this use, although in 1928 Great Britain reported that combinations of mercury vapour and incandescent lamps were being used for lighting from 600 to 700 miles of highways and streets in that country. By that year New Jersey had taken the lead in the U.S. with 220 miles of lighting on state highways, a 56-mile installation of highway lighting in that state being at that time the longest lighted highway in the world.

MODERN LIGHT SOURCES

Nonelectrical

Candles.—The modern candle is usually produced by moulding, and may be composed of stearine, wax, spermaceti or paraffin. The wick is a cotton yarn either plaited or braided and treated with mineral salt. Candles are used for festive occasions, decoration and in places where other portable lights are not available. The modern candle is completely consumed without objectionable odour or smoking, and burns uniformly.

Kerosene.—The kerosene lamp with reservoir, a perforated metal chimney holder which admits a supply of air and a chimney of glass has not deviated markedly from the improved types suggested by Argand. Kerosene is available in most parts of the world and the kerosene lamp is widely used in regions lacking modern gas or electrical facilities.

Gas.—Gas used for illumination may be of three types: natural; manufactured and distributed from a central plant; or "bottled gas" delivered to the premises in containers. Although acetylene gas may be delivered in drums it is more frequently generated at the lamp by chemical action. The burner used with the acetylene gas lamp is usually of the "fishtail" flat flame type, and the acetylene lamp is used by miners and as navigation markers.

To reach a maximum of efficiency with any gaslighting equipment and to give a light comparable with incandescent and fluorescent lighting, some form of Welsbach burner must be used. This burner is used in both the portable and stationary forms of gaslight source.

Electrical

Arc Lamps.—The atmospheric arc lamp, which at one time ranked as the most important electric light source, lost its importance with the movement to "subdivide the electric light." Its present value (1945) lies in the concentration of the light and the intensity of the light source. It is used in large-wattage units for searchlights and for projection, and where a special need exists for the blue and ultra-violet portion of the spectrum. When desired the colour of the arc light may be controlled by use of various materials in the electrodes.

Arc lamps may be classified as: (1) carbon arcs, using pure carbon electrodes and producing light by the incandescence of the electrode; (2) flame arcs, using mineralized carbon electrodes and producing the light from a luminous arc with some incandescence at the electrode ends; (3) magnetite and luminous arcs, using metallic electrodes and producing light from a luminous arc into which are conducted light-giving elements from the cathode. With the exception of the last group, arc lamps have been developed for both D.C. and A.C. operation.

Arc lamps operating at atmospheric pressure are essentially constant current lamps and when operated in parallel it is necessary to control the flow of current by a ballast. Arcs will not start with the applied voltage at which they will operate, because they have a negative volt ampere characteristic. Arc lamps must be equipped with automatic mechanisms for starting the arc and adjusting the electrodes. The maximum brightness obtained in an arc lamp depends upon the size of the carbons and operation of the arc more than upon the nature of the carbon. The carbon arc lamp operates at an efficiency of from 40 to 65 lumens per w., and the brightness varies from 160 candles per sq.mm. to 1,200 candles per sq.mm. The objectionable noise and unsteady operation of the earlier types have been overcome in the modern arc lamp. Special arc electrodes and construction are used for wavelength standard measurements, and the line at the red end (6432.5696 angstroms) of the cadmium arc has been so accurately measured that the standard of length could be reproduced by using this wave length as a base.

The flame arc is little used in the U.S. and the metallic arc has been largely replaced by the incandescent lamp for street lighting. Street lighting practice in the U.S. employs the series arc, while in European practice the multiple system is preferred.

For military use the carbon arc has proved more satisfactory than other types of light sources. Since the arc approaches a point source of light, it works well with precision optical systems. In the searchlight and projection field, ranges of from 20 amp. at 55 volts (1,100 w.) for 10-mm. carbons to 200 amp. at 90 volts (18,000 w.) for 16-mm. carbons are used. These D.C. arcs give most of their light from a very hot positive crater.

Incandescent Lamps.—Edison's contribution to the art of incandescent lamp making was a carbon filament of such a length and diameter as to produce a lamp of 100 w. with a life of 600 hrs. and efficient enough in light production to compete with the existing flame sources, when placed across a 110-v. circuit. This lamp produced 1.8 lumens per w.; the comparable incandescent lamp with improvements to 1945 had an equivalent of 16.5 lumens per w.

Losses.—Losses in the incandescent lamp are caused by: (1) inadequate filament efficiency control: (2) heat conduction by leads and supports; (3) voltage loss in the leads; (4) light absorption by the glass and the base; and (5) bulb blackening. The lamp engineer recognizes that higher temperature filaments will produce a more satisfactory light quality and a more efficient lamp; therefore, progress has been marked by increased filament temperatures. Drawn tungsten wire, because of its favourable radiating characteristics, lower vapour pressure, high melting point, high tensile strength and ductility has become the preferred material for lamp filaments. This metal seems to be available in sufficient quantity for all lighting needs since filaments for 75,000 40-w. or 1,000 500-w., 115-v. lamps can be made from one pound. No known substance exists with the efficiency of tungsten for converting electrical energy into light with no reservations as to cost, manufacturing difficulties or other considerations. The introduction of machines into the manufacture of incandescent lamps aided in the production of a superior, uniform lamp at a nominal cost, and high quality of the lamp is maintained by rigid specifications and tests.

Gas-filled and Vacuum Incandescent Lamps.—Air is exhausted from the lamps to eliminate oxygen, thereby preventing filament vapourization. Air seepage into an incandescent lamp causes rapid deterioration of the filament and whitening of the bulb.

Attempts to introduce inert gases into the carbon lamp for increasing filament temperatures failed because the resultant losses by conduction neutralized filament temperature gains.

The first major improvement of the tungsten lamp was the introduction of an inert gas into the bulb. Nitrogen was first used because the rarer gases were too expensive to obtain; however, by improved processes enough argon is now available so that the atmosphere surrounding the filament is composed of 80% argon and 20% nitrogen. Krypton has better characteristics than argon, but its cost offsets any gains from its use. Because the gas used must be very pure and free from moisture, "getters" are used for removing harmful gases and water vapour.

Higher lamp efficiency can be obtained by increasing the size of the filament, because the protective sheath of gas which reduces loss depends upon filament size. Coiling the filament increased the efficiency of the 500-w., gas-filled lamp by 40% as compared with the same size straight filament vacuum lamp.

The next step in reducing filament loss was an apparent increase in filament size produced by winding the coiled filament around a mandrel, forming the coiled-coil filament with an additional 10% to 15% increase in efficiency.

End Losses.—Materials used for lead-ins and supports have been improved and the number of supports has been reduced until end losses from these sources have been reduced to about 2%. Elimination of a support increases the efficiency approximately 0.5%. In the 40-w. lamp, supports have been reduced from 11 in the vacuum tungsten lamp to 3 in the gas-filled lamp.

Lamp Blackening.—A certain amount of blackening inside the bulb is inevitable and is removed in some of the high-intensity short-life lamps by sealing coarse tungsten powder inside the bulb, for scouring the inside surface at intervals, increasing both the light output and useful life of the lamp. In the bipost lamp the vapourized tungsten is removed by passing the hot gases carrying the vapour from the filament through a screen above the filament.

Mechanical Features.—The incandescent lamp is an assemblage of a mount, a base and a glass bulb. Lamps of 40-w. or larger contain gas, which permits higher temperature of the filaments. The usual mixture of gas is argon and nitrogen, but in special types krypton or hydrogen are used. The complete mount consists of: (1) the stem which carries the molybdenum support wires held in a glass button at the end of the stem; (2) the exhaust tube; (3) lead-in wires with a nickel-iron core and a copper sleeve used in the press because they have the same coefficient of expansion as glass, and of copper to the base and nickel to the filament; and (4) the tungsten filament. In some of the larger sizes a mica disk on the stem protects the socket from the filament heat when the lamp is burned base up. The base is used for the connection to the electrical circuit. To protect the line fuse or to open when the filament arcs there is a small fuse just outside the stem press on the mount.

The filaments are supported in many ways for various types of duty. The filament form determines the position in which the lamp may be burned and its resistance to vibration. The filament form also controls the incandescent plane important in projector service. The base of the lamps adapts it to the holder of the equipment, and is cemented except where current requirements would produce an excessive heat, when the fastening is by mechanical means. When the screw lacks carrying capacity in large lamps, it is replaced by the bipost base which forms a pin-type positive connection. Where accurate location is essential prefocus bases are used so that in an optical system lamps may be interchanged with the filament remaining in the same plane. Bayonet, disk and pin bases are used on smaller types and tubular lamps.

Eight shapes of lamps were offered in 1945 to the trade in the U.S. because of production controls, many more being available on the European market. In the U.S. 20 principal types of lamps consume 95% of the electrical energy used in lighting. The remaining 5% embodied the same principles but were manufactured for special services.

Spectral Quality of the Incandescent Lamp.—The light emitted from the incandescent lamp is deficient in blue radiation and very strong in the red, the exact distribution depending on filament temperature which in turn is influenced by lamp size. If additional radiation is desired in the blue region, lamps are overvoltaged resulting in shorter lamp life. The enclosing bulb influences the spectral distribution, the "daylight" lamp using a blue bulb for correcting this region, which lowers lamp efficiency because of the light absorbed by the filter.

Other Factors Affecting Light Output.—The frequency of the system supplying the incandescent lamp will influence its output. A lamp filament varies as the current decreases from maximum to zero. This is noticeable in the lower frequencies, and is present to some extent in the 60-cycle system, although invisible to the unaided eye. The larger the lamp, the more "carry-over" there will be. A 40-w. lamp has 14% variation at 60-cycles, while a 500-w. lamp has only 4% and the same sizes range from 23% to 12% with 25 cycles. Flicker in lighting will be noticed if a 3% change of voltage is applied for a two-cycle duration.

Lamps should be operated at rated voltage, for instance, a 10% increase of voltage causes a consumption of 117% watts, gives 136% lumen output, 350% lamp cost per 1,000 hr. and a lumen-hour cost of light equivalent to 100.5%, while a 10% decrease of voltage causes an 85% wattage consumption, gives 70% lumens, 24% lamp cost per 1,000 hr. and a 113.9% lumen-hour cost of light. The selection of 1,000 hr. for a lamp life is determined by a balance between lamp cost, power cost, cost of maintenance and overhead.

As the temperature of the filament was increased, lamp brightness also increased so that besides using special equipment for light control, the bulb of the lamp was given special treatment. Enamelling processes first used for this were inefficient, and increased the collection of dirt. The most successful treatment is an inside frosting. The outside treatment absorbed 5% to 20% of the light, while inside frosting absorbs approximately 1%. There is a secondary gain in that the lamp bulb is strengthened by the process.

Gaseous Vapour Lamps

Low-pressure Mercury Vapour Lamps.—The Cooper-Hewitt source was the first of the commercial low-pressure lamps. These have been built in 200 to 1,600-w. sizes using mercury gas, at 1 to 2 mm. pressure, and a mercury cathode, giving a relatively cool light (200° to 250° C.). The tubes have a rated life of 4,000 hr., which advantage is offset by the poor colour characteristics. The tube will operate on either A.C. or D.C. current but in each instance special means must be used for starting, this being part of the auxiliary equipment. The volt-ampere characteristics of the mercury arc are such that within certain limits the voltage is approximately constant throughout a range of current variation.

The modern lamp is 50 in. long, consumes 250 watts, which has been pushed from 18 lumens per w. to 24 lumens per w., has a brightness of 0.031 candles per mm. and a pressure of 0.0003 atmospheres.

Cooper-Hewitt 85-w. Fluorescent Lamp.—The advent of the use of fluorescent materials suggested the possibility of applying phosphors to the principles developed in the low-pressure tube. On a competitive basis the new lamp offered had a life of 3,000 hr., was rated at 85-w., delivered 4,000 lumens, which is 47 lumens per w., and operated on a full-wave rectifier with a power factor of 85% for the complete auxiliary. As it operates on D.C. there is no stroboscopic effect.

Low-pressure Mercury Vapour, Incandescent Lamps Combination.—Much experimental work has been done in an effort to correct the poor colour quality of the mercury arc. The combination of Cooper-Hewitt tubes with incandescent lamps was an additive method of colour correction. Although this correction did not produce a colour matching light, it did produce a soft white light which for a time found favour in commercial and industrial fields. For adaption to desired luminaire design, tubes were produced in straight, round and square form with a possibility of obtaining "U" and "M" tubes. Most pleasing results were obtained by combinations of 2-w. of incandescence with 1-w. of mercury, giving a lumen ratio of 2.5 lumens to 1 lumen respectively. The development of the fluorescent lamp with its excellent colour of light-control possibilities superseded this more complex and expensive means of producing a pleasing colour quality in lighting.

High-Pressure Mercury Vapour Lamps.—The radiation from a mercury arc changes with pressure, and ranges of pressure from 30 atmospheres to about 280 atmospheres have been investigated. At high pressures the spectral lines of mercury radiation are no longer sharp but are broadened, giving a background radiation. This broadening is greater toward the red end of the spectrum, which improves the light quality with respect to colour, although it still does not give a balanced spectrum.

One disadvantage of this source is that it requires a starting time ranging from minutes in the ordinary type to seconds in one special 1,000-w. unit, and any interruption requires a repetition of the starting cycle. Although efficient in itself, the unit is usually used in combination with incandescent lighting to (1) ensure continuity of light, and (2) to correct the colour of the light source by additive means. The combination should be made on a lumen-to-lumen basis between the high-pressure mercury lamp and the incandescent lamp.

Table I gives the characteristics of the general high-pressure mercury lamps, which besides being used for general lighting have many special applications.

The 1,000-w. lamp with its quartz lamp enclosed in a water jacket is one of the brightest compact lighting units offered. It is a relatively cool light because the heat is conveyed away by the circulating water. The initial lumens are 65,000 or 65 lumens per w., the rated life, 75 hr. It requires 4 sec. for starting and 2 sec. for a restart, and operates at 110 atmospheres with a brightness of 300 candles per sq.mm.

Other Gaseous Vapour Discharge Lamps.—The sodium vapour lamp, built in 300- to 500-w. sizes, gives efficiencies of 50 to 70 lumens per watt. The discharge gives a warm yellow light with almost monochromatic radiation. Because of this colour characteristic the lamps are not suitable for home or commercial use, but may be adapted for some industrial installations. When used for highway lighting they are both successful and economical.

High-Voltage Neon Lamps.—The neon lamp bulb is associated with the cold cathode group, with the luminescence produced by an electrical discharge through gases. They are efficient when of considerable length and have a rated life of 3,000 hr. Neon tubes contain a high percentage of neon gas, giving the characteristic orange-red colour; to obtain other colours mercury, argon, carbon dioxide and xenon are used, and coloured glass tubes are used in conjunction with the gases. The voltages range from 8,000 to 12,000 volts. The operation of the high-voltage cold-cathode and the high-voltage hot-cathode fluorescent lamp is the same except at the cathodes, where the cold-cathode lamp has the higher voltage loss. Actually, the hot-cathode lamp is cooler even though the filament is present.

Prior to the introduction of the fluorescent coating, sign tubing had little application for illumination purposes, its low lumen output being used to create luminous patterns. With fluorescent coating, and depending on diameter, current rating and length, 20 to 30 lumens per w. are obtainable. The units are from 4 to 10 ft. long and are connected in series to operate from 1,000 to 15,000-v. transformers. By 1945 there was a definite competition from sign manufacturers for some of the interior lighting business, and claims of 10,000 hours of operation have been made. (*See* Table II.)

TABLE I.—*General Lighting High-pressure Mercury Vapour Lamps Characteristics*

Watts	Lumens at 100 hr.	Lumens per watt*	Rated life (hr.)	Starting time (min.)	Restart time (min.)	Pressure atmospheres	Brightness c./sq.mm.
100	3,000	30	1,000	3	3	8	9
250	10,000	40	2,000	4	4	4	4
400	16,000	40	3,000	7	7	1.2	1.4
3,000	120,000	40	2,000	7	8	0.7	0.29

*Efficiency of the lamp only. To compare with incandescent lamp it is necessary to reduce the lumens per watt because of transformer loss, approximately 20%.

Fluorescent Lamps

Low-voltage, Low-pressure, Hot-cathode, Mercury Vapour Fluorescent Lamps.—These lamps are designated as "fluorescent lamps." The fluorescent lamp is a glass tube coated on the inside with a phosphor (fluorescent powder) and filled with mercury vapour, with a trace of argon to facilitate starting. After starting, the current is carried essentially by the mercury vapour. The design adjustment is such that the desired resonant radiation of mercury at 2,537 angstroms is produced. Small coils of tungsten wire (electrodes) are sealed into each end and these filaments are

TABLE II.—*Comparative Data on Light Sources**

Source	Candles per sq. in.	Lumens per watt	Luminous efficiency %	Cost million lumen hr.
Sun	923×10^3		16	
Candle	3.5			$400.00
Kerosene flame	9.0			13.50
Gas flame	2.7			
Acetylene flame	40			
Welsbach mantle	31			
Carbon arc	92×10^3	7	1.1	
Flaming arc	5×10^3	17	2.7	
Magnetite arc	4×10^3	90	14.5	
Mercury arc	8×10^2	12.7	2.0	
Cooper-Hewitt	14.9			
Cold-cathode				
Red	0.5			
Green	0.16			
Blue	0.1			
Hot-cathode, 40-w.				
White	3.87			
Daylight	3.1			
Soft white	2.76			
Carbon filament	340	2.6	0.42	17.60
Gem filament	615	4		
Nernst glower	1,660			
Tantalum filament	750			
Tungsten filament (Vacuum)	1,328	10		
Tungsten filament (gas)	7,800	20	3.2	2.55
Tungsten filament coated lamp (25-w)	11			
Tungsten filament inside frosted (25-w)	22		8	

*Information from numerous sources.

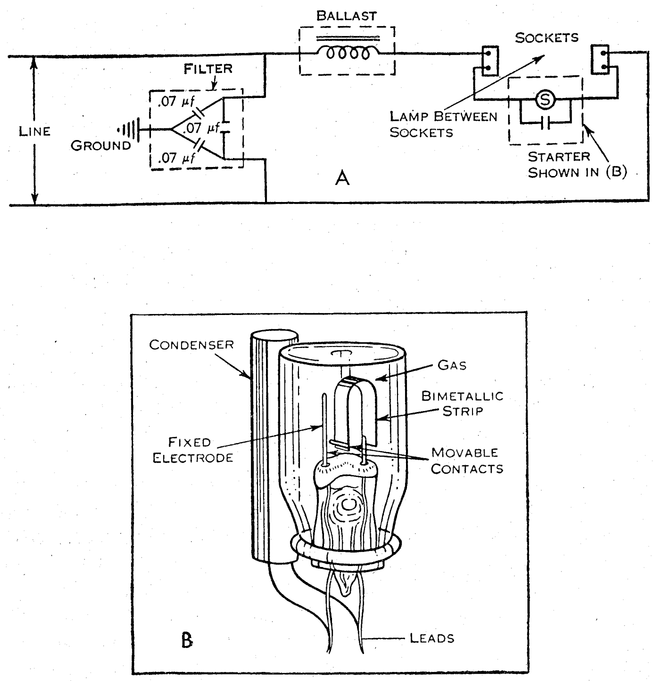


FIG. 2.—(A) FLUORESCENT LAMP CIRCUIT WITH FEEDBACK FILTER

The socket holds the lamp, the ballast (a coil of wire wound on an iron core) furnishes the *inductive kick* to start the arc and limits the flow of current through the arc; the filter reduces feedback into the electric supply circuit which may cause radio interference. (B) Internal Elements of the Glow-switch Starter.—The bulb is filled with neon, helium or argon gas and has a fixed electrode and a movable contact. At starting, the voltage is high across the glow switch and the glow heats the switch elements causing the switch to close. The lamp cathodes are now placed in the circuit and are heating. When the glow switch opens, the mercury vapour will be ready for the arc. The glow switch opens when it has cooled, which follows the shorting of the glow at closing, which removes the heating source. On opening there is an *inductive kick* from the energy stored in the ballast striking an arc. During the operation of the lamp the voltage across the glow switch is too low to cause a glow, therefore, the switch stays open until the lamp is turned off. In the "no-blink" type of auxiliary a thermal switch keeps the glow starter from operating when a faulty lamp develops

coated with an active electron emissive material. The lamp is essentially a discharge lamp with a negative volt-ampere characteristic, and requires ballast equipment.

The ultra-violet radiated from the conducting mercury gas energizes the phosphor which radiates light in the visible region. Different mixtures of the powders forming the phosphors control the colour of the emitted light. Some modifications with coloured glass must be made to obtain the ranges of colour desired. In the 40-w. fluorescent lamp approximately 1% of the radiation in the visible region is delivered by the mercury vapour, the total 22.5% converted into visible radiation being more than three times the radiation from the 40-w. incandescent lamp, which delivers only 7% of its wattage in the visible region.

Operation.—The operation of the fluorescent lamp requires two switches, one for normal switching as in the incandescent lamp and the other for closing the circuit on the cathodes for an instant, allowing the cathodes to preheat, then opening, producing an inductive voltage which causes the arc to strike (fig. 2b). The choke or ballast (fig. 2a) limits the current flow when the lamp is operating. Circuits have been designed for the elimination of this switch, always a source of operating trouble. For the higher voltage hot-cathode lamps and for cold-cathode types, no switch is needed.

The fluorescent lamp has a high efficiency but introduces several operating characteristics which produce a lighting installation less simple in theory and functioning than the incandescent lamp. Complications caused by necessary auxiliary equipment are reflected in the reliability of the lighting system.

Characteristics.—Diameter and length of the fluorescent lamp depend upon several factors. Design has been centred about 1-in. and $1\frac{1}{2}$-in. tubes for the lower voltages, and the $\frac{3}{4}$-in. tube for the higher voltages. The fluorescent lamp is more critical to both voltage and surrounding temperature than the incandescent lamp. The operating voltage divides between the electrode drop (12 to 18 volts) and the voltage gradient, which is the voltage per in. of tube required to neutralize the ions at the walls, plus the conversion of the energy into radiation. The starting voltage is about four times the operating voltage.

When a single lamp is being used, the stroboscopic effect caused by the lamp being extinguished twice during each cycle is annoying in some operations. This may be eliminated by using two lamps in the same luminaire, with the circuit so arranged that the lamps do not extinguish at the same time. This effect is different from "swirling," a type of lamp flicker which is also annoying. The swirl may appear in a new lamp or at any time in its life and may disappear as suddenly as it occurred.

The fluorescent lamp can be the cause of radio interference either from direct radiation, radiation from the electric supply or from feedback from the line. Proper filtering will eliminate the last two causes, while removal of the radio from the field or proper screening will eliminate the first (fig. 2a).

Failure of the lamp to function properly may lie within the lamp itself, in the auxiliary or the switch. The safest rule to follow in correcting the fault is to eliminate by replacement with spare parts which should be available, in the order of switch, lamp, then ballast; but under no circumstances should the lamp be left in operation if trouble develops.

Economic Consideration.—Economic consideration of the fluorescent lamp requires a very close study of cost of both equipment and power. The first cost of the fluorescent lamp is relatively high as compared with the incandescent lamp, while its operation cost is relatively low. Replacement of small wattage incandescent lamps by fluorescent lamps of the same wattage will give 3.5 times more light, and replacement of an incandescent lighting system by a fluorescent system of equal quality will give about twice as many lumens per watt. However, the simplicity of operation and maintenance of the incandescent system must be considered.

Since fluorescent lighting systems create less heat, they are valuable in conjunction with modern air-conditioning systems and they are also of great usefulness where colour-matching, or coloured lighting is required.

Because of the various ways in which efficiencies may be stated, many claims have been made concerning fluorescent lamps, but it is necessary to include all the losses in the auxiliary with the lamp wattage to arrive at a correct evaluation. Brightness of the fluorescent lamp is much less than that of the incandescent lamp, but it is still so bright that neither the eye nor the work should be directly exposed to it. Any comparison of lighting systems must be on the basis of equal quality of lighting (*see* Table III).

TABLE III.—*Fluorescent Lamps "White" Characteristics**

Watts or size (in.)	Tube size (in.)	Current lumens †	Lumens per watt ‡	Brightness ft.L.
12 in. circular	1¼	0.42 a. 1,600	50	2,040
15-w.	1	0.30 a. 585	39	2,040
	1½	0.33 a. 525	35	1,400
20-w.	1½	0.35 a. 860	43	1,850
30-w.	1	0.34 a. 1,450	48	2,480
40-w.	1½	0.41 a. 2,100	53	1,750
65-w.	2⅛	1.35 a. 2,100	32	1,530
100-w.	2⅛	1.45 a. 4,200	42	2,180
42-in.	¾	100 ma. 900	60	1,675
		200 ma. 1,400	56	2,600
64-in.	¾	100 ma. 1,400	61	1,650
		200 ma. 2,150	57	2,550
72-in.	1	100 ma. 1,400	64	1,050
		200 ma. 2,350	62	1,800
96-in.	1	100 ma. 1,950	65	1,100
		200 ma. 3,300	63	1,850

*The life of the lamp on a 3-hr. cycle is 2,500 hr.
†The symbol a. stands for amperes, and ma. for milliamperes.
‡Efficiency of the lamp only. To compare with incandescent lamp it is necessary to reduce the lumens per watt because of ballast loss, approximately 15% to 30%.

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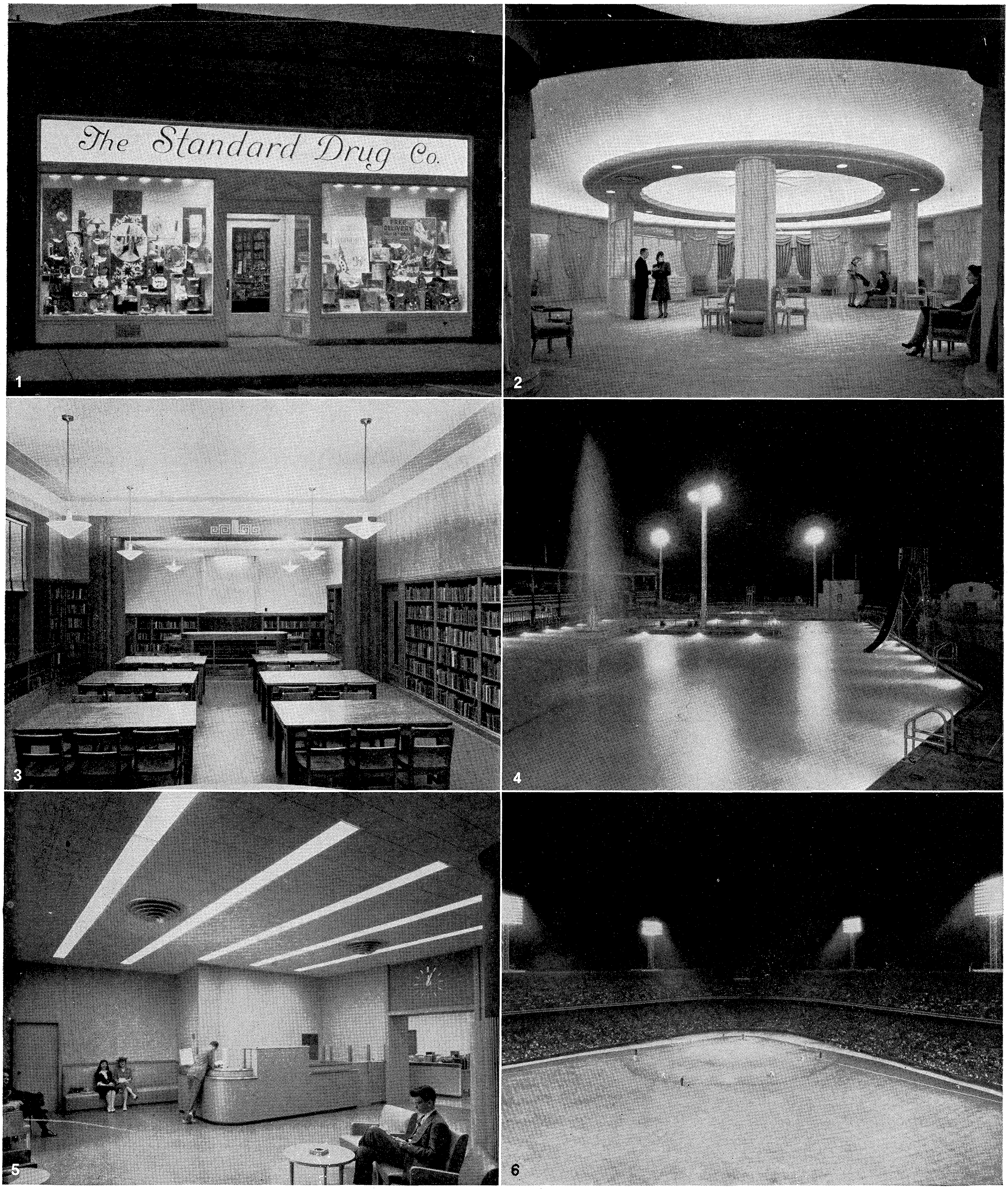
LIGHTING FOR VARIOUS KINDS OF INTERIORS

1. Continuous rows on 10-ft. centres light a factory room. Each reflector contains two 40-watt fluorescent lamps mounted approximately 9½ ft. above the floor. Rows at right angles form a grid pattern, produce 80 foot-candles maintained in service on the work plane
2. Fluorescent lighting units in a schoolroom which are open at the top to light the ceiling
3. Lighting for the inspection of paintings in an art gallery, filtered through prismatic glass plates in the ceiling
4. Continuous rows of lamps in a luminous soffit produce pleasing wall and ceiling brightness in this section of a department store
5. Individually located diffuse aluminum troffers in an office, spaced on 3-ft. centres in the crosswise direction
6. Continuous-row troffers for an office



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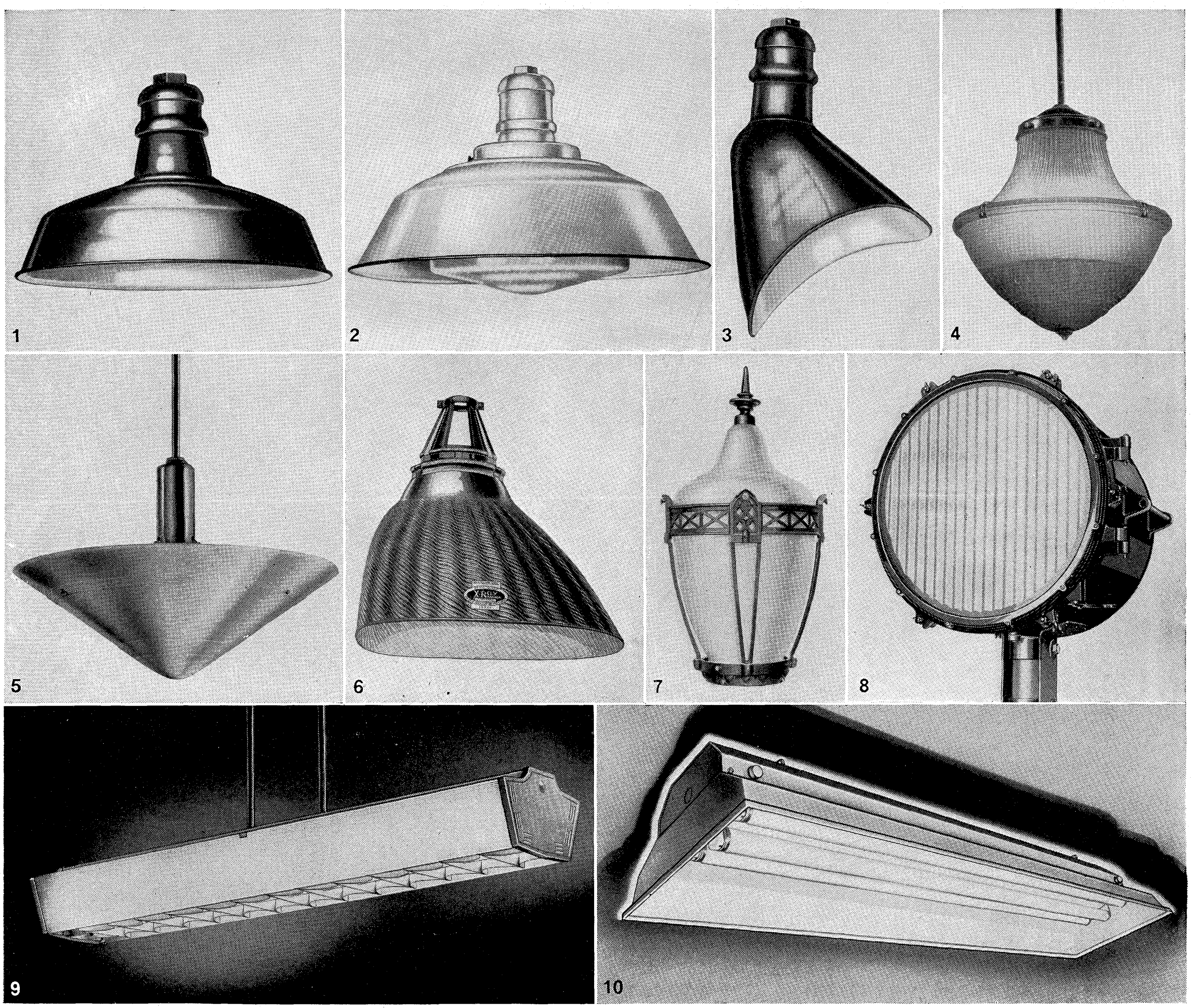
MODERN LIGHTING ARRANGEMENTS

1. Show windows are lighted with 150-watt filament lamps in reflectors on 14-in. centres. Luminous panel of tempered enamelled glass with attached letters lighted from the rear by ten 4-ft. white fluorescent lamps in two rows in a white finished cavity
2. Sales area in the Marshall Field & Company store. Coves contain about 110 40-watt fluorescent lamps; the centre fixture eight 40-watt fluorescent and 20 60-watt filament lamps. Eight louvred downlights and two lens plate units each use 300-watt filament lamps
3. A library. John Simpson, Jr., High School, Mansfield, Ohio, lighted with luminous indirect incandescent fixtures. An area 22½ ft. by 44 ft. is lit by eight fixtures with an average intensity of 23 foot-candles
4. Crystal Pool in Glen Echo Park, Washington, D.C. Underwater units and overhead floodlights make this pool safe as well as attractive at night
5. National Gypsum company offices, Buffalo, New York. The foyer is lighted by five rows of the troffers on 5-ft. centres
6. Major league baseball at night. Philadelphia (Pennsylvania) Athletics Shibe park, where 780 1,500-watt floodlights on 8 towers 150 ft. in height provide intensity of 185 foot-candles on the infield, 120 on the outfield



BY COURTESY OF (4) THE HOLOPHANE COMPANY, (5) WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, (6) THE CURTIS LIGHTING INCORPORATED, (9) THE F. W. WAKEFIELD BRASS CO., (10) BENJAMIN ELECTRIC MFG. COMPANY

VARIOUS TYPES OF STANDARD LIGHTING UNITS

1. A porcelain enamel steel reflector known as the RLM Dome. Made to uniform minimum specifications by many manufacturers, it is of high quality construction, has an efficiency of at least 70%, uses inside frosted or white bowl lamps preferably, and is most often mounted 9–12 ft. from the floor
2. The Glassteel Diffuser—similar to Fig. 1 but producing a more diffused light as a result of the lamp-enclosing glass globe. Used at medium low mounting, for general industrial areas
3. An elliptical angle reflector used for lighting vertical and inclined surfaces, usually constructed of porcelain enamel steel. In general the above three industrial units are available for 100- to 1,000-watt lamps
4. A prismatic enclosing globe, for stores and offices. Other types are available in which, by scientific arrangement of the prisms, wide differences in light distribution are procurable for specific needs
5. An open top luminous bowl unit for indirect lighting. The prevailing trend in office, school and similar commercial applications is toward semi-indirect and indirect units which can produce high intensities with minimum glare discomfort
6. One of many varieties of show window reflectors. Individual design is based on the general proportions of show windows, with due consideration for both horizontal and vertical illumination
7. An ornamental street lighting unit for parkway or residential thoroughfare illumination. Pendant types are also frequently used
8. A special type of outdoor unit—an airport landing field floodlight whose output must be spread over large horizontal areas, usually employing 3,000- and 5,000-watt lamps
9. A typical commercial fluorescent lighting unit
10. A 3-lamp, 40-watt closed-end industrial fluorescent unit

LIGHTING AND ARTIFICIAL ILLUMINATION

BY COURTESY OF (1) SYLVANIA ELECTRIC PRODUCTS INC., (2) GENERAL ELECTRIC COMPANY, LAMP DEPARTMENT, (3, 4, 5, 6) WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, LAMP DIVISION

MODERN HOME LIGHTING ARRANGEMENTS

1. Studio bedroom. General illumination comes from the fluorescent ceiling fixture, from fluorescent lamps concealed behind the window valance, and above and in the bookcase
2. The recessed box in the overhang (three 25-watt filament bulbs) is especially effective with this simple architectural treatment
3. A kitchen entirely lighted by fluorescent lamps. Sink, range and work counters are locally lighted. In the section over the sink two 30-watt fluorescent lamps are recessed and covered by glass. Under the front edge of the cabinets are single 15-watt fluorescent lamps
4. Across the top of the recess are two rows of three 30-watt fluorescent tubes covered by frosted glass and a valance of fabric. The niches are lighted by long, slender fluorescent tubes mounted vertically in the front and at the sides of each niche. These tubes are 42″ long (approximately 25 watts each)
5. General lighting is produced from a continuous cove that conceals an unbroken line of fluorescent lamps (10 watts per running foot). The sectional davenport is backed by a fluorescent-lighted ledge
6. Dining room chandelier designed to provide general lighting throughout the room and glareless light downward on the table. This is accomplished by a diffusing glass reflector under the metal shade. Fixtures of this style are made to accommodate a three-light lamp with a choice of 100, 200 or 300 watts, plus a 32-watt circular fluorescent lamp

APPLIED LIGHTING

In applying lighting to any task, consideration must be given to both the human and the mechanical elements involved. In the design of a lighting installation the opinions and requirements of the eye specialist, the architect and the interior decorator must be considered, as well as the control and the amount of lighting. A successful lighting system must be a part of the building or activity for which it has been designed.

Measurement of Light.—Light is measured by its capacity to produce a sensation. The eye interprets this sensation in that region of the electro-magnetic spectrum which extends from 7,600 A. (angstroms) to 3,800 A. The eye does not respond equally to the radiant energy in this octave, responding more efficiently to the green and yellow than to the reds, blues and violets.

There are three units of special importance in the application of lighting in practice; the lumen (unit of luminous flux), the foot-candle (ft.c.) (1 lumen incident per sq.ft.) and brightness. Brightness is measured by foot-lamberts (ft.L.) for surfaces of low intensity and by candles per sq.in. for sources of high intensity. In the metric system the corresponding units are the lux (1 lumen incident per sq.m.), and the lambert (1 lumen per sq.cm.) for brightness. The lumen is used in lighting calculations, while field measurements are made of illumination (foot-candles) and brightness (ft.L. or candles per sq.in.).

Illumination is measured by means of a light meter (foot-candle meter) usually of the photoelectric type. When using the photoelectric light meter care should be exercised because its positive indication often leads to a false sense of security in the results. Unless the cell is corrected by a proper filter to correspond to the response curve of the eye, readings under coloured lights will be incorrect. There may be electrical contact errors caused by incomplete contact of the conductor and the cell surface. Light coming from the radiating surface may be blocked by either the observer or the edge of the cell frame.

Measurements of brightness are made with some form of brightness meter which the observer is required to adjust for photometric balance. This is to some degree subjective, in particular where the source measured does not match the standard lamp in colour temperature. In the past, average illumination has been relied upon to a great extent, but present tendency is to give serious consideration to brightness, and future design will continue in this direction.

Lighting Environment.—The act of seeing depends upon vision, the size of the object and its brightness, the contrast between object and background and the length of time the object is exposed for viewing. The first essential to proper seeing conditions is that the eyes be corrected; the second essential is the proper amount and quality of lighting from artificial sources.

Period of Exposure.—If the object is large and long periods of time are allowed for exposure, the task can be adequately lighted with little illumination, but for small objects and short exposure periods, the illumination must be correspondingly increased. The retina will retain an image with no consciousness on the part of the observer that the lighting is continuous if the flicker is rapid. Motion picture projection bears witness to this fact. However, sudden changes of light at long intervals will cause blurring of moving objects, which becomes more pronounced at low foot-candle levels of illumination. The stroboscopic effect from fluorescent lamps and the 25-cycle flicker are examples of a lack of continuity of light.

Size of Object.—The size of an object establishes the lighting requirements. By size is meant visual size, which is a combination of dimensions of the smallest detail which must be observed and the distance of the object from the eye. More foot-candles are needed for smaller objects, all other factors being equal. The normal eye can distinguish any object which subtends an angle of one minute. This is an important factor in the design of signs which are to be seen from some distance.

Contrast.—An object is seen more clearly if background and object are of different colours. A white object against a black background can be more readily seen than a black object against a black background. This fact is utilized in industry to obtain contrast between the machine and its moving parts, the material being worked and the surround (visual field).

Brightness.—Brightness leads directly to the visibility of the object. A very dark object requires more foot-candles for illumination than one with a high reflection factor. For many years foot-candles of illumination were the index to lighting design and specifications, and failure to recognize the importance of reflection factor led to faulty lighting. More attention is being paid to the brightness of the task and its surroundings in design.

Glare.—When brightness becomes irritating it is recognized as "glare." Glare contributes more to the poor quality of a lighting system than any other factor. Glare may depend upon several conditions present in the lighting system: (1) high brightness of the source; (2) high brightness contrast between the source and the background; (3) location of the source in the field of view; (4) the total volume of the light entering the eye; and (5) the time of exposure to the brightness source. The correction of any one of these contributing factors becomes simple when it is considered individually. Because of the injurious effect of glare, either direct as from a source, or reflected from some object which reflects a specular image, bare lamps exposed in any plane should never be used. It is of prime importance that all forms of glare be controlled properly.

Investigation and experience have established principles for studying the installation in order to control glare. These are not recommended as precise, but are suggestive of order of evaluation: (1) the light output of a source cannot be increased as fast as its area, but it is safe to increase the output as fast as the diameter; (2) increasing the foot-candles ten times in a room permits only doubling the brightness of the light source; (3) doubling the mounting height of a unit allows a lumen output of approximately three times that used previously; (4) brightness ratio of adjacent areas should be within limits of ten to one; (5) there should be more light on the work than at the eye; (6) each light in a row makes the same contribution to glare. All these specifications are based on equal comfort from the lighting system.

Proper Amount of Lighting.—The severity of the task is the first index to the amount of light required. Lighting may be specified as: (1) For severe and prolonged tasks with details small, contrast low, and speed of operation high, 100 ft.c. or more should be used, best obtained by supplementary lighting. (2) For installations in which speed is not a factor and the object is small, 50 to 100 ft.c should be used, and again should be obtained by supplementary lighting. (3) For normal industrial and commercial tasks, 20 to 50 ft.c. will suffice and may be supplied by a well-designed general lighting system. Where economy is a factor supplementary lighting should be used. (4) For most recreational needs and ordinary tasks which are not prolonged throughout the working day, 10 to 20 ft.c. from a general lighting system is satisfactory. (5) Where seeing is important but not prolonged, the contrast good, the object fairly large and the speed of movement slow, 5 to 10 ft.c. from a general lighting system is specified. (6) Levels of less than 5 ft.c. should be specified only for casual and nonhazardous passageways. This is obtainable with a relatively cheap general lighting installation since for this use the quality of the lighting is of minor importance.

Considering the high foot-candle level to which the eye is accustomed out-of-doors, it is logical to believe that the eye will function best under high foot-candle levels of properly controlled light; that is, light in which quality of distribution approaches that of the out-of-doors. Control of the surround requires a reduction in the foot-candles. The spectral quality of the light source has no influence on seeing and the modern light source does not contain enough of the harmful wave lengths so that repeated applications are injurious.

Colour and Shadow.—Colour and shadow are not necessarily factors in seeing but are of importance in recognition of objects. Colour must be treated carefully when used in conjunction with light. If coloured light is used, white or neutral gray makes the best surround. With the incandescent lamp, usually considered as white light, the spectral distribution of the output must be considered when colours are to be extenuated or are to appear in their natural intensity.

Moods are suggested and depth control is effected by colours. Although the lighting specialist is not to assume the functions of the artist or the decorator, it is necessary in the application of lighting to recognize the effect light has upon colour and atmosphere and to proceed accordingly.

Shadows may be either detrimental or helpful, depending upon the task to be performed. For decoration the shadow removes the monotony of a uniform lighting system and adds atmosphere to areas of relaxation, as in the home. In industry the shadow facilitates inspection tasks, emphasizes reliefed surfaces and thereby improves visual conditions. Where there is moving machinery or the work lies within a single plane, shadow is detrimental both to safety and visibility. Small concentrated sources will produce harsh, severe shadows, while large area sources of low brightness will produce, for practical purposes, a shadowless surface. Between these two extremes are gradations adaptable to specific types of tasks. Shadow control on stair treads, at corners and on moving machine parts are important applications of light to safety.

The Surround.—The surface which the eye encounters as relaxation areas from a severe task should be properly prepared and illuminated both for light reflection and psychological effect. Brightness of the surround should be at least 10% of the brightness of the task, although research has shown that, if it were feasible, the task and the surround should be equally bright.

Ceilings should have a reflection factor of 75% or more, and side walls of from 50% to 70%. Any trim above 30 in. from the floor may be as dark as desired up to a small percentage of the wall surface. The use of warm and cool colours in shades or tints makes little difference if the reflection factors are correct.

Factors Controlling the Effectiveness of a Lighting System.—These factors should be considered carefully when analyzing a lighting system: (1) The quantity of light should be such as to produce a desired brightness for the severity of the task. (2) There should be no direct glare from the light source and the reflected glare should be reduced to a minimum. This can be aided by selection of equipment and work surfaces producing no specular images. (3) Uniformity of the lighting should be controlled. For tasks in one plane such as writing, drawing and reading, a shadow-free light is desirable. For tasks in three dimensions such as relief work and inspection, a nonuniform light may be better. (4) Illumination of the surround is essential for the relief of eye strain by providing the proper atmosphere for eye relaxation.

The amount of illumination has been so strongly stressed that frequently quality of lighting is sacrificed by lack of consideration of the elements outside the brightness of the light falling on the task. A lower foot-candle level with proper control is better than a high foot-candle level improperly controlled. The recommendations of the Illuminating Engineering society for the amount of illumination are conservative specifications.

Light Control.—Primitive light sources required no shielding and there was no attempt to control artificial lighting until the 13th century when mirrors were placed behind the Venetian standlamp, the *lucerna.* In 1490 Leonardo da Vinci introduced control by refraction, and in 1745 polished metal reflectors were used in the *reverbere.* For the most part control of light belongs to the 20th century.

Classes of Substances.—Transparent materials are not effective with modern light sources because the bare source has a brightness which must be controlled. Transparent material can be used with lighting equipment having very low candlepower; however, this class of equipment is more for period reproduction than for lighting, and when used for lighting as well as decoration the quality of light is very poor.

Translucent materials are more widely used than any other light-control substance, and the introduction of plastics into this field in 1933 marked a new stage of light-control development. Translucent glasses of the more dense types (opal and alabaster) are used for light backgrounds, while the configurated, decorated, structural and architectural glasses are used for decoration where atmosphere rather than illumination of a task is important. The flashed opal, cased, enamelled and light opal glasses have a relatively high transmission and good diffusing qualities. These latter two classes of glass have been widely used in the better grade of lighting glassware and luminous elements.

The opaque materials are used primarily as reflectors and shields. Reflectors for beam control should have a high reflection factor and usually some form of protected metal film or treated metal is used, silver and aluminum ranking high for this application. For industrial equipment, white enamel and paints on opaque surfaces give high reflection with reasonable maintenance and replacement.

Light-Beam Control.—There are three ways in which the light beam may be controlled: (1) reflection; (2) transmission; and (3) refraction. The opaque materials are of the reflection type, and the translucent of the transmission type. Refraction is redirection of light caused by surface shape of the transmitting material. One of the most efficient means of control is by use of prisms, but control in one direction may cause bright spots in others, if not properly designed.

Nature of the Surface.—Light may be diffused by transmission or reflection from a surface, and diffused light is very acceptable for lighting purposes. Redirected light, or even scattered light has its merits in the instance of the special reflector, but may cause specular images or highlights producing objectionable reflected glare. It is recommended that all lighted surfaces within the line of vision (walls and equipment) be of the diffusing type.

Optical Control.—Where accurate control of the light is desired, as in projectors or searchlights, optical reflectors or lenses may be used and for fine control these devices must be accurate. For automobile headlights and floodlights the control lenses and the reflectors may be made by moulding the glass and drawing or spinning the metal.

Luminaire and Installation.—The design of the lighting equipment and the character of the room and cleanliness are controlling factors in lighting efficiency and light distribution.

Lighting equipment is classified into five groups:

Classification	Approximate Light Distribution	
	% Upward	% Downward
Direct	0–10	90–100
Semidirect	10–40	60–90
General diffusing	40–60	40–60
Semi-indirect	60–90	10–40
Indirect	90–100	0–10

The dimensions of the room, colour of the ceiling and side walls, as well as the efficiency, depreciation and candlepower distribution of the equipment control the output. In design the equipment is classified by a coefficient of performance ("utilization factor") designating the control in the room of the light from the luminaire, and the "coefficient of utilization" which includes the luminaire efficiency and, therefore, designates control from the lamp to the work surface. These coefficients may be determined accurately for a specific equipment or may be grouped into classes for practical use.

Classification of Outdoor Equipment.—Lighting units for outdoor service are classified as "floodlights" when the area is not restricted in pattern, and may have broad, medium or narrow beams. The broad beam equipment is used where the surface to be illuminated is in the immediate area; narrow beam equipment is used for more distant areas. For a controlled beam the "projector" or "searchlight" is used, the first lacking the optical accuracy of the latter. Rotating or fixed equipments used for signal systems are classified as "beacons." Floodlighting is used for safety, protection, advertising and recreational lighting, while railroads, navigation and aviation use the various forms of signal lighting.

Design of the Lighting Installation.—There are two methods of lighting design, the "point-by-point" and the "lumen." Each has its specific use and the accuracy attained with each is satisfactory for practical purposes. The point-by-point method is used to determine the illumination at a point from a specific lighting equipment for which the distribution curve is known. Where there is no inter-reflection the point-by-point method gives the total illumination on the surface at the point, but in an enclosure inter-reflections will increase the illumination. The point-by-point method is accurate for outdoor lighting, for calculation and design of supplementary lighting and for down lights in interiors. The lumen method is satisfactory for determining the illumination within enclosures and is the procedure accepted in the designing of interior illumination. This is a method of determining average illumination and not specific illumination at a point. Although the method is relatively simple, it considers room proportions, colouration of the room, efficiency of the equipment, type of equipment to be installed and conditions contributing to the depreciation of the lighting system, such as operation and the presence of dirt. The method is based upon empirical data obtained by careful research into the actual performance of lighting systems in controlled installations.

The Point-by-Point Method.—This method assumes that for actual conditions the source of light may be considered a point source when the illumination is to be determined on a surface that is at least five diameters from the light source.

The illumination at a point *d* distance from a source (fig. 3) is directly proportional to the intensity of the source and inversely as the square of the distance. This is the illumination on a surface normal to the incident beam of light. When the horizontal or the vertical illumination is desired, the illumination on the normal is corrected by the cosine of the vertical angle for the horizontal and by the sine of the vertical angle for the vertical illumination. Determination of the normal illumination (fig. 3):

$$E_N = \frac{I\theta}{d^2} \qquad \text{(a)}$$

horizontal illumination,

$$E_H = E_N \cos\theta \qquad \text{(b)}$$

vertical illumination,

$$E_V = E_N \sin\theta \qquad \text{(c)}$$

Lumen Method.—The general expression for the determination of the necessary lamp size is:

Lumens per outlet =

$$\frac{\text{Area per outlet x foot-candles}}{\text{Efficiency x utilization factor x maintenance factor}} \qquad \text{(d)}$$

The following steps are necessary in the logical solution of a specific determination:

(1) Have a simple but complete sketch of the room to be lighted, with information as to its use, location, dimensions, and any special information as to the placing of work surfaces and machines with the bay dimensions of the ceiling pattern and the nature of any beam structures at the ceiling.

(2) Determine the number of units and the spacing of the units. It is good practice to arrange the units symmetrically and space the units at the corners of squares dividing the room into a symmetrical pattern. Where beams or other obstructions are present the pattern of outlet arrangement should conform to the general ceiling pattern. Outlet spacing should not exceed 1.5 times the mounting height above the work surface for units of the direct, semidirect and general diffusing type, and not more than twice the height of the ceiling above the work surface for the semi-indirect and indirect units. The spacing to the side wall should be approximately one-half the spacing between units. From the layout with the location of the lamps marked it is possible to determine the area per outlet.

(3) The amount of illumination must be determined for the specific task to be performed. The general requirements previously given will determine in general the foot-candles. To determine the best recommended practice for an installation reference should be made to the *Recommended Practices of the Illuminating Engineering Society.*

(4) Equipment must be chosen for the particular task to be performed. In industrial installations the equipment must usually be relatively inexpensive and easy to clean, and will be of the direct or semidirect type, as the ceiling and walls cannot be expected to reflect much of the light. For commercial installations diffusing types are preferable. In either instance the more successful lighting is obtained where the light source is large and of low brightness. In the indirect system of lighting the ceiling acts as a reflector. Use of luminous elements and cove lighting attains lighting conditions similar to that of indirect lighting. The introduction of the fluorescent lamp requiring many tubes to obtain the desired foot-candles gives a light distribution comparable with an indirect lighting installation. The practice of using bare fluorescent lamps without proper light control will produce lighting with distressing glare while indirect lighting will not.

(5) The *efficiency* and the *utilization factor,* or their product, the *coefficient of utilization,* must be determined for the type of equipment chosen. The room proportion, room colouration and type of equipment enter into this coefficient. The manufacturer of the equipment can supply this information for the specific equipment chosen or values may be chosen for the general type, given in widely published tables. Considering the very light ceiling, and a fairly light side wall colouring, the utilization factors average approximately 0.5 for direct equipment, 0.3 for semi-indirect equipment and 0.25 for indirect equipment. High coefficients are associated with large and light rooms, and the lower coefficients with small and dark rooms. The over-all efficiency utilization factor of a lighting system is relatively poor.

(6) The *maintenance factor* (one minus depreciation factor) is an estimate of the cleanliness of the location and the maintenance of the lighting system. This factor ranges from 60% in relatively poor conditions to as high as 75% under favourable conditions. Direct equipment will maintain better lighting under the adverse conditions of normal industrial usage than will the semi-indirect or indirect lighting systems, which are generally used for commercial purposes.

Having determined the quantities to substitute, the result given is the number of lumens required per outlet (equation d). From manufacturer or laboratory data a lamp or a number of lamps may be selected which will most nearly approximate the required lumens. These lamps are rated in watts and should be so specified. Since the lumen output is constantly being changed in the manufacture of lamps it is desirable to refer to the latest tables of lumen output.

The incandescent lamp in medium sizes emits approximately 18 to 20 lumens per w. while the fluorescent lamp emits approximately 45 lumens per w., including ballast loss. The larger the incandescent lamp, the more efficient the output, and the 40-w., hot-cathode, fluorescent lamp reaches the optimum developed for general service to 1945. Fluorescent lamps are being developed in circular form and for operation at higher voltages exceeding the lumen values given above.

Cove Lighting.—Where the lighting equipment is concealed by

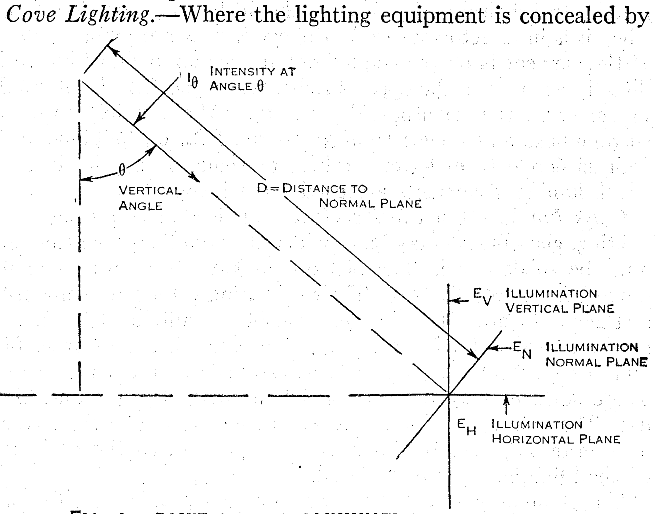


FIG. 3.—POINT SOURCE ILLUMINATION CALCULATIONS

The illumination on the normal, vertical and horizontal planes are given by the equations a, c, b respectively coves, with the ceiling and upper wall used as a luminous surface, the system may be designed by the lumen method. Good reflecting equipment will have an efficiency of approximately 70% while the cove itself may show efficiencies ranging from 25% to 40%. Recessed coves and coves close to the ceiling will have utilization factors of 0.35.

Coves placed too close to the ceiling will give an uneven illumination, a ratio of 1 ft. from the ceiling to every 5 ft. of lighted surface being the minimum that should be used. Plaster coves, finished with the wall and ceiling surface, are very inefficient and will give spotty lighting. The use of reflectors increases cove efficiency and with the correct design the coves can be moved closer to the ceiling. Where the control is obtained by use of some form of prismatic lens it is possible to mount the light source against the ceiling. Relief decorations must be cross-lighted to eliminate undesirable shadows, and produce uniform lighting.

The designer has a choice of having uniform light along the cove or producing a scalloped effect by using clear lamps which create a brushed pattern on the wall. For uniform light properly spaced, inside-frosted lamps, recessed lamps utilizing the concealing surface for reflection, or tubular lamps are required. The fluorescent lamp is applicable to cove lighting.

Luminous Architectural Elements.—Luminous elements became a part of general lighting design following the Century of Progress exposition at Chicago, in 1933. They are applicable both to the exterior or interior of buildings. The term is applied to large, low-brightness lighting sources under which it is correct to consider all forms of indirect lighting as well as architectural elements. The correct application of this type of lighting demands close study, with consideration of the design of the structure as a whole. Luminous elements may take the form of panels, recesses, cavities, niches, pylons, columns, pilasters, parapets, spandrels, soffits, beams, coves, coffers, or mouldings, or may be incorporated into any architectural design. The light may be controlled by diffusing glass, reflectors, louvers, grillwork or by design of the element shape.

The louver, although a very satisfactory control, is not efficient. The concentrating type is the most efficient, but the diffusing reflector causes appreciable loss, reaching a maximum when the distributing system is combined with a cover glass. There are two types of louvers, "source-concealing," which conceal the light source 10° from vertical only, and "general-concealing," which conceal both the source and the reflector 30° from vertical. From 15% to 50% more lumens must be allotted for the losses in louvers. The louver itself may take the form of a decorative element.

The lumen method is used in the design of the luminous element. Projecting elements have utilization factors of 0.5 and maintenance factors of 0.75, while the flush types have utilization factors of 0.7. Efficiency varies from 10% to 90% depending on the reflection material, the shape and the transmission media. In brightness the element should be so proportioned that when it is in direct exposure to the eye it does not exceed 75 ft.L. If the element is on the ceiling and at such an angle as not to be directly exposed to the eye, a brightness of 500 ft.L. is allowable. For exteriors the brightness depends upon the illumination of the surroundings and ranges from 30 to 400 ft.L. on buildings to as high as 600 ft.L. in letter strokes for signs, on applications for which luminous elements are used extensively.

Glass Blocks.—Used in structures for decorative purposes and lighting, glass blocks may be considered as luminous elements and must be so designed. The blocks will have transmission values ranging from 10% to 85%. Their obscuring value varies inversely as their efficiency. The transmission of an individual block cannot be considered, as the transmission value of a wall or surface built of glass blocks is largely controlled by the construction. These surfaces may be constructed for both daytime and night use. The lighting equipment must not interfere with light transmission during the day and must be so placed that the rudiments of good lighting are not violated.

It is commonly accepted by the lighting specialist that the providing of illumination is the least successful function performed by windows. Glass blocks allow light to enter but eliminate the normal view from the window. Sunlight falling upon glass blocks will produce a brightness surface which must be controlled and the removal of a window which can be opened makes it necessary to remove the building heat by some other means. Consideration of glass walls or surfaces exposed to the outside requires careful co-ordination of functional design by the architect and the illuminating engineer.

Floodlighting.—Floodlighting should be designed to produce an effective harmony with the object to be lighted. Daylight effect cannot be reproduced by floodlights, and the effect produced must be studied carefully. The simple straight lines of modern structures are excellent subjects for floodlighting. Statues and monuments should be lighted in collaboration with the artist, while recreational areas and sports fields should be lighted to satisfy the requirements of those proficient in the particular sport.

Locating Equipment.—In locating equipment the surrounding buildings, topography, area to be lighted and economical aspects of the installation must be considered. If not located directly on the building to be illuminated, the equipment may be located on adjacent buildings, electric service poles, street lighting standards (for buildings not in excess of three floors), in shrubbery or trees, or on poles installed for the purpose. On the building itself, ledges, cornices and parapets will provide concealment. When sports, construction and air strips are lighted it is usually necessary to supply towers, poles or special mounting elements.

Equipment Characteristics.—For illumination at a distance, narrow beam equipment is used, ranging from searchlights with optical control to standard narrow beam (15° or less) equipment. For near areas broad beam (30° and over) equipment is used. Intermediate ranges and surface areas may use medium beam (16° to 29°) equipment. The lumen method of design is used for determination of the average illumination with a standard maintenance factor of 0.7 and the output is determined from the beam lumens of the equipment. Since little if any light can be obtained by inter-reflection, such light as does not strike the specific area to be illuminated, is lost. There must be provision for control of the "spill light" which may become objectionable, and there must be about 10% overlapping of beam pattern so as to attain some degree of uniformity. Tables of recommended ft.c. should be used and buildings with reflection factors of 20% or less will prove uneconomical to illuminate. Loading areas and railway yards have been successfully lighted by floodlighting, as well as areas where construction schedules require 24-hr. operation.

Operation and Maintenance.—The success of a lighting system depends upon selection of the proper installation and lighting source and the maintenance. The lighting source should be the most economical, determined from first cost of the equipment, its installation and the power and labour costs in the community where the installation is to be made. Frequently there may be a choice of several schemes and systems which will be adequate and satisfactory as to lighting quality and no general rule can be applied which definitely determines any combination as superior.

For "seeing," even the monochromatic lights seem to prove equally efficient and comfortable to users. Research has not been able to determine any one source quality which is superior to another for the usual seeing tasks. When colour-matching is involved in production, daylight sources of artificial light have proved more satisfactory than natural daylight. No artificial source for lighting, either incandescent or fluorescent, radiates wave lengths which under continued usage are harmful to the eyes; neither has it been found that any one of these, including daylight sources, has superior qualities for seeing.

Lamp Selection.—The general service lamp, in the voltage rating of the electric system, satisfies the usual conditions. For severe tasks under conditions of vibration, heat, weathering and unusual position, the type of lamp designed for the particular service should be selected. Special usage lamps vary in their base construction, cementing and filament suspension. In lamps of the projection type the filaments may be arranged into a single plane.

Fluorescent lamps of the hot-cathode type may be selected from several sizes in length and wattage, with some lengths being available in the cold-cathode type. The fluorescent lamp has various voltage requirements which must be met by the selection of the correct auxiliary equipment. Development of the circular-type fluorescent lamp permits a selection of form as well.

Proper Voltage.—Since the electric lamp is critical to the applied voltage, to be efficient, lamps should be operated at their rated voltage. To maintain the voltage at the lamp it is necessary to install adequate wiring systems. The voltage at the lamp, when the system is fully loaded, should not deviate more than 2%. Wiring systems that are inadequate are expensive for reasons of output loss and extra losses in the wiring system. A 120-v. incandescent lamp burned at 115 v. gives only 86.4% of the normal lumen output and will be operating at 92.3% efficiency. The fluorescent lamp is even more critical to voltage change than the incandescent lamp, to the extent of becoming inoperative at incorrect voltages.

Maintenance.—From the first hour that a lighting system begins to operate it deteriorates through darkening of the lamp, dirt accumulation on the lighting equipment and general depreciation of the reflecting surfaces. When this depreciation of the system reduces the initial illumination about 30% it is necessary to consider some form of maintenance. The loss can be partially restored by renewing the darkened lamps, cleaning the equipment and, if these fail, by either washing or painting the reflecting surfaces. A schedule of washing equipment monthly and walls every two years (this requires painting every six years) is satisfactory in the average commercial installation. The installation must be designed so that maintenance is possible at low unit costs.

The "smashing point" of lamps, at which it is economical to replace the lamp even though it is still operative, is reached when the lumen output of the lamp has been reduced to the point at which the cost of energy consumed per million lumen-hours exceeds the average cost of light produced up to that time, including initial cost of lamp and energy.

Study has shown that the renovated lighting system could gain 12% by repainting of reflecting surfaces, 20% by cleaning and 19% by using new lamps with proper voltage ratings, a total of 51%.

SPECIFIC APPLICATION

Home Lighting.—Entrance lighting should serve as a welcome to the home and as a protection at night. Brackets on each side of the door should have 40-w. lamps and where a general lighting is used on an entrance porch, a 60-w. lamp should be used. The position of the light should be such as to illuminate the person outside the door. The front entrance may have a bracket or soffit light which not only illuminates the entrance but contains an illuminated house number. The numerals should be at least 3 in. high and have ½-in. strokes. Back entrances and grade entrances should be lighted along the same principles. The lighting should be such that all steps or offsets in the approaches are illuminated for safety.

Hard glass projectors and flood lamps may be used to illuminate the grounds, the drive and the area surrounding the garage. Lights placed under the eaves may be used both for making the property attractive at night and for protection. There should be outlets available for garden lighting and seasonal decorative lighting.

Hall lights should be simple in construction and properly selected to become a part of the passage area. Selection and location of equipment should be such that it is not unsightly from above if located on the ceiling of a hall from which other floor levels are reached. The average hall can be adequately lighted with 40- to 80-w. equipment.

Living Room Lighting.—There should be a central fixture with 150-w. or more, and bracket lighting may be used for both decoration and useful lighting. The bracket lights should be well shielded and use 60-w. lamps. Portable lamps usually make up a major portion of the working light, and floor types should have from 150-w. to 500-w. with table types using from 100-w. to 150-w. Built-in lighting may be used for lighting recesses or dark areas and if properly planned may reduce the need for portable lights. The correct number of outlets and a wide distribution of these will permit of flexibility in rearranging the rooms. One duplex outlet per 20 running ft. of baseboard would be a minimum allowance. If there is more than one entrance to the room, lighting should be controlled from each entrance. Living room outlets should be distributed over several circuits and wall receptacles controlled by means of a switch.

Dining Room Lighting.—The dining table being the centre of interest in this room, illumination of the table surface is the principal function of dining room lighting. When used for dining purposes only, little attention need be given to any requirements other than desires of the occupants, but it is often necessary that the dining room table serve as a study centre or work surface. When this is the case, illumination from either the centre fixtures or portable lamps must be increased and controlled for this purpose. As a rule the dining room table is the largest free surface in a home and is frequently used for any work requiring a large surface. To meet this requirement it should be illuminated uniformly over its entire surface.

Choice of equipment for the dining room is similar to that for living rooms and all outlet and switching requirements are the same. Suspended centre fixtures should be from 30 to 36 in. above the table top. Some form of "down lighting" should be used to illuminate the table when set, to produce the desired glint and sparkle from table service. Central fixtures designed to produce the above effect should not be used if the dining room is required to serve as a work area also. A minimum of 150-w. should be used in a central fixture. Brackets are usually decorative and lighting behind valances and cornices, or built-in, may supply the general lighting, using either 40-w. fluorescent lamps or 10-w. per running ft. of incandescent lighting.

Kitchen, Laundry, Workshop and Garage Lighting.—The utility areas need the illumination level specified for the difficulty of work to be performed in them. The equipment is less decorative and less expensive, but it must have equal if not better lighting characteristics than for other areas of the home.

The kitchen should have a central light of 150-w. or more in incandescent lighting or equivalent light output from fluorescent lamps. Each of the work surfaces (stove, sink and counter surfaces) should be independently illuminated. A minimum of 40-w. each for these supplementary lights will usually prove satisfactory. Shadows caused by using a central fixture alone are annoying and may be dangerous. The availability of a concentrating light permitting close inspection of food is desirable.

In the laundry, direct lighting equipment of the R.L.M. reflector type is inexpensive and efficient. If used with a 150-w. silver-bowl lamp, specular images are eliminated with little loss of light. In the home workshop, this same type of lighting, either incandescent or fluorescent, can be used over the work bench or where some constructive hobby is in progress.

The garage, coal storage area and furnace room each require adequate light, not so much for work purposes as for safety. The R.L.M. reflector equipped with inside-frosted lamps of 75- to 100-w. will illuminate these areas satisfactorily. Two fixtures, one mounted at the front and one at the rear of the garage, give satisfactory lighting even when cars are in the garage. There should be an outlet available for a portable lamp for necessary adjustments and work. Portable lamps should meet the requirements for cords and sockets in damp places with an approved guard for protection.

Bathrooms.—The important light centre in the bathroom is the mirror, which may be illuminated by an encircling light or by side brackets providing shadow-free light on the person reflected, and not upon the mirror. Fluorescent lamps in the brackets distribute the light more evenly. The light in the bathroom should be controlled by a switch located away from any grounded plumbing or other grounded metallic conductor. For economy in the small bathroom, the bracket light may be the only one, but a ceiling light is desirable and in the large room it is essential. Ceiling lights of 100 w. and bracket lights of 20 to 40 w. are satisfactory. If fluorescent lamps are used, the larger diameter tubes are of a lower brightness and, therefore, better. Switches should be located at each door. An additional convenience is a night light which may be incorporated in the switch assembly, or as an additional baseboard light.

Bedrooms.—Since the modern bedroom is frequently used for sewing, reading, writing and study purposes, as well as for sleeping, the lighting must be adapted to these various needs. A ceiling fixture with a relatively low brightness should be installed to reduce glare. This is particularly important for rooms to be occupied by children. For small rooms the ceiling fixture should use a 40-w. lamp, and for large rooms, 100-w. should be used. If all or part of the furniture is of the built-in type lighting equipment may be incorporated in the design at a relatively low cost. Bracket lights for mirrors and dressing tables and trough lights for full-length mirrors are desirable. Supplementary lighting may be obtained by portable lamp stands or pin-up lamps installed over the bed, either of which should provide sufficient illumination for reading. Closets should have a simple but adequate lighting system, usually a bracket light with a pull-chain socket and a 60-w. lamp. Drop cords should not be used because of the danger of fire if clothes come in accidental contact with the lighted lamp. In an elaborate installation door switches can be used for turning the light on and off.

Detailed specifications for home lighting can be found in *Recommended Practice of Home Lighting,* of the Illuminating Engineering society.

School and Public Building Lighting.—Although children attend school during daylight hours, it is during the season of the year in which days are short and frequently cloudy, requiring additional artificial light to illuminate the desks farthest from the window to a minimum level, though not equal to that at the window. In sight-saving rooms, artificial illumination is necessary even on the brightest day to illuminate writing boards and desks more than 10 ft. from the window. In elementary grades the eyes are subjected to tasks incompatible with the natural accommodation of the eye. Poor lighting will influence the posture of the student, who seeks positions of least discomfort for the eyes and at the same time attempts to balance out strains upon body muscles. Every effort should be made to furnish the amount of illumination that is needed, the light being given off from the source and secondary surfaces in such a way as to eliminate all elements of discomfort. High levels of illumination without proper control are more detrimental than properly controlled low levels.

The amount of lighting should range from 50 ft.c. for the sight-saving room (and in some instances for drafting rooms which are to be used for long periods) to 5 ft.c. for passageways and locker rooms. The average classroom should have a minimum illumination of 25 ft.c. For high over-all efficiencies ceilings should reflect 75% of the light, and side walls 50% to 60%. Matte finishes should be used on all surfaces, and any glass doors, glass in picture frames or any other specular material should be eliminated to avoid reflection of images to any other position in the room. Desk tops and floors should have light finishes.

Writing boards should have dull finishes and be placed so as to eliminate reflected glare. Marked colour contrast between the writing boards and surrounding finish is a source of discomfort and not very pleasing in room composition.

Natural lighting seems essential in the school, not so much because of the light itself as for the psychological atmosphere which is created by windows. Orientation of the building controls the benefits to be obtained from the lighting. Orientation depends upon climactic and seasonal conditions and no standard rules can be applied. Rooms with unilateral lighting are least difficult to control. Lighting should come from the left, never from the right and front of the room. Window structures should be reduced to a minimum so as to avoid casting shadows. Even in corner rooms there is little value to windows in the rear of the room. The top of the window should be as near the ceiling as possible, not less than a distance above the floor equal to one-half the room width. To increase the glass area in a room it is better to add height than width. The glass area should be as large as possible, not less than 18% of the floor area when starting three feet from the floor, or 16% when starting four feet from the floor. These percentages are for rooms in which all glass area is exposed to the sky; if trees or buildings obscure the light, the glass area is increased proportionately. Windows at the front of the room should stop at the front row of seats; at the rear they should be carried close to the back wall. The skylight frequently used over auditoriums should be eliminated, for it is difficult to clean, frequently subject to leaks and makes light control difficult.

Window light control must intercept the direct sunlight and diffuse it throughout the room, eliminate the glare from any exterior surfaces and control the relative illumination at different points in the room. The venetian blind, which may be classified as a louver control, may be used to deflect the light to the ceiling, thereby diffusing the light over the room, at the same time intercepting the direct or annoying reflected light from the outside. A double shade, drawing up and down from the centre of the window, has second place as a light-control device. To use projection equipment the room may be darkened by a second set of dark shades running in light-sealing guides. When selecting the light equipment, efficiency and light control should be the most important points to consider with emphasis on appearance, construction, maintenance and flexibility for the service.

The standard school room, measuring 20 by 30 ft. with a 12-ft. ceiling requires six outlets for incandescent lamps and an equivalent for fluorescent lighting. Usually the row of desks farthest from the window must have artificial light even on the brightest days. Photoelectric equipment should be used to control the light.

Industrial Lighting.—Good lighting in industry should correlate with plant safety, improved quality of product, increased production with decreased costs, better use of floor space, better seeing conditions for the employees, more cleanliness and neatness, better supervision of the work, less eyestrain and with a decrease of labour turnover because of improved morale.

Because it is necessary to see easily and accurately and often quickly, the glare, diffusion, direction and distribution of the light must be given special consideration and definitely controlled. Where severe tasks are performed or where economics does not justify a high level of illumination, extensive use must be made of the supplementary light. Attention must be directed toward specular images and veiling glare. This must be controlled by using large low-brightness lighting equipment or systems.

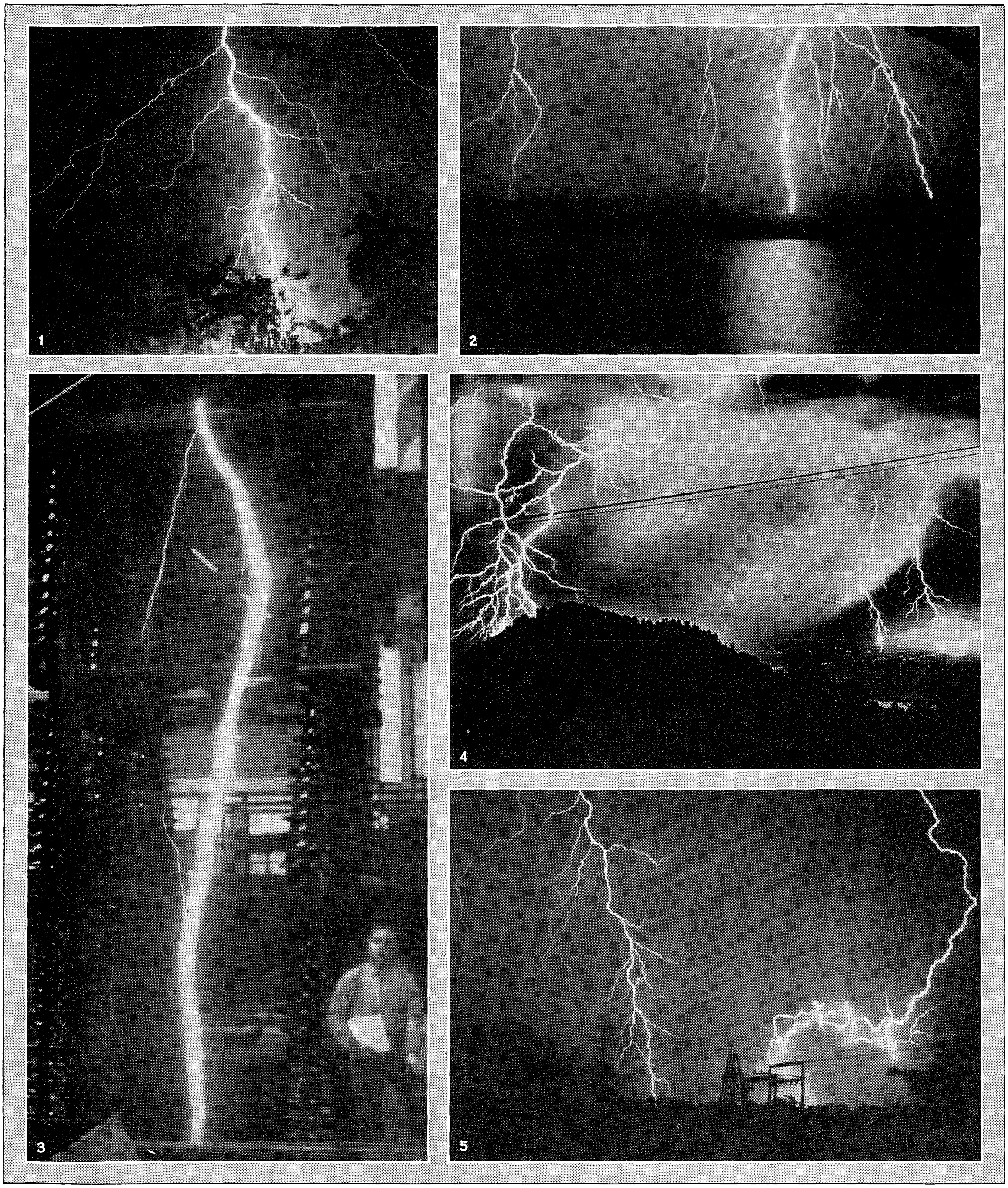
Correct reflecting factors for ceilings, walls and floors should be used in industry. Light colours will give high utilization factors and the painting of the recessed work areas of the machines will, by inter-reflection, illuminate details of the work. Use of paint contrast is an aid to speed and safety in production. For ceilings and side walls light colours should be used; for machines, a corresponding reflection factor in a contrasting colour so that masses, either moving or stationary, can be recognized. White-reflecting surfaces should be used on all enclosures tending to cast a shadow on the task.

Machine tools and inspection lighting require separate study. Machine tool operations controlled by dial settings or measurements with calipers, micrometers and dial gauges should have source brightnesses of low value, located to give satisfactory illumination without veiling glare or specular images. Inspection lighting sometimes requires specular images. Mirroring of the light source in the work makes it possible to detect flaws and irregularities; however, the inspector must be protected by positioning and control of the brightness contrast.

Natural lighting should be utilized to the greatest extent. Lighting from a window decreases very rapidly, the horizontal illumination falling from 200 ft.c. near the window to 5 ft.c. at 20 feet from the window. Although windows present a surface of low brightness or are reduced to one of low brightness by controlling means, the extent of the surface in itself produces deleterious glare effects. A worker should never face directly into a window, because even a large low-brightness surface becomes annoying with time. Saw-tooth, monitor or skylight illumination in modern factory construction offers better light control than large glass side walls. Natural lighting should be considered in proportioning the room in factory design. If one wall contains

BY COURTESY OF THE U.S. WEATHER BUREAU

LIGHTNING FLASH AND SHEET LIGHTNING BEHIND DENSE CLOUDS



BY COURTESY OF (1, 4) THE U.S. WEATHER BUREAU, (2, 3, 5) THE GENERAL ELECTRIC COMPANY (U.S.)

VIEWS OF LIGHTNING FLASHES AND AN ARTIFICIAL STROKE OF LIGHTNING

1. Main discharge of forked lightning and its ramifications
2. Simultaneous lightning discharges beyond Indian Lake, Worcester, Mass.
3. Artificial lightning produced in the General Electric plant by a discharge of about two million volts
4. Brilliant complicated ramifications of flashes of lightning striking to the plain beyond the hill
5. A dangerous area for lightning discharges; in the foreground an oil derrick together with the switching station and lines of a gas and electric company, Drumright, Oklahoma

windows, the room should have a depth perpendicular to this wall of less than twice the window height above the floor. When two parallel sides have windows, the room depth should not exceed six times the window height. Monitor window width should be one-half the monitor width. The height of the saw-tooth window should be one-third the span. As a general rule, window area should be approximately one-third the floor space.

Windows need periodic cleaning, both inside and outside to maintain efficiency. When using natural lighting, glare from windows, as well as that produced by any object on the outside must be controlled. Because daylight is so variable this lighting must be used in conjunction with proper arrangement and switching of artificial light. Photoelectric control of lighting circuits is desirable to maintain a minimum level of illumination at machines. When portions of the shop must be lighted by artificial lighting, and the remainder uses natural lighting, it is necessary to have the illumination in the artificially lighted area much brighter than normal night lighting because of excessive brightness contrast between the areas under the two arrangements. Industrial plants are being built without windows and operated entirely under artificial lighting with satisfactory results. Windows are not considered good lighting sources by illuminating engineers; however, windows have a psychological value.

The U.S. *Recommended Practice of Industrial Lighting* discusses factory and industrial lighting in detail.

Street Lighting.—Street lighting design should lead to recognition of the presence of an object and not necessarily to distinguishing fine details. Objects on the street or highway are discerned by silhouette when the illumination on the object is lower than the background, as when the object lies between two approaching cars; the reverse silhouette occurs when the object is more brightly lighted than the background, which requires relatively high illumination, usually in the vicinity of the lighting equipment. If details and colour of the object are discernible very high illumination is responsible. When the object emits specular light the visibility is caused by glint. Shadow and shadow pattern are important in recognition of the presence of an object. This effect depends upon the amount of relief and the angularity of the light.

The utilization and recognition of the above factors are more important in adequate street lighting than the production of the equivalent of daylight. The problem requires the best visibility consistent with a relative low cost per unit of light. Some traffic centres require more than usual visibility lighting, because of the presence or congregation of pedestrians. In these localities both the pedestrian and the driver must quickly discern objects with enough distance of visibility to react safely.

Equipment should direct the greater portion of the light toward the street, not skyward or into adjoining properties. Sufficient spill light should illuminate the sidewalk for protection and travel. There should be a proper adjustment between mounting height, spacing and lamp size. Mounting height may vary from 15 to 30 ft. and will depend upon glare, foliage interference and appearance. High mountings are associated with wider spacing and larger lamps, thereby reducing the first cost and operating cost. In residential districts, lower mounting heights, though not desirable, are used because of foliage. The spacing-mounting height ratio should not exceed eight to one. Lighting standards may be placed opposite one another or staggered on the two sides of the street; in alleys and outlying side streets, standards along one side of the street may be used. The equipment should either eliminate glare, or the time exposure to glare should be reduced to a minimum. Avoidance of pavements or surfacing which does not reflect light will aid street lighting; even black surfaces can be improved by correct top dressing.

Streets are classified according to the volume of maximum night traffic per hour (going both ways). Class divisions recommended are (1) very light traffic, (2) light traffic, (3) medium traffic, (4) heavy traffic, (5) very heavy traffic, (6) heaviest traffic, ranging from 150 vehicles per hr. and under to 4,000 per hr. and over. The street illumination, for average values, ranges from 0.1 ft.c. to 1.5 ft.c. Business districts, street intersections, boulevards and park drives, alleys, bridges, traffic circles, tunnels and other unusual problems must be subjected to a detailed analysis and lighting specified to meet the needs. (*See* also LIGHT; VISION.)

Further data may be obtained from the manufacturers; information concerning past practice and recent developments from the *Transactions* of the American and English Illuminating Engineering Societies. Information on illuminating engineering, from *Scientific Basis of Illuminating Engineering* by Parry Moon (1936); on illumination practice, from *Electrical Illumination* by John O. Kraehenbuehl (1942); and for fluorescent lighting, from *Fluorescent Lighting Manual* by Chas. L. Amick (1942). (J. O. K.)

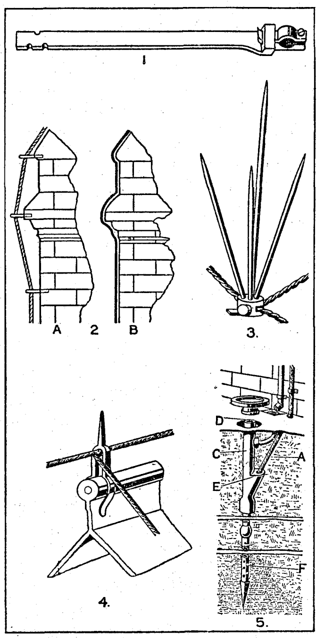
LIGHTNING, the visible flash accompanying an electric discharge between two clouds or between a cloud and the earth. In certain electrical conditions a cloud becomes highly charged by the coalescence of droplets, for a large drop has a less superficial area than the total area of its constituent droplets; hence its electric potential and that of the whole cloud, rises. When the cloud passes near another cloud stratum or a projection on the earth, a discharge of lightning occurs. In the case of "forked" lightning the actual path of the discharge is visible but "sheet" lightning is merely the visible illumination of a cloud by a discharge of which the actual path is not seen. Rain and certain "lightning conductors" discharge the electricity quietly to earth, hence lightning frequently ceases on the fall of rain (*see* ELECTRICITY, ATMOSPHERIC).

LIGHTNING BUG, the name often given in the United States to the firefly (*q.v.*).

LIGHTNING CONDUCTOR, or, according to Benjamin Franklin, "lightning rod," the name usually given to apparatus designed to protect buildings or ships from the destructive effects of lightning (Fr. *paratonnerre*, Ger. *Blitzableiter*). The upper regions of the atmosphere being at a different electrical potential from the earth, the thick dense clouds which are the usual prelude to a thunder storm serve to conduct the electricity of the upper air down towards the earth, and an electrical discharge takes place across the air space when the pressure is sufficient. Lightning discharges were distinguished by Sir Oliver Lodge into two distinct types, the *A* and *B* flashes. The *A* flash is of the simple type which arises when an electrically charged cloud approaches the earth without an intermediate cloud intervening. In the second type *B*, where another cloud intervenes between the cloud carrying the primary charge and the earth, the two clouds practically form a condenser and when a discharge from the first takes place into the second the free charge on the earth side of the lower cloud is suddenly relieved, and the disruptive discharge from the latter to earth takes such an erratic course that according to the Lightning Research Committee "no series of lightning conductors of the hitherto recognized type suffice to protect the building." In Germany two kinds of lightning stroke have been recognized, one as *zündenden* (causing fire), analogous to the *B* flash, the other as *kalten* (not causing fire), the ordinary *A* discharge. The destructive effect of the former was noticed in 1884 by A. Parnell, who quoted instances of damage due to mechanical force, which he stated in many cases took place in a more or less upward direction.

The object of erecting a number of pointed rods to form a lightning conductor is to produce a glow or brush discharge and thus neutralize or relieve the tension of the thunder-cloud. This, if the latter is of the *A* type, can be successfully accomplished, but sometimes the lightning flash takes place so suddenly that it cannot be prevented, however great the number of points provided, there being such a store of energy in the descending cloud that they are unable to ward off the shock. A *B* flash may ignore the points and strike some metal work in the vicinity; to avoid damage to the structure this must also be connected to the conductors. A single air terminal is insufficient. Besides multiplying the number of points, numerous paths, as well as interconnections between the conductors, must be arranged to lead the discharge to the earth. According to Lodge "there is no space near a rod which can be definitely styled an area of protection, for it is possible to receive violent sparks and shocks from the conductor itself, not to speak of the innumerable secondary discharges that are liable to occur in the wake of the main flash." The report of the Lightning Research Committee contains many examples of buildings struck in the so-called "protected area."

Franklin's original rods (1752) were made of iron, and this metal is still employed throughout the continent of Europe and in the United States. British architects, who objected to the unsightliness of the rods, eventually specified copper tape, which is generally run round the sharp angles of a building in such a manner as to increase the chances of the lightning being diverted from the conductor. The popular idea is that to secure the greatest protection a rod of the largest area should be erected, whereas a single large conductor is far inferior to a number of smaller ones and copper as a material is not so suitable for the purpose as iron, which offers more impedance, and allows the flash to leak away by damping the oscillations. Iron is not suitable in cities, or factories where coal is used.



TYPES OF LIGHTNING CONDUCTORS
1, Holdfast; fixed, to allow sufficient space for the conductor to clear projections. 2A, sharp bends prevented by holdfasts. 2B, method condemned by L.R.C. rules. 3, aigrette, fixed to a horizontal conductor. 4, holdfast on tiles; horizontal conductor, jointed by U-shaped lead. 5, tubular earth

In 1876 J. Clerk Maxwell read a paper before the British Association in which he brought forward the idea (based on Faraday's experiments) of protecting a building from the effects of lightning by surrounding it with a sort of cage of rods or stout wire. It was not, however, until the Bath meeting of the British Association in 1888 that the subject was fully discussed by the physical and engineering sections. Sir Oliver Lodge showed the futility of single conductors, and advised the interconnection of all the metal work on a building to a number of conductors buried in the earth. The action of lightning flashes was also demonstrated by him in lectures delivered before the Society of Arts (1888). The Clerk Maxwell system was adopted to a large extent in Germany, and in July 1901 a sub-committee of the Berlin Electrotechnical Association was formed, which published rules. In 1900 a paper entitled "The Protection of Public Buildings from Lightning," by Killingworth Hedges, led to the formation, by the Royal Institute of British Architects and the Surveyors' Institution, of the Lightning Research Committee, on which the Royal Society and the Meteorological Society were represented. The *Report,* edited by Sir Oliver Lodge, Sir John Gavey and Killingworth Hedges, was published in April 1905. An illustrated supplement, compiled by K. Hedges and entitled *Modern Lightning Conductors,* contains particulars of the independent reports of the German committee, the Dutch Academy of Science, and the Royal Joseph university, Budapest. A description is also given of the author's modified Clerk Maxwell system, in which the metal work of the roofs of a building forms the upper part, the rain-water pipes taking the place of the usual lightning-rods.

A number of failures of conductors were noticed in the 1905 report of the Lightning Research Committee. One cause was the insufficient number of conductors and earth connections; another was the absence of any system for connecting the metallic portion of the buildings to the conductors. In some cases the main stroke was received, but damage occurred by side-flash to isolated parts of the roof. There were several examples of large metallic surfaces being charged with electricity, the greater part of which was safely discharged, but enough followed unauthorized paths, such as a speaking-tube or electric bell wires, to cause damage. In one instance a flash struck the building at two points simultaneously; one portion followed the conductor, but the other went to earth jumping from a small finial to a greenhouse 30 ft. below. (Photographs and specimens showing such damage are exhibited in gallery 44, Geophysics, of the Science Museum, London.)

Construction of Conductors.—The general conclusions of the Lightning Research Committee agree with the independent reports of similar investigators in Germany, Hungary and Holland. The following is a summary of the suggestions made: "The conductors may be of copper, or of soft iron protected by galvanizing or coated with lead. A number of paths to earth must be provided; well-jointed rain-water pipes may be utilized." Every chimney stack or other prominence should have an air terminal. Conductors should run in the most direct manner from air to earth, and be kept away from the walls by holdfasts (fig. 1), in the manner shown by *A* (fig. 2); the usual method is seen in *B* (fig. 2), where the tape follows the contour of the building and causes side flash. A building with a long roof should also be fitted with a horizontal conductor along the ridge, and to this aigrettes (fig. 3) should be attached; a simpler method is to support the cable by holdfasts armed with a spike (fig. 4). Joints must be held together mechanically as well as electrically, and should be protected from the action of the air. At Westminster Abbey the cables are spliced and inserted in a box which is filled with lead run in when molten.

Earth Connection.—A copper plate not less than 3 sq.ft. in area and $\frac{1}{8}$ in. thick may be used if buried in permanently damp ground and surrounded with charcoal or carbon. (If coke is used it must be thoroughly washed.) Instead of a plate there are advantages in the tubular earth shown in fig. 5. The conductor *A* packed in carbon *C,* descends, jointed at *E,* to the bottom of the perforated tube *F,* which is driven into the ground, a connection being made to the nearest rain-water pipe to secure the necessary moisture; in dry seasons it is watered at *D.* Plate earths should be tested every year. The number of earths depends on the area of the building, but at least two should be provided. Insulators on the conductor are of no advantage, and it is useless to gild or otherwise protect the points of the air-terminals. Heated air offers a good path for lightning (which is the reason why the kitchen-chimney is often selected by the discharge). A copper-band, with a number of points, should be fixed near the top of factory chimney stacks; there should be at least two interconnected conductors to earth. All roof metals, such as finials, flashings, rain-water gutters, ventilating pipes, cowls and stove pipes, should be connected to the system of conductors. The efficiency of the installation depends on the interconnection of all metallic parts, also on the quality of the earth connections, each of which should not exceed a resistance of 5 ohms. A disconnecting joint for testing should be inserted near the ground. In the case of magazines used for explosives, it is questionable whether the usual plan of erecting rods at the sides of the buildings is efficient.

The only way to ensure safety is to enclose the magazine in iron; the next best is to arrange the conductors so that they surround it like a bird cage. The numerous elevated fire-lookout stations in the United States are safeguarded by means of a skeleton cage of wire cable, connected to earths, sometimes made by blasting the solid wall. A new system for petroleum storage tanks, invented by J. M. Cage of Los Angeles, Calif., U.S.A., aims at the prevention of lightning discharges by dissipation; three parallel wires armed with points are suspended from steel towers and completely enclose the area to be protected.

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LIGHTNING INSURANCE: *see* FIRE INSURANCE.

LIGHT ORGAN: *see* COLOUR-MUSIC.

LIGHT RAILWAYS, MILITARY. Railways of less than standard gauge have often been used for military purposes. A great development of such "light railways" came during the

World War of 1914–18. Two general types of track were used, both of 60cm. gauge: (1) "foreways" consisting of sections of steel ties and rails bolted in units about 16ft. long; (2) 30ft. rails weighing 25lb. per yard, on small wood ties and preferably ballasted, of the general type of standard gauge railways.

Rolling-stock.—The rolling-stock consisted of three types of wagon: (1) Low-sided four-wheel trucks with capacity of four tons. (2) Flat bogie wagons with carrying capacity of eight tons. (3) Bogie well-wagons with carrying capacity of 10 tons. The last mentioned were used almost entirely for transporting heavy ammunition.

Motive Power.—The motive power consisted of: (1) Six-wheel coupled locomotives weighing up to 14 tons, capacity 60h.p., and capable of hauling 65 tons up a gradient of 1 in 40. (2) Four-wheel coupled locomotives weighing up to eight tons, capacity 35h.p., and capable of hauling 40 tons up a gradient of 1 in 40. (3) Petrol tractors weighing up to four tons and capable of hauling a load of 14 tons up a gradient of 1 in 40; these petrol tractors had two gears, the speed on the low gear being about four miles and on the high gear 10 miles per hour.

During the latter part of the World War, 1917–18, light railways were very extensively used on the Western front for transporting supplies to the smaller supply depôts away from the standard-gauge railways, and ammunition to the heavy gun and howitzer positions. During 1917–18, 1,780m. of light railway were laid, but only about half of this was ever used. While the war was stationary light railways were of very great service to the armies, but as soon as a retreat or a continued advance took place they became out of action. They are not economical, the maintenance alone during 1917 requiring an average of 15 men per mile, which, as the lines became consolidated, was reduced to five men per mile. The average effective haul of a locomotive was 23 train miles per day, and that of a tractor was 20 train miles per day. The average coal consumption per locomotive was 62 lb. of coal per effective train mile and the average petrol consumption per tractor was ·56gal. of petrol per effective train mile. The average loaded wagon mile per day per effective was 4·25.

With the advance in Sept. 1918, light railways were of great assistance in getting forward ammunition and evacuating the wounded. They were joined on to the German 60cm. railways which had not been destroyed, but they were soon left behind and the armies relied entirely on the standard gauge railways and road transport. Light railways, when worked to their maximum capacity, carry, on an average, about 140 tons of supplies per mile of track per day, according to the grading of the line, and the cost in man-power for operating purposes only, as compared with a standard-gauge railway, is as 3·45 to 1 per mile and cost in man-power for construction as 2·2 to 4·7. The extension to light railways, known as "foreways," and used for carrying supplies from the end of the light railways up to the trenches, consisted of 60cm. gauge track laid on an unballasted formation; the rails weighing about 9 lb. per linear yard of rail on sleepers weighing 8 lb. and spaced 3ft. apart, centre to centre; on these lines flat-topped, four-wheel trolleys were pushed by two men during the night right up to the communication trenches. (D. L.; X.)

American Practice in the World War.—The American light railways were 60-cm. gauge like those of the French, British, Italians and Germans. The service of the narrow gauge lines began at the standard gauge railheads, up to which point the transportation of munitions and supplies was carried out by standard gauge railways and canals. At the railheads or corresponding canal heads transfer was made either directly or after storage to the equipment of the 60-cm. lines. The light railways were extended very nearly to the front line trenches, and they were constructed, maintained, and operated by special regiments assigned to the light railway service. Regimental headquarters combined the functions of military control over light railway personnel and the management of railway lines in a given sector. Motive power consisted of steam locomotives, 4-cylinder geared gasoline locomotives of 50 and 35 h.p. and small gasoline locomotives.

A central assembly and repair shop for light railway equipment was established at Abainville (Meuse), and comprised 70,000 sq.ft. of buildings, including an erecting shop, smith shop, machine shop, foundry, gasoline engine repair shop, car shop, oil house, power plant, storehouse, and carpenter shop. The largest number of American light railway troops engaged at any one time was between Sept. 15, and Nov. 9, 1918, when the number rose to 13,650. The daily net tonnage handled by narrow gauge lines operated by the American Expeditionary Force was 8,100 tons in Oct. 1918. It was found that the average progress in the construction of new line was at the rate of 3 ft. of completed track per man per day. An average of 2·2 men per km. was required for maintenance of way. Contrary to the British and French practices, the Americans lengthened the usual haul of freight in certain cases far beyond anything previously considered practicable for 60-cm. army lines. The average for the entire American light railway operation was 15·2 km., which is about 30% above British or French practice. On Nov. 10, 1918, the American light railways were operating 623 km. of main line, with a personnel on operation alone of 57 officers and 3,557 men. The total of tonnage handled by light railways from the commencement of operation to Feb. 1, 1919, was 860,652.

Lessons from World War.—First, light railway traffic was more easily interrupted than paved road traffic; 2nd, it was claimed that standard gauge tracks with light rails and light rolling stock were better than narrow gauges, in that they could be made suitable for heavy traffic, if desired. (G. B. T.; X.)

LIGHTSHIP or **LIGHTVESSEL,** a vessel bearing a light, and frequently a fog-signal in addition, for the guidance and warning of mariners. Lightships vary in size from small decked boats, carrying an unattended light which functions automatically for several months, up to self-propelled ships of over 700 tons displacement, provided with powerful lighting and fog-signalling apparatus and manned by crews of 15 men or more. They are usually moored in positions marking shifting shoals or other submerged dangers, or in wide sandy estuaries where a fixed lighthouse or lighted beacon cannot conveniently be placed. Many unattended floating-lights of considerable size and power are now in use. The first lightship to be established in English waters was that placed at the Nore in 1732. (*See* LIGHTHOUSES.)

LIGHT-YEAR, an astronomical unit of length, the distance travelled by light in the course of one year, being equivalent to about six million million (6×10^{12}) miles. The distance of stars may be measured in terms of this unit or in terms of the parsec (*q.v.*).

LIGNE, CHARLES JOSEPH, PRINCE DE (1735–1814), soldier and writer, came of a princely family of Hainaut, and was born at Brussels in 1735. He distinguished himself at Breslau, Leuthen, Hochkirch and Maxen, and after the Seven Years' War rose to the rank of lieutenant field marshal. An intimate friend and counsellor of Emperor Joseph II., he lived luxuriously on his estates, returning to his military duties during the War of the Bavarian Succession, and again in 1784. During his travels in Europe he was a prominent figure both in society and in scholastic circles. In 1787 he was with Catherine II. in Russia, accompanied her in her journey to the Crimea, and was made a Russian field marshal by the empress. In 1788 he was present at the siege of Belgrade. Shortly after this he was invited to place himself at the head of the Belgian revolutionary movement, in which many of his relatives took part, but he declined. He was given the rank of field marshal (1809) and an honorary command at court, where he lived in comparative luxury devoting himself to literary work. He lived long enough to characterize the proceedings of the congress of Vienna with the famous *mot: "Le Congrès danse mais ne marche pas."* He died at Vienna on Dec. 13, 1814. His grandson, Eugene Lamoral de Ligne (1804–1880), was a distinguished Belgian statesman.

His collected works appeared in thirty-four volumes at Vienna during the last years of his life (*Mélanges militaires, littéraires, sentimentaires*), and selections were published in French and German, and in English (1927).

LIGNITE. Unfortunately the terms "brown coal" and "lignite" have come to be used interchangeably. Commonly speaking, all the immature coals of, chiefly, tertiary origin, whether black or brown, woody, amorphous, or having a conchoidal or cubical fracture, are called lignites.

Lignite is a French word, probably derived from *Lithanthrax Lignius* which, according to Hausmann was used by Wallerius (*Systema Mineralogicum*, Vol. 2 p. 98, 1775) for the woody type of coal. Thus the great mass of German brown coal is not lignite in the sense of being a woody coal which splits up into slabs on drying, but an amorphous brown earthy substance or brown coal containing bands of lignite. Many countries contain immature black coal, differing little in appearance from true bituminous coal, which is usually known by the name of "black lignite," an inappropriate designation seeing they have no woody structure. To these coals, the Geological Survey of the United States of America has applied the term "sub-bituminous" coal, restricting the word lignite to those coals of lower grade which are either lignitic in character or are brown coals, which would appear to afford a satisfactory distinction and definition (*see* the section *Lignite* under Coal and Coal Mining). (R. R.)

LIGONIER, JOHN (Jean Louis) **LIGONIER,** Earl, cr. 1766 (1680–1770), British field marshal, came of a Huguenot family settled in England. He served throughout Marlborough's campaigns in Flanders (1702–10). In 1720 he became colonel of the "Black Horse" (now 7th Dragoon guards), a command which he retained for a period of 29 years. At Fontenoy Ligonier commanded the British foot, and acted throughout the battle as adviser to the duke of Cumberland. During the "Forty-Five" he was called home to command the British army in the Midlands, but in Jan. 1746 was placed at the head of the British and British-paid contingents of the Allied army in the Low Countries. He was present at Roucoux (Oct. 11, 1746) and, as general of horse, at Val (July 1, 1747), where he led the charge of the British cavalry, his horse being killed and he himself taken prisoner, though exchanged in a few days. With the close of the campaign ended Ligonier's active career, but (with a brief interval in 1756–57) he occupied various high civil and military posts to the close of his life. In 1766 he became field marshal.

See Combes, *J. L. Ligonier, une étude* (Castres, 1866), and the histories of the 7th Dragoon guards and Grenadier guards.

LIGUORI, ALFONSO MARIA DEI (1696–1787), saint, was born at Marianella, near Naples, on Sept. 27, 1696, the son of Giuseppe dei Liguori, a Neapolitan nobleman. He studied law, passed his examination for the doctor's degree at the age of 16 and practised law for eight years. Giving up the bar, he was ordained priest in 1726. In 1732 he founded the Congregation of the Most Holy Redeemer, commonly called the Redemptorists, In 1762 he became bishop of Sant' Agata del Goti, a small town about 30 mi. east of Naples. He resigned this bishopric in 1775 and died on Aug. 1, 1787. He was canonized in 1839, and declared a doctor of the church in 1871. His feast is celebrated Aug. 2.

After his death his Congregation of the Most Holy Redeemer spread rapidly throughout the world. In 1945 it numbered more than 6,000 members.

Besides his congregation, Liguori is known especially for his spiritual writings. They have had an almost unparalleled circulation; up to 1939 his various works had gone through some 17,500 editions, and had been translated into 60 languages. His works fall into three classes. The first, in the field of moral theology, is headed by his *Theologia Moralis,* which first appeared in 1748, and went through nine editions in his lifetime, and more than 60 after his death; this he later summarized in a short work, *Praxis Confessarii.* The second is that of his ascetical or devotional writings, written for all classes of Catholics, priests, nuns, lay people, and including especially his *Visits to the Blessed Sacrament, The Glories of Mary, The True Spouse of Christ* (for nuns) and *The Selva* (for priests). The third class is that of his dogmatic writings, especially *History of Heresies* and his works on the infallibility of the pope; also his various works on the power of prayer. The latter theme he stressed so constantly throughout all his writings that he is known popularly as "The Doctor of Prayer."

Liguori was also a musician and poet. Many of the hymns he composed and put to music are still the favourites of the people of southern Italy. His Christmas hymn, *Tu Scendi dalle Stelle,* in particular, is as closely associated with Christmas in Italy as are *Adeste Fideles* and *Silent Night* in other countries.

Among Catholic theologians, Liguori is known as the founder of *equiprobabilism.* This is a system of principles designed to guide the conscience when in doubt as to whether free from, or bound by, a given law. The system is based on the legal axiom, "in doubt, the presumption favours the possessor." Applying it to doubts of conscience, Liguori laid down these three principles. (1) In a doubt with equally probable reasons pro and con, a person is free from the obligation of the law if he has been free from it hitherto,—for freedom is in possession, and the presumption favours the possessor. (2) In a doubt with equally probable reasons pro and con, a person is bound to keep the law if he has been bound by it hitherto,—for then the law is in possession. (3) In a doubt, when the reasons are not equally probable pro and con, but considerably more probable on the side of the obligation of the law, then the law must be kept.

Bibliography.—See *Lives* by A. M. Tannoia, a pupil of Liguori's, (3 vols., Naples 1798–1802) English translation by F. W. Faber (4 vols., London, 1848–49); also Villecourt (4 vols., Tournai, 1863); K. Dilgskron (2 vols., Regensburg, 1887); A. Capecelatro (2 vols., Rome, 1893); A. C. Berthe (2 vols., Paris, 1900); Berthe-Castle (2 vols., Dublin, 1906); Miller-Aubin (1 vol., 1940).

Works: (*a*) Collected editions. Italian: Monza, 1822–33; Ancona, 1822–43; Venice, 1831–48; Naples, 1838–43; 1857–59; 1871; Turin, 1825–27; 1826–33; 1845–86. French: Tournai, 1856–78; Paris, 1834–38; 1842; 1876–79. German: Regensburg, 1842–46; 1846–48. Dutch: Utrecht, 1849–56. English: New York, 1886–97. (*b*) *Letters:* to be found in the various collected editions; also Italian (2 vols., Rome, 1887); German (3 vols., Regensburg 1893–94). *See* de Meulemeester, *Bibliographie Generale des Ecrivains Redemptoristes* (3 vols., Louvain, 1933–39). (Ra. J. M.)

LIGURES BAEBIANI, a settlement of Ligurians in Samnium, Italy. The towns of Taurasia and Cisauna in Samnium had been captured in 298 B.C. by the consul L. Cornelius Scipio Barbatus, and the territory of the former remained Roman state domain. In 180 B.C. 47,000 Ligurians from Luna (Ligures Apuani), were transferred to this district, and two settlements were named after the consuls of 181 B.C., the Ligures Baebiani and the Ligures Corneliani.

The site of the former town lies 15 mi. N. of Beneventum, on the road to Saepinum and Aesernia. The site of the other settlement—that of the Ligures Corneliani—is unknown.

LIGURIA, a modern territorial division of Italy containing the provinces of Genoa, Imperia, Savona and Spezia, and once forming the republic of Genoa. It lies between the Ligurian Alps and the Apennines on the north, and the Mediterranean on the south, and extending from the frontier of France on the west to the Gulf of Spezia on the east. Its northern limits touch Piedmont and Lombardy, while Emilia and Tuscany fringe its eastern borders, the dividing line following as a rule the summits of the mountains.

The area of Liguria is 2,098 sq.mi. Pop. (1936) 1,466,915, as compared with 1,075,760 in 1901. The railway from Pisa skirts the entire coast of the territory, throwing off lines to Parma from Sarzana and Spezia, to Milan and Turin from Genoa and to Turin from Savona; there is also a line from Ventimiglia north to Cuneo and Turin by the Col di Tenda. Its sparsely-peopled mountains slope gently northward towards the Po, descending, however, abruptly into the sea at several points; the narrow coast district is famous under the name of the Riviera (*q.v.*).

The principal products of Liguria are maize, wine, oranges, lemons, fruits, olives and potatoes, though the olive groves are being rapidly supplanted by flower gardens. In the mountains the forests are important and considerable hydraulic power is also derived from the streams and used for railway traction, etc.

Copper, manganese and iron pyrites are mined: and Sardinian lead is smelted at Pertusola on the Gulf of Spezia. The principal industries are ironworks, foundries, iron shipbuilding, engineering and boilerworks (Genoa, Spezia, Sampierdarena, Sestri Ponente, etc.), railway signals (Savona) and the manufacture of cottons and woollens.

The inhabitants have always been adventurous seamen—Columbus and Amerigo Vespucci were Genoese—and the coast has several good harbours, Genoa, Spezia and Savona being the best. In educational and general development, Liguria stands high among the regions of Italy.

Archaeology and Philology.—In earlier times the Ligurians occupied a much more extensive area than the ninth Augustan region of Italy; for instance, Strabo gives earlier authorities for their possession of the land on which the Greek colony of Massalia (Marseille) was founded; and Thucydides speaks of a settlement of Ligurians in Spain who expelled the Sicani thence. Southward their domain extended as far as Pisa on the coast of Etruria and Arretium inland in the time of Polybius (ii. 6). Seneca (*Cons. ad Helv.* vii. 9), states that the population of Corsica was partly Ligurian. For the archaeological side of the question *see* GOLASECCA and COMACINES, THE. Archaeological evidence shows them to have been a part of the "Mediterranean race," and confirms the tradition as to the area they occupied. The Bronze age rock engravings near Ventimiglia (*q.v.*) are interesting. Their culture was much modified in the Iron age by a Celtic invasion, after which the two peoples were inextricably mixed.

On the linguistic side some fairly certain conclusions have been reached. We may note the frequency of the suffix *-asco-* (and *-usco-*) both in ancient and in modern Ligurian districts, and as far north as *Caranusca* near Metz, and also in the eastern Alps and in Spain. Most of the Ligurian proper names (*e.g.*, the streams, *Vinelasca, Porcobera, Comberamea; mons Tuledo; Venascum*) have a definite Indo-European character, as have those preserved in Latin inscriptions of the Ligurian districts, such as the *Tabula Genuatium* (C.I.L. I. 584) of 117 B.C. A complete collection of Ligurian place and personal names combined with the inscriptions of the district is printed in *The Pre-Italic Dialects*, edited by R. S. Conway and J. Whatmough. There is strong evidence in these names that the language spoken before the Roman conquest was Indo-European, and belonged to those languages which preserved the original *q* as Latin did, and did not convert it into *p* as did the Umbro-Safine tribes. The same is probably true of Venetia (*see* VENETI), and of an Indo-European language preserved on inscriptions found at Coligny and commonly referred to the Sequani. The "Lepontic" inscriptions found in a small area (50 m. by 35 m.) round the lakes of Como, Lugano, Maggiore and Orta, are also Ligurian, with Celtic affinities. The Ligurian ethnica show the prevailing use of the two suffixes *-co-* and *-ati-*, which there is reason to refer to the pre-Roman stratum of population in Italy. (*See* VOLSCI.)

The Ligurians were eventually restricted more and more to the county adjoining the Gulf of Genoa, and at last they occupied only an area bounded by the upper reaches of the Po and Ticino on the north, the Arno on the east, and the Alps and the Var on the west. They are described as thin and wiry, short of stature and dark complexioned, hardy and warlike people winning a difficult livelihood from the soil, but also interested in commerce, and some of them daring seafarers.

The Ligurian coast became gradually subject to the Romans, and the road along it must have been correspondingly prolonged: up to the end of the Hannibalic war the regular starting-point for Spain by sea was Pisae; in 195 B.C. it was the harbour of Luna (Gulf of Spezia), though Genua must have become Roman a little before this time, while, in 137 B.C. C. Hostilius Mancinus marched as far as Portus Herculis (Villafranca), and in 121 B.C. the province of Gallia Narbonensis was formed and the coast-road prolonged to the Pyrenees. In 14 B.C. Augustus restored the whole road from Placentia to Dertona (Via Postumia), and thence to Vada Sabatia (Via Aemilia [2]) and the River Varus (Var), so that it thenceforth took the name of Via Julia Augusta. (*See* AEMILIA, VIA [2].) The other chief roads of Liguria were the portion of the Via Postumia from Dertona to Genua, a road from above Vada through Augusta Bagiennorum and Pollentia to Augusta Taurinorum, and another from Augusta Taurinorum to Hasta and Valentia. The names of the villages—Quarto, Quinto, etc.—on the south-east and Pontedecimo on the north of Genoa allude to their distance along the Roman roads. Even the Roman Liguria, forming the ninth region of Augustus, was thus far more extensive than the modern, including the country on the north slopes of the Apennines and Maritime Alps between the Trebia and the Po, and extending a little beyond Albintimilium. On the west Augustus formed the provinces of the Alpes Maritimae and the Alpes Cottiae. Towns of importance were few, owing to the nature of the country. Dertona was the only colony, and Alba Pompeia, Augusta Bagiennorum, Pollentia, Hasta, Aquae Statiellae, and Genua may also be mentioned; but the Ligurians dwelt entirely in villages, and were organized as tribes. The mountainous character of Liguria made the spread of culture difficult; it remained a forest district, producing timber, cattle, ponies, mules, sheep, etc. Oil and wine had to be imported, and when the cultivation of the olive began is not known.

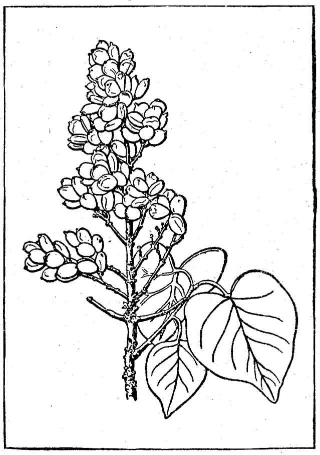
The arrangement made by Augustus lasted until the time of Diocletian, when the two Alpine provinces were abolished, and the watershed became the boundary between Italy and Gaul. At this time we find the name of Liguria extended as far as Milan, while in the 6th century the old Liguria was separated from it, and under the Lombards formed the fifth Italian province under the name of Alpes Cottiae. In the middle ages the ancient Liguria north of the Apennines fell to Piedmont and Lombardy, while that to the south, with the coast strip, belonged to the republic of Genoa.

LI HUNG CHANG (lē-hoong-chahng) (1823–1901), Chinese statesman, was born on Feb. 16, 1823 at Hofei, in Ngan-hui. In 1847 he became a Chin-shih, or graduate of the highest order, two years later entering Hanlin university. He raised a regiment of militia against the Taiping rebels, thus earning the good will of the commander-in-chief, Tseng Kuo-fan. In 1859 he was transferred to the province of Fu-kien, where he was given the rank of taotai, or intendant of circuit. But at Tseng's request Li was recalled to take part against the rebels. He found his cause supported by the "Ever Victorious Army," which, after having been raised by an American named Ward, was finally placed under the command of Charles George Gordon. With this support Li gained victories which led to the surrender of Suchow and the capture of Nanking. For these exploits he was made governor of Kiangsu, was decorated with the yellow jacket, and was created an earl. An incident connected with the surrender of Suchow left a lasting stain upon his character. By an arrangement with Gordon the rebel wangs, or princes, yielded Nanking on condition that their lives should be spared. In spite of the assurance given them by Gordon, Li ordered their instant execution. This breach of faith so enraged Gordon's indignation that he seized a rifle and would have shot Li if he had not saved himself by flight. On the suppression of the rebellion (1864) Li took up his duties as governor, but on the outbreak of the rebellion of the Nienfei, a remnant of the Taipings, in Ho-nan and Shan-tung (1866) he was ordered again to take the field, and suppressed the movement. A year later he was appointed viceroy of Hukwang, where he remained until 1870, when the Tientsin massacre led to his transfer to the scene. He was appointed to the viceroyalty of the metropolitan province of Chihli, where he actively repressed anti-foreign sentiment. For his services he was made imperial tutor and member of the grand council of the empire, and was decorated with many-eyed peacocks' feathers.

To his duties as viceroy were added those of the superintendent of trade, and from that time until his death, with a few intervals of retirement, he practically conducted the foreign policy of China. He concluded the Chifu convention with Sir Thomas Wade (1876), and thus ended the difficulty caused by the murder of Mr. Margary in Yunnan; he arranged treaties with Peru and Japan, and he actively directed the Chinese policy in Korea. On the death of the emperor T'ungchi in 1875 he effected the *coup d'état* by which the emperor Kwang Sü was put on the throne under the tutelage of the two dowager empresses; and in 1886, on the conclusion of the Franco-Chinese war, he arranged a treaty with France. When viceroy of Chihli he had raised a large, well-drilled and well-armed force, and spent vast sums both in fortifying Port Arthur and the Taku forts and in increasing the navy. For years he had watched the successful reforms effected in Japan, and he feared and hated a conflict. But in 1894 events forced his hand, and war broke out. Both on land and at sea the Chinese forces were ignominiously routed, and in 1895, on the fall of Wei-hai-wei, the emperor sued for peace. Li represented the emperor at the Shimonoseki conference.

With great diplomatic skill Li pleaded the cause of his country, but finally had to agree to the cession of Formosa, the Pescadores, and the Liaotung peninsula to the conquerors, and to the payment of an indemnity of 200,000,000 taels. By a subsequent arrangement the Liaotung peninsula was restored to China, in exchange for an increased indemnity. During the peace discussions at Shimonoseki an attempt was made on his life. He was wounded, but soon recovered. In 1896 Li represented the emperor at the coronation of the tsar, and visited Germany, Belgium, France, England and the United States of America. For some time after his return to China he was virtually constituted minister for foreign affairs; but in 1900 he was transferred to Canton as viceroy of the two Kwangs. The Boxer movement induced the emperor to recall him to the capital, and the peace of Sept. 1901 was largely secured by his efforts. He died on Nov. 7, 1901. He left three sons and one daughter.

LILAC or **PIPE TREE** (*Syringa vulgaris*), a shrub of the family Oleaceae. The genus contains over 25 species of ornamental hardy deciduous shrubs and trees, native in eastern Europe and temperate Asia. They have opposite, generally entire leaves and large panicles of small regular flowers, with a bell-shaped calyx and a 4-lobed cylindrical corolla, with the two stamens characteristic of the family attached at the mouth of the tube. The common lilac is said to have come from Persia in the 16th century, but is doubtfully indigenous in Hungary, the borders of Moldavia, etc.



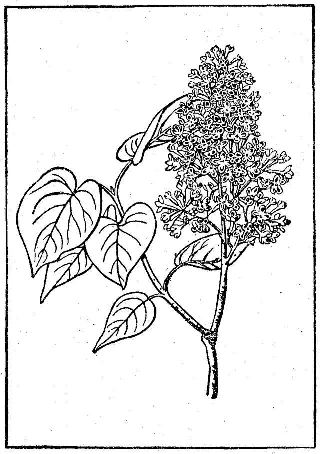
FROM COOPER AND WESTELL, "TREES AND SHRUBS OF THE BRITISH ISLES" (DENT & SONS, LTD.)
BRANCH OF THE LILAC (SYRINGA VULGARIS) SHOWING FRUIT

Two kinds of *Syringa,* viz. *alba* and *caerulea,* are figured and described by Gerard (*Herball,* 1597), which he calls the white and the blue pipe privets. The white is the common privet, *Ligustrum vulgare,* which, with the ash tree, *Fraxinus excelsior,* are the only members of the family found wild in Great Britain.

The "blue pipe privet" is the lilac, as both figure and description agree accurately with it. It was carried by the European colonists to northeast America, and is still grown in gardens of the northern and middle states.

There are many fine varieties of lilac, both with single and double flowers; they are among the commonest and most beautiful of spring-flowering shrubs.

The Persian lilac of gardens (*S. persica*), also known as the Chinese or Rouen lilac, a small shrub 4 to 6 ft. high with intense violet flowers appearing in May and June, is much cultivated for ornament.



FROM COOPER AND WESTELL, "TREES AND SHRUBS OF THE BRITISH ISLES" (DENT & SONS, LTD.)
BRANCH OF THE LILAC (SYRINGA VULGARIS) SHOWING INFLORESCENCE

Of other species, *S. josikaea* from Transylvania, has scentless bluish-purple flowers; *S. emodi,* a native of the Himalayas, is a handsome shrub with large ovate leaves and dense panicles of purple or white strongly scented flowers. Lilacs grow freely and flower profusely in almost any soil and situation, but when neglected are apt to become choked with suckers which shoot up in great numbers from the base.

They are readily propagated by means of these suckers. By far the most handsome lilacs, of which there are hundreds of varieties, are of hybrid, mostly French origin. Notable collections of these are found at Rochester, N.Y., and at the Arnold Arboretum, Jamaica Plain, Mass.

Syringa is also a common name for the mock orange, which are unrelated shrubs of the genus *Philadelphus.* (N. Tr.)

LILBURNE, JOHN (*c.* 1614–1657), English political agitator, born in the county of Durham, was apprenticed at 12 years old to a clothier in London, but he appears to have early addicted himself to the "contention, novelties, opposition of Government, and violent and bitter expressions" for which he afterwards became so conspicuous as to provoke the saying of Harry Marten (the regicide) that, "if the world was emptied of all but John Lilburn, Lilburn would quarrel with John, and John with Lilburn." He appears at one time to have been law-clerk to William Prynne. In Feb. 1638, for his share in importing and circulating *The Litany* and other publications of John Bastwick and Prynne, offensive to the bishops, he was sentenced by the Star Chamber to be publicly whipped from the Fleet prison to Palace Yard, Westminster, there to stand for two hours in the pillory, and afterwards to be kept in gaol until a fine of £500 had been paid. He did not regain his liberty until Nov. 1640, one of the earliest recorded speeches of Oliver Cromwell being made in support of his petition to the House of Commons (Nov. 9, 1640). In 1641 he received an indemnity of £3,000. He now entered the army, and in 1642 was taken prisoner at Brentford and tried for his life; sentence would no doubt have been executed had not the parliament by threatening reprisals forced his exchange. He soon rose to the rank of lieutenant-colonel, but in April 1645, having become dissatisfied with the predominance of Presbyterianism, and refusing to take the covenant, he resigned his commission, presenting at the same time to the Commons a petition for arrears of pay. His violent language in Westminster Hall led in July to his arrest and committal to Newgate. He was discharged in October. In Jan. 1647 he was committed to the Tower for a short time for accusations against Cromwell. In Feb. 1649 he along with other petitioners presented to the House of Commons a paper entitled *The Serious Apprehensions of a part of the People on behalf of the Commonwealth,* which he followed up with a series of pamphlets attacking the council. On April 11 he was again imprisoned, but was acquitted of sedition at his trial in the following October. In 1650 he was advocating the release of trade from the restrictions of chartered companies and monopolists.

In Jan. 1652 Lilburne was banished, but he returned from the Low Countries in 1653. He was immediately arrested; the trial (July 13–Aug. 20) issued in his acquittal, to the great joy of London, but it was nevertheless thought proper to keep him in captivity for "the peace of the nation." He was detained successively in the Tower, in Jersey, in Guernsey and in Dover castle. At Dover he came under Quaker influence, and in 1655, on giving security for his good behaviour, he was set free. He now settled at Eltham in Kent, where he died on Aug. 29, 1657.

His brother, Colonel Robert Lilburne, was among those who signed the death-warrant of Charles I. In 1656 he was M.P. for the East Riding of Yorkshire, and at the restoration was sentenced to lifelong imprisonment.

See Clement Walker, *The Compleat History of Independency,* vol. ii. (4 pts., 1661); W. Godwin, *History of the Commonwealth,* vol. iii. (4 vols., 1824–28); D. Masson, *Life of Milton,* vol. iv. (7 vols., 1859–94); Andrew Bisset, *Omitted Chapters of the History of England,* vol. i. (1864) of *History of the Commonwealth* (2 vols., 1867).

LILIACEAE, in botany, a family of Monocotyledons belonging to the series Liliiflorae, and generally regarded as representing the typical order of Monocotyledons. The plants are generally perennial herbs growing from a bulb or rhizome, sometimes shrubby as in butcher's broom (*Ruscus*) or tree-like as in species of *Dracaena, Yucca* or *Aloe.* The flowers are with few exceptions hermaphrodite, and regular with parts in threes, the perianth which is generally petaloid occupying the two outer whorls followed by two whorls of stamens, with a superior ovary of three carpels in the centre of the flower; the ovary is generally three-chambered with a number of anatropous ovules on axile placentas. The fruit is a capsule splitting along the septa (septicidal), or between them (loculicidal), or a berry; the seeds contain a small embryo in a copious fleshy or cartilaginous endosperm. Liliaceae is one of the larger families of flowering plants containing about 2,700 species in 233 genera being approximately one-eighth of the Monocotyledons; it is of world-wide distribution. It contains many useful plants (onion, leek, garlic) and garden plants (lily, tulip, hyacinth). The plants show great diversity in vegetative structure, which together with the character and mode of dehiscence of the fruit affords a basis for the subdivision of the family into tribes, eleven of which are recognized. The following are the most important tribes.

Melanthioideae.—The plants have a rhizome or corm, and the fruit is a capsule. Many are north temperate and three are represented in Britain, viz. *Tofieldia,* an arctic and alpine genus of small herbs with a slender scape springing from a tuft of narrow ensiform leaves and bearing a raceme of small green flowers; *Narthecium* (bog asphodel), herbs with a habit similar to *Tofieldia,* but with larger golden-yellow flowers; and *Colchicum,* a genus with about 30 species including the meadow saffron or autumn crocus (*C. autumnale*). *Colchicum* illustrates the corm-development which is rare in Liliaceae, though common in the allied family Iridaceae. *Gloriosa,* well known in cultivation, climbs by means of its tendril-like leaf-tips; it has handsome flowers with recurved orange-red or yellow petals; it is a native of tropical Asia and Africa. *Veratrum* is an alpine genus of the north temperate zone.

Asphodeloideae.—The plants generally have a rhizome bearing radical leaves, as in asphodel, rarely a stem with a tuft of leaves as in *Aloe,* very rarely a tuber (*Eriospermum*) or bulb (*Bowiea*). The flowers are borne in a terminal raceme, the anthers open introrsely and the fruit is a capsule, very rarely, as in *Dianella,* a berry. *Asphodelus* (asphodel) is a Mediterranean genus; *Simethis,* a slender herb with grassy radical leaves, is a native of west and southern Europe extending into south Ireland. *Anthericum* and *Chlorophytum,* herbs with radical often grass-like leaves and scapes bearing a more or less branched inflorescence of small generally white flowers, are widely spread in the tropics. Other genera are *Hosta,* native of China and Japan, cultivated in the open air in Britain; *Hemerocallis,* a small genus of central Europe and temperate Asia—*H. flava* is known in gardens as the day lily; *Phormium,* a New Zealand genus to which belongs New Zealand flax, *P. tenax,* a useful fibre-plant; *Kniphofia* (red-hot poker), South and East Africa, several species of which are cultivated; and *Aloe*. A small group of Australian genera closely approach the family Juncaceae in having small crowded flowers with a scarious or membranous perianth; they include *Xanthorrhoea* (grass-tree or black-boy) and *Kingia.*

FROM H. J. ELWES, "MONOGRAPH OF THE GENUS LILIUM"

LONG-FLOWERED WHITE LILY (LILIUM LONGIFLORUM). A, SCALY BULB, WITH TWO SMALL BULBS

Allioideae.—The plants grow from a bulb or short rhizome; the inflorescence is an apparent umbel formed of several shortened monochasial cymes and subtended by a pair of large bracts. The largest genus *Allium* has about 325 species—7 are British; *Agapanthus* or African lily is a well-known garden plant; in *Gagea,* a genus of small bulbous herbs found in most parts of Europe, the inflorescence is reduced to a few flowers or a single flower; *G. lutea* is a local and rare British plant.

Lilioideae.—Bulbous plants with a terminal racemose inflorescence; the anthers open introrsely and the capsule is loculicidal. It contains about 30 genera, several being represented in Britain. The typical genus *Lilium* and *Fritillaria* are widely distributed in the temperate regions of the northern hemisphere; *F. meleagris,* snake's head, is found in moist meadows in some of the southern and central English counties; *Tulipa* contains about 50 species in Europe and temperate Asia, and is specially abundant in the dry districts of central Asia; *Lloydia,* a small, slender alpine plant, widely distributed in the northern hemisphere, occurs on Snowdon in Wales; *Scilla* (squill) is a large genus, chiefly in Europe and Asia—*S. nutans* is the blue-bell or wild hyacinth; *Ornithogalum* (Europe, Africa and west Asia) is closely allied to *Scilla*—*O. umbellatum,* star of Bethlehem, is naturalized in Britain; *Hyacinthus* and *Muscari* are chiefly Mediterranean; *M. racemosum,* grape hyacinth, occurs in sandy pastures in the eastern counties of England. To this group belong a number of tropical and especially South African genera, such as *Albuca, Urginea, Drimia, Lachenalia* and others.

Dracaenoideae.—The plants generally have an erect stem with a crown of leaves which are often leathery; the anthers open introrsely and the fruit is a berry or capsule. It contains a small number of genera, several of which, such as *Yucca, Dracaena* and *Cordyline* include arborescent species in which the stem increases in thickness continually by a centrifugal formation of new tissue; an extreme case is afforded by *Dracaena Draco,* the dragon-tree of Teneriffe. *Yucca* and several allied genera are natives of the dry country of the southern and western United States and of Central America. *Dracaena* and the allied genus *Cordyline* occur in the warmer regions of the Old World.

Asparagoideae.—Plants growing from a rhizome; fruit a berry. *Asparagus* contains about 120 species in the dryer, warmer parts of the Old World; it has a short creeping rhizome, from which springs a slender, herbaceous or woody, often very much branched, erect or climbing stem, the ultimate branches of which are flattened or needle-like, leaf-like structures (cladodes), the true leaves being reduced to scales or, in the climbers, forming short, hard, more or less recurved spines. *Ruscus aculeatus* is butcher's broom, an evergreen shrub with flattened leaf-like cladodes, native of the southerly portion of England and Wales; the small flowers are unisexual and borne on the face of the cladode; the male contains three stamens, the filaments of which are united to form a short stout column on which are seated the diverging cells of the anthers; in the female the ovary is enveloped by a fleshy staminal tube on which are borne three barren anthers. *Polygonatum* and *Maianthemum* are allied genera with a herbaceous leafy stem and, in the former axillary flowers, in the latter flowers in a terminal raceme; both occur rarely in woods in Britain; *P. multiflorum* is the well-known Solomon's seal of gardens, so called from the seal-like scars on the rhizome of stems of previous seasons, the hanging flowers of which contain no honey, but are visited by bees for the pollen. *Convallaria* is lily of the valley; *Aspidistra,* native of the Himalayas, China and Japan, is a well-known pot plant; its flowers depart from the normal arrangement of the family in having the parts in fours (tetramerous). *Paris,* including the British Herb Paris (*P. quadrifolia*), has solitary tetra- to poly-merous flowers terminating the short annual shoot which bears a whorl of four or more leaves below the flower; in this and in some species of the nearly allied genus *Trillium* (chiefly temperate North America) the flowers have a fetid smell, which together with the dark purple of the ovary and stigmas and frequently also of the stamens and petals, attracts carrion-loving flies, which alight on the stigma and then climb the anthers and become dusted with pollen; the pollen is then carried to the stigmas of another flower.

Luzuriagoideae are shrubs or undershrubs with erect or climbing branches and fruit a berry. *Lapageria,* a native of Chile, is a favourite greenhouse climber with fine bell-shaped flowers.

Smilacoideae are climbing shrubs with broad net-veined leaves and small dioecious flowers in umbels springing from the leaf-axils; the fruit is a berry. They climb by means of tendrils, which are stipular structures arising from the leaf-sheath. *Smilax* is a characteristic tropical genus containing about 210 species; the dried roots of some species are the drug sarsaparilla.

The two tribes *Ophiopogonoideae* and *Aletroideae* are sometimes removed from the Liliaceae and placed in the family, Haemodoraceae. The plants have a short rhizome and narrow or lanceolate basal leaves; and they are characterized by the ovary being often half-inferior. They contain a few genera chiefly old world tropical and subtropical. The leaves of species of *Sansevieria* yield a valuable fibre and the tubers of *Ophiopogon japonicus* are edible. *See* K. Krause in Engler and Prantl, *Die Natürlichen Pflanzenfamilien,* ed. 2, 15a:227–386, fig. 81–161 (1930).

LILIENCRON, DETLEV VON (1844–1909), German poet and novelist, was born at Kiel on June 3, 1844. He entered the army and took part in the campaigns of 1866 and 1870–71, in both of which he was wounded. He retired with the rank of captain, and spent some time in America. On his return (1882) he entered the civil administration at Kellinghusen in Holstein, where he remained till 1887. After some time at Munich, he settled in Altona and then at Altrahistedt, near Hamburg, where he died on July 22, 1909. He first attracted attention by the volume of poems *Adjutantenritte und andere Gedichte* (1883), which was followed by several dramas, a volume of short stories, *Eine Sommerschlacht* (1886), and a novel, *Breide Hummelsbüttel* (1887). In the collections of short stories which appeared under the titles *Unter flatternden Fahnen* (1888), *Der Mäcen* (1889) and *Krieg und Frieden* (1891), he gave powerful, realistic studies of war. Liliencron is one of the greatest of modern German lyric poets; his *Adjutantenritte,* with its fresh original note, broke with the well-worn literary conventions which had been handed down from the middle of the century. His other volumes of lyrics were *Der Heidegänger* (1893), *Neue Gedichte* (1893), *Bunte Beute* (1903), and the posthumous *Gute Nacht* (1909). To this poetical work should be added the humorous epic in *Ottava rima, Poggfred* (1896; re-written and extended 1904). Liliencron's genius was essentially lyric. He has many exquisite lines, and many perfect stanzas, but few perfect long pieces. In much of his work the influence of the quiet landscape of Holstein is evident.

Liliencron's *Sämtliche Werke* were published in 14 vols. (1904–05), and edit. by R. Dehmel (8 vols., 1911–13). *See* studies by H. Spiero (Berlin and Leipzig, 1913, bibl.); H. Maynz (1920); I. Wichmann (1922). His published correspondence includes *Ausgewählte Briefe* (ed. Dehmel, 2 vols., 1910); *Liliencrons Briefe an seinen Verleger* (ed. W. Friedrich, 1910); *Unbegreiflich Herz,* letters to his first wife (ed. H. Spiero, 1925).

LILIENTHAL, OTTO (1848–1896), German inventor and aeronaut, was born at Auklam on May 23, 1848. With a view to studying the problem of equilibrium, Lilienthal made careful observations of the flight of birds, and succeeded in constructing an aeroplane in which a gliding flight could be maintained. Although his work was improved upon by Pilcher, to Lilienthal belongs the credit of demonstrating the superiority of arched over flat surfaces and of reducing gliding flight to regular practice. He made over 2,000 glides in safety, but on Aug. 9, 1896, his machine was upset by a sudden gust of wind, and he was killed near Rhinow. He was the author of a valuable book, *Der Vogelflug als Grundlage der Fliegekunst* (1889).

LILITH, a female demon of Jewish folk-lore, equivalent to the English vampire. The personality and name ("night-monster") are derived from a Babylonian-Assyrian demon Lilit or Lilu. Lilith was believed to have a special power for evil over children. The superstition was extended to a cult surviving among some Jews even as late as the 7th century A.D. In the Rabbinical literature Lilith becomes the first wife of Adam, but flies away from him and becomes a demon.

LILLE (L'Ile), a city of northern France, capital of the department of the Nord, 154 mi. N. by E. of Paris on the Northern railway. Pop. (1936) 200,757. Lille lies in a rich agricultural and industrial plain on the right bank of the Deûle. In 1030, Count Baldwin IV of Flanders surrounded with walls a little town which had arisen around the castle of Buc. In the first half of the 13th century, the town obtained communal privileges. Destroyed by Philip Augustus in 1213, it was rebuilt by Joanna of Constantinople, countess of Flanders, but besieged and retaken by Philip the Fair in 1297. After having taken part with the Flemings against the king of France, it was ceded to the latter in 1312. In 1369 Charles V, king of France, gave it to Louis de Male, who transmitted his rights to his daughter Margaret, wife of Philip the Bold, duke of Burgundy. Under Burgundian rule Lille prospered and its merchants were at the head of the London Hansa. Philip the Good made it his residence. With Flanders it passed from the dukes of Burgundy to Austria and then to Spain. After the death of Philip IV of Spain, Louis XIV reclaimed the territory and besieged Lille in 1667. He forced it to capitulate, but preserved its liberties. In 1708, after an heroic resistance, it surrendered to Prince Eugène and the duke of Marlborough. The treaty of Utrecht restored it to France.

In World War I Lille was first reached by advance German patrols in Aug., 1914. It was afterwards re-occupied by the French, but they retired again early in Oct., the serious defense of the city not being part of the general plan of campaign. After several days' bombardment the Germans entered on Oct. 12, 1914, and remained till Oct., 1918, when they were outflanked by the Allied capture of neighbouring towns. The deportation of a large number of citizens in 1916 was the culminating point of tyranny suffered by the people of Lille under war conditions.

The city was a favourite resort for German officers on leave, as it was not shelled by the Allies, although it was within range of the guns.

Lille is the headquarters of the I army corps, and has an enceinte and a pentagonal citadel, one of Vauban's finest works, west of the town, across the Deûle. Before 1858 the town, fortified by Vauban about 1668, occupied an elliptical area of about 2,500 yd. by 1,300, with the church of Notre Dame de la Treille in the centre, but the southern ramparts and ditches were replaced by the Boulevard de la Liberté, a straight line from the goods railway station to the citadel. The new enceinte encloses the old communes of Esquermes, Wazemmes and Moulins-Lille, the area of the town being thus more than doubled and boulevards and squares added. The district of St. André to the north is the only elegant part of the old town. Outside the enceinte populous suburbs surround the city and on the north and east demolition of fortifications and rapid building are making Lille expand towards Roubaix and Tourcoing. At the demolition of the southern fortifications, the Paris gate, erected in 1682 in honour of Louis XIV, after the conquest of Flanders, was preserved. On the east are the Ghent (1617) and Roubaix (1622) gates, in Renaissance style, in bricks of different colours. On the same side the Noble-Tour is a relic of the mediaeval ramparts. There are water gates for the canal of the Deûle and for the Arbonnoise, which extends into a marsh in the southwest. The citadel, with barracks and arsenal, is surrounded by public gardens. The churches possess valuable pictures and the modern cathedral of Notre Dame de la Treille has an ancient statue of the virgin, an object of pilgrimage. Lille was made a bishopric in 1913. The Bourse (17th century) is built round a courtyard; the Hôtel d'Aigremont, the Hôtel Gentil and other houses are in the Flemish style; the Hôtel de Ville was destroyed in the explosion of a munition dump in 1916 but a part of an old palace of Philip the Good (15th cent.) near to it still remains. The Palais des Beaux-Arts contains a museum and picture galleries including a unique collection of original designs of the great masters and a celebrated wax model of a girl's head usually attributed to some Italian artist of the 16th century. Many pictures were removed before the French evacuated Lille in 1914 and the galleries were largely restored after the end of the war in 1918. The large military hospital was once a Jesuit college.

Lille is the seat of a prefect and has tribunals of first instance and of commerce, a board of trade arbitrators, a chamber of commerce and a branch of the Bank of France. It is the centre of an académie (educational division) and has a university with faculties of laws, letters, science and medicine and pharmacy, together with a Catholic institute comprising faculties of theology, law, medicine and pharmacy, letters, science, a technical school, and a department of social and political science. There are also a higher school of commerce, a national technical school, schools of music and fine arts, and the industrial and Pasteur institutes.

The chief industries are the spinning of flax and the weaving of cloth, table-linen, damask, ticking and flax velvet. The spinning of flax thread for sewing and lace-making is specially connected with Lille. The manufacture of woollen fabrics and cotton-spinning and the making of cotton-twist of fine quality are also carried on. There are important printing establishments, state factories for the manufacture of tobacco and the refining of saltpetre and very numerous breweries, chemical, oil, white lead and sugar-works, distilleries, bleaching-grounds, dye-works, machinery and boiler works. Plant for sugar-works and distilleries, military stores, steam-engines, locomotives, and bridges of all kinds are produced by the company of Fives-Lille. Lille is one of the most important junctions of the Northern railway, and the Deûle canal affords communication with neighbouring ports and with Belgium. Trade is chiefly in the raw material and machinery for its industries, in the products thereof, and in the wheat and other agricultural products of the surrounding district.

LILLEBONNE, a town of France in the department of Seine-Inférieure, $3\frac{1}{2}$ mi. N. of the Seine and 24 mi. E. of Le Havre by the Western railway. Pop. (1936) 5,033. It lies in the valley of the Bolbec at the foot of wooded hills. Lillebonne—under the Romans, *Iuliobona*—was the capital of the Caletes in the time of Caesar, by whom it was destroyed. Rebuilt by Augustus, it became an important focus of Roman roads, but was later ruined by barbarian invasion. The remains of ancient baths and of a great theatre have been brought to light, and many Roman and Gallic relics found. The mediaeval fortifications were built of materials from the theatre.

The church of Notre-Dame has a 16th century tower and portal; the donjon of a 13th century castle stands in the park. The principal industries are cotton-spinning and the manufacture of calico and candles.

LILLIBULLERO or **LILLIBURLERO,** the name of a song popular at the end of the 17th century, especially among the army and supporters of William III. in the war in Ireland during the revolution of 1688. The tune appears to have been much older, and was sung to an Irish nursery song at the beginning of the 17th century. The attribution to Henry Purcell is based on the very slight ground that it was published in *Music's Handmaid,* 1689, as "A new Irish Tune" by Henry Purcell.

The doggerel verses have generally been assigned to Thomas Wharton, and deal with the administration of Talbot, earl of Tyrconnel, appointed by James as his lieutenant in Ireland in 1687. The refrain of the song *Lilliburlero bullen a la* gave the title of the song. Wharton claimed he had "sung a king out of three kingdoms" and Burnet says "perhaps never had so slight a thing so great an effect." The air was introduced with success by Gay (*q.v.*) into *The Beggar's Opera.*

LILLO, GEORGE (1693–1739), English dramatist, son of a Dutch jeweller, was born in London on Feb. 4, 1693. He was brought up to his father's trade and was for many years a partner in the business. His first piece, *Silvia, or the Country Burial,* was a ballad opera produced at Lincoln's Inn Fields in Nov. 1730. On June 22, 1731, his domestic tragedy, *The Merchant,* renamed later *The London Merchant, or the History of George Barnwell,* was produced by Theophilus Cibber and his company at Drury Lane. The piece is founded on "An excellent ballad of George Barnwell, an apprentice of London who . . . thrice robbed his master, and murdered his uncle in Ludlow." Lillo went back to the Elizabethan domestic drama of passion of which the *Yorkshire Tragedy* is a type. Scoffing critics called it, with reason, a "Newgate tragedy," but it was regularly acted for many years at holiday seasons for the moral benefit of the apprentices. The last act contained a scene, generally omitted on the London stage, in which the gallows actually figured. In 1734 Lillo celebrated the marriage of the Princess Anne with William IV. of Orange in *Britannia and Batavia,* a masque. His other dramas were: *The Christian Hero* (1735), *Fatal Curiosity* (1736), an adaptation of *Pericles, Prince of Tyre,* with the title *Marina* (1738) and *Elmerick, or Justice Triumphant* (1740). Lillo died on Sept. 3, 1739. He left an unfinished version of *Arden of Feversham,* which was completed by Dr. John Hoadly and produced in 1759. Lillo has a certain cosmopolitan importance, for the influence of *George Barnwell* can be traced in the sentimental drama of both France and Germany.

See *Lillo's Dramatic Works with Memoirs of the Author by Thomas Davies* (reprint by Lowndes, 1810); Leopold Hoffmann, *George Lillo* (Marburg, 1888); Paul von Hofmann-Wellenhof, *Shakspere's Pericles und George Lillo's Marina* (1885).

LILLY, WILLIAM (1602–1681), English astrologer, was born in 1602 at Diseworth in Leicestershire. He received a tolerably good classical education at the school of Ashby-de-la-Zouche. In his eighteenth year, his father having fallen into great poverty, he went to London and was employed in attendance on an old citizen and his wife. His master, at his death in 1627, left him an annuity of £20; and, Lilly having soon afterwards married the widow, she, dying in 1633, left him property to the value of about £1,000. He now began to dabble in astrology, reading all the books on the subject he could find, and particularly studying Valentine Naibod's *Commentary on Alchabitius.* He then began to issue his prophetical almanacs and other works, which met with serious attention from some of the most prominent members of the Long Parliament. The chief difference between Lilly and the mass of the community at the time was that, while others believed in the general truth of astrology, he ventured to specify the future events to which its calculations pointed. Even from his own account of himself, however, it is evident that he did not trust implicitly to the indications given by the aspects of the heavens, but kept his eyes and ears open for any information which might make his predictions safe.

After the Restoration Lilly very quickly fell into disrepute. His sympathy with the parliament, which his predictions had generally shown, was not calculated to bring him into royal favour. He came under the lash of Butler, who, making allowance for some satiric exaggeration, has given in the character of Sidrophel a probably not very incorrect picture of the man; and, having by this time amassed a tolerable fortune, he bought a small estate at Hersham in Surrey, to which he retired, and where he diverted his talents to the practice of medicine. He died in 1681.

Lilly's life of himself, published after his death, is still worth looking into as a remarkable record of credulity. In 1852 a prominent London publisher put forth a new edition of Lilly's *Introduction to Astrology,* "with numerous emendations adapted to the improved state of the science."

LILOAN, a municipality of the province and island of Cebu, Philippine Islands, 10 mi. N.E. of Cebu, the provincial capital. Pop. (1939) 13,662. One of the principal coal deposits on the island is at Liloan, but the main industry is fishing. The agricultural products include palay (rice), maize (corn), sugar, coffee, coco-nuts and tropical fruits. Cebuano, a dialect of Bisayan, is the vernacular. Of the inhabitants aged 6 to 19 inclusive, 25·1% in 1939 attended school. Of the total population 10 years old and over, 36·1% was literate.

LILY, *Lilium,* the typical genus of the family Liliaceae, embracing nearly 60 species, all confined to the northern hemisphere, and widely distributed throughout the north temperate zone. The earliest in cultivation were described in 1597 by Gerard (*Herball,* p. 146), who figures eight kinds of true lilies, which include *L. candidum* and a variety, *bizantinum,* two umbellate forms of the type *L. bulbiferum,* named *L. aureum* and *L. cruentum latifolium,* and three with pendulous flowers, apparently forms of the martagon lily. Parkinson, in his *Paradisus* (1629), described five varieties of martagon, six of umbellate kinds—two white ones, and *L. pomponium, L. chalcedonicum, L. carniolicum* and *L. pyrenaicum*—together with one American, *L. canadense,* introduced in 1629. For the ancient and mediaeval history of the lily, *see* M. de Cannart d'Hamale's *Monographie historique et littéraire des lis* (Malines, 1870). Later authorities for description and classification of the genus are J. G. Baker ("Revision of the Genera and Species of Tulipeae," *Journ. of Linn. Soc.* xiv, p. 211, 1874), and J. H. Elwes (*Monograph of the Genus Lilium,* 1880). Information on the cultivation of lilies and their diseases will be found in the report of the Conference on Lilies, in the *Journal of the Royal Horticultural Society,* 1901, in L. H. Bailey, *The Standard Cyclopaedia of Horticulture,* 1933, and in Helen M. Fox, *Garden Cinderellas,* 1932.

The structure of the flower represents the simple type of monocotyledons, consisting of two whorls of petals, of three free parts each, six free stamens, and a consolidated pistil of three carpels, ripening into a three-valved capsule containing many winged seeds. In form, the flower assumes three types: trumpet-shaped, with a more or less elongated tube, e.g., *L. longiflorum* and *L. candidum;* an open form with spreading perianth leaves, e.g., *L. auratum;* or assuming a pendulous habit, with the tips strongly reflexed, *e.g.,* the martagon type. All have scaly bulbs, which in three west American species, as *L. humboldti,* are remarkable for being somewhat intermediate between a bulb and a creeping rhizome. *L. bulbiferum* and its allies produce aerial reproductive bulbils in the axils of the leaves. The bulbs of several species are eaten, such as of *L. avenaceum* in Kamchatka, of *L. martagon* by the Cossacks, and of *L. tigrinum,* the tiger lily, in China and Japan. Medicinal uses were ascribed to the species, but none appear to have any marked properties in this respect.

The white lily, *L. candidum,* was one of the commonest garden flowers of antiquity, appearing in the poets from Homer downwards side by side with the rose and the violet. According to Hehn, roses and lilies entered Greece from the east by way of Phrygia, Thrace and Macedonia (*Kulturpflanzen und Hausthiere,* 3rd ed., p. 217). Mythologically the white lily, *Rosa junonis,* was fabled to have sprung from the milk of Hera. As the plant of purity it was contrasted with the rose of Aphrodite. The word *κρίνον*, on the other hand, included red and purple lilies, Plin. *H.N.* xxi, 5 (11, 12), the red lily being best known in Syria and Judaea (Phaselis). This perhaps is the "red lily of Constantinople" of Gerard, *L. chalcedonicum.* The lily of the Old Testament (shôshan) may be conjectured to be a red lily from the simile in Cant. v, 13, unless the allusion is to the fragrance rather than the colour of the lips, in which case the white lily must be thought of. The "lilies of the field," Matt. vi, 28, are *κρίνα,* and the comparison of their beauty with royal robes suggests their identification with the red Syrian lily of Pliny. Lilies are not a conspicuous feature in the flora of Palestine, and the red anemone (*Anemone coronaria*), which dots all of the hillsides of Galilee in the spring, is more likely to have suggested the figure.

The noble *L. auratum,* with its large white flowers, having a yellow band and numerous red or purple spots, is a magnificent plant when grown to perfection; and, so are the varieties called *rubro-vittatum* and *cruentum,* which have the central band crimson instead of yellow; and the broad-petalled *platyphyllum,* and its almost pure white sub-variety called *virginale.* Of *L. speciosum* (well known to most gardeners as *lancifolium*), the true typical form and the red-spotted and white varieties are grand plants for late summer blooming.

The tiger lily, *L. tigrinum,* and its varieties *fortunei, splendidum* and *florepleno,* are among the best species for the flower garden.

The pretty *L. leichtlinii* and *L. monadelphum* with drooping yellow flowers and the scarlet drooping-flowered *L. tenuifolium* make up, with those already mentioned, a series of the finest hardy flowers of the summer garden. The Indian *L. giganteum* is perfectly distinct in character, having broad heart-shaped leaves, and a noble stem 10 to 14 ft. high, bearing a dozen or more large deflexed, funnel-shaped, white, purple-stained flowers; *L. cordifolium* (China and Japan) is similar in character, but dwarfier in habit.

The word "lily" is loosely used in connection with many plants which are not really members of the genus *Lilium,* but belong to genera which are quite distinct botanically.

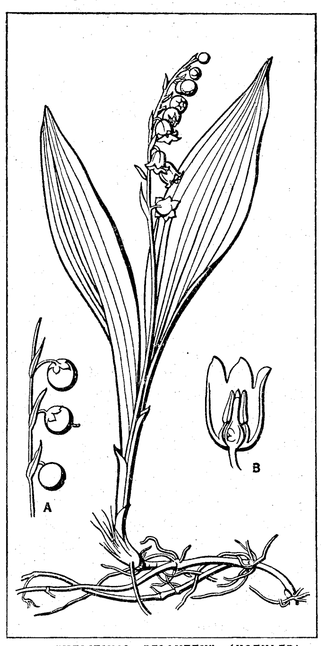
Thus, the Lent lily is a *Narcissus;* the African lily is *Agapanthus africanus;* the Belladonna lily is *Amaryllis belladonna* (*see* AMARYLLIS); the Jacobaea lily is *Sprekelia formosissima;* the Mariposa lily is *Calochortus;* the Peruvian lily is *Alstroemeria;* St. Bernard's lily is *Anthericum liliago;* St. Bruno's lily is *Paradisea liliastrum;* the water lily is *Nymphaea;* the giant water lily of the Amazon is *Victoria regia* (*q.v.*); the arum lily is *Zantedeschia aethiopica;* and there are many others, among them the day lilies (*Hemerocallis*).

No true lily is found native in Great Britain. In North America about 20 native species occur. In the eastern half of the continent the best-known are the wood lily (*L. philadelphicum*), the meadow lily (*L. canadense*), the American Turk's-cap lily (*L. superbum*) and Gray's lily (*L. grayi*). Noteworthy among the ten native lilies found in the Pacific states are the Washington lily (*L. washingtonianum*), the Columbia lily (*L. columbianum*) and the Humboldt lily (*L. humboldti*).

LILYE or LILY, **WILLIAM** (*c.* 1468–1522), English scholar, was born at Odiham in Hampshire. He entered the University of Oxford in 1486, and after graduating in arts went on a pilgrimage to Jerusalem. On his return he put in at Rhodes, which was still occupied by the knights of St. John, under whose protection many Greeks had taken refuge after the capture of Constantinople by the Turks. He then went on to Italy, where he attended the lectures of Sulpitius Verulanus and Pomponius Laetus at Rome, and of Egnatius at Venice. After his return he settled in London (where he became intimate with Thomas More) as a private teacher of grammar, and is believed to have been the first who taught Greek in that city. In 1510 Colet, dean of St. Paul's, who was then founding the school which afterwards became famous, appointed Lilye the first high master. He died of the plague on Feb. 25, 1522.

Lilye is famous not only as one of the pioneers of Greek learning, but as one of the joint authors of a book, familiar to many generations of students during the 19th century, the old Eton Latin grammar. The *Brevissima Institutio,* a sketch by Colet, corrected by Erasmus and worked upon by Lilye, contains two portions, the author of which is indisputably Lilye. His verse *Antibossicon ad Gulielmum Hormannum* (1521) is directed against a rival schoolmaster and grammarian, Robert Whittington, who had "under the feigned name of Bossus, much provoked Lilye with scoffs and biting verses."

See the sketch of Lilye's life by his son George, canon of St. Paul's, written for Paulus Jovius who was collecting for his history the lives of the learned men of Great Britain; and the article by J. H. Lupton, formerly sur-master of St. Paul's School, in the *Dict. Nat. Biog.*



FROM "MEDIZINAL PFLANZEN" (KOEHLER)
LILY OF THE VALLEY, SHOWING UNDERGROUND STEM
A, a spray with fruit
B, vertical section through flower

LILY OF THE VALLEY (*Convallaria majalis*), a beautiful plant of the lily family (Liliaceae), native to woods in some parts of England, Europe, northern Asia and in the higher Allegheny mountains of North America. It is widely cultivated for its dainty, white, nodding, fragrant flowers, borne in spring on slender stalks, which, like the two oblong basal leaves, rise from an underground creeping stem.

LIMA, a coast department of central Peru; area, 15,048 sq.mi.; population (1940), 849,171. The coastal plain is for the most part narrow and covered in many places by vast alluvial fans, built by streams which originate in the western watershed of the Cordillera; spurs from the Andes interrupt the lowland at irregular intervals. The department lies within the belt of arid climates which extends southward along the west coast of South America from the Gulf of Guayaquil to central Chile. Nowhere along the coast of Lima does the average annual rainfall exceed two inches, and many years may pass during which there is no measurable rainfall. From June to October fog and stratus clouds are frequent phenomena along the coast and lower slopes of the Cordillera. In a zone of variable width along the western slopes of the mountains (roughly between 2,500 and 4,500 ft. above sea level, but varying with latitude) the clouds come in direct contact with the ground, producing a drenching mist (*garua*) which supports a lush growth of herbaceous annuals (*loma*). Above the zone of the *lomas* there is a regular rainy season from October to April. Thus the two zones complement each other in providing pasturage for the considerable livestock industry of the *sierra*. Agriculture in the arid coastal zone antedates the rule of the Incas, but the irrigation works and terraced gardens of the Indians were ruined by neglect during the first centuries of Spanish occupation. The period of commercial agriculture dates from about 1885, at which time the white and mestizo landowners began to grow sugar cane, cotton, fruits, vegetables and forage crops in the coastal oases. With the development of irrigation works, many of which have been subsidized by the government, tens of thousands of acres of desert land have been brought under cultivation, with cotton ranking first in acreage and value of crops produced. (R. W. RD.)

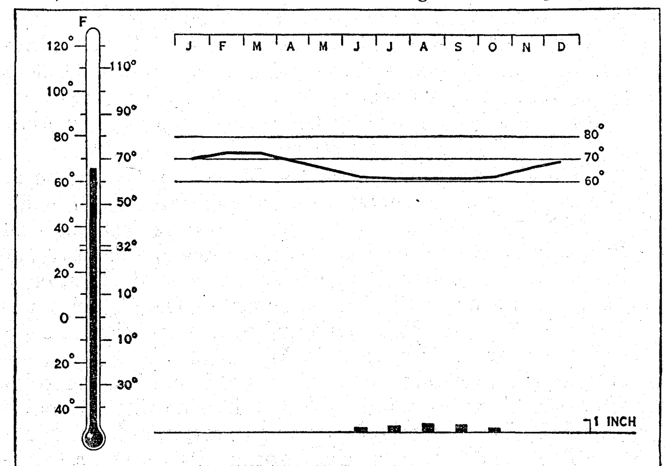
LIMA (a corruption of Rimac), capital of Peru and of the department of Lima (12° 2′ 34″ S., 77° 7′ 36″ W.), on the Rimac, a river in summer, a rivulet in winter, is 8½ mi. from its seaport, Callao (*q.v.*). In the desert coast zone, nearly 500 ft. above sea level, the city is surrounded by an irrigated plain, out of which rise, here and there, rugged hills, among them San Cristóbal (1,411 ft.) just north of the city. Population (1940) 533,645. The climate is moderate, the mean annual temperature being 66° F; it seldom drops below 54° or rises above 80°. Though there is almost no precipitation, the sky is overcast during the winter, when fogs and high relative humidity make it seem colder than it is.

History.—Lima was founded as the City of the Kings by Francisco Pizarro on Jan. 18, 1535, on the left bank of the Rimac. He traced the outlines of the chief plaza (*Plaza de Armas*) and the checkerboard of streets enclosing square areas (*manzanas*) with open plazas at intervals, a pattern which still survives. On the same day he laid the cornerstone of the cathedral, consecrated in 1625, where his remains may still be seen. Lima became the luxurious capital of the viceroys, the first of whom arrived in 1544. The obligatory centre of Spanish trade on the entire continent, it was the focus of Spanish colonization in South America. By a grant from Charles V, the Universidad Mayor de San Marcos was founded in 1551 under Dominican direction and secularized in 1571. The first archbishop was appointed in 1545. In 1570 the Inquisition was established. As vast wealth from the mines accumulated, the city was embellished with elaborate balconies and carved stone portals, while churches and monasteries glittered with gold and silver. Stone bridges were built across the Rimac; that of 1610 is still standing. Meanwhile, for protection against attacks of foreign pirates, the Duque de la Palata (viceroy 1681–89), built the city walls which stood until 1870, when they were razed and replaced by the present boulevards. This metropolis of a colonial empire was destroyed by earthquake on Oct. 28, 1746, and little in the present city antedates that catastrophe.

During Peru's struggle for independence Lima was the centre of Spanish resistance, and even after independence was declared (1821), it remained rigidly conservative. The era of reconstruction was followed by a vast influx of money from guano deposits, which resulted in some public improvements, such as the railway to Callao (1851), lighting and water systems. The city has suffered from all the revolutions which have convulsed Peru under the republic, but the greatest calamity was its occupation by a Chilean army from Jan. 17, 1881, to Oct. 22, 1883. During that time public buildings and scientific, literary and artistic collections were systematically pillaged. The spirit, as well as much of the history of Lima, is embodied in the six volumes of *Tradiciones Peruanas* by Ricardo Palma.

Streets, Buildings and Public Utilities.—The present city is a curious blend of old and new. The streets, about 30 ft. wide, are paved with stone or asphalt. Most of them have a different name on every block. The houses are usually one story in height, of adobe covered with plaster, built about a patio with plants and flowers, and barred outer windows. The better ones are two storys high, with balconies overlooking the street. The Torre-Tagle mansion, now the foreign office, is the best remaining example of secular colonial architecture. The *Plaza de Armas* is still the centre of Lima, from which tram and omnibus lines radiate. It is surrounded by the cathedral on the east, the archbishop's palace, municipal building, government palace (Palace of the Viceroys), recently rebuilt and enlarged; shops and arcades. On the *Plaza de la Inquisición* is the ancient Inquisition building, now the senate house, and the chamber of deputies is near by.

All the plazas of Lima have fountains, shrubs and flowers, and some, statues of national heroes including Manco Capac, Bolívar,



WEATHER GRAPH OF LIMA. THE THERMOMETER INDICATES THE ANNUAL MEAN TEMPERATURE. THE CURVE SHOWS THE NORMAL MONTHLY TEMPERATURE, AND THE COLUMNS, THE NORMAL MONTHLY PRECIPITATION. MONTHS NOT ACCOUNTED FOR IN COLUMN HAVE A "TRACE" OF PRECIPITATION, LESS THAN 0.1 INCH

San Martín and Bolognesi. Many wide avenues, paved with concrete, are favourite promenades. The *Paseo Colón,* 1 mi. long, 150 ft. wide, with a statue of Columbus, is bordered by trees, flowers and beautiful residences. At one end is the Exposition park, 30 ac. of gardens, walks, artificial lakes, the national museum, mining and metallurgy exposition building and a zoological garden. A favourite promenade for the poorer classes is the *Alameda de los Descalzos,* north of the river, a shady avenue with statues and marble benches, leading to the monastery of the barefoot friars. Several concrete or asphalt highways have been built to neighbouring towns and suburbs, such as the *Avenida del Progreso* to Callao and *Avenida Leguía* to Miraflores, five miles to the south. Electric tramways and buses run to Miraflores, Barranco and Chorrillos, to Magdalena and through Callao to La Punta, all of which are bathing and yachting resorts. In and about Lima there are more than 90 mi. of street railways.

During winter, the favourite resort is Chosica, 30 mi. east of Lima on the Central railway, with a sunny climate above the fogs. Chosica may also be reached by the Central highway. Peruvians are fond of sports, especially association football. There is a modern country club with tennis courts, golf links and polo field. The Jockey club has a racecourse with large grandstand, but the best races are now held at the *Hipódromo San Felipe,* recently built by the government. The bull ring, *Plaza de Toros* in Alameda de Acho, built in 1768, holds 8,000 people. There are several theatres of the better class, and a score of cinemas. The ancient City of the Kings is beginning to take on a modern appearance, with tall office buildings, banks, schools, dwellings, excellent hotels, tobacco monopoly headquarters, post and telegraph office, and a large central market housed in a two-story building which covers an entire block.

An enlarged water supply involved building two reservoirs of reinforced concrete, of 26,000,000 and 13,000,000 litres capacity, additional collecting galleries, a new aqueduct, and renewing 62 mi. of pipe. A 16 in. main has also been built to Miraflores.

Churches and Other Institutions.—In spite of these modern improvements, the past still presides over Lima. More than 50 Spanish colonial churches are scattered throughout the city, among which are Santo Domingo, San Francisco, La Merced, San Agustín and the Sanctuary of Santa Rosa de Lima, built on the site of the house where she was born in 1586, besides monasteries and convents of which that of San Francisco is the largest. Freedom of worship was granted to Protestants in 1915, and there are now seven Protestant churches. Among the clubs, some of which are located on the *Plaza de Armas,* should be mentioned the National, founded 1855, Union, 1868, and many foreign clubs such as the Phoenix (British) club. Learned societies include the Athenaeum, founded (1877) as a literary organization, the Historical institute (1905) and the Geographical society (1888), with a library of 10,000 volumes, 2,000 maps and a small museum as well as a seismological observatory. Its bulletins are a treasure house of information. The Corps of Mining and Hydraulic Engineers (1902) also issues bulletins indispensable to a student of the field. There is a national academy of medicine (1885), an outgrowth of that established by Dr. Unánue in 1787, engineers' and lawyers' clubs, a geological society and many more.

Education.—The University of San Marcos (1551) has faculties of theology, jurisprudence, medicine, political and economic science, philosophy, history and letters, mathematical, physical and natural sciences, and institutes of pharmacy and dentistry. It has a library, two museums, a department of physical education, a gymnasium and a meteorological observatory. The Catholic university has faculties of letters, jurisprudence and political science. A school of engineering was established in 1876 with departments of mines, civil engineering and architecture. There is a school of scientific agriculture, a military school in Chorrillos, a naval academy in La Punta, a school of arts and crafts, a popular university, established in 1921, a school of fine arts (1918), a teachers' college (1905), normal schools, a reform school for boys, the Jorge Chávez school of aviation, a national academy of music and conservatory, business and language schools, numerous secondary schools for boys, the largest of which is Guadalupe (1841) and some for girls, though the majority of schools for girls are convents or private schools. There are in all ten museums, which include collections of Peruvian antiquities, arts, costumes and paintings of scenes and characters in national history. The Lima charity organization maintains public hospitals, including the Arzobispo Loayza, modern in design and equipment. There are many private hospitals, eight volunteer fire companies, five large markets and a modern prison. The National library, founded in 1821 and destroyed by the Chileans in 1881, was razed by fire on May 10, 1943, destroying the library's valuable collection of some 120,000 volumes. A new library is being built on the same site. There is postal and telegraphic service with cable connection at Callao, and wireless communication from a high-power station near Lima. Lima's airport, 3 mi. from the city at Limatambo, is the west coast terminus of the new Panagra-Panair transcontinental air service. There are many newspapers, chief among them *El Comercio* (1839), and periodicals devoted to various interests, some illustrated, some published in foreign languages.

Trade, Industry and Finance.—Hydroelectric power for city lighting and tramways, as well as for industrial purposes, is furnished by the Lima Light, Power and Tramways company, transferred by high-tension wires from Chosica and Yanacoto. Business is chiefly in the hands of wholesale houses, both native and foreign, which export raw products and import manufactured goods. They have chains of branch houses throughout the republic. Many of these have fine buildings in Lima, as do also insurance companies, construction firms and large corporations, both national and foreign, whose activities are elsewhere in the republic.

The most important manufacturing industry is textiles; eight cotton and two woollen mills have a total production of more than 30,000,000 yd. a year. Other industries are tanneries, factories for making shoes and leather articles, hats, furniture, chocolate and biscuits, tile, candles, soap and powder; also oil refineries, coke ovens and railway shops, flour mills, distilleries and breweries.

The *Estanco del Tabaco,* subsidiary of the National Tax Collecting company, has a factory in Lima which produces cigarettes and cigars. Some recently established industries include factories for making glass, Portland cement, aluminum articles for household use, rubber goods, hosiery and chemicals (caustic soda and chloride of lime). There are shops of all sizes and a merchants' association, as well as many workmen's protective associations.

The principal banks, with branches in other cities, are the Bank of London and South America; Italian bank (1889), now the Credit Bank of Peru; Popular bank (1899); Royal Bank of Canada (1916); National City bank (1920). The *Caja de Ahorros* (Savings bank) was established in 1868, the *Caja de Depósitos y Consignaciones* (a depository for government trust funds such as customs receipts, internal taxes, tobacco and salt revenues) in 1905 and the Reserve bank in 1922 (*see* also PERU).

(M. T. BI.; X.)

LIMA, a city of northwestern Ohio, U.S.A., 79 mi. S.S.W. of Toledo; the county seat of Allen county. It is on federal highways 25 and 30S (the Harding), and is served by the Baltimore and Ohio, the Detroit, Toledo and Ironton, the Erie, the Nickel Plate and the Pennsylvania railways, and by motor truck and bus lines. Pop. (1940) 44,711 by federal census. The principal crops of the vicinity are corn, oats, wheat, soybeans, onions, sugar beets and potatoes. Lima supports over 100 diversified industries, including the manufacturing of steam locomotives, diesel engines, cigars, electric and neon signs, steam shovels, steel castings, school and highway buses, electric motors, rubber and petroleum products. At one time it was the centre of the northwest Ohio oil fields, which at peak production (1890–1900) had an annual output of over 20,000,000 bbl. As production diminished in later years, the network of pipe lines was extended until today Lima is the centre of a huge pipe-line distribution system operated by six major oil companies through Lima from the oil fields of Wyoming, Texas and Oklahoma, to the Great Lakes and the east coast. Lima was settled in 1831 and chartered in 1842. Near by are three state parks: Indian lake, Lake St. Mary's and Ft. Amanda. Ohio Northern university at Ada, O., and Bluffton college at Bluffton are near by.

LIMAÇON: *see* CURVES, SPECIAL.

LIMAN VON SANDERS, OTTO (1855–1929), German soldier, was born in Stolp, Prussia, Feb. 18, 1855. Entering the German army in 1874 he held various posts in the cavalry, and in 1913 was sent to Turkey as leader of a German military mission. His appointment as commander of the 1st Turkish army was annulled on account of Russian protests, but he remained inspector of the Turkish army. Made a Prussian general in Jan. 1914, in Nov. of the same year he was given the chief command of the Turkish troops in the Caucasus. In March 1915, as commander of the 5th Turkish army, he successfully opposed the British and French attacks on the Dardanelles and Gallipoli. In 1918 von Sanders succeeded von der Goltz as leader of the Turkish forces in the middle east, and was in command in Syria and Palestine when General Allenby was victorious there. Von Sanders escaped capture, but after the armistice gave himself up to the Allies and was interned until Aug. 1919. He gave an account of his experiences in Turkey in *Fünf Jahre Türkei* (1920; Eng. trans. 1928), a book which throws much light on the Dardanelles campaign and on Turkish politics. He died at Munich on Aug. 23, 1929.

LIMASOL (anc. LEMESSUS), a seaport on the south coast of Cyprus, in Akrotiri Bay with a considerable trade in wine and carobs. Pop. (1944) 17,825. Only a fort attributed to the 13th century has survived many earthquakes and much warfare. In the neighbourhood are the ancient sites of Amathus and Curium. Limasol was the scene of the marriage of Richard I, king of England, with Berengaria of Navarre, in 1191.

LIMB. (1) A word of Teutonic origin, meaning any member of the body, but now restricted to the legs and arms. The word is also used of the main branches of a tree, of the projecting spurs of a range of mountains, of the arms of a cross, etc. "Limb" was used by ecclesiastical writers of the 16th and 17th centuries of a person as being a component part of the church or other corporate body; *cf.* such expressions as "limb of the law," etc. It is also a term for an estate dependent on another, or for the subordinate members of the Cinque Ports, attached to one of the principal towns; Pevensey was thus a "limb" of Hastings. (2) An edge or border, frequently used in scientific language for the boundary of a surface; *e.g.,* the edge of the disk of the sun or moon, or of the expanded part of a petal or sepal in botany. This word is a shortened form of *limbo* or *limbus,* Lat. for "edge," for the theological use of which *see* LIMBUS.

LIMBA, a small group of intelligent, dark-skinned people of medium stature, living in the valleys of the upper Little Skarcies and Kakuna rivers in Sierra Leone, skilled traders, speaking an ancient language related to Landuman and Timne. They are grouped in confederated villages under a paramount chief. The paternal nephew marries the widow of his paternal uncle. The Limba are organized in clans and have secret societies and age classes. They are engaged in cultivation, arboriculture and cattle-raising. Their religion is animist in type, and there are traces of totemism.

See N. W. Thomas, *Anthropological Report on Sierra Leone* (1916).

LIMBACH, a town in the *Land* of Saxony, Germany, in a manufacturing district 6 mi. W.N.W. of Chemnitz. Pop. (1939) 19,663. Its industries include the making of hosiery, gloves, cloth, silk and sewing-machines, and dyeing and bleaching.

LIMBORCH, HENDRICK VAN (1680–1758), Dutch painter, was born at The Hague, Holland. He studied painting under Adriaan van der Werff, whose style he imitated rather successfully, although he never acquired the skill of his master. Limborch is known for landscapes, portraits and historical paintings. His extant works include "The Repose in Egypt" and "The Golden Age," both of which hang in the Louvre, "Venus and Cupid" and "Cupid and Psyche."

LIMBORCH, PHILIPP VAN (1633–1712), Dutch Remonstrant theologian, was born on June 19, 1633, at Amsterdam, where his father was a lawyer. He received his education at Utrecht, at Leyden, in his native city and finally at Utrecht university, which he entered in 1652. In 1657 he became a Remonstrant pastor at Gouda, and in 1667 he was transferred to Amsterdam, where, in the following year, the office of professor of theology in the Remonstrant seminary was added to his pastoral charge. He was a friend of John Locke. He died at Amsterdam, April 30, 1712.

His most important work, *Institutiones theologiae christianae, ad praxin pietatis et promotionem pacis christianae unice directae* (Amsterdam, 1686, 5th ed., 1735, Eng. trans. 1702), is a full and clear exposition of the system of Simon Episcopius and Stephan Curcellaeus. The fourth edition (1715) included a posthumous "Relatio historica de origine et progressu controversiarum in foederato Belgio de praedestinatione." Limborch also wrote *De veritate religionis Christianae amica collatio cum erudito Judaeo* (Gouda, 1687); *Historia Inquisitionis* (1692), in four books prefixed to the "Liber Sententiarum Inquisitionis Tolosanae" (1307–23) and *Commentarius in Acta Apostolorum et in Epistolas ad Romanos et ad Hebraeos* (Rotterdam, 1711). His editorial labours included the publication of various works of his predecessors and of *Epistolae ecclesiasticae praestantium ac eruditorum virorum* (Amsterdam, 1684), chiefly by Jakobus Arminius, Joannes Uytenbogardus, Konrad Vorstius (1569–1622), Gerhard Vossius (1577–1649), Hugo Grotius, Simon Episcopius (his granduncle) and Gaspar Barlaeus; they are of great value for the history of Arminianism. An English translation of the *Theologia* was published in 1702 by William Jones (*A Complete System or Body of Divinity, Both Speculative and Practical, Founded on Scripture and Reason,* London, 1702); and a translation of the *Historia Inquisitionis,* by Samuel Chandler, with "a large introduction concerning the rise and progress of persecution and the real and pretended causes of it" prefixed, appeared in 1731.

LIMBOURG, POL DE (*fl. c.* 1400), Flemish miniature painter, the most famous of three brothers whose family name was Malouel, all of whom followed the same profession. At one time Pol travelled to Italy to study at first hand the works of contemporary Italian artists, whose influence is clearly evident in his later work, but little else is known of the details of his early life. Any records there may have been have disappeared, probably destroyed by the wars which ravaged the Netherlands during his lifetime.

For a time he and his two brothers, Hermann and Janneken, worked for Philip the Bold, duke of Burgundy, beginning for him the illustration of the *Bible historiée.* This manuscript was later finished by other hands after Philip's death in 1404 had terminated the brothers' efforts on it. Not long after, probably about 1411, they entered the service of Philip's brother, John, duke of Berry, and it was under his patronage that Pol did his best work, the illuminating of the two prayer books, *Les Très Riches Heures du duc de Berry* and *Les Heures d'Ailly.* Although Pol did not finish the first manuscript in his lifetime, he and his brothers are thought to be responsible for nearly half of it, and it may have been partially completed after his death by Hubert and John van Eyck, whose style Pol was one of the first of the Flemish painters to foreshadow.

LIMBURG, one of the many small feudal states into which the duchy of Lower Lorraine was split up in the second half of the 11th century. The first count was Walram of Arlon, who married Judith, the daughter of Frederick of Luxembourg, duke of Lower Lorraine (d. 1065), who bestowed upon him a portion of his possessions lying upon both sides of the river Meuse. It received its name from the strong castle built by Count Walram on the river Vesdre, where the town of Limburg now stands. Henry, Walram's son (d. 1119), was turbulent and ambitious. On the death of Godfrey of Bouillon (1089) he forced the emperor Henry IV to recognize him as duke of Lower Lorraine. He was afterwards deposed and imprisoned by Count Godfrey of Louvain, on whom the ducal title had been bestowed by the emperor Henry V (1106). For three generations the possession of the ducal title was disputed between the rival houses of Limburg and Louvain. At length a reconciliation took place (1155). The name of duke of Lower Lorraine thenceforth disappeared, the rulers of the territory on the Meuse becoming dukes of Limburg, those of the larger territory to the west, dukes of Brabant. With the death of Duke Walram IV (1280) the succession passed to his daughter, Irmingardis, who was married to Reinald I, count of Guelders. Irmingardis died without issue (1282); and her cousin, Count Adolph of Berg, laid claim to the duchy. His rights were disputed by Reinald, who was in possession and was recognized by the emperor. Too weak to assert his claim by force of arms Adolph sold his rights to John I, duke of Brabant (*q.v.*) in 1283. This led to a long and desolating war which lasted until 1288. At the end of that time, finding the power of Brabant superior to his own, Reinald in his turn sold his rights to Count Henry III of Luxembourg.

Henry and Reinald, supported by the archbishop of Cologne and other allies, now raised a great army. The rival forces met at Woeringen and John of Brabant gained a complete victory, after which the duchies of Limburg and Brabant passed under the rule of a common sovereign. The duchy comprised during this period the bailiwicks of Hervé, Montzen, Baelen, Sprimont and Wallhorn and the counties of Rolduc, Daelhem and Falkenberg, to which was added in 1530 the town of Maastricht. The provisions and privileges of the famous Charter of Brabant, the *Joyeuse Entrée* (*q.v.*), were from the 15th century extended to Limburg and remained in force until the French Revolution.

By the Treaty of Westphalia (1648) the duchy was divided into two portions, the counties of Daelhem and Falkenberg with the town of Maastricht being ceded by Spain to the United Provinces, where they formed what was known as a "Generality-Land." At the peace of Rastatt (1714) the southern portion passed under the dominion of the Austrian Habsburgs and formed part of the Austrian Netherlands until the French conquest in 1794. During the period of French rule (1794–1814) Limburg was included in the two French departments of Ourthe and Meuse Inférieure. In 1814 the old name of Limburg was restored to one of the provinces of the newly created kingdom of the Netherlands, but the new Limburg comprised, besides the ancient duchy, a piece of Gelderland and the county of Looz. At the revolution of 1830 Limburg, with the exception of Maastricht, threw in its lot with the Belgians, and during the nine years that King William refused to recognize the existence of the kingdom of Belgium, the Limburgers sent representatives to the legislature at Brussels and were treated as Belgians. When in 1839 the Dutch king suddenly announced his intention of accepting the terms of the settlement proposed by the treaty of London, as drawn up by representatives of the great powers in 1831, Belgium found herself compelled to relinquish portions of Limburg and Luxembourg. The part of Limburg that lay on the right bank of the Meuse, together with the town of Maastricht and a number of communes on the left bank of the river, became a sovereign duchy under the rule of the king of Holland. In exchange for the cession of the rights of the Germanic confederation over the portion of Luxembourg which was annexed by the treaty to Belgium, the duchy of Limburg (excepting the communes of Maastricht and Venloo) was declared to belong to the Germanic confederation. This somewhat unsatisfactory condition of affairs continued until 1866, when at a conference of the great Powers, held in London to consider the Luxembourg question (*see* LUXEMBOURG), it was agreed that Limburg should be freed from every political tie with Germany. Limburg became henceforth an integral part of Dutch territory.

In Dec. 1918 indignation was expressed by Belgium at the authorization by the Dutch government of the passage of the retreating German army through Limburg, which enabled the Germans to save 70,000 to 120,000 men and to carry away the proceeds of their exactions in Belgium, and a large quantity of war material. Feeling in Belgium was the more inflamed because the Dutch government had refused to liberate the Belgians interned in Holland until the consent of Germany had been obtained; an attitude which should have had its logical counterpart in the internment of the retreating Germans. It was felt that Holland had created a precedent affecting the security of Belgium. In 1918–19 a proposal was brought before the Peace conference in Paris for the revision of the treaty of 1839, in order to place Dutch Limburg under Belgian rule. This was not favourably received in Paris and was strenuously opposed in Holland. It was finally vetoed. Limburg was occupied by Germany in 1940.

See P. S. Ernst, *Histoire du Limbourg* (Liége, 1837–52); M. J. de Poully, *Histoire de Maastricht et de ses environs* (1850); *Diplomaticke bescheiden betreffends de Limburg-Luxemburgsche aangelegenheden 1866–67* (The Hague, 1868); C. J. Luzac, *De Landen van Overmuze in Zonderheid 1662* (Leyden, 1888); R. Fruin, *Geschied. der Staats-Instellingen in Nederland* (The Hague, 1901).

LIMBURG, the N.E. province of Belgium, part of the ancient duchy of Limburg. The part of the duchy east of the Meuse was transferred to Holland by the London conference and a part including the old capital, now called Dolhain, was put into the province of Liége.

The Kempen, a wild heath district, has coal under it, workings on which began in 1906 and production in 1917. Towns include Hasselt (the capital), St. Trond, Tongres, Maeseyck and Looz, from the last of which an ancient ducal family takes its title. There are 3 administrative *arrondissements,* 13 cantons and 206 communes. Area 929 sq.mi. Pop. (est. 1939) 420,817, or 452.9 per sq.mi.

LIMBURG, a town in the Prussian province of Hesse-Nassau, on the Lahn, here crossed by a bridge dating from 1315, and on the main railway line from Coblenz to Lollar and Cassel. Pop. (1933) 12,002. It is the seat of a Roman Catholic bishop and the small seven-towered cathedral, dedicated to St. George the Martyr, was founded early in the 10th century and consecrated in 1235. It was restored in 1872–78. Limburg, which has a castle, was a flourishing place during the middle ages and had its own line of counts until 1414, when it was purchased by the elector of Trier. It passed to Nassau in 1803. Its industries include the manufacture of tobacco, soap, machinery of various kinds, paints and leather.

LIMBURG, the southeasternmost and smallest province of the Netherlands, bounded north by Gelderland, northwest by North Brabant, southwest by the Belgian province of Limburg and south by that of Liége and east by Germany. Its area is 846 sq.mi. and its population (est. 1938) was 602,983, the density per sq.mi. being 713. In the extreme southeast there are Cretaceous hills rising to over 300 ft. (the highest land in the Netherlands), while the rest of the province is formed of more recent deposits. It is watered by the Meuse (Maas), which forms part of its southwestern boundary (with Belgium) and then flows through its northern portion, and by such tributaries as the Roer. Its capital is Maastricht, at the ancient river-crossing, giving its name to one of the two administrative districts into which it is divided, the other being Roermond. Venlo is a station on the railway from Crefeld to Breda which crosses the province, while subsidiary lines link it with Maastricht to the south and Nijmwegen to the north.

The richest part of the province is the southeast: on the loess deposits here there is a rich cultivation of wheat, rye, sugar beet and fruit. There is a coalfield near Heerlen and Kerkrade, and among the industries of Maastricht are glass, porcelain and leather. The province was speedily overrun by German troops during the invasion of May 1940.

LIMBURG CHRONICLE or **FESTI LIMPURGENSES,** a German chronicle written probably by Tileman Elhen von Wolfhagen after 1402. It is a source for the history of the Rhineland between 1336 and 1398 but is more valuable philologically and for the folk-lore and pictures of manners which it contains.

First published by Faust in 1617, it was edited by Wyss for *Monumenta Germaniae historica. Deutsche Chroniken,* Band iv (Hanover, 1883). *See* A. Wyss, *Die Limburger Chronik untersucht* (Marburg 1875).

LIMBURGITE, in petrology, a dark-coloured volcanic rock resembling basalt in appearance, but containing normally no felspar. The name is taken from Limburg (Germany), where it occurs in the well-known rock of the Kaiserstuhl. It consists essentially of olivine and augite with a brownish glassy ground mass, in which a second generation of small augites frequently occurs; more rarely olivine is present also as an ingredient of the matrix.

The principal accessory minerals are titaniferous iron oxides and apatite, and in some limburgites large phenocrysts of hornblende and biotite are found; in others large crystals of soda-orthoclase or anorthoclase. Haüyne is an ingredient of some of the limburgites of the Cape Verde Islands. Rocks of this group occur in considerable numbers in Germany (Rhine district) and in Bohemia, also in Scotland (Whitelaw hill, Haddington), Auvergne, Spain, Kilimanjaro, Brazil, etc. They are associated principally with basalts, nepheline- and leucite-basalts and monchiquites. From the last-named rocks the limburgites are not easily separated as the two classes bear a very close resemblance in structure and in mineral composition.

The ground mass of the monchiquites is not a glass, however, but crystalline analcite. Limburgites may occur as flows, as sills or dikes, and are sometimes highly vesicular. Closely allied to them are the *augitites,* which are distinguished only by the absence of olivine; examples are known from Bohemia, Auvergne, the Canary Islands, Ireland, etc.

LIMBUS, a theological term denoting the border of hell, where dwell those who, while not condemned to torture, yet are deprived of the joy of heaven. The more common form in English is "limbo," which is used both in the technical theological sense and derivatively in the sense of "prison," or for the condition of being lost, deserted, obsolete. In mediaeval theology there are (1) the *Limbus Infantum* and (2) the *Limbus Patrum.*

1. The *Limbus Infantum* or *Puerorum* is the abode to which human beings dying without actual sin, but with their original sin unwashed away by baptism, were held to be consigned; the category included, not unbaptized infants merely, but also idiots, cretins and the like. The word "limbus," in the theological application, occurs first in the *Summa* of Thomas Aquinas; for its extensive currency it is perhaps most indebted to the *Commedia* of Dante (*Inf.* c. 4). The question as to the destiny of infants dying unbaptized presented itself to theologians at a comparatively early period. Generally speaking it may be said that the Greek fathers inclined to a cheerful and the Latin fathers to a gloomy view. Thus Gregory of Nazianzus (*Orat.* 40) says "that such children as die unbaptized without their own fault shall neither be glorified nor punished by the righteous Judge, as having done no wickedness, though they die unbaptized, and

as rather suffering loss than being the authors of it." Similar opinions were expressed by Gregory of Nyassa, Severus of Antioch and others—opinions which it is almost impossible to distinguish from the Pelagian view that children dying unbaptized might be admitted to eternal life, though not to the kingdom of God. In his recoil from Pelagian heresy, Augustine was compelled to sharpen the antithesis between the state of the saved and that of the lost and taught that there are only two alternatives—to be with Christ or with the devil, to be with Him or against Him. Following up, as he thought, his master's teaching, Fulgentius declared that it is to be believed as an indubitable truth that "not only men who have come to the use of reason, but infants dying, whether in their mother's womb or after birth, without baptism in the name of the Father, Son and Holy Ghost, are punished with everlasting punishment in eternal fire." Later theologians and schoolmen followed Augustine in rejecting the notion of any final position intermediate between heaven and hell but otherwise inclined to take the mildest possible view of the destiny of the irresponsible and unbaptized. Thus the proposition of Innocent III that "the punishment of original sin is deprivation of the vision of God" is practically repeated by Aquinas, Scotus and all the other great theologians of the scholastic period, the only outstanding exception being that of Gregory of Rimini, who on this account was afterward called "tortor infantum."

The first authoritative declaration of the Latin Church upon this subject was that made by the second council of Lyons (1274) and confirmed by the council of Florence (1439), with the concurrence of the representatives of the Greek Church, to the effect that "the souls of those who die in mortal sin or in original sin only forthwith descend into hell, but to be punished with unequal punishments." Perrone remarks (*Prael. Theol.* pt. iii, chap. 6, art. 4) that the damnation of infants and also the comparative lightness of the punishment involved in this are thus *de fide;* but nothing is determined as to the place which they occupy in hell, as to what constitutes the disparity of their punishment or as to their condition after the day of judgment. In the council of Trent there was considerable difference of opinion as to what was implied in deprivation of the vision of God, and no definition was attempted, the Dominicans maintaining the severer view that the *Limbus Infantum* was a dark subterranean fireless chamber, while the Franciscans placed it in a region of light above the earth. Some theologians continue to maintain with Bellarmine that the infants "in limbo" are affected with some degree of sadness on account of a felt privation; others, following the *Nodus praedestinationis* of Celestine Sfrondati (1649–96), hold that they enjoy every kind of natural felicity, as regards their souls now and as regards their bodies after the resurrection, just as if Adam had not sinned. In the condemnation (1794) of the synod of Pistoia (1786) the 26th article declares it to be false, rash and injurious to treat as Pelagian the doctrine that those dying in original sin are not punished with fire, as if that meant that there is an intermediate place, free from fault and punishment, between the kingdom of God and everlasting damnation.

2. The *Limbus Patrum* or *Sinus Abrahae* ("Abraham's Bosom") is defined in mediaeval theology as the place in the underworld where the saints of the Old Testament were confined until liberated by Christ on his "descent into hell." Regarding the locality and its pleasantness or painfulness nothing has been taught as *de fide*. It is sometimes regarded as having been closed and empty since Christ's descent, but other authors do not think of it as separate in place from the *Limbus Infantum*. The whole idea, in the Latin Church, has been described as the mere *caput mortuum* of the old doctrine of Hades, which was gradually superseded in the west by that of purgatory.

LIME, the fruit of *Citrus aurantifolia,* which is regarded by W. T. Swingle (1943) as distinct and not closely related to any other *Citrus* species. It is thought to be native to the East Indies and to have been brought from there, by man, to the Asiatic mainland and, finally, to the subtropical countries of Europe and north Africa. Spanish and Portuguese explorers introduced the lime to the West Indies and the American continents in the early part of the 16th century. It escaped from cultivated areas in southern Florida and elsewhere and has been found in various places growing wild, as individual trees or sometimes as thickets (H. J. Webber, 1943).

The lime tree seldom grows more than 8 to 15 ft. high, and, if not pruned, becomes shrublike in character of growth; branches spreading, irregular, with short stiff twigs, small leaves and an abundance of small, very sharp thorns; leaves pale green; small white flowers, usually borne in clusters; fruit $1\frac{1}{4}$–$1\frac{3}{4}$ in. in diameter, oval to nearly globular, often with small apical nipple; peel very thin, greenish yellow when fruit is ripe; pulp tender, very juicy, yellowish green in colour, and decidedly acid. As a group, limes somewhat exceed lemons in both acid and sugar content. There are, however, some varieties so lacking in citric acid that they are known as sweet limes; they are not commonly grown in comparison with the acid type.

The lime hybridizes readily with other *Citrus* species, and numerous hybrid varieties are grown as novelties; a few are grown for commercial purposes. Perhaps the most important of the hybrids is the Perrine lemon, an intrageneric hybrid of Mexican lime (*C. aurantifolia*) and Genoa lemon (*C. limon*), which resembles more nearly the lemon than the lime, both in fruit and foliage characteristics and in resistance to frost. This fruit was originated in Florida in 1909 by investigators in the United States department of agriculture and is recommended for local production and use for parts of Florida, Louisiana and Texas.

The two general groups of acid limes grown in the United States are the Mexican and the Tahiti. The former group is characteristic of the species *C. aurantifolia,* described above. Numerous thornless strains of Mexican limes have arisen from seedlings and from bud sports, the first one being recorded in the West Indies in 1892. The trees of the Tahiti group resemble the lemon and are larger and more vigorous than those of the Mexican group; leaves larger and darker coloured. The fruit is larger and more elongated than the Mexican lime; peel thicker; fruit nearly seedless. The flavour of the fruit of the two groups is similar, but the Tahiti lime lacks some of the bouquet which is typical of the Mexican. The Tahiti lime so closely resembles a lemon that the fruit could easily be confused except for the colour of the pulp and the distinctive taste. From the appearance of the Tahiti group, there seems to be a possibility that this fruit may be a hybrid between the lemon and the typical Mexican lime (Webber, 1943).

Methods of culture, propagation and pest control for limes are comparable to those used in other citrus orchards (*see* LEMON and ORANGE). Limes are less resistant to cold than are lemons, and are therefore planted only in relatively frostless locations. It is for this reason that they are grown in the warmer subtropical countries, such as the West Indies and Mexico; in the United States, they are grown only in the extreme south of Florida and in certain favourable sites in California. This fruit is especially popular in Egypt, and production in that country in 1936 exceeded the combined production of the rest of the world. The supply of limes consumed in United States comes from the aforementioned sources in the western hemisphere, with Mexico the most important source.

Concentrated lime juice may be prepared in a manner similar to that used in preparing lemon juice. The yield of fresh juice depends upon the variety and the condition of the fruit and varies from 60 to 90 gal. per 2,000 lb. of fruit. The small Mexican lime is less readily handled by machinery in the reaming process than are the larger varieties.

Lime juice has been supplanted to a great degree by lemon juice. For limeade and some carbonated and alcoholic beverages, lime juice is preferred; but fresh limes are usually available during the summer months, when such drinks are most in demand. The lime is also used for various culinary purposes. It contains no vitamin A and less vitamin C than the lemon; its use as a preventive of scurvy has therefore become secondary to that of lemons and oranges.

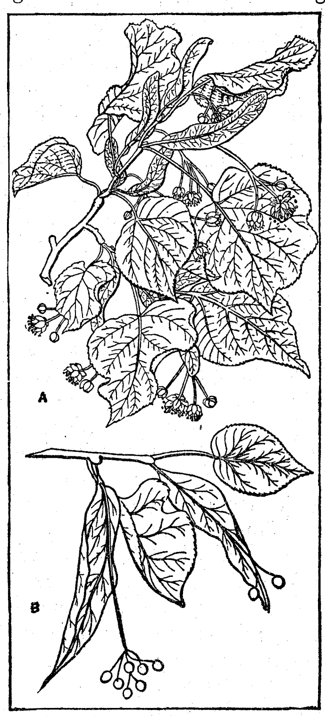
Lime oil is a by-product of this fruit, the chief centre for its production being the West Indies. Citrate of lime and citric acid are also prepared from limes.

Bibliography.—W. T. Swingle, "The Botany of Citrus and Its Wild Relatives of the Orange Subfamily (Family Rutaceae, Subfamily Aurantioideae)," vol. 1, chap. iv, in *The Citrus Industry* (1943); H. J. Webber, "Cultivated Varieties of Citrus," vol. 1, chap. v, in *The Citrus Industry* (1943). (L. D. B.)

LIME, the name given to a viscous exudation of the holly-tree, used for snaring birds and known as "bird-lime" (O. Eng. *lim,* Lat. *limus,* mud, from *limere,* to smear); the popular name of calcium oxide or "quick-lime," a substance employed since very early times as a component of mortars and cementing materials. It is prepared by the burning of limestone (a process described by Dioscorides and Pliny) in kilns similar to those described under Cement. The value and subsequent treatment of the product depend on the purity of the limestone; a pure stone yields a "fat" lime which readily slakes; an impure stone, especially if magnesia be present, yields an almost unslakable "poor" lime. (*See* Cement; Concrete; and Mortar in Building for details.) Pure calcium oxide, CaO, obtained by heating the pure carbonate, is a white amorphous substance, which can be readily melted and boiled in the electric furnace, cubic and acicular crystals being deposited on cooling the vapour. It combines with water, evolving much heat and crumbling to pieces; this operation is termed "slaking" and the resulting product "slaked lime"; it is chemically equivalent to converting the oxide into hydroxide. An aqueous solution of the hydroxide, known as lime-water, has a weakly alkaline reaction; it is employed in the detection of carbonic acid. "Milk of lime" consists of a cream of the hydroxide and water. Dry lime has no action upon chlorine, carbon dioxide and sulphur dioxide although, in the presence of water, combination ensues. In medicine lime-water, applied externally, is an astringent and desiccative, and it enters into the preparation of *linamentum calcis* and carron oil which are employed to heal burns, eczema, etc. Applied internally, lime-water is an antacid; it prevents the curdling of milk in large lumps (hence its prescription for infants); it also acts as a gastric sedative. It is an antidote for mineral and oxalic acid poisoning (*see* also Calcium).

LIME CEMENT: *see* Cement.

LIME or **LINDEN.** The lime trees, species of *Tilia,* are familiar timber trees with sweet-scented flowers which are borne on a common peduncle proceeding from the middle of a long strap-like bract. The genus, which gives the name of the family Tiliaceae, contains about 30 species of trees, natives of the north temperate zone. The general name *Tilia europaea,* European lime, includes several well-marked sub-species, often regarded as distinct species by many authorities. These are: (1) the small-leaved lime, *T. ulmifolia* (or *T. parvifolia*), probably wild in woods in England and also wild throughout Europe, except in the extreme southeast, and Russian Asia; (2) *T. europaea* (or *T. intermedia*), the common lime, which is widely planted in Britain but not wild there, has a less northerly distribution than *T. ulmifolia,* from which it differs in its somewhat larger leaves and downy fruit; (3) the large-leaved lime, *T. platyphyllos* (or *T. grandifolia*), occurs only as an introduction in Britain and is wild in Europe south of Denmark. It differs from the other two limes in its larger leaves, often 4 in. across and downy beneath, its downy twigs and its prominently ribbed fruit. The lime sometimes acquires a great size; one is recorded in Norfolk as being 16 yd. in circumference, and Ray mentions one of the same girth. The famous linden tree which gave the town of Neuenstadt in Württemberg the name of *Neuenstadt an der grossen Linden* was 9 ft. in diameter.



THE LIME (TILIA EUROPAEA)
A. Flowers in small cymes arising from axils of leaf of current year. B. Fruits

The lime is an object of beauty in the spring, when the delicately transparent green leaves are bursting from the protection of the pink and white stipules which have formed the bud-scales, and retains its fresh green during early summer. Later, the fragrance of its flowers, rich in nectar, attracts innumerable bees; in the autumn the foliage becomes a clear yellow but soon falls. Among the many famous avenues of limes are the Unter den Linden of Berlin and the avenue at Trinity college, Cambridge.

The economic value of the tree chiefly lies in the inner bark, sometimes called bast, and the wood. The former was used for paper and mats and for tying garlands by the ancients. Bast mats are now made chiefly in the U.S.S.R., the bark being cut in long strips when the inner layer is easily separable from the corky superficial layer. The wood is used by carvers, being soft and light, and by architects in framing the models of buildings. Turners use it for light bowls, etc.

T. americana (basswood) is one of the most common trees in the forests of Canada and extends into the eastern and southern United States. It is sawed into lumber and under the name of whitewood is used in the manufacture of woodenware, cheap furniture, etc., and also for paper pulp. It was cultivated by Philip Miller at Chelsea in 1752. There are at least 10 other species of basswood native to the southeastern United States, but their separation is fraught with difficulty. (E. S. Hr.)

LIMEHOUSE, a parish of east London, England, in the eastern part of the metropolitan borough of Stepney, on the north bank of the Thames river. It is bordered by the West India and the East India docks and is therefore largely inhabited by labourers from the docks and by sailors, both natives of London and foreigners off merchant ships temporarily in port. A common form of philanthropy has been the establishment of homes and hostels for seamen in Limehouse. The parish also contains London's Chinese quarter. The Limehouse Cut, a channel which connects the Lea with the Thames, was constructed in 1769. St. Anne's, the parish church, was designed by Nicholas Hawksmoor, a pupil of Sir Christopher Wren, and was begun in 1724. It was restored after 1850, when it was partially destroyed by fire on Good Friday. The name Limehouse is probably a corruption of the original Lime Hurst or Lime Host, which referred to the limekilns in the district.

LIMERICK, THOMAS DONGAN, Second Earl of (1634–1715), governor of New York, was born in Castletown, Ireland. He began his career in the army, serving first in England and later under Louis XIV in France in an Irish regiment. He abandoned the army, however, to accept the position of lieutenant-governor of Tangiers, an office he resigned in 1680. Two years later the Duke of York named him governor of New York, which included, at that time, a portion of New England.

Dongan was responsible for a number of important developments in the history not only of New York but of the entire group of American colonies. The so-called "Charter of Liberties," drawn up by the New York assembly, which he convened shortly after he arrived in the colony, served as the basis of New York's later constitution and of the constitution of the entire United States in many of its provisions. It was, however, never put into effect in New York, since the Duke of York, although he signed it, failed to return the charter to the colony, probably because of its extreme liberalism. Dongan helped to fix the boundaries of New York by treaty with the Indians and by agreement with the surrounding colonies and Canada. His charters for the cities of New York and Albany both remained in effect for many years after they were drawn up, New York's for more than 100 years and Albany's for nearly 200. He was responsible for convincing the king of England that French power in America should not be allowed to increase if the English were to maintain their supremacy, especially with regard to the Indians of the Five Nations, and his Indian policy set the example for English colonial governors thereafter.

In 1688 Dongan was relieved of his governorship but remained in New York until 1689, when he was forced to take refuge in New England because of the persecution of Roman Catholics which followed the fall from power of James II. He returned to England in 1691 and seven years later succeeded his brother as earl of Limerick. His family's lands had been seized even before he received the title, and he never recovered them. He died in London, a poor man, on Dec. 14, 1715.

LIMERICK, a western county of Eire, province of Munster, bounded north by the Shannon estuary and the counties of Clare and Tipperary, east by Tipperary, south by Cork and west by Kerry. The area is 663,971 ac., or about 1,037 sq.mi. Pop. (1936) 141,153.

This is mainly a Carboniferous Limestone county, with fairly level land, broken by ridges of Old Red Sandstone. On the north-east, the latter rock rises on Slievefelim, round a Silurian core, to 1,523 ft. In the south, Old Red Sandstone rises above an enclosed area of Silurian shales at Ballylanders, the opposite scarp of Old Red Sandstone forming the Ballyhoura hills on the Cork border. The Galtee mountains, which extend into Tipperary, attain in Galtymore a height of 3,015 ft. Volcanic ashes, andesites, basalts and intrusive sheets of basic rocks are well seen under Carrigogunnell castle and in a ring of hills round Ballybrood. The coals in the west are not of commercial value. Lead-ore has been worked in places in the limestone.

The Shannon is navigable for large vessels to Limerick, above which are the rapids of Doonas and Castleroy and a canal. Castleconnell is a fishing centre. The Maigue, which rises in the Galtees and flows into the Shannon, is navigable as far as the town of Adare.

Limerick was included in the kingdom of Thomond. Afterwards it had a separate existence under the name of Aine-Cliach. From the 8th to the 11th century it was partly occupied by the Danes. (*See* LIMERICK, City.) Limerick is one of the 12 counties generally considered to owe their formation to King John. About 100,000 ac. of the estates of the earl of Desmond, which were forfeited in 1586, were situated in the county, and other extensive confiscations took place after the Cromwellian wars. In 1709 a German colony from the Palatinate was settled by Lord Southwell near Bruff, Rathkeale and Adare.

There are remains of round towers at Ardpatrick and at Dysert; another at Kilmallock is largely a reconstruction. There are remains of stone circles, pillar stones and altars at Loch Gur. In several places there are remains of old moats and tumuli. Besides the monasteries in the city of Limerick, the most important monastic ruins are those of Adare abbey, Askeaton abbey, Galbally friary, Kilflin monastery, Kilmallock and Monaster-Nenagh abbey.

Limerick includes the greater part of the Golden Vale, the most fertile district of Ireland, which stretches from Cashel in Tipperary nearly to the town of Limerick. Along the banks of the Shannon there are fertile tracts of meadowland formed of deposits of calcareous and peaty matter. The soil in the mountainous districts is mostly thin and poor and incapable of improvement. The large farms are almost wholly devoted to grazing. All the crops (of which oats and potatoes are the principal) show a decrease, but there is a growing acreage of meadowland. Cattle, sheep, pigs, goats and poultry are all extensively reared. Coarse woollens are manufactured and also paper, and there are many meal and flour mills. The flax-spinning and weaving industry is now practically extinct.

Limerick is the headquarters of an important salmon-fishery on the Shannon. The Great Southern main line crosses the south-eastern corner of the county, with two branches to the city of Limerick from Limerick Junction and from Charleville and lines from Limerick southwestward to Tralee in County Kerry and to Foynes on the Shannon estuary. The administrative county of Limerick and the county borough of Limerick together return 7 members to Dáil Eireann.

LIMERICK, a county borough, port and the chief town of Co. Limerick, Eire, occupying both banks and an island (King's island) of the river Shannon, at the head of its estuary, 129 mi. W.S.W. of Dublin by rail. Pop. (1936) 41,061.

Limerick is said to have been the *Regia* of Ptolemy and the *Rosse-de-Nailleagh* of the Annals of Multifernan. There is a tradition that it was visited by St. Patrick in the 5th century, but it is first authentically known as a settlement of the Danes, who sacked it in 812 and afterward made it the principal town of their kingdom of Limerick but were expelled from it toward the close of the 10th century by Brian Boroimhe. From 1106 till its conquest by the English in 1174 it was the seat of the kings of Thomond or North Munster, and, although in 1179 the kingdom of Limerick was given by Henry II to Herbert Fitzherbert, the city was frequently in the possession of the Irish chieftains till 1195. Richard I granted it a charter in 1197.

By King John it was committed to the care of William de Burgo, who founded English Town, and for its defense erected a strong castle. The city was frequently besieged in the 13th and 14th centuries. In the 15th century its fortifications were extended to include Irish Town, and until their demolition in 1760 it was one of the strongest fortresses of the kingdom. In 1651 it was taken by General Ireton, and after an unsuccessful siege by William III its resistance was terminated in 1691 by the treaty of Limerick. The dismantling of its fortifications began in 1760, but fragments of the old walls remain. The original municipal rights of the city had been confirmed and extended by a succession of sovereigns, and in 1609 it received a charter constituting it a county of a city and also incorporating a society of merchants of the staple, with the same privileges as the merchants of the staple of Dublin and Waterford. The powers of the corporation were remodelled by the Limerick Regulation Act of 1823.

The prosperity of the city dates chiefly from the foundation of Newtown Pery in 1769 by Edmund Sexton Pery (d. 1806), speaker of the Irish house of commons. Under the Local Government Act of 1898 Limerick became one of the six county boroughs having a separate county council. The city is divided into English Town (on King's Island), Irish Town and Newtown Pery, the first including the ancient nucleus of the city, and the last the principal modern streets. The main stream of the Shannon is crossed by Thomond bridge and Sarsfield or Wellesley bridge. The first is commanded by King John's castle, on King's Island, a Norman fortress fronting the river. At the west end of the bridge is preserved the Treaty stone, on which the Treaty of Limerick was signed in 1691. The cathedral of St. Mary, also on King's Island, was originally built in 1142–80 and exhibits some Early English work. The modern Roman Catholic cathedral of St. John is in early pointed style. The churches of St. Munchin (to whom is attributed the foundation of the see in the 6th century) and St. John, Whitamore's castle and a Dominican priory, are of interest.

Communication with the Atlantic ocean is open, while inland navigation is facilitated by a canal which avoids the rapids above the city. Quays extend for about 1,600 yd. on each side of the river, and vessels of 600 tons can moor alongside at spring tides. There is a graving dock with a length of 428 ft., a breadth of 46 ft. and a depth of 17 ft. The wet dock has a length of 830 ft., a breadth of 465 ft. and a depth of 20 ft. The principal imports are grain, timber and coal. The exports consist mainly of fish and agricultural produce. The principal industrial establishments include flour mills (Limerick supplying most of the west of Ireland with flour), factories for bacon-curing and for condensed milk and creameries. Some brewing, distilling and tanning are carried on, and the manufacture of lace is maintained at the Convent of the Good Shepherd; but a formerly important textile industry has lapsed. The salmon fisheries of the Shannon, for which Limerick is the headquarters of a district, are the most valuable in Ireland.

LIMERICKS. The origin of this very popular type of nonsense-verse is lost in obscurity, and recent research work has done little to pierce the gloom. Nor is it known for what reason the name "Limerick" is attached to it. The theory that the title derives from the chorus "Will you come up to Limerick?" sung after impromptu verses composed at convivial parties, helps us not at all, since there is no record of this kind of verse being used at such parties. Rather is the limerick a kind of ribald epigram, passed on by word of mouth, and more often whispered than sung.

Langford Reed, the only collector of limericks who has toiled valiantly with their history, suggests that "this peculiar form of verse was brought direct to Limerick by the returned veterans of the Irish Brigade, who were attached to the French army for a period of nearly 100 years from 1691." The brigade was organized in Limerick, and when disbanded was no doubt responsible for giving currency to many rude barrack-room songs; but the evidence of a French origin for the five-lined metrical scheme of the limerick rests upon very feeble foundations. Langford Reed quotes from Boswell's *Life of Johnson:*

On s'étonne ici que Caliste
Ait pris l'habit de Moliniste;
Puisque cette jeune beauté
Ôte à chacun sa liberté
N'est-ce pas une Janseniste?

—an epigram in *The Menagiana* (1716) on a young lady who appeared at a masquerade dressed as a Jesuit during the fierce contentions of the followers of Molinos and Jansenius. But Reed also quotes:

Digerie, Digerie, Doge,
La souris ascend l'horloge;
L'horloge frappe
La souris s'échappe,
Digerie, Digerie, Doge,

and appears to consider this a true limerick form, thus permitting the verse-form almost as wide a license in metre as it has latterly attained in morals.

It may be sufficient to suppose that the limerick satisfies some natural instinct of the ear in rhymed verse, the prefatory couplet demanding a third line as complement, and staving this off, for the sake of surer effect, by the interposed short lines. But this would not account for the famous limericks of Edward Lear, in his *Book of Nonsense* (1846), where the last line is merely a choric repetition, employing one of the previous rhymes, and adding little or nothing to the sense. In spite of this defect, Lear certainly gave to what is now known as the limerick its modern popularity—some even assert that "learick" is the proper form of the word—and established at once its insistence on topography and its attention to varieties of personal behaviour.

There was a young girl of Majorca
Whose aunt was a very fast walker;
She walked sixty miles
And leaped fifteen stiles,
Which astonished that girl of Majorca.

Or again,

There was an old person of Anerly
Whose conduct was strange and unmannerly:
He rushed down the Strand
With a pig in each hand,
But returned in the evening to Anerly.

Lear, however, did previsage the now usually accepted formula:

There was an old man at the Cape
Who made himself garments of crape;
When asked "Will they tear?"
He replied "Here and there,
But they keep such a beautiful shape!"

Limericks have been composed upon every conceivable topic, not excluding philosophy and religion—

There was a young man who said "Damn!
It is borne upon me that I am
An engine which moves
In predestinate grooves,
I'm not even a bus; I'm a tram!"

but their usual themes became similar to those of the epigrams of Martial, and would doubtless so have remained, milder variants being substituted when blushes were to be spared, had it not been for their sudden vogue at the beginning of the present century as a subject for prize competitions in the newspapers, which gave large sums of money to readers for supplying the cleverest last line. The judges in these competitions must have had poor ears for scarcely any of the winning lines contained the correct number of feet. A good limerick should have the consecutive fluency of conversational prose, the metre remaining faultlessly dactylic throughout. No better example can be given than

There was an old man of Khartoum
Who kept two tame sheep in his room:
"For," he said, "they remind me
Of one left behind me,
But I cannot remember of whom."

Fantastic rhyme schemes to the limerick are innumerable. As for instance,

The lifeboat that's kept at Torquay
Is intended to float in the suay:
The crew and the coxswain
Are sturdy as oxswain,
And as smart and as brave as can buay.

Limericks have been translated into all languages, and the globe has been ransacked for rhymable towns. The best verses contain the largest amount of improbable incident or of subtle innuendo that can be crowded into the available space, and they may be regarded as the fixed English form for light or indelicate epigrammatic satire, as opposed to the ordinary rhyming quatrains which are used on more dignified occasions. (E. V. K.)

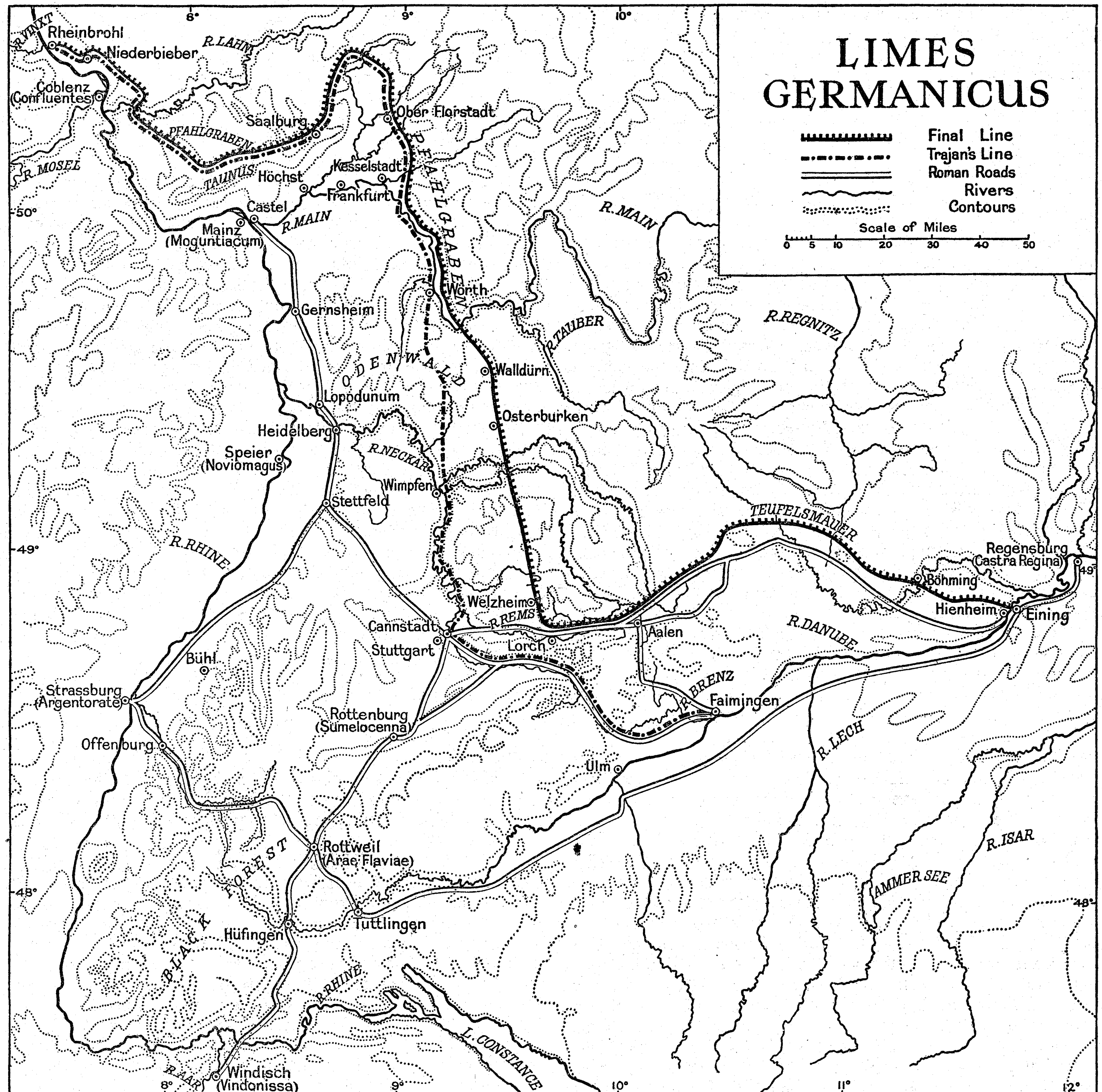
LIMES GERMANICUS. The Latin *limes* denoted a path, a boundary path, or boundary; hence it was utilized to denote frontiers marked in some distinct fashion. In the sense of frontiers, the term has been extended by modern historians. Thus the Wall of Hadrian in North England (*see* BRITAIN: *Roman*) is now sometimes styled the *Limes Britannicus,* and so forth. In particular the frontier lines which bounded the Roman provinces of upper (southern) Germany and Rhaetia, stretching from near Bonn on the Rhine to near Regensburg on the Danube, are called the *Limes Germanicus.* The history of these lines is the subject of the following paragraphs. They have become much better known through systematic excavations and other researches, and though many details are still doubtful, their general development can be traced.

From the death of Augustus (A.D. 14) till after A.D. 70, Rome accepted as her German frontier the water-boundary of the Rhine and upper Danube. Beyond these rivers she held only the fertile plain of Frankfürt, opposite the Roman border fortress of Moguntiacum (Mainz), the southernmost slopes of the Black Forest and a few scattered têtes-du-pont. The northern section of this frontier, where the Rhine is deep and broad, remained the Roman boundary until the empire fell. The southern part was different. The upper Rhine and upper Danube are easily crossed. The frontier which they form is inconveniently long, enclosing an acute-angled wedge of foreign territory—the modern Baden and Württemberg. Geographical convenience and movements of Roman subjects across the Rhine combined to urge a forward policy at Rome, and Vespasian began a series of advances which gradually closed up the acute angle, or at least rendered it obtuse.

The first advance came about A.D. 74, when what is now Baden was invaded and roads carried from the Roman bases on the upper Rhine, Strassburg (Argentoratum) and Windisch (Vindonissa) to Rottweil (Arae Fluviae). This road was subsequently extended to Cannstadt, meeting a road from Mainz, and was then probably extended to reach the Danube at Faimingen below Ulm. The point of the angle was broken off. The second advance was made by Domitian about A.D. 83. He pushed out from Moguntiacum, extended the Roman territory east of it, and enclosed the whole within a systematically defended frontier with numerous blockhouses along it and larger forts in the rear.

Among the blockhouses was one which by various enlargements grew into Saalburg fort, near Homburg. This advance necessitated a third movement, the construction of a frontier, connecting the annexations of A.D. 74 and 83. The line of this frontier ran from the Main to the upper waters of the Neckar, and was defended by a chain of forts. The whole was reorganized, probably by Hadrian, with a continuous wooden palisade reaching from the Rhine to the Danube. Either Hadrian or Pius marked out a new frontier roughly parallel to, but in advance of, these two lines.

This is the frontier which is now visible and visited by the curious. It consists of two distinct frontier works; one, known as



FROM H. F. PELHAM, "ESSAYS ON ROMAN HISTORY," BY PERMISSION OF THE CLARENDON PRESS

the Pfahlgraben (or "Pale"), is an earthen mound and ditch, best seen in the neighbourhood of the Saalburg, but which once extended from the Rhine southwards into southern Germany. The other, which begins where the earthwork stops, is a stone wall, though not very formidable, the Teufelsmauer ("Devil's Wall"); it runs roughly east and west parallel to the Danube, which it finally joins at Hienheim near Regensburg. The Pfahlgraben is extraordinarily direct in its southern part, which for more than 50 m. runs mathematically straight and points almost absolutely true to the Polar star. It is an ancient frontier laid out in American fashion. This frontier remained for about 100 years, and no doubt in that long period much was done to it. The exact date even of the Pfahlgraben and Teufelsmauer is uncertain. But the pressure of the barbarians began to be felt seriously in the latter part of the 2nd century A.D., and the whole or almost the whole district E. of the Rhine and N. of the Danube was lost about A.D. 250.

Bibliography.—The best English account is in H. F. Pelham's essay in *Trans. of the Royal Hist. Soc.*, vol. xx., reprinted in his *Essays on Roman History*, p. 179–211 (1911), where the German authorities are fully cited. *Cf.* J. E. Sandys, *Companion to Latin Studies* (1921).

LIMESTONE, in petrography, a rock consisting essentially of calcium carbonate ("carbonate of lime"). Many varieties are included within the group, some of which are very distinct, but all have certain properties in common, arising from the similar chemical composition, and mineralogical characters. All limestones, exclusive of dolomite (*q.v.*) dissolve readily in cold dilute acids, giving off bubbles of carbon dioxide. Even "weak" acids like citric or acetic acid will effect this change, though the mineral acids are more commonly employed. Limestones are readily scratched with a knife-blade or the edge of a coin, their hardness being 3; but unless they are earthy or incoherent, like chalk or calcareous sinter, they do not disintegrate by pressure with the fingers and cannot be scratched with the finger-nail. When free from impurities limestones are white, but they generally contain small quantities of minerals other than crystalline calcium carbonate which affect their colour. The presence of iron oxide or clay results in creamy, yellowish or brownish coloration; iron sulphide and carbonate, or carbonaceous and bituminous impurities, render limestones bluish, grey or black. Crystalline limestones or marbles, which in the process of metamorphism (*see* METAMORPHISM) have been mineralogically reconstituted under the action of heat or pressure, frequently contain minerals like epidote, chlorite, olivine, serpentine, garnet, spinel and augite of varying colours. The specific gravity of limestones ranges from 2·6 to 2·8 in typical examples.

In the field, limestones are usually recognizable by their characteristic method of weathering. Where reasonably pure, they may display solution-phenomena such as smooth, rounded surfaces, or may be covered with narrow runnels cut by rain. In such cases there is little soil, and plants and trees grow only in fissures where insoluble impurities from the limestone have collected. Thus in mountainous districts limestones tend to yield bare rocky ground (*e.g.,* the Karst) or country covered by scanty soil and short grass. The rain which falls on them sinks into the earth and passes underground. All waters in such regions tend to be hard on account of the abundant carbonate of lime dissolved during percolation. Thus caves, swallow-holes, sinks, pot-holes and underground rivers are formed. By redeposition of the carbonate of lime in underground caves stalactites, stalagmites and deposits of travertine, often beautifully tinted by impurities, are produced. The chalk downs are celebrated for their close green swards; surface-waters are often notably scarce, although the chalk in depth holds large supplies of water. Impure limestones such as those of the Cornbrash, Oolites and Lias contain enough impurities in the form of clay, sand and other mineral matter to yield thick soils of considerable agricultural value.

Most limestones are of organic origin, and are formed from the debris of the skeletons of animals. Off the coast of Florida a fine chalky deposit (drewite) is being laid down on the sea-bed, apparently as a result of the precipitating power of bacteria. Foraminifera, crinoids (sea-lilies), shells and corals build up considerable masses of limestone. Some bands of the chalk are largely composed of foraminifera such as *Globigerina.* Another notable foraminiferal limestone, that made by the disc-shaped *Nummulites,* is well developed in Mediterranean countries. From this rock the pyramids of Egypt were built.

Crinoidal limestones, although frequently found in the older rocks, such as the Carboniferous, are not now being formed on any scale, for these organisms are not abundant at the present day. The small cylindrical joints (or ossicles) of these organisms are easily recognized ("St. Cuthbert's beads") on the Northumbrian coast, washed out of the Carboniferous Limestone. Coral limestones are being formed over a large extent of the tropical seas. Ancient coral-reefs have been recognized in the older rocks of the earth's crust. They are usually composed of pure limestone (free from silt and sand), but may subsequently be altered to dolomite, as in the well-known region of the Tirol. Shelly limestones may consist of Mollusca or of Brachiopoda, the former occurring plentifully in Secondary and Tertiary rocks, but the latter in limestones of rather earlier age. The remains are often fragmentary, and the limestones may, like shore-sands to-day, consist of a mixture of comminuted shell-fragments and muddy, silty or even sandy material. Other organisms such as corallines (bryozoa), sea-urchins, starfishes, crustaceans and sponges contribute material to the formation of these rocks. Fresh-water limestones are composed usually of the shells of Mollusca (*e.g., Paludina* limestone) which inhabit lakes; they are often marly from an admixture of clay.

Consolidation and cementation are effected by finer calcareous material or subsequent crystallization of the carbonate of lime. Limestones are very susceptible to chemical changes and may be replaced by iron oxide or carbonate, yielding ores of great commercial value. They may be silicified and become cherts, often with the retention of their organic structures. On certain islands in the Pacific (Ocean I. etc.), they become phosphatized from the replacement of carbonate by the phosphates removed by percolating waters from guano. Such rock-phosphate is utilized for artificial fertilizers.

Limestones are used for a large variety of economic purposes. They are "burnt" for lime, or when argillaceous, hydraulic lime; when intimately mixed with sandy clay and burnt, they yield portland cement; in their purer forms they are widely used in the chemical, glass, soap-making and silicate industries; they serve as fluxes in the preparation of basic steel; and oolitic, dolomitic and ornamental limestones are utilized for building-stones, and less pure varieties for road-stones.

Dolomite-rock, also known as dolomitic or magnesian limestone, consists principally of the mineral dolomite, which is a carbonate of magnesium and calcium, but often contains admixture of other substances such as calcite, quartz, carbonates and oxides of iron, argillaceous material and chert or chalcedony. Dolomites when pure and well crystallized may be snowy white (*e.g.,* some examples from the eastern Alps) but are commonly yellow, creamy, brownish or grey from the presence of impurities. Dolomite dissolves only very slowly in dilute hydrochloric acid in the cold, but readily when the acid is warmed. Dolomites of compact structure have a higher specific gravity than limestones, but they often have a cavernous or drusy character, the walls of the hollows being lined with small crystals of dolomite having a pearly lustre and rounded faces. They are also slightly harder, and for this reason and on account of their greater resistance to weathering, they last better as building-, paving- and road-stones. Dolomites are rarely fossiliferous, as the process of dolomitization (which may be either pene-contemporaneous with, or subsequent to, the formation of the limestone) tends to destroy any organic remains originally present. Many dolomites, particularly those of Permian age in the north of England (Sunderland) show remarkable concretionary structures. The beds look as if made up of rounded balls of all sizes. These are composed of radiating calcite crystals. Dolomites furnish excellent building-stones, such, for example, as those of the north-east of England (Mansfield stone, etc.). Parts of the houses of parliament at Westminster are built of dolomite. Granular dolomite is also used, on account of its refractoriness to heat, for lining the hearths of furnaces in which basic steel is prepared. (P. G. H. B.)

LIMICOLAE, shore birds, known as suborder Charadrii, including jaçanas, snipe, oyster catchers, lapwings, plovers, woodcock, sandpipers, stilts, avocets, phalaropes, pratincoles and sheathbills (*qq.v.*). (G. F. Ss.)

LIMINA APOSTOLORUM, an ecclesiastical term used to denote Rome and especially the church of St. Peter and St. Paul. A *Visitatio Liminum* might be undertaken *ex voto* (in accordance with a vow) or *ex lege* (in accordance with a law). In 743 a Roman synod decreed that all bishops subject to the metropolitan see of Rome should meet personally every year in that city to give an account of the state of their dioceses. Gregory VII and Sixtus V greatly enlarged the number of bishops subject to this law; the latter, in a bull of 1584, ordering all bishops in the world to pay visits to Rome at stated intervals. Benedict XIV in 1740 extended the summons to all abbots, provosts and others who held territorial jurisdiction.

LIMING. Very early in the development of agriculture it was noted that the use of calcic materials, such as slaked lime [$Ca(OH)_2$], ground limestone ($CaCO_3$) and marl, not only increased crop yields in many instances, but also improved the physical condition of the soil. Liming has become a general agricultural practice, and the list of materials utilized includes, in addition to those named above, ground dolomite (a double carbonate of calcium and magnesium), ground oyster shells, furnace slags (mostly calcium silicates) and several other materials. In general, limestone and dolomite bring equal responses, but dolomite proves more effective in those regions where commercial fertilizers have been used extensively for decades. The role of calcium compounds in the soil is by no means a simple one, and, in spite of much research, all of its actions are not yet fully understood. It is known that certain plants will not grow in highly acidic soils. The addition of lime naturally decreases the acidity of such a soil, but inasmuch as the highly acidic condition of the soil is itself an indication of a calcium deficiency, the effect of liming is to supply needed calcium as well as to decrease the acidity.

When rocks and minerals weather to form a soil, such of the resultant products as are soluble in water containing dissolved carbon dioxide and bacteria-generated acids are either used by plants or lost by leaching. Where rainfall is sufficient, this process sooner or later develops a soil of relatively low calcium and magnesium content. The remaining bases are held chiefly in chemical combination with the clay. When the clay yields bases to plants or loses them through leaching, the soil becomes progressively acidic. The acidity is a symptom of calcium deficiency, and some of the micro-organisms favourable to plant growth, such as the nitrogen-fixing bacteria, do not function in a highly acidic soil environment.

In regions of moderate to high rainfall most soils are acidic, a fact expressed in technical parlance by saying that the *p*H of the soil is less than 7. The root sap of most agricultural plants is faintly acidic, the *p*H varying from 4 to 6. Legumes such as alfalfa and clover grow well in a soil of *p*H about 6.5 when calcium and the other necessary mineral elements are present, whereas some agricultural crops grow satisfactorily in somewhat more acidic soil. In general, a soil *p*H from 6 to 8, *i.e.*, from slightly acidic to slightly alkaline, is favourable for nearly all agricultural plants. All crops remove calcium from the soil, however, and liming is necessary to maintain the supply and thereby prevent the normal acidity of the soil from increasing beyond a desirable limit.

A soil should not be overlimed, for this will depress the availability of added phosphate and other plant nutrients, particularly potassium and magnesium and some of the minor nutrients such as boron, iron, zinc and manganese.

There is a decided calcium deficiency in nearly all agricultural areas of the United States where rainfall exceeds 30 in. annually. The use of liming materials, ground limestone in particular, is increasing rapidly in these areas. In the decade 1933–43, the use of liming materials increased in the United States about tenfold, from 1,670,000 tons to 17,885,000, largely because of grants-in-aid made to farmers by the Federal Agricultural Adjustment administration. The requirement is far greater than the amount applied even under the stimulus of federal aid. (H. A. Cs.)

LIMIT, a mathematical concept of great importance which has emerged slowly through long historical stages; it is best presented through an account of its origin and development. Among the ancients the method of exhaustion played the rôle which in more recent times has been taken by the method of limits; the former is ascribed to Eudoxus (*q.v.*) of Cnidus. It was frequently employed by Euclid (*q.v.*), and was further developed by Archimedes (*q.v.*). In one form it may be stated as follows: If from a magnitude more than half of it is taken away, and from the remainder more than half is taken, and from what then remains more than half is again taken, and if this process is continued, the magnitude remaining will ultimately become less than any magnitude which may have been pre-assigned. This principle is frequently employed in the *Elements* of Euclid for finding areas and volumes. To find the area of a circle, for instance, we may inscribe a regular polygon and find its area; then we may inscribe a larger regular polygon including the former and differing in area from the area of the circle by less than half the difference of area between the preceding polygon and the circle; we may then repeat the process indefinitely. According to the principle of exhaustion a polygon will thus be obtained whose area differs from that of the circle by less than any pre-assigned magnitude. Nowadays we say that the areas of these inscribed polygons approach the area of the circle as a limit in accordance with the following abstract definition of limit:

A variable x is said to approach a given constant a as a limit if the law of variation of x is such that the numerical value of the difference between x and a becomes and remains smaller than any (whatever) pre-assigned positive number.

In finding the area of a circle by the method just indicated the variable x has for its values the areas of the inscribed polygons while the constant a is the area of the circle. Here the variable x remains always less than its limit. If we should similarly find the area a of a circle by means of circumscribed polygons, then the corresponding variable x would always remain greater than its limit a. According to the definition in its general form x may vary in such a way as to be sometimes less than a and sometimes greater than a and indeed sometimes equal to a. What is essential is that it shall vary so that the numerical value of the difference between a and x shall become and shall remain less than any (whatever) positive number assigned in advance.

The method employed by Archimedes was more general than the simple method of exhaustion already described. It consisted in enclosing the magnitude to be evaluated between two others which can be brought by a definite process to differ by less than any pre-assigned magnitude. Thus in finding the area of a circle he employed regular inscribed and regular circumscribed polygons and showed that the number of sides could be taken large enough to render the difference in area between such an inscribed and such a circumscribed polygon less than any pre-assigned magnitude.

Arithmetical Theory of Limits.—The reduction of the idea of limit to the arithmetic form given in the foregoing formal definition is due to John Wallis (*q.v.*). His method, described in modern language, rests on the simultaneous consideration of a sequence, $a_1, a_2, a_3, \ldots$ of numbers arranged in order according to some law, and a number a such that the varying differences $a-a_n$ as n increases, become and remain smaller than any pre-assigned number whatever. The arithmetic character of the notion of limit was put in clearer light by Augustin Cauchy (*q.v.*) in his demonstration of the existence of definite integrals of continuous functions. Wallis always supposes essentially that the limit is known or that its existence is evident. In the work of Cauchy we have the clear conception of the existence of the limit as dependent upon certain properties of the numbers constituting the infinite set of values of the variable. In this connection the fundamental theorem for limits of sequences is the following:

In order that the sequence $a_1, a_2, a_3, \ldots$ shall have a limit it is necessary and sufficient that for each positive number ϵ there shall exist a positive integer n such that the difference a_m-a_n shall be numerically less than ϵ for every integer m greater than n.

The method of limits, in its arithmetical formulation, underlies the entire development of the infinitesimal calculus and has important applications in geometry and mechanics. The general principle of convergence to a limit, summed up in the general theorem just stated, provides a criterion for the existence of the limit of a sequence of numbers; and a considerable part of modern mathematical analysis is devoted to the problem of obtaining special forms of the general principle suited to particular classes of cases. The logical development of the theory depends essentially on the introduction of irrational numbers and cannot be carried through without a previous development of the theory of these numbers. (*See* NUMBER and NUMBER SEQUENCES.)

Typical Limiting Processes.—If u and v are variables approaching the limits a and b respectively and if c is a constant, then the variables cu, $u+v$, $u-v$, uv, u/v approach respectively the limits ca, $a+b$, $a-b$, ab, a/b, the last holding only when b is different from zero. These facts afford the rules for the elementary operations with limits. (*See* also SERIES.)

The proposition that x approaches the limit a is written in the symbolic form $\lim x=a$. If x approaches the limit a then a function $f(x)$ of x may approach a limit A; that is, as x varies according to its law of variation, the variation of $f(x)$ according to the induced law of variation may be such that the difference between $f(x)$ and A becomes and remains smaller than any assigned number. In that case we write

$$\lim_{x=a} f(x)=A$$

If x varies so as to become numerically larger than any pre-assigned number whatever, then x is said to become infinite. We write this statement symbolically in the form $\lim x=\infty$. It is not to be understood that there is a number infinity (∞) which x approaches; the symbol merely says that x becomes infinite in the sense of the definition as given. As x becomes infinite a function $f(x)$ of x may approach a limit A or it may become infinite; in these respective cases we write

$$\lim_{x=\infty} f(x)=A, \lim_{x=\infty} f(x)=\infty$$

Of course, as x approaches a limit or becomes infinite a given function may neither become infinite nor approach a limit. Thus if x approaches zero as a limit over all numbers near zero the function $\sin (1/x)$ does not approach a limit but oscillates between the bounds -1 and 1.

If $a_1, a_2, a_3, \ldots$ is a sequence of real numbers and if a number a exists such that for every positive number ϵ each of an infinite number of the elements $a_1, a_2, a_3, \ldots$ lies between $a-\epsilon$ and $a+\epsilon$ then a is said to be a value approached by the sequence. In this case a subsequence of the given sequence exists of such sort as to admit the limit a If there is a subsequence of positive numbers in the given sequence such that the elements of the subsequence become infinite then the given sequence is said to admit ∞ as a value approached; if a subsequence of negative numbers has this property then the given sequence is said to admit $-\infty$ as a value approached. The greatest value approached is called by Cauchy the greatest limit of the sequence; the least value approached is called the lowest limit of the sequence. If the greatest limit and the lowest limit are equal, then the variable has a limit in the sense of the earlier definition. In fact it may be shown that a necessary and sufficient condition that a sequence shall have a limit in the sense of the earlier definition is that it shall admit but one value approached.

See Hobson's *Theory of Functions of a Real Variable*, Cambridge University Press, vol. I. (3rd ed. 1927) and vol. II. (2nd ed. 1926). *See* also *Encyclopédie des Sciences Mathématiques*, tome I., vol. I., pp. 133–208. (R. D. CA.)

LIMITATION, STATUTES OF, the name given to Acts of parliament by which rights of action are limited in England, Wales and the north of Ireland to a fixed period after the occurrence of the events which give rise to the cause of action. This is one of the devices by which lapse of time is employed to settle disputed claims. The principle was first adopted in English law in connection with actions for the recovery of real property. At first a fixed date was taken, and no action could be brought of which the cause had arisen before that date. By the Statute of Westminster the First (3 Edward I. c. 39), the beginning of the reign of Richard I. was fixed as the date of limitation for such actions. Possession of rights in *alieno solo* from time immemorial was held to be an indefeasible title, and the courts held time immemorial to begin with the first year of Richard I.

A large number of statutes since that time have established periods of limitation for different kinds of actions. Of those now in force the most important are the Limitation Act 1623 for personal actions in general, and the Real Property Limitation Act 1833 relating to actions for the recovery of land. The latter statute has been much amended by the Real Property Limitations Act 1874.

By s. 14 of the Act of 1833, when any acknowledgment of the title of the person entitled has been given to him, the statute begins to run from that fact. By s. 15, persons under the disability of infancy, lunacy or coverture, or beyond seas, and their representatives, are to be allowed ten years from the termination of this disability, or death (which shall have first happened), notwithstanding that the ordinary period of limitation shall have expired.

By the Act of 1623 actions of trespass, detinue, trover, replevin or account, actions on the case (except for slander), actions of debt arising out of a simple contract and actions for arrears of rent not due upon specialty shall be limited to six years from the date of the cause of action. Actions for assault, menace, battery, wounds and imprisonment are limited to four years, and actions for slander to two years. Persons labouring under the disabilities of infancy, lunacy or unsoundness of mind are allowed the same time after the removal of the disability. When the defendant was "beyond seas" (*i.e.*, outside the United Kingdom and the adjacent islands) an extension of time was allowed, but by the Real Property Limitation Act of 1874 such an allowance is excluded as to real property, and as to other matters by the Mercantile Law Amendment Act 1856.

An acknowledgment, whether by payment on account or by mere spoken words, was formerly sufficient to take the case out of the statute. The Act 9 Geo. IV. c. 14 (Lord Tenterden's Act) requires any promise or admission of liability to be in writing and signed by the party to be charged, otherwise it will not bar the statute.

Contracts under seal are governed as to limitation by the Act of 1883, which provides that actions for rent upon any indenture of demise, or of covenant, or debt or any bond or other specialty, and on recognizances, must be brought within 20 years after cause of action. Actions of debt on an award (the submission being not under seal), or for a copyhold fine, or for money levied on a writ of *fieri facias*, must be brought within six years. With regard to the rights of the Crown, the principle obtains that *nullum tempus occurrit regi*, so that no statute of limitation affects the Crown without express mention. But by the Crown Suits Act 1769, as amended by the Crown Suits Act 1861, in suits relating to land, the claims of the Crown to recover are barred after the lapse of 60 years. For the prosecution of criminal offences generally there is no period of limitation, except where they are punishable on summary conviction. In such case the period is six months by the Summary Jurisdiction Act 1848. Suits and indictments under penal statutes are limited to two years if the forfeiture is to the Crown, to one year if the forfeiture is to the common informer. Penal actions by persons aggrieved are limited to two years by the Act of 1833. Prosecutions under the Riot Act can only be sued upon within 12 months after the offence, and offences against the Customs Acts within three years. By the Public Authorities Protection Act, 1893, a prosecution against any person acting in execution of statutory or other public duty must be commenced within six months.

Trustees are expressly empowered to plead statutes of limitation by the Trustees Act 1888. For further information *see* the Crown Suits Acts 1769 and 1861, Summary Jurisdiction Acts 1848 and 1925, the Riot Act, the Customs Acts, the Public Authorities Protection Act 1893, the Criminal Law Amendment Acts 1885 and 1922, and the Trustees Act 1888. (*See* PRESCRIPTION, LACHES.)

As regards the application and adoption of the English statutes in the colonies, *see* W. Burge, *Commentaries on Colonial and Foreign Laws* (new ed., 1907–27), vol. iv., pt. ii.

United States.—The various States possess their own statutes of limitation which are modelled in the main upon the English statutes but differ widely in their minor details. Real actions are usually not barred for twenty years, whereas personal actions survive only for six years. Numerous distinctions exist with reference to personal actions, a distinction generally being drawn between actions sounding in contract and those sounding in tort, the latter having a shorter *period* ranging from two to six years. About half the States have copied the provisions of the English statute of 1833 known as Lord Tenterden's Act requiring any promise or acknowledgment of liability to be in writing in order to revive a debt barred by the period of limitation. Separate statutes prescribe varying periods of limitation for the prosecution of criminal offenses. A difference of opinion exists in the State courts as to whether the statute of limitations must be specially pleaded in order to be available as a defense. A few States take judicial notice of the running of the period but most States insist that the defendant must expressly claim the benefit of the statute.

LIMOGES, a town of west-central France, capital of the department of Haute-Vienne, formerly capital of the old province of Limousin, 176 m. S. by W. of Orléans on the railway to Toulouse and a junction for Poitiers, Angoulême, Périgueux and Clermont Ferrand. Pop. (1936) 91,375.

Limoges sent a large force to the defense of Alesia. In 11 B.C. it took the name of Augustus (*Augustoritum*); but in the 4th century it was called anew by the name of the *Lemovices*, whose capital it was. It then contained palaces and baths, had its own senate and the right of coinage. Christianity was introduced by St. Martial. From the 5th century onwards Limoges suffered greatly through wars. Under the Merovingians Limoges was celebrated for its mints and its goldsmiths' work. In the middle ages and until 1792 the town was divided into two distinct parts, each surrounded by walls. The Château, which grew up around the tomb of St. Martial in the 9th century, and was surrounded with walls in the 10th and again in the 12th, was under the jurisdiction of the viscounts of Limoges, and contained their castle and the monastery of St. Martial; the *Cité,* under the jurisdiction of the bishop, had but a sparse population, the habitable ground being practically covered by the cathedral, the episcopal palace and other churches and religious buildings. In the Hundred Years' War the bishops sided with the French, while the viscounts were unwilling vassals of the English. In 1370 the *Cité,* which had opened its gates to the French, was taken by the Black Prince and given over to fire and sword. The religious wars, pestilence and famine desolated Limoges in turn but Henri d'Aguesseau and Turgot helped it to recover. Limoges celebrates every seven years the Fête d'Ostension during which the relics of St. Martial are exposed for seven weeks, attracting large numbers of visitors. It dates from the 10th century, and commemorates a pestilence believed to have been stayed by the saint.

The town, on a hill on the right bank of the Vienne, comprises two parts originally distinct, the *Cité* with narrow streets and old houses occupying the lower slope, and the town proper the summit. In the latter a street known as the Rue de la Boucherie is occupied by a powerful and ancient corporation of butchers. Boulevards have replaced the ramparts, outside which are suburbs with wide streets and spacious squares. The cathedral was begun in 1273, in 1327 the choir was completed, and before the middle of the 16th century the transept, with its fine north portal and the first two bays of the nave; from 1875 to 1890 the construction of the nave was continued, and it was united with the west tower (203 ft. high) the base of which belongs to a previous Romanesque church. In the interior there is a magnificent rood loft of the Renaissance. St. Michel des Lions (14th and 15th centuries) and St. Pierre des Queyroix (12th and 13th centuries) contain interesting stained glass. An old basilica of St. Martial was pulled down after 1794. The Vienne is crossed by a railway viaduct and four bridges, two of which, the Pont St. Étienne and the Pont St. Martial, date from the 13th century. The museum includes a rich ceramic collection.

Limoges is the headquarters of the XXII army corps and the seat of a bishop, a prefect, a court of appeal and a court of assizes, and has tribunals of first instance and of commerce, a board of trade, arbitrators and a chamber of commerce. The educational institutions include a national school of decorative art. The chief industry is that of making and decorating porcelain, others are enamelling, a mediaeval industry revived at the end of the 19th century, the making of shoes and clogs and skin gloves, cloth weaving, straw paper making and printing. The Vienne is navigable for rafts above Limoges, and the logs brought down by the current are stopped at the entrance of the town by the inhabitants of the Naveix quarter, who form a special gild for this purpose.

LIMÓN or **PUERTO LIMÓN,** principal Caribbean port of Costa Rica, capital of the Province of Limón and shipping point of the leading banana plantations of the country. Pop. (1941) est. at 9,320. Limón is the eastern terminus of the Costa Rica railway, one of the first railways built on the Caribbean, and was the shipping point by mule and ox-cart of rails, a locomotive and cars, to San José, for the concession provided that the railway be built out from San José, in the mountains, and not merely up from the sea. This railway (103 mi. long) is now the chief route of travel to and from San José and carries millions of bunches of bananas yearly from the surrounding plantations to Port Limón. The town has a deep-water pier, with cranes and mechanical loading devices, and the banana ships are loaded at the dock. Limón is a port of call for liners from Europe and the United States, and is on the route of travel from the Panama Canal Zone to San José, which, as it is the nearest highland city to the canal, is a popular vacation resort. The United Fruit Company has large storehouses and administrative offices in Limón, and the chief business of the town is importing and exporting, the chief items of export being bananas and coffee.

LIMONITE or BROWN IRON-ORE, a natural ferric hydrate named from the Gr. λειμών (meadow), in allusion to its occurrence as *bog-ore* in meadows and marshes. It is never crystallized, occurring in earthy or compact masses which are sometimes mammillated, botryoidal, reniform or stalactitic and may have a fibrous internal structure. Its hardness is about 5, and its specific gravity varies from 3·5 to 4. The colour is yellow to brown. Limonite gives a brown streak, which distinguishes it from haematite with a red, and from magnetite with a black, streak. In many cases it has been formed by the alteration of other iron minerals; *e.g.,* by hydration from haematite or magnetite, or by oxidation and hydration from siderite or pyrites. It has been commonly assumed that a series of hydrates of ferric oxide exist in nature, some of which have received specific names —*turgite, limonite, xanthosiderite, limnite;* but recent researches by Posnjak and Merwin (*Amer. Jour. of Sc.,* 1919, p. 311), have shown that there is no foundation for this assumption, there being only one true hydrate, namely, ferric oxide monohydrate, $Fe_2O_3{\cdot}H_2O$. It occurs in two polymorphs as the minerals, goethite (*q.v.*) and lepidocrocite and in an amorphous condition as limonite. The latter mineral contains a variable quantity of absorbed and capillary water. The so-called turgite, which has less water than the monohydrate, appears to represent a solid solution of goethite with haematite, together with enclosed and absorbed water. (*See* also IRON: *Compounds of Iron.*) Limonite abounds at Salisbury and Kent, Conn., in Berkshire county, Mass., and in Vermont, Pennsylvania, Alabama, Ohio, etc., and is a common ore in many European countries. (F. H. HA.)

LIMOUSIN (or LIMOSIN), **LÉONARD** (*c.* 1505–*c.* 1577), French painter, the most famous of a family of seven Limoges enamel painters, was the son of a Limoges innkeeper. He was at the beginning of his career influenced by the German school—indeed, his earliest authenticated work, signed L. L. and dated 1532, is a series of eighteen plaques of the "Passion of the Lord," after Albrecht Dürer, but this influence was counterbalanced by that of the Italian masters of the school of Fontainebleau, Primaticcio, Rosso, Giulio Romano and Solario, from whom he acquired his taste for arabesque ornament and for mythological subjects. Nevertheless the French tradition was sufficiently ingrained in him to save him from becoming an imitator and from losing his personal style. In 1530 he entered the service of Francis I. as painter and *varlet de chambre,* a position which he retained under Henry II. For both these monarchs he executed many portraits in enamel—among them plaques depicting Diane de Poitiers in various characters,—plates, vases, ewers, and cups, besides decorative works for the royal palaces, for, though he is best known as an enameller distinguished for rich colour, and for graceful designs in grisaille on black or bright blue backgrounds, he also enjoyed a great reputation as an oil-painter. His last signed works bear the date 1574, but the date of his death is uncertain, though it could not have been later than the beginning of 1577. It is on record that he executed close upon two thousand enamels. He is best represented at the Louvre, which owns his two famous votive tablets for the Sainte Chapelle, each consisting of twenty-three plaques, signed L. L. and dated 1553; and many portraits. Other representative examples are at the Cluny and Limoges museums, and in the London collections.

See *Léonard Limousin: peintre de portraits* (*L'Oeuvre des peintres émailleurs*), by L. Boudery and E. Lachenaud (Paris, 1897)—with a catalogue of the known existing examples of the artist's work. *See* also Alleame and Duplessis, *Les Douze Apôtres—émaux de Léonard Limousin,* etc. (Paris, 1865); L. Boudery, *Exposition retrospective de Limoges en 1886* (Limoges, 1886), *Léonard Limousin et son oeuvre* (Limoges, 1895), *Limoges et le Limousin* (Limoges, 1865); A. Meyer, *L'Art de l'émail de Limoges, ancien et modern* (Paris, 1896); Émile Molinier, *L'Émaillerie* (Paris, 1891).

LIMOUSIN, a former province of France. In the time of Julius Caesar the *pagus Lemovicinus* covered the county now comprised in the departments of Haute-Vienne, Corrèze and Creuse, with the *arrondissements* of Confolens in Charente and Nontron in Dordogne. These limits it retained until the 10th century, and they survived in those of the diocese of Limoges (except a small part cut off in 1317 to form that of Tulle) until 1790. The break-up into great fiefs in the 10th century, however, tended rapidly to disintegrate the province, until at the close of the 12th century Limousin embraced only the viscounties of Limoges, Turenne and Comborn, with a few ecclesiastical lordships, corresponding roughly to the present *arrondissements* of Limoges and Saint Yrien in Haute-Vienne and part of the *arrondissements* of Brive, Tulle and Ussel in Corrèze. In the 17th century Limousin, thus constituted, had become no more than a small *gouvernement*.

Limousin takes its name from the *Lemovices*, a Gallic tribe whose country was included by Augustus in the province of *Aquitania Magna*. Politically it shared in general the vicissitudes of Aquitaine, whose dukes were its over-lords from 918 until 1264, after which it was sometimes under them, sometimes under the counts of Poitiers, until the French kings succeeded in asserting their direct over-lordship. It was, however, until the 14th century, the centre of a civilization of which the enamelling industry (*see* ENAMEL) was only one expression. The Limousin dialect, now a mere *patois*, was regarded by the troubadours as the purest form of Provencal.

LIMPKIN, a single species of big, brown, rail-like bird of the Americas, constituting the family Aramidae, closely related to the crane (*q.v.*). This bird (*Aramus scolopaceus*), 28 in., called courlan or crying bird from its loud, prolonged, wailing cry, and limpkin from its peculiar halting gait as it hunts along the ground, ranges lowlands from eastern Argentina north to southern Mexico, Puerto Rico and Hispaniola, one race (*A. s. pictus*) resident in interior of the Florida peninsula and southern Georgia (Okefinokee swamp). It is found along borders of wooded streams, bayous, sloughs or in open marshes, sometimes uplands, where it runs rail-like through tangle with long strides, flies with short concave wings slowly flapping, neck extended, legs dangling or perches heronlike on a small tree. It feeds on mollusks, crustaceans, aquatic insects, frogs, worms, in the Everglades largely on large greenish fresh-water snails (*Ampullaria*) carried to nest or favourite feeding perch, held firmly in one foot, and struck several powerful blows with the 4-in. bill, which is then forced into the spiral opening of the shell to pull out the animal. The bulky nest is of leaves, twigs and Spanish moss, in tall sawgrass or among vines in bush or low tree over or near water; the eggs, four to six, rarely eight, are buff splashed with browns and drabs.

(G. F. Ss.)

LIMPOPO or Crocodile, a river of S.E. Africa more than 1,000 mi. in length, next to the Zambezi the largest river of Africa entering the Indian ocean. Its head streams rise on the northern slopes of the Witwatersrand less than 300 mi. due W. of the sea, but the river makes a great semicircular sweep across the high plateau. For a great part of its course the Limpopo forms the north-west and north frontiers of the Transvaal. Its banks are well wooded and present many picturesque views. In descending the escarpment of the plateau the river passes through rocky ravines, piercing the Zoutpansberg near the northeast corner of the Transvaal at the Toli Azimé falls. In the low country it receives on the right bank its chief affluent, the Olifants river (450 mi. long), which shares with the main river the distinction of having cut back across the eastern escarpment, and of draining parts of the interior plateau. The Limpopo enters the ocean in 25° 15′ S. The mouth, about 1,000 ft. wide, is obstructed by sand banks. In the rainy season the Limpopo loses a good deal of its water in the swampy region along its lower course. High-water level is 24 ft. above low-water level, when the depth in the shallowest part does not exceed 3 ft. The river is navigable all the year round by shallow-draught vessels from its mouth for about 100 mi. to a spot known as Gungunyana's Ford. In flood time there is water communication south with the river Komati (*q.v.*). At this season stretches of the Limpopo above Gungunyana's Ford are navigable. The river valley is generally unhealthy.

The basin of the Limpopo includes the northern part of the Transvaal, the eastern portion of Bechuanaland, southern Matabeleland and a large area of Portuguese territory north of Delagoa bay. Its chief tributary, the Olifants, has been mentioned. Of its many other affluents, the Macloutsie, the Shashi and the Tuli are the most distant northwest feeders. Among the streams which, flowing north through the Transvaal, join the Limpopo is the Nylstroom, so named by Boers trekking from the south in the belief that they had reached the river Nile. In the coast region the river has one considerable affluent from the north, the Chengane, which is navigable for some distance.

The Limpopo is a river of many names. In its upper course called the Crocodile, that name is also applied to the whole river. Though claiming the territory through which it ran the Portuguese made no attempt to trace the river. This was first done by Captain J. F. Elton, who in 1870 travelling from the Tati goldfields sought to open a road to the sea via the Limpopo. He voyaged down the river from the Shashi confluence to the Toli Azimé falls, which he discovered, following the stream thence on foot to the low country. The lower course of the river had been explored 1868–69 by another British traveller—St. Vincent Whitshed Erskine.

LINACEAE, the flax family, comprising 22 genera and 320 species, mostly herbs and shrubs. The only important genus of this family of dicotyledons is *Linum*. (*See* FLAX; LINSEED.) For a consideration of the genera *see* H. Winkler, "Linaceae," Engler and Prantl, *Die Natürlichen Pflanzenfamilien* 19a:82–130, fig. 43–59 (1931).

LINACRE (or LYNAKER), **THOMAS** (*c.* 1460–1524), English humanist and physician, was probably born at Canterbury. He attended the cathedral school of Canterbury, then under the direction of William Celling (William Tilly of Selling), one of the earliest Greek scholars in England. Linacre entered Oxford about the year 1480, and in 1484 was elected a fellow of All Souls' college. Shortly afterward he visited Italy in the train of Celling, who was sent by Henry VII as an envoy to the papal court, and he accompanied his patron as far as Bologna. There he became the pupil of Angelo Poliziano, and afterward shared the instruction which that great scholar imparted at Florence to the sons of Lorenzo de' Medici. The younger of these princes became Pope Leo X, and was in after years mindful of his old companionship with Linacre. Among his other teachers and friends in Italy were Demetrius Chalcondyles, Hermolaus Barbarus, Aldus Romanus the printer, of Venice, and Nicolaus Leonicenus of Vicenza. Linacre took the degree of doctor of medicine with great distinction at Padua. On his return to Oxford he formed one of the brilliant circle of Oxford scholars.

Linacre does not appear to have practised or taught medicine in Oxford. About the year 1501 he was called to court as tutor of the young prince Arthur. On the accession of Henry VIII he was appointed the king's physician, and practised medicine in London, having among his patients most of the great statesmen and prelates of the time, as Cardinal Wolsey, Archbishop Warham and Bishop Fox. In 1520 he received priest's orders, though he had for some years previously held several clerical benefices. There is no doubt that his ordination was connected with his retirement from active life. Literary labours, and the cares of the foundation which owed its existence chiefly to him—the Royal College of Physicians—occupied Linacre's remaining years until his death on Oct. 20, 1524.

Linacre was more of a scholar than a man of letters, and rather a man of learning than a scientific investigator. He was one of the first Englishmen who studied Greek in Italy, whence he brought back to his native country and his own university the lessons of the "New Learning." Among his pupils was one—Erasmus—and others of note in letters and politics, such as Sir Thomas More, Prince Arthur and Queen Mary. Colet, Grocyn, William Lilye and other eminent scholars were his intimate friends.

Linacre wrote a Latin grammar (*Progymnasmata Grammatices vulgaria*), composed in English, a revised version of which was made for the use of the Princess Mary, and afterward translated into Latin by Robert Buchanan; and a work on Latin composition *De emendata structura Latini sermonis* (1524). His only medical works were his translations. None of his translations of Aristotle has survived. The following are the works of Galen translated by Linacre: (1) *De sanitate tuenda,* printed at Paris in 1517; (2) *Methodus medendi* (Paris, 1519); (3) *De temperamentis et de Inaequali Intemperie* (Cambridge, 1521); (4) *De naturalibus* *facultatibus* (London, 1523); (5) *De symptomatum differentiis et causis* (London, 1524); (6) *De pulsuum Usu* (London, without date). Linacre also translated, for Prince Arthur, an astronomical treatise of Proclus, *De sphaera,* which was printed at Venice by Aldus in 1499. The accuracy of these translations and their elegance of style were universally admitted. They have been generally accepted as the standard versions of those parts of Galen's writings, and frequently reprinted, either as a part of the collected works or separately.

The foundation by royal charter of the College of Physicians in London was mainly due to Linacre, and he was the first president of the new college, which he further aided by conveying to it his own house, and by the gift of his library. Shortly before his death Linacre obtained from the king letters patent for the establishment of readerships in medicine at Oxford and Cambridge, and placed valuable estates in the hands of trustees for their endowment. Two readerships were founded in Merton College, Oxford, and one in St. John's College, Cambridge. The Oxford foundation was revived by the university commissioners in 1856 in the form of the Linacre professorship of anatomy.

The materials for Linacre's biography are to a large extent contained in the older biographical collections of George Lilly (in Paulus Jovius, *Descriptio Britanniae*), Bale, Leland and Pits, in Wood's *Athenae Oxonienses* and in the *Biographia Britannica;* but all are completely collected in the *Life of Thomas Linacre,* by Dr. Noble Johnson (1835). Reference may also be made to Dr. Munk's *Roll of the Royal College of Physicians* (2nd ed., 1878); and the Introduction, by Dr. J. F. Payne, to a facsimile reproduction of Linacre's version of *Galen de temperamentis* (Cambridge, 1881).

LINARES, an inland province of central Chile, bounded north by Talca, east by Argentina, south by Ñuble and west by Maule. Pop. (1940) 134,968; area 3,791 sq.mi. The river Maule forms its northern boundary and drains its northern and northeastern regions. The province belongs partly to the great central valley of Chile and partly to the western slopes of the Andes, the S. Pedro volcano rising to a height of 11,800 ft. not far from the sources of the Maule. The northern part is fertile, as are the valleys of the Andean foothills, but arid conditions prevail throughout the central districts, and irrigation is necessary for the production of crops. The vine is cultivated to some extent, and good pasturage is found on the Andean slopes. The province is traversed from north to south by the Chilean Central railway, and the river Maule gives access to the small port of Constitución, at its mouth. From Parral, near the southern boundary, a branch railway extends westward to Cauquenes.

LINARES, a town of southern Spain, in the province of Jaén, among the southern foothills of the Sierra Morena, 1,375 ft. above sea-level and 3 mi. N.W. of Guadalimar river. Pop. (1940) 31,720 (mun., 47,562). It is connected by four branch railways with the argentiferous lead mines on the north-west, and with the main railways from Madrid to Seville, Granada and the principal ports on the south coast. Its population is chiefly engaged in the lead mines, and in the manufacture of powder, dynamite, match for blasting purposes, rope and the like. The mining plant is entirely imported, and smelting, desilverizing and the manufacture of lead sheets, pipes, etc., are carried on. Linares lead is unsurpassed in quality. About 2 mi. S. is the village of Cazlona, with remains of the ancient *Castulo.* Linares remained in government hands until shortly before the close of the civil war of 1936–39.

LINCOLN, EARLS OF. The first earl of Lincoln was probably William de Roumare (*c.* 1095–*c.* 1155), who was created earl about 1140. King Stephen granted the earldom to one of his supporters, Gilbert de Gand (d. 1156), who was related to the former earl. After Gilbert's death the earldom was dormant for about 60 years; then in 1216 it was given to another Gilbert de Gand, and later it was claimed by the great earl of Chester, Ranulf or Randulph, de Blundevill (d. 1232). From Ranulf the title to the earldom passed through his sister Hawise to the family of Lacy, John de Lacy (d. 1240) being made earl of Lincoln in 1232. He was son of Roger de Lacy (d. 1212), justiciar of England and constable of Chester. It was held by the Lacys until the death of Henry, the 3rd earl.

Henry served Edward I. in Wales, France and Scotland, both as a soldier and a diplomatist. He succeeded (1296) Edmund, earl of Lancaster, as commander of the English forces in Gascony. He fought at Falkirk in July 1298. He was then employed by Edward to negotiate successively with popes Boniface VIII. and Clement V., and also with Philip IV. of France; and was present at the death of the English king in July 1307. Under Edward II. he joined Earl Thomas of Lancaster and the baronial party, was one of the "ordainers" appointed in 1310 and was regent of the kingdom during the king's absence in Scotland in the same year. He died in London on Feb. 5, 1311, and was buried in St. Paul's cathedral. He married Margaret (d. 1309), granddaughter and heiress of William Longsword, 2nd earl of Salisbury, and his only surviving child, Alice (1283–1348), became the wife of Thomas, earl of Lancaster, who thus inherited his father-in-law's earldoms of Lincoln and Salisbury. Lincoln's Inn in London gets its name from the earl, whose London residence occupied this site. He founded Whalley abbey in Lancashire, and built Denbigh castle.

In 1349 Henry Plantagenet, earl (afterwards duke) of Lancaster, a nephew of Earl Thomas, was created earl of Lincoln; and when his grandson Henry became king of England as Henry IV. in 1399 the title merged in the crown. In 1467 John de la Pole (*c.* 1464–87), a nephew of Edward IV., was made earl of Lincoln, and the same dignity was conferred in 1525 upon Henry Brandon (1516–45), son of Charles Brandon, duke of Suffolk. Both died without sons, and the next family to hold the earldom was that of Clinton. Edward Fiennes Clinton, 9th Lord Clinton (1512–85), lord high admiral and the husband of Henry VIII.'s mistress, Elizabeth Blount, was created earl of Lincoln in 1572. The title is still held by Clinton's descendants. In 1768 Henry Clinton, the 9th earl (1720–94), succeeded his uncle Thomas Pelham as 2nd duke of Newcastle-under-Lyne, and since this date the title of earl of Lincoln has been the courtesy title of the eldest son of the duke of Newcastle.

See G. E. C(okayne), *Complete Peerage,* vol. v. (1893).

LINCOLN, ABRAHAM (1809–1865), sixteenth president of the United States, was born on Feb. 12, 1809, on a farm in Kentucky. In early childhood he was moved to another farm "in the valley (of Knob creek) surrounded," in his own words, "by high hills and deep gorges"; a rocky unfruitful soil where the furious washing of a "big rain in the hills" would sometimes sweep new planting "clear off the field." Here, in virtually peasant conditions, his childhood was spent.

The paternal descent, though unknown to him beyond the third generation back, has been traced by enthusiastic genealogists to a lost or strayed member of a distinguished New England family of the same name. On his mother's side he was descended from an east Virginia family of the name of Hanks who were of humble station. His grandmother, Lucy Hanks, migrated with her parents in 1782 to the Virginia mountains. There soon afterward she had a natural child, Nancy Hanks, who eventually removed to Kentucky and married in 1806 Thomas Lincoln. Their second child but first son was Abraham Lincoln. Nothing is known of the father of Nancy Hanks, though there is a persistent tradition that he was a Virginia aristocrat. Nancy's famous son appears to have believed this story and to have felt that whatever distinction he possessed had come to him from this unacknowledged heritage of aristocracy. Lincoln's parents have become the subject of sentimental controversy to such a degree that it is hard to remove the clouds of myth surrounding them and uncover the actual humanity which their son inherited. It seems tolerably certain that the father, Thomas, was a shiftless person who tried this and that, both carpentering and farming, who had something of the vagabond in his blood, also something of the dreamer, and was always at heart a rolling stone. Besides shifting from farm to farm in Kentucky he subsequently took his family far afield, settling in Indiana when Abraham was eight years old, and moving on to Illinois when his son was 21. Nancy Hanks is even more shadowy. Though enthusiasts talk of her as "a forest madonna," it is impossible to say what they mean. It may be believed that she was good-looking, sensitive, pious, with an air about her that seemed to bespeak a different social world from the one in which she moved. She also seems to have been something of a dreamer. Many, if not all, frontier women of the old days were that. Their lives were hard, their emotions in the main were sealed up, but all around them was the mystery of the primitive forest; they treasured it in silence and gave vent to it only now and then in the ecstasies of religious revival. It is not fanciful to perceive in Abraham Lincoln all the characteristics of these two nor to believe that during much of his life they were appearing and disappearing in a way that is sometimes bewildering and that not until late in life were they blended coherently.

In 1816 Thomas Lincoln insisted on taking to the road. Tradition has it that Nancy was loath to go, that she was oppressed by a sense of unhappiness. The winter of 1816–17 was spent by the Lincolns in a "half-faced camp"—that is, a cabin with but three walls, the fourth side being entirely open—on land for which Thomas had contracted in the valley of Pigeon Creek in southern Indiana. His son remembered long afterward that their settlement was "in an unbroken forest" and that, young as he was, "an ax was put into his hands" at once, and that all of them accepted as their chief task the clearing of the wood. A cheerless life ensued—"pretty pinching times," he says. After two years of dreary struggle, Nancy Lincoln broke down and was carried off by an epidemic which swept the country-side in the autumn of 1818. The pathetic note that somehow is present always in her story closes with a glimpse of her husband returning to his former trade as a carpenter and fashioning her coffin out of green lumber.

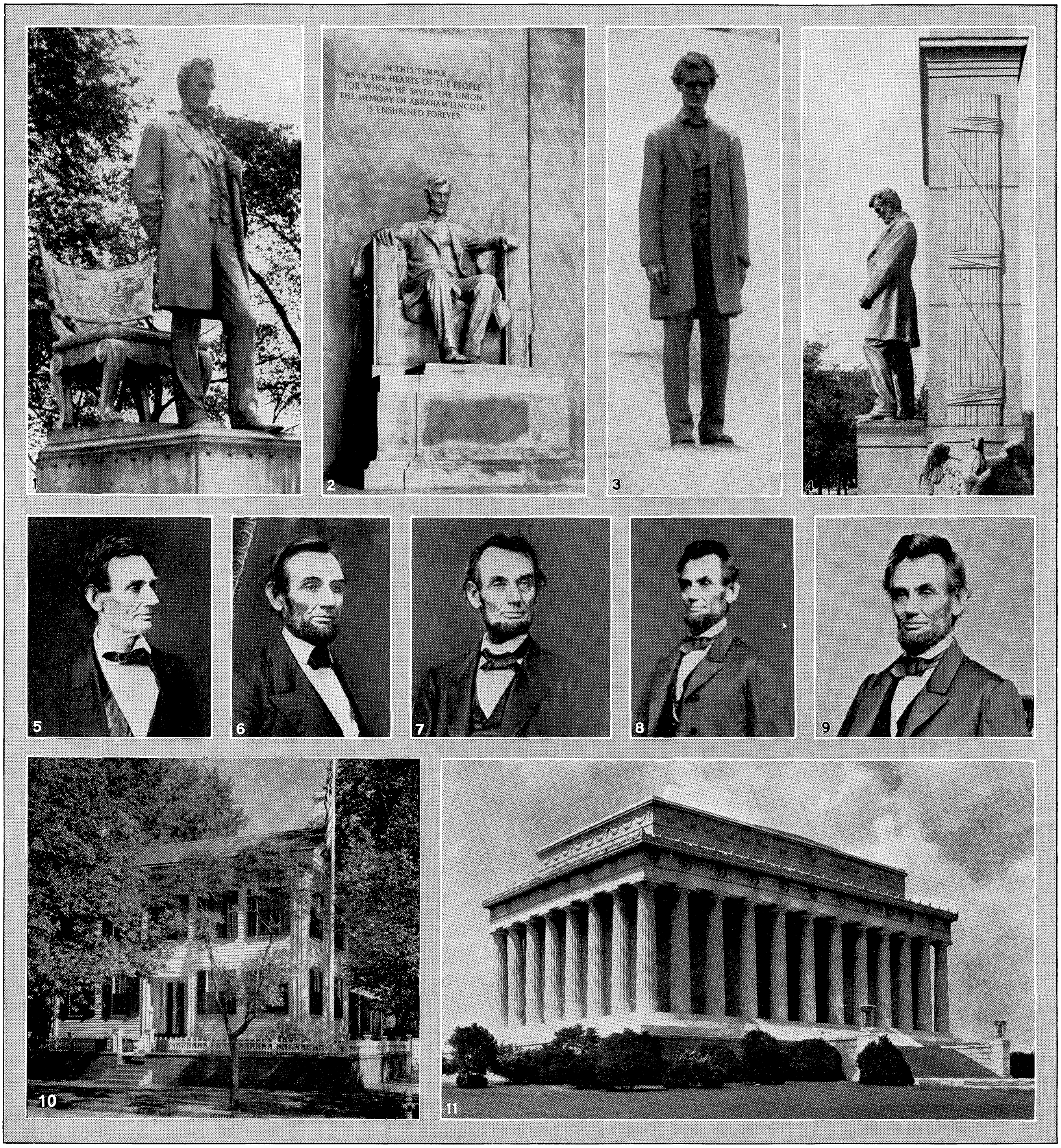
Lincoln's home was in Indiana from his eighth year until shortly after his twenty-first birthday. During this period his father married secondly a Kentucky widow, Sarah Bush Johnson. In his stepmother, Lincoln found a kind, practical, understanding friend. To her, doubtless, may be traced an increase of general comfort in the family's way of living. Nevertheless, they continued to be poor people in a poor community. Thomas Lincoln never rose above the estate of a peasant farmer. Abraham had less than a year's schooling. Such as he had was mainly in Indiana, though a very little elementary schooling had been given him in Kentucky. None of it went beyond "readin', writin' and cipherin'." Although, in his own words, "there was absolutely nothing to excite ambition for education" he had an innate hunger for it and would lie before the fire at night doing sums with a piece of wood for a slate. A few books which early came his way were eagerly devoured. *Pilgrim's Progress, Aesop, Robinson Crusoe,* Weem's *Life of Washington* and Franklin's *Autobiography* were the earliest foundations of that sense of style which later was one of his characteristics.

He was a good-humoured, rather idle, imaginative boy who appears to have been a general favourite. Unlike the typical frontiersman he never became a hunter, never pulled a trigger on anything larger than a wild turkey. "I was raised to farm work," he writes. Even as a boy he exhibited a faculty for story-telling, could make jingling rhymes on occasion and was a droll mimic. His easy-going camaraderie informs an oft-repeated anecdote. In spelling class a little girl hesitated between "i" and "y"; Lincoln slyly put his finger on his own eye. About the same time occurred his first experiment with imagination. A party of travellers stopped briefly at his father's house while their wagon was being mended. Among them was a little girl who took the boy's fancy. After she had gone he wove out of the memory an elaborate romance in which he was the hero of an elopement and she the heroine. Talking long after of this boyish dreaming he said, "I think it was the beginning of love for me." Of his real experiences the first that opened up the world beyond Pigeon Creek occurred when he was 19. This raw farm-hand was engaged as "hired man merely" to go down to New Orleans on a flat-boat. The strange old semi-Spanish city even as late as 1828 was a striking, exotic place unlike anything else in the United States. The strength of the imaginative faculty in Lincoln is attested by much evidence both direct and indirect. Who can doubt that New Orleans was as wonderful to him as the *Arabian Nights?* And yet with singular reticence he has left no record of his impressions. Reticence, degenerating at times into secretiveness, is one of his fixed characteristics. A second journey to New Orleans three years later is also without the slightest explanatory comment either in his letters or his table talk.

Between these two journeys, the Lincoln family with several of their "in-laws" formed a small migration to Illinois (March 1830). The women went in a wagon drawn by oxen. The men walked. Abraham was the ox-driver during much of the journey. By this time he was a very tall young man, six feet three or four, raw-boned, lanky, but possessed of immense physical strength. He was noted for the skill and power with which he could wield an axe. During his first autumn in Illinois he made use of his skill as an axe-man splitting fence rails. A contract to split three thousand rails was not filled until late in the following winter. At this time he was casting about for other employment. His father was comfortably settled on a new farm, but the son had had enough of farming. Presently, he fell in with a trader, Denton Offcutt, who engaged him for that second trip to New Orleans already mentioned. A good deal of legend has grown up about this journey. Most of it may be discarded. It seems likely, however, that he saw more of slavery than on the previous journey and that what he saw shocked him. But the evidence is irregular.

First Essay in Politics.—One result of this journey was the employment of Lincoln as clerk in a general store which Offcutt decided to open in the village of New Salem, Ill. During six years (1831–37) Lincoln counted himself a resident of New Salem. It was a forlorn village, one of those accidental congestions of population that often appeared on the frontier with no true reason for their existence and that eventually melted off the map. There was a mill, a tavern, a few stores and a handful of people. The Offcutt store proved a failure. Offcutt left town and Lincoln was without employment. He turned to politics. This move had been made possible by events that reveal two more of his fundamental characteristics. New Salem contained a group of young roughs known as the Clary Grove Boys, who were eager to try the mettle of any new-comer in the town. A wrestling match was arranged between their best man and Lincoln in which the unexpected happened, the local hero was overthrown. The astonishing part of the episode was the promptness with which Lincoln, while not displacing their leader in their estimation, won over both him and them, with the result that they formed the nucleus of a devoted personal following. A peculiar power to attract men, joined with complete ability to remain himself, becomes hereafter characteristic of all he does. The secret appears to lie in the blending in his own mind of humour and toleration combined with a singular non-censorious purity of life, and all reinforced by his immense physical strength. How far his peculiar character was enhanced, in the eyes of ordinary humanity, by his capacity for what Stevenson would have called "a large and genial idleness" is worth considering.

His first candidacy for the legislature (1832) was unsuccessful. Two years later New Salem changed its mind and elected him. He continued to represent the town during the remainder of his stay there. All the while he was extremely poor. For a time he tried to keep a store in partnership with a man named Berry. They failed, leaving debts which Lincoln assumed and which he slowly, painfully paid off during the next 15 years. He obtained the beggarly office of postmaster at New Salem but this did not suffice for a livelihood. In desperation he borrowed a book on surveying and with extraordinary mental quickness made himself at home in it. He subsisted by working as a surveyor during several years. Meanwhile, he formed a friendship with John T. Stuart who advised him to study law. To gain admittance to the bar in a frontier community was, in those days, a simple matter. Lincoln read hard by himself, obtained a licence to practise, removed to Springfield and on April 12, 1837, entered into partnership with Stuart. An episode of his life at New Salem was his enlistment as a volunteer in the Black Hawk War (1832). His Clary Grove friends also enlisted and made their earliest display of devotion by electing him captain of their company. This was in the midst of his first candidacy for the legislature. He saw no fighting. Apparently he was so easy-going as an officer that the real soldiers at the front regarded him as inefficient. The one



BY COURTESY OF (4) THE CHAMBER OF COMMERCE, LINCOLN, NEB., (5) THE F. H. MESERVE COLLECTION, (7, 8, 9) THE U.S. SIGNAL CORPS; PHOTOGRAPHS, (1, 10) EWING GALLOWAY, (2) ERNEST L. CRANDALL, (3) RAYMOND H. GEORG, (11) THE C. O. BUCKINGHAM COMPANY

LINCOLN MONUMENTS AND PHOTOGRAPHS

1. Statue of Abraham Lincoln, Lincoln Park, Chicago, Ill. (1887), by Augustus St. Gaudens (1848–1907)
2. Statue of Abraham Lincoln, Lincoln Memorial, Washington, D.C. (1920), by Daniel Chester French (1850–1931)
3. Statue of Abraham Lincoln, State House Grounds, Springfield, Ill., by Andrew O'Connor (1874–1941)
4. Lincoln Monument, State Capitol Grounds, Lincoln, Neb. (1912). Bronze statue by Daniel Chester French. Architect, Henry Bacon. The vertical sides of the bronze slab which has the Gettysburg Address on its face have the Roman *fasces* carved in low relief
5. Abraham Lincoln, June 1860, at the age of 51, during his first presidential campaign, from a photograph, Springfield, Ill., by Alexander Hesler. It is one of the last to show him without a beard
6. Abraham Lincoln, Jan. 3, 1861, Springfield, Ill., from the C. S. German-Butler-F. M. McNulty photograph. The original negative is owned by H. W. Fay, custodian of the Lincoln Tomb, 1928
7. Photograph of Abraham Lincoln, 1864, at the age of 55, by M. B. Brady, Washington, D.C.
8. Photograph of Abraham Lincoln, probably 1864, by M. B. Brady, Washington, D.C.
9. Photograph of Abraham Lincoln, one of the later ones, by M. B. Brady, Washington, D.C.
10. Lincoln's house, Springfield, Ill., where he lived from 1844–61. It now belongs to the State of Illinois and is open to the public
11. Lincoln Memorial, Potomac Park, Washington, D.C., erected by the United States and dedicated May 30, 1922. Architect, Henry Bacon. The colonnade, 188 ft. long and 118 ft. wide, of 36 columns, represents the 36 States existing at the time of Lincoln's death

LINCOLN'S GETTYSBURG ADDRESS

THE Battle of Gettysburg was fought on the first, second and third days of July, 1863. On November 19 of the same year a portion of the battlefield was dedicated as a final resting place for those who died there. The main address on that occasion was one of two hours in length, delivered by Edward Everett, the best known orator of the time. After his address, Lincoln delivered the short speech now so famous. Lincoln had begun the preparation of this address the day before the dedication while still in Washington. After reaching Gettysburg he spent a portion of the evening and of the next morning in finishing the address, writing it out, partly in ink and partly in pencil. He delivered the address, however, without even a passing reference to his written draft. At the time almost no attention was paid to this address, it being relegated to the inner pages of the newspapers, while Edward Everett's elaborate oration received unqualified praise. It was not until many years later that the address became recognized as one of the classic utterances of all time.

It is interesting, however, to know that Edward Everett wrote to Mr. Lincoln on the day following the address, saying: "I wish that I could flatter myself that I had come as near to the central idea of the occasion in two hours as you did in two minutes."

The following is the text of the Gettysburg Address:

"FOURSCORE and seven years ago our fathers brought forth on this continent a new nation conceived in liberty and dedicated to the proposition that all men are created equal. Now we are engaged in a great civil war testing whether that nation, or any nation so conceived and so dedicated, can long endure. We are met on a great battlefield of that war. We have come to dedicate a portion of that field as a final resting-place for those who here gave their lives that that nation might live. It is altogether fitting and proper that we should do this. But, in a larger sense, we cannot dedicate, we cannot consecrate, we cannot hallow this ground. The brave men, living and dead, who struggled here have consecrated it far above our poor power to add or detract. The world will little note nor long remember what we say here, but it can never forget what they did here. It is for us the living rather to be dedicated here to the unfinished work which they who fought here have thus far so nobly advanced. It is rather for us to be here dedicated to the great task remaining before us—that from these honoured dead we take increased devotion to that cause for which they gave the last full measure of devotion—that we here highly resolve that these dead shall not have died in vain, that this nation under God shall have a new birth of freedom, and that government of the people, by the people, for the people, shall not perish from the earth."

valuable result of the episode is a fragment of writing in which he describes the scene of a skirmish where he arrived with his company in time to bury the dead. The few sentences, in which we glimpse the dead men "painted all over" by the red sunset, have a strange undertone that is perhaps the first appearance in his preserved memorabilia of the mystical vein which was part of his distinctiveness. Mysticism of some sort was universal in the frontier people. Usually it took a supernatural bent. One cannot doubt that Lincoln's mother was an instinctive mystic in the familiar sense. But her sort of mysticism did not descend to her son. In its place, the same fundamental impulse toward wonder and awe established a frame of mind that might be called naturalistic mysticism. Years afterward, on his first visit to Niagara, Lincoln was for the moment lost in reverie; but the subject of his reverie was neither supernatural nor, as so readily it might have been, literary; he was lost in wondering where all the water came from. This ability to be so impressed by the stark realities of life and death and nature that they took on all the significance of the supernatural reappeared frequently throughout his later life. Along with it were evidences of the familiar forms of supernaturalism. He confessed himself to be "superstitious." He believed in dreams as omens. On the day before his death he narrated a dream which he had the night before. He told the cabinet he had had that same dream preceding all the great events of the war. He was sure its recurrence presaged a great and fortunate happening.

In the New Salem period occurred his first actual love affair, of which anything is known. Doubtless there is some significance in the fact that he recognized, even if playfully, that the beginning of love for him was the idle dreaming over the girl in the wagon. All his life long there was a certain remoteness in him, a something that made him not quite a realist, but which was so veiled by apparent realism that careless people did not perceive it. He did not care whether they perceived it or not, was willing to drift along, permitting circumstances to play the main part in determining his course and not stopping to split hairs as to whether his earthly attachments sprang from genuine realistic perceptions of affinity or from approximation more or less to the dreams of his spirit. Of a girl named Ann Rutledge who lived at New Salem and died there in 1835, aged 19, very little is certainly known. She was a daughter of the tavern keeper. Lincoln boarded for a time in her father's house. Young as she was, Ann had had a desperate love affair which turned out badly (the man disappeared) before Lincoln fell in love with her. The affair was cut short by her sudden death from malarial fever. The episode has been magnified out of all proportion to the known facts by sentimental biographers. It may be safely dismissed as not deeply significant in itself. Traditions of its aftermath have more importance. They reveal the profound sensibility, also the vein of melancholy and the unrestrained emotional reaction which came and went, in alternation with boisterous mirth, to the end of his days. Following Ann's death he fell into a state of morbid depression which appears to have given rise to the report that he had a streak of insanity. Apparently he himself felt a terror of this side of his make-up, a terror that is revealed in the most mysterious of his experiences, several years later. He recovered rapidly from the abnormal condition following Ann's death. Perhaps it was on the rebound from the melancholy affair of Ann that he became entangled the next year in an affair that caused him almost at once to wish he was out of it. Mary Owens was a bouncing, sensible lass with whom he drifted into an engagement but who was not long in deciding that he was "deficient in those little links that make up the chain of a woman's happiness." This affair overlapped his removal to Springfield. Mary Owens broke the engagement, greatly to his relief, in the spring of 1838. Two years passed and Lincoln found himself engaged to Mary Todd, a beautiful young woman, high-spirited, well-educated and much higher in social origin than he. The fact of their engagement is evidence that now at 29 he had either "arrived" or was on the sure road to arrival. The Springfield of 1840 contained a wide variety of stocks and characters but all were united in a democracy of endeavour where ability and promise were the prime qualifications for admission to society. Though Lincoln, very probably, was accurately described by Mary Owens, although he was undeniably awkward, even crude, the powers that had enthralled Clary Grove had continued to develop. Both men and women appear to have trusted him so completely as to pay no heed to his peculiarities and to give no thought to his origin. His melancholy and a curious vein of indecision did not ordinarily manifest themselves. He was still a member of the legislature, and both as politician and lawyer he had captured general confidence. Springfield took his engagement to Mary Todd as altogether appropriate.

There followed that mysterious experience which has never been explained. On Jan. 1, 1841—"the fatal first of January," as he called it—the engagement was broken off. After his death his biographer, Herndon, gave to his other biographer, Lamon, a story he had pieced together, to the effect that a date had been set for the wedding of Lincoln and Mary Todd, that everything was in readiness, the bride dressed for the ceremony, but that no bridegroom appeared, that he was discovered by friends in a state of temporary insanity. Infinite controversy has grown out of this story. One of Mary Todd's sisters told a third biographer, Jesse W. Weik, that it was true; another sister told a fourth biographer that it was false. There can be no doubt that the facts in the story are all in confusion. No marriage licence for Abraham Lincoln and Mary Todd was issued either in 1840 or 1841. But what lay behind the story, and why the two sisters of the bride should have disagreed about it as they did, is an unsolved puzzle. That Lincoln was in a desperate frame of mind in Jan. 1841 is attested in his own letters, especially in one recently made public by Dr. Barton. He wrote to his partner Stuart, on Jan. 20, 1841, "I have within the last few days been making a most discreditable exhibition of myself in the way of hypochondriasm"; therefore, he was much concerned that a certain Dr. Henry should be induced to remain in Springfield through the gift of the office of postmaster. At the same time he proved not incapable of discharging his duties in the legislature, though speaking of himself as "the most miserable man living." A safe conclusion is that while he had sufficient control of himself to keep at routine work with an appearance of steadiness he was suffering from intense nervous excitement—similar, doubtless, to that which he had experienced in 1835—that it alarmed him deeply, that somehow it upset his engagement and led those who knew about it at all to form the rash conclusion of virtual though concealed insanity. Within nine months he was himself again. His recovery is recorded in a group of letters which form the most remarkable personal monument of him that has survived. A close friend, Joshua F. Speed, had removed from Springfield to his former home in Kentucky. Lincoln visited him in the summer of 1841. He returned to Springfield in a wholesome frame of mind. The letters of Speed in the next 12 months show that the latter also had fallen into a painful state of introspection, doubting whether he truly loved the woman to whom he was engaged. Lincoln, now in a serenely cheerful mood, analyses his case, roundly lectures him and indirectly draws an outline of his own psychology. He exclaims, "I know what the painful point with you is at all times when you are unhappy; it is an apprehension that you do not love her as you should. What nonsense!" Again he writes, "I have no doubt that it is the peculiar misfortune of both you and me to dream dreams of Elysium far exceeding all that anything earthly can realize." Nevertheless, "I was always superstitious," he concludes later. "I believe God made me one of the instruments for bringing your Fanny and you together, which union I have no doubt He foreordained." While this correspondence was proceeding his recovered cheerfulness found expression in another love affair, a slight, playful episode, with a chit of a girl, Sarah Rickard, 17 or 18 years old when he was 32 and 33—a flirtation more properly than an affair. Which one cried it off it is not known; but it is quite plain that neither suffered as a consequence. In the latter part of 1842 Lincoln was in high good spirits. One of his characteristics in these earlier years was a love of sarcasm. His political speeches were at times biting. Only an idolizer can escape the conclusion that he indulged this propensity through sheer love of it. He gave it free rein in derisive open letters to the Sangamon

Journal making fun of an enemy politician, James Shields. Lincoln pretended to be an illiterate person—a sort of countrified parallel to Yellowplush—and signed himself "Aunt Rebecca." Ironical fate inspired Mary Todd and a girl friend of hers, who presumably thought Aunt Rebecca the essence of funniness, to try their hand at the same sort of thing. Their open letter to Shields also got into print. Shields, in a rage, demanded the authorship of the letters. Lincoln assumed responsibility both for what he had written and for the work of the young women. Shields challenged him. Lincoln reluctantly accepted. The duel was prevented through the intercession of friends at the very last moment. Senator Beveridge was the first to point out that the incident probably made a lasting impression on Lincoln because thereafter his sarcastic vein disappeared. An immediate result was a meeting with Mary Todd, followed by reconciliation and their marriage on Nov. 4, 1842.

Lincoln was still poor. The debts contracted in New Salem were not yet cleared away. But his political position as a local leader in the Whig Party was now well established. A change in law partners had created the firm of Logan and Lincoln (1841), the senior member of which was one of the most distinguished lawyers of the State. In 1843 the junior member felt he had a chance for Congress. The failure of his effort to secure the nomination was explained in a letter which he wrote soon after: "There was, too, the strangest combination of church influence against me. . . . It was everywhere contended that no Christian ought to go for me because I belonged to no church, was suspected of being a deist, and had talked about fighting a duel."

Attitude to Religion.—The report that he was a deist may be taken as evidence that he had talked rashly upon the subject of religion or, more exactly, upon sceptism. His rashness of speech politically in these early years appears to have been paralleled in other connections. On Washington's birthday, 1842, he had made an address before the Washingtonian Temperance Society which, while it expressed the most unconditional disapproval of intemperance, held a brief for sympathy with the drunkard as an individual, for putting aside all condescension with regard to him. Views of this sort were not likely to be popular in a frontier community where one was expected to be heartily one thing or another. But doubtless the real cause of his momentary unpopularity lay in sceptical books that had fallen into his hands, particularly Volney's *Ruins of Time,* about which he appears to have talked too freely for his own good. That these books really affected him may be doubted. Far more plausible is the assumption that the year 1843 marks a general change in his attitude to the rest of the world, and that just as he put a stop to his political sarcasm so also he pulled himself together and put aside a corresponding early impulse for religious banter.

It is hard to believe that Lincoln was at any time a genuine sceptic. His temper was essentially religious. The letters to Speed give clear evidence of a mood of faith which reappeared long afterward in his Fast Day Proclamations and in certain fragments that are among his most extraordinary writings. His peculiar mysticism would not let him escape from that community of wonder which made all the frontier people, if they thought at all about unseen things, one spiritual kindred. His belief in dreams is again in point. When he called himself superstitious he probably meant to acknowledge belief in the supernatural but at the same time to evade all attempt to define his belief. Here is one of his main characteristics. He both is and is not of the world that produced him. So far as wonder, awe, the sense of mystery go, he is one with his mother, with strange and vehement revivalists who roamed the frontier country and gave ghostly ministration to souls athirst for ecstasy. But on all points of dogma he has nothing in common with them. While still a boy he is reported to have made mock of revivals. Certain it is that the fury, the vindicative theology, the hell-fire creed of those religious primitives deeply offended him. With such theology and such ethics he stood in strong contrast through his amazing power to be, at the same time, passionless in temper while unfaltering in conviction. His religious attitude was put into words in the latter part of his life when he said, "I have never united myself to any church because I have found difficulty in giving my assent, without mental reservations, to the long complicated statements of Christian doctrine which characterize their Articles of Belief and Confessions of Faith. When any church will inscribe over its altar, as its sole qualification for membership, the Master's condensed statement of the substance of both Law and Gospel 'Thou shalt love the Lord thy God, with all thy heart and with all thy soul and with all thy mind, and thy neighbour as thyself' that church will I join with all my heart and with all my soul."

It must not be supposed that the change about 1843 was obvious and unconditional. It was merely a facing in a new direction. Thereafter sarcasm and rash banter—the impulse to play with other men's ideas—steadily ebb, though once in a while they suddenly flood back, as in some of the savage passages of the debates with Douglas in 1858. As a party speaker and debater Lincoln had formed bad mental habits, of which he may not have been aware, which did not wholly disappear until many years had passed. For one thing the humour in his political speeches was crude to a degree. It was the conventional humour of his time. Almost the only deliberate instance that has survived is a speech which was made when at last he had succeeded in getting into Congress. His aim was to ridicule Lewis Cass; the way he did it, like so much American humour of that day, suggests Dickens at his worst.

In Congress, where he served a single term, 1847–49, Lincoln was a staunch party man doing the routine business of the Whig organization with conventional faithfulness. Like all the rest of the Whigs, he tried to carry water on both shoulders with regard to the Mexican War, voting army supplies, posing as the soldiers' friend, but denouncing the president for having forced them into a position where they could not patriotically do anything else. Certain resolutions introduced by Lincoln and dubbed "the spot resolutions" obtained notoriety. They called upon the president to indicate the precise spot where previous to his declaration of war American blood had been shed on Mexican soil. Lincoln's one congressional action that revealed an individual point of view was a bill for emancipating slaves in the District of Columbia. Long since he had become a hater of slavery. But he had had no toleration for the Abolitionists. As far back as 1837, at the end of a session of the legislature when all its serious business was out of the way, he had introduced resolutions asserting "that the institution of slavery is founded on both injustice and bad policy; but that the promulgation of abolition doctrines tends rather to increase than to abate its evils"; asserting also that Congress had power to abolish slavery in the District of Columbia but "that the power ought not to be exercised unless at the request of the people of the District." During 12 years he had held to this serene and unemotional attitude while the storm of Abolition swept over the country, and in 1849 he restated his views of 1837. His bill provided for emancipation in the District with consent of the voters and with compensation to the owners. The bill was not considered. Lincoln had not satisfied anyone as a Congressman. The local political machine did not admit that he deserved any special consideration and felt that others were entitled to their day in the sun at Washington. The younger Whigs wanted a more aggressive type of leader. Apparently he was out of it politically in Illinois. Lincoln's life is a succession of waves of energy rising and falling. There is good reason to believe that his spirit was in an ebb tide, a tide of disappointment and depression, when he returned from Congress in 1849. Such a mood was likely to make manifest in Lincoln the vein of indecision that was in the background of his nature, that he did not conquer until after the tremendous experiences of 1862. At this critical moment he was offered the governorship of the new territory of Oregon. He seems to have thought, for a space, of following his father's example and escaping from trouble by seeking a new horizon. His wife saved him. A long controversy has raged about her character and whether she and her husband were truly congenial. That Mrs. Lincoln was a matter-of-fact, perhaps a self-willed, even tyrannical woman is not unlikely. That in some respects her narrow vision and her dogmatic firmness may have been the saving of her husband is equally probable. She was emphatic on the refusal of the Oregon offer. Her husband acquiesced. They remained in Springfield and Lincoln escaped his last serious temptation to follow in the footsteps of wandering Thomas.

The next five years were devoted to the law. The firm of Logan and Lincoln had disappeared (1845) and the more famous firm of Lincoln and Herndon had taken its place. During this period Lincoln at last became prosperous. Though not a legal scholar he was a great jury lawyer. He had a genius for perceiving the essentials of a case. It was a saying of his, "If I can strip this case of technicalities and swing it to the jury I'll win it." He was fanatically honest. Having been deceived by a client when on the circuit, he threw up the case in the midst of the trial, withdrew to his hotel and sent word to the presiding judge, "My hands are dirty and I came over to clean them."

The Peoria Speech.—He was recalled to politics by the Kansas-Nebraska Act of 1854 opening the north-western territories to slavery. The five years of hard work at the law had developed in him exceptional powers of lucid argument. When Stephen A. Douglas became the champion of the Kansas-Nebraska Act Lincoln was urged to reply to him. He did so at Peoria on Oct. 16, 1854. The great speech delivered that day gave him his place in history. The change from the inadequate politician who had failed in Congress five years before is so great as to seem all but incredible. For directness of vision, for scope of argument, for breadth of sympathy the speech is unrivalled by anything in the previous literature of the slavery controversy. Unlike the Abolitionists he admitted no abstractions into his thought on this subject and no vindictiveness; he was wholly the democrat and the humanitarian; he wanted to check the extension of slavery because he thought it inhuman but even more because, as he put it, "new free states are places for poor people to go to and better their condition." This was the key-note of his thought ever after, both in regard to the territories and in regard to the preservation of the Union. He admitted frankly that his overmastering concern was the welfare of the free poor people of the white races.

The Peoria speech made him famous. His political ambition immediately sprang to life again. He stood for the senatorship. But though the Whigs accepted him as their candidate they were not strong enough to elect him. At the last moment Lincoln scored a partial triumph by throwing his votes to Lyman Trumbull, a seceding Democrat opposed to the policies of Douglas. There followed a political duel between Lincoln and Douglas culminating in the famous debates of 1858 when both were candidates for the senate. Douglas obtained the prize. But Lincoln was now one of the conspicuous leaders of the day. After much hesitation he had joined the New Republican Party two years previous to his defeat by Douglas. At the State Republican Convention in 1856 he made his "Lost Speech" which was not reported at the time but which is supposed to have been a masterpiece of compelling oratory. His speech accepting the Republican nomination for the senate (1858) contained the most noted single passage in any of his speeches. It began, "A house divided against itself cannot stand. I believe this Government cannot endure permanently half slave and half free."

This was the idea upon which he rang the changes in the debates with Douglas. In one of them, by skilful questioning he forced Douglas into a dilemma from which he could extricate himself only by formulating what at once became known as "the Freeport Doctrine." Douglas was defending the idea of complete local autonomy on the subject of slavery—"squatter sovereignty," as it was called—and yet trying to avoid challenging the validity of the recent decision of the supreme court in the Dred Scott case which denied that it was possible to close a territory to slavery. Lincoln's purpose was to trap Douglas into taking a position which, while it might save him with the Illinois Democrats who were for squatter sovereignty and indifferent to the supreme court, would split the party as a whole by alienating the Southerners who were strong for the Dred Scott decision. Driven to the wall, Douglas chose to make sure of Illinois and announced the doctrine that no matter what the court might do, slavery could exist only through friendly local legislation and therefore that squatter sovereignty was omnipotent. He was returned to the senate but the national Democratic Party was split in two. The man who had out-generalled Douglas and split the Democrats was inevitably a possible candidate for the presidency two years later. During 1859 he hesitated whether he was strong enough to risk letting his name go before the Republican Convention. Long before he made up his mind his friends were hard at work. At length he consented.

It was while this determination was still young that he went to New York and delivered what is probably the best known though far from the greatest of his speeches, the address at Cooper Union on Feb. 27, 1860. A large part of his purpose was to dissociate the Republican cause from the recent attempt of John Brown to provoke a slave insurrection. He succeeded brilliantly in giving to the Republican position a sober and conservative cast. Cooper Union established him as at least second choice for president in the minds of many of the Eastern Republicans. When, in the Republican National Convention at Chicago, it became plain that none of these Easterners could nominate his first choice, many of them combined with the Western supporters of Lincoln to nominate him uproariously on the third ballot. In the election, out of some 4,500,000 votes cast, he got less than 2,000,000 and all but about 24,000 of these were in the Free States. But this minority of the popular vote was so distributed that it gave him the electoral college and elected him president.

In 1860 Lincoln was in one of those rising tides of energy that had come and gone throughout his life. Its culmination was reached on Dec. 20, the very day on which South Carolina seceded. *See* UNITED STATES (OF AMERICA), THE: *History*. Congress had met; it was believed that a compromise could be made with the Slave States on the basis of a division of the territories between slavery and freedom. Thurlow Weed had come to Springfield on behalf of the Republican leaders to find whether Lincoln would participate in compromise. On Dec. 20 he closed the door by issuing an ultimatum: he insisted on complete exclusion of slavery from the territories but he would promise to let slavery alone in the States and to advocate a strenuous enforcement of the laws for recovering fugitive slaves and returning them to their owners. This decision put an end to compromise and led straight to war. The next 18 months form the most singular period in Lincoln's life. They are his last period of the ebb tide. During this period he is often at the mercy of his indecision. And yet, from this welter of uncertainty he issues suddenly, in July, 1862, the final Lincoln, sure of himself and master of his world.

Interval of Indecision.—The startling change in his mood following his ultimatum was revealed in fatuous speeches which he made on the way to Washington. The Southern Confederacy had been formed and yet he assured the country that there was no crisis but an "artificial" one. His Inaugural, though it struck a new note of literary power, merely exhorted the seceding States to return into the Union and discoursed at length upon slavery. Until April 14, when Sumter was fired upon, he was all indecision, taking advice from every member of his cabinet (*see* SEWARD, WILLIAM H.; CHASE, SALMON P.; WELLES, GIDEON), and though he promptly accepted the gage of battle, issuing a call for volunteers (*see* AMERICAN CIVIL WAR), he allowed a cabal of rash and headstrong senators to force his hand and that of his commanding general (*see* MCDOWELL, IRVIN), with results that ended in the defeat of the Union forces at Bull Run. He shook off momentarily the influence of the senatorial cabal and appointed a Democrat, George B. McClellan as commander of the army of the Potomac. But he soon lost faith in McClellan and blunderingly interfered with his plans. He permitted the creation of various bodies such as an army board with ill-defined and conflicting functions. Having required McClellan to submit his plans to a council of general officers, Lincoln attended the council and promised to be governed by the opinion of the majority. The strange story of the latter part of the period of uncertainty is summed up in the contrast between his attitude at this council and his attitude about four months later, after McClellan's defeat in the Seven Days, when Lincoln visited the front and summoned the generals before him to make reports but asked of them no advice. Meanwhile he had suffered a profound personal affliction in the death of his favourite son and had been tormented almost beyond endurance by officious senators now organized in the Committee on the Conduct of the War. What caused his sudden emergence into self-confidence is a mystery. The transitional moment appears to be a sudden visit to West Point and a long confidential talk with Gen. Scott. A few days later, in his conferences at the front, he took things into his own hands and never thereafter relinquished supreme control.

His story thenceforward is the story of his country. It is needless here to do more than catalogue in order the main events; his struggle with the Committee on the Conduct of the War for control of the army; his removal of Gen. Frémont because of the latter's rash course of freeing slaves in Missouri; the narrow avoidance of war with England by promptly acknowledging the error of Commander Wilkes when he boarded a neutral ship and took off Confederate envoys; the establishment of a new understanding with regard to contraband (*see* further article on NEUTRALITY); his gradual solution of the problem of army control in a democracy; his slow acceptance of the idea that the policy of emancipation must be accepted as a war measure partly to solidify his own support at home, partly to secure international support; his issue of the Emancipation Proclamation, tentatively on Sept. 22, 1862, permanently on Jan. 1, 1863; his temporary loss of popularity due largely to the terrible sufferings of the Federal armies in 1864 and the combination against him of the Abolitionists of the senate who felt he was lacking in sternness; the salvation of his leadership by Sheridan's victories in the Shenandoah valley and Sherman's capture of Atlanta; his second election as president; his opposition to Congress with the purpose of setting up a generous plan of reconstruction in the conquered South. The latter purpose inspired one of his most notable actions. Shortly before his death, he proposed to his cabinet to urge upon Congress the appropriation of $400,000,000 to assist the South in its economic recovery. The opposition of the cabinet led him to set the scheme aside, temporarily, as he thought. His last public address contained an assurance to the nation that he was pondering this difficult problem. "I am considering and will not fail to act when satisfied that action will be proper." At that same moment, a fanatic of secession, John Wilkes Booth, was planning his assassination. While Lincoln was sitting in Ford's theatre, on the night of April 14, 1865, Booth stole into his box and shot him through the head. He lingered unconscious until 7:25 the next morning when he died.

During the years that had followed his election as president the qualities that had enabled him to attain success were all in process either of transformation or of reorganization. The former is the dominant note until midsummer 1862; the latter in the remaining years. But there is no definite division in time. In some respects the period of uncertainty contradicts itself. Timid and indecisive in action as, in the main, he was in that period, he was never more clear and self-sufficient in thought. Two sides of his nature were in conflict. While as man of action he waited upon the opinions of others, as man of thought he consulted no one and formulated his position out of his own meditations. This is strikingly apparent in the contrast as State papers of the First Inaugural and the First Annual Message. In March 1861 Lincoln still believed that the divisions of the sections was a mere quarrel over the extension of slavery. He had not then taken the measure of the secession movement and did not understand that independence, not simply the preservation of slavery, was what the South had in view. He was still blinded by the provincial bias of Springfield, by his own lack of contact with Washington. In the next eight months he made the great discovery of his life—that there was no one cause of secession, that the South had become a nation within the Union, that both the Southerners who loved slavery and the Southerners who hated slavery were tired of living with the North and wanted a legal separation. In these months while he fumbled weakly with the reins of power his mind called up all its reserves and set to work to form a philosophical-historical defense of the cause of the Union. The result was his most remarkable State paper, the First Message. Its origins lie undoubtedly in a long train of thoughts that had been moving through his mind, more or less subconsciously, during 20 years. All that while he had been growing in the belief that the basic issue of the time was not the freedom of the slaves but the preservation of the ideal of democracy. Jefferson came very near being his patron saint. Two propositions were in solution in his mind when he was elected president: that slavery must be checked because it was an aristocratic institution inimical to the interests of the "plain people"; that the Union was sacred because it made possible a great experiment in government "of the people, for the people and by the people." Neither of those ideas played an important part at the Inaugural; they are the bedrock of the Message. Incidentally, the Message contained an historical argument which was based on inadequate knowledge and has not stood the test of scientific criticism. The immeasurable importance of the Message is as the statement of a creed. "This is essentially a people's contest. On the side of the Union it is a struggle for maintaining in the world that form and substance of government whose leading object is to elevate the condition of men; to lift artificial weights from all shoulders; to clear the paths of laudable pursuit for all; to afford all an unfettered start and a fair chance in the race of life."

Evolution As a Writer.—Even more striking than the precipitation of political thinking is the sudden leap forward of his power as a writer. Previous to 1860 he had displayed a wonderful gift of lucidity; his style differed from the prevailing styles of the time in his love of temperance, in a general repudiation of rhetoric, in candour, in serenity. He had also the gift of noble rhythm. But in those early days his language lacked beauty in any rich sense; it was not shot through with imagination; it had nothing of what was vaguely termed "the poetical." This quality appeared suddenly in the First Inaugural. Thereafter his writing steadily grew in richness without letting go its soundness of method, without becoming decorated, without lapsing into rhetoric. Here is another mystery of his later development. How he had gathered into himself a subterranean sense of beauty in words, whether it had grown out of long reading of the Bible, Shakespeare and Burns—the favourite books of his maturity—whether it linked back with his mother's world, with its forests and empty spaces, its loneliness and its lampless nights of stars, who can say? Something perhaps may be allowed to the influence of the brilliant Seward whose hand is known to be present in the First Inaugural, and who was certainly his close friend as well as secretary of State during the later years. But such literary sense as Seward possessed is slight compared with that which appears in Lincoln's Fast Day Proclamations, in his description of the map of the United States in the Second Inaugural Message, in the oration at Gettysburg on Nov. 19, 1863, in the Second Inaugural, in some fragments and letters such as the famous letter to Mrs. Bixby upon the death of her sons in battle, or the letter to Gen. Hooker on Jan. 26, 1863, informing him of his appointment as commanding general and quietly discussing in the most objective vein his recent talk that "both the army and the Government needed a dictator. . . ." The speech at Gettysburg condensing into one page of eloquent prose the purport of the First Message is probably his most famous utterance.

There is a new sense of balance in him and of self confidence. He has grasped the full nature of his task as military executive of a democracy and has thought out his own conception of the division and articulation of powers among the president, the legislature and the generals. He puts this conception firmly into effect despite furious clamour from Congress. In the latter stage of his government he follows his own judgment alone in making or unmaking generals, but once they are in command he permits no civilian interference with their plans. His own meddling in army matters in 1861 has no parallel after 1862. The terrible Committee on the Conduct of the War, which had the temper and aimed to get the power of the great Committee of the French Revolution, was slowly but steadily forced into insignificance. The aim of the committee and its associates was to conduct the war on a purely partisan basis while Lincoln was determined to conduct it on a national basis transcending party. Broadly speaking, he was successful. It was as the "Union" not merely as the

"Republican" candidate that he was re-elected in 1864. In all his later thinking two ideas which have been frequently overlooked were harped upon. He steadily insisted that the United States formed a strictly federal community, that the States were as essential to its welfare as was the central Government and that he was fighting neither to enable the North to dominate the South nor to centralize the Union through the overthrow of the States. His party enemies were for Northern domination and for centralization. The second idea, too often overlooked or explained away, is his steady insistence on the executive as the proper centre of gravity in exceptional conditions and his virtual assumption of the rôle of dictator. No small part of the significance of this final stage is the struggle between himself and Congress for possession of the extraordinary powers which inevitably are generated in time of war. Nowhere was he denounced more bitterly than in the House of Representatives by fanatical Republicans. His views upon both these crucial matters were summed up in the Emancipation Proclamation which is even more important as a statement of administrative policy than as a step in the history of Abolition. Quite frankly, he defended the theory that the "war powers" of the president formed a virtual dictatorship in two open letters justifying the punishment by military process of persons charged with sedition. He was able to maintain this bold attitude involving a questionable interpretation of the Constitution because of the dominance he acquired in the hearts and imaginations of the mass of the people. Defending the most high-handed case of military arrest (*see* VALLANDIGHAM, CLEMENT LAIRD) he said of this great power which he claimed for the president, "if he uses the power justly, the . . . people will probably justify him; if he abuses it, he is in their hands to be dealt with by all the modes they have reserved to themselves under the Constitution."

His success in his second election when the mere politicians of his party very generally intrigued against him was a justification of himself as the tribune of the people. His hold upon them was accomplished partly by his utterances, partly through the communication to others of the vivid and compelling impression he made on individuals close to him, partly through the open receptions which he held every few days which any one was permitted to attend. He called them his "baths of public opinion." Through them he found out the heart of the nation and communicated himself to the nation.

In the character revealed in these later days are found all the qualities of the earlier unfused Lincoln, excepting only those which began to disappear about 1843, and taken separately they do not appear different from what they once had been. He was still susceptible to fits of melancholy so profound that he felt them to be all but unendurable. On the other hand he was still recklessly humorous, telling funny stories on all occasions, sometimes giving offence by so doing. To a Congressman who showed dislike for his stories he said, "You cannot be more anxious than I have been constantly since the beginning of the war; and I say to you now, that were it not for this occasional vent I should die." The difference between the earlier Lincoln and the later is not in the details but in the whole. The same elements have been recombined in a changed pattern. There are salty, coarse elements in 1864 no less than in 1834, but instead of forming discords they now blend. He has achieved an individual tone all his own, comparable to that amazing unity of discordant elements that pervades and makes inimitable the great masterpieces of literature. His secretaries adored him. One of them, John Hay, has left admirable contemporary sketches of his personality. "The Tycoon (as his secretaries called him) is in fine whack. I have rarely seen him more serene and busy. He is managing this war, the draft, foreign relations and planning a reconstruction of the Union all at once. I never knew with what a tyrannous authority he rules the cabinet until now. The most important things he decides and there is no cavil. . . . There is no man in the country so wise, so gentle and so firm."

The measure of his difference from most of the men who surrounded him is best gauged by his attitude toward the fundamentals of religion. For all his devotion to his cause he did not allow himself to believe that he knew the mind of God with regard to it. He was never so much the mystic as in his later days and never so far removed from the dogmatist. Here was the final flowering of that mood which appears to have lain at the back of his mind from the beginning—his complete conviction of the reality of a supernatural world joined with a belief that it was too deep for man to fathom. His refusal to accept the "complicated" statements of doctrine which he rejected carried with it a refusal to predicate the purposes of the Almighty. Again, that singular characteristic, his power to devote himself wholly to a cause and yet to do so in such a detached unviolent way that one is tempted to call it passionless. He retained nothing of the tribal forms of religion and was silent while they raged about him with a thousand tongues. Upon this innermost subject the best expression of him is an amazing fragment which he wrote down but which was not intended for any eye but his own. "The will of God prevails. In great contests each party claims to act in accordance with the will of God. Both may be, and one must be, wrong. God cannot be for and against the same thing at the same time. In the present civil war it is quite possible that God's purpose is something different from the purpose of either party; and yet the human instrumentalities, working just as they do, are the best adaptations to effect His purpose. I am almost ready to say that this is probably true; that God wills this contest and wills that it shall not end yet. By His mere great power on the minds of the now contestants, He could have either saved or destroyed the Union without a human contest. Yet the contest began. And, having begun, He could give the final victory to either side any day. Yet the contest proceeds."

BIBLIOGRAPHY.—The most famous life of Lincoln is by his law partner, William H. Herndon, in collaboration with J. W. Weik, *The True Story of a Great Life* (1890). It has been the subject of furious controversy. Ward H. Lamon, with *The Life of Abraham Lincoln* (1872), antedated Herndon in publication but drew freely from Herndon's materials. J. W. Weik, who had collaborated with Herndon, brought out long afterward *The Real Lincoln* (1922). The literature that has grown up about Lincoln numbers literally thousands of volumes. Conspicuous is *Abraham Lincoln: A History* (1890), by his secretaries, John G. Nicolay and John Hay, published with the approval of his son, Robert Todd Lincoln. There are two general collections of his writings: *Complete Works of Abraham Lincoln,* Nicolay and Hay ed. (1905); *The Complete Works of Abraham Lincoln,* George Haven Putnam and Arthur Brookes Lapsley ed. (1888–1906). Neither of these collections is complete. At intervals new letters are discovered and published; for example, *Uncollected Letters of Abraham Lincoln,* first brought together by Gilbert Tracy (1917). Many important details of his origin and early life have been determined by William E. Barton, notably in *The Paternity of Abraham Lincoln* (1920); in *The Life of Abraham Lincoln* (1925); and *The Women Lincoln Loved* (1927). Recent biographies that deserve attention are Ida M. Tarbell, *The Life of Abraham Lincoln* (1917); Lord Charnwood, *Abraham Lincoln* (1917); Nathaniel Wright Stephenson, *Lincoln* (1922). The Lincoln Memorial Association is publishing gradually a record of his daily life. What promised to be the definitive life of Lincoln was undertaken by Albert J. Beveridge and was to be on the same scale as his monumental life of Marshall. Unfortunately, but two volumes had been completed at the time of his sudden death in 1927. They were published under the title *Abraham Lincoln* (1928), and supersede everything that has been written on the portion of Lincoln's life previous to 1858. (N. W. S.)

LINCOLN, a city and county of a city, municipal, county and parliamentary borough, and the county town of Lincolnshire, England. Pop. (1938) 63,050. Area 7.08 sq.mi. It is on the summit and south slope of the limestone ridge of the Cliff range of hills, which rises from the north bank of the river Witham, at its confluence with the Foss Dyke, to an altitude of 200 ft. above the river. The cathedral stands on the hill, and is a landmark for miles. Lincoln is 130 mi. N. by W. from London by the L.N.E.R.; it is also served by branches of the L.M.S. ry.

History.—The British Lindun, which, according to the early geographer, Ptolemy, was the chief town of the Coritani, was probably the nucleus of the Roman town of Lindum. This was at first a Roman legionary fortress, and on the removal of the troops northward was converted into a municipality with the title of *colonia.* Important structural remains attest the rank and importance of the place, which, however, did not attain a very great size. Its bishop attended the council of Arles in 314, and Lincoln (*Lindocolina, Lincolle, Nicole*) is mentioned in the

Itinerary of Antoninus written about 320. Although said to have been captured by Hengest in 475 and recovered by Ambrosius in the following year, the next authentic mention of the city is Bede's record that Paulinus preached in Lindsey in 628 and built a stone church at Lincoln in which he consecrated Honorius archbishop of Canterbury.

The Danes in 877 established themselves at Lincoln, which was one of the five boroughs recovered by King Edmund in 941. A mint existed here in the reign of Alfred and was maintained until the reign of Edward I. At the time of Domesday, Lincoln was governed by twelve Lawmen, relics of Danish rule, each with hereditable franchises of sac and soc. The strength of the position of the castle built by William I in 1068, brought much fighting on Lincoln.

In 1141 King Stephen regained both castle and city from the empress Maud, but was attacked and captured in the same year at the "Joust of Lincoln." In 1144 he besieged the castle, held by the earl of Chester, and recovered it as a pledge in 1146. In 1191 it was held by Gerard de Camville for Prince John; in 1210 it stood a siege by the partisans of the French prince Louis, who were defeated at the battle called Lincoln Fair on May 19, 1217. Granted by Henry III to William Longespée, earl of Salisbury, in 1224, the castle descended by the marriage of his descendant Alice to Thomas Plantagenet, and became part of the duchy of Lancaster.

In 1157 Henry II gave the citizens their first charter, granting them the city at a fee-farm rent and all the liberties which they had had under William II. In 1200 the citizens obtained release from all but pleas of the crown without the walls, and pleas of external tenure, and were given the pleas of the crown within the city according to the customs of the city of London, on which those of Lincoln were modelled. The charter also gave them quittance of toll and lastage throughout the kingdom, and of certain other dues. The mayor's office was abolished by Henry III and by Edward I in 1290, though restored by the charter of 1300. In 1275 the citizens claimed the return of writs, assize of bread and ale and other royal rights, and in 1301 Edward I, when confirming the previous charters, gave them quittance of murage, pannage, pontage and other dues. The mayor and citizens were given criminal jurisdiction in 1327, when the burghmanmot held weekly in the guildhall since 1272 by the mayor and bailiffs was ordered to hear all local pleas which led to friction with the judges of assize. The city became a separate county by charter of 1409, when it was decreed that the bailiffs should henceforth be sheriffs and the mayor the king's escheator, and the mayor and sheriffs with four others, justices of the peace, with defined jurisdiction. As the result of numerous complaints of inability to pay the fee-farm rent of £180 Edward IV enlarged the bounds of the city in 1466, while Henry VIII in 1546 gave the citizens four advowsons, and possibly also in consequence of declining trade the city markets were made free of tolls in 1554. Incorporated by Charles I in 1628 under a common council with 13 aldermen, 4 coroners and other officers, Lincoln surrendered its charters in 1684, but the first charter was restored after the Revolution, and was in force till 1834.

Parliaments were held at Lincoln in 1301, 1316 and 1328, and the city returned two burgesses from 1295 to 1885, when it lost one member. After the 13th century the chief interests of Lincoln were ecclesiastical and commercial. As early as 1103 Odericus declared that a rich citizen of Lincoln kept the treasure of King Magnus of Norway, supplying him with all he required, and there is other evidence of intercourse with Scandinavia. There was an important Jewish colony, Aaron of Lincoln being one of the most influential financiers in the kingdom between 1166 and 1186. Made a staple of wool, leather and skins in 1291, famous for its scarlet cloth in the 13th century, Lincoln had a few years of great prosperity, but with the transference of the staple to Boston early in the reign of Edward III, its trade began to decrease. The craft guilds remained important until after the Reformation, a pageant still being held in 1566. The fair now held during the last whole week of April seems to be identical with that granted by Charles II in 1684. Edward III authorized a fair from St. Botolph's day to the feast of SS. Peter and Paul in 1327, Henry IV granted one in 1409 for fifteen days before the feast of the Deposition of St. Hugh, and William III gave one for the first Wednesday in September in 1696.

Architecture.—The ancient British town occupied the crown of the hill beyond the Newport or North Gate. The Roman town consisted of two parallelograms of unequal length, the first extending west from the Newport gates to a point a little west of the castle keep. The second parallelogram, added as the town increased in size and importance, extended due south from this point down the hill towards the Witham as far as Newland, and thence in a direction due east as far as Broad street. Returning thence due north, it joined the southeast corner of the first and oldest parallelogram in what was afterwards known as the Minster yard, and terminated its east side upon its junction with the north wall in a line with the Newport gate. This is the oldest part of the town, and is named "above hill." After the departure of the Romans, the city walls were extended still farther in a south direction across the Witham to the great bar gate, the south entrance to the High street of the city; the junction of these walls with the later Roman one was effected immediately behind Broad street. The south portion, named "below hill," contains the principal business premises and the railway stations.

Lincoln cathedral contains the earliest purely Gothic work extant, as well as every style from the simple massive Norman of the central west front and the later Norman of the west doorways and towers onward through all the Gothic styles, of each of which both early and late examples appear. The building material is the oolite and calcareous stone of Lincoln Heath and Haydor, which has the peculiarity of becoming hardened on the surface when tooled. Formerly the cathedral had three spires, all of wood or leaded timber. The spire on the central tower, which would appear to have been the highest in the world, was blown down in 1547. Those on the two western towers were removed in 1808. In 1921 the north and southwest and centre towers were found to be in imminent danger of collapse. To save them they, with the west transept, Galilee porch and nave were treated by grouting, the work being completed in 1932. The peal of 12 bells in the southwest tower, of which four were a World War I memorial to ringers, were lowered 30 ft. and the upper part of the tower was reconstructed with a lantern roof and the lower louvers were closed.

The ground plan of the first church, adapted from that of Rouen, was laid by Bishop Remigius in 1086, and the church was consecrated three days after his death, on May 6, 1092. The west front consists of an Early English screen (*c.* 1225) thrown over the Norman front, the west towers rising behind it. The earliest Norman work is part of that of Remigius; the great portals and the west towers up to the third story are Norman *c.* 1148. The upper parts of them date from 1365. Perpendicular windows (*c.* 1450) are inserted. The nave and aisles were completed *c.* 1220. The transepts mainly built between 1186 and 1235 have two rose windows; that in the north Early English, that in the south Decorated. The first has contemporary stained glass. These are called respectively the Dean's Eye and Bishop's Eye. A Galilee of Early English work forms the entrance of the south transept. Of the choir the western portion known as St. Hugh's (1186–1204) is the famous first example of pointed work; the eastern, called the Angel choir, is ornate work completed in 1280. Perpendicular canopied stalls fill the western part. The great east window, 57 ft. high, is an example of transition from Early English to Decorated *c.* 1288. Other features of the interior are the Easter sepulchre (*c.* 1300), and the organ screen of a somewhat earlier date. The great central tower is Early English as far as the first story, the continuation dates from 1307. The total height is 271 ft.; and the tower contains the bell, Great Tom of Lincoln, weighing over 5 tons. The dimensions of the cathedral internally are—nave, 252×79.6×80 ft.; choir, 158×82×72 ft.; angel choir, which includes presbytery and lady chapel, 166×44×72 ft.; main transept, 220×63×74 ft.; choir transept, 166×44×72 ft. The west towers are 206 ft. high.

The buildings of the close that call for notice are the chapter-house of ten sides, 60 ft. diameter, 42 ft. high, with a vestibule of the same height, built *c.* 1225, and therefore the earliest of English polygonal chapter-houses, and the library, a building of 1675, which contains a small museum. The episcopal palace contains work of the date of St. Hugh, and the great hall is mainly Early English. There is some Decorated work, and much Perpendicular, including the gateway. It fell into disuse after the Reformation, but by extensive restoration was brought back to its proper use at the end of the 19th century. The see covers almost the whole of the county, with very small portions of Nottinghamshire; it included all Nottinghamshire until the formation of the bishopric of Southwell in 1884. At its earliest formation, when Remigius, almoner of the abbey of Fécamp, removed the seat of the bishopric here from Dorchester in Oxfordshire shortly after the Conquest, it extended from the Humber to the Thames, eastward beyond Cambridge, and westward beyond Leicester. It was reduced, however, by the formation of the sees of Ely, Peterborough and Oxford, and by rearrangement of diocesan boundaries in 1837. Lincoln cathedral possesses the finest copy extant of Magna Carta (1215). It was exhibited at the New York World's Fair, 1939–40, and was afterwards sent to the Library of Congress, Washington, where it remained during World War II.

The Newport Arch or northern gate of *Lindum* is one of the most perfect specimens of Roman architecture in England. It consists of a great arch flanked by two smaller arches, of which one remains. The Roman Ermine street runs through it, leading northward almost in a straight line to the Humber. Fragments of the town wall remain at various points; a large quantity of coins and other relics has been discovered; and remains of a burial-place and buildings unearthed. Of these last the most important is the series of column-bases, probably belonging to a Basilica, beneath a house in the street called Bail Gate, adjacent to the Newport Arch. A villa in Greetwell; a tesselated pavement, a mile-stone and other relics in the cloister; an altar unearthed at the church of St. Swithin, are among many other discoveries. Among churches, apart from the minster, two of outstanding interest are those of St. Mary-le-Wigford and St. Peter-at-Gowts (*i.e.,* sluice-gates), both in the lower part of High street. Their towers are examples of very early Norman work, though they possess characteristics of pre-Conquest workmanship. Bracebridge church shows similar early work; but as a whole the churches of Lincoln show plainly the results of the siege of 1644.

There were formerly three small priories, five friaries and four hospitals in or near Lincoln. The preponderance of friaries over priories of monks is explained by the fact that the cathedral was served by secular canons. Bishop Grosseteste was the devoted patron of the friars, particularly the Franciscans, who were always in their day the town missionaries. The Grey friary, near St. Swithin's church, is a picturesque two-storied building of the 13th century, now housing a museum. The building known as John of Gaunt's stables, actually St. Mary's Guildhall, is of two stories, with Norman doorway and moulding. The Jew's House is another 12th-century building; and Norman remains appear in several other houses, such as Deloraine Court and the House of Aaron the Jew. Lincoln Castle, lying west of the cathedral, was newly founded by William the Conqueror when Remigius decided to found his minster under its protection. The site, with its artificial mounds, is of much earlier, probably British, date. There are Norman remains in the Gateway Tower; parts of the walls are of this period, and the keep dates from the middle of the 12th century. Among mediaeval gateways, the Exchequer Gate, serving as the finance-office of the chapter, is a fine specimen of 13th-century work. Pottergate is of the 14th century, and Stonebow in High Street of the 15th, with the Guildhall above it. St. Dunstan's Lock is the name, corrupted from Dunestall, now applied to the entrance to the street where a Jewish quarter was situated; here lived the Christian boy afterwards known as "little St. Hugh," who was asserted to have been crucified by the Jews in 1255. His shrine remains in the S. choir aisle of the minster. Other antiquities are the Perpendicular conduit of St. Mary in High street and the High bridge, carrying High street over the Witham and retaining some old houses upon it. The principal industry is the manufacture of agricultural machinery and implements; there are also iron and steel foundries and maltings, and a large trade in corn and agricultural produce. The race course, famous for the Lincolnshire handicap, is owned by the corporation. The county borough of Lincoln with the urban district of Bracebridge returns one member to parliament.

LINCOLN, a city of central Illinois, U.S.A., on Federal highway 66, and served by the Chicago and Alton, the Illinois Central and the Illinois Traction (electric) railways; the county seat of Logan county. The population was 11,882 in 1920 (87.6% native white), and was 12,752 in 1940 by the federal census. Lincoln is the seat of the state institution for feeble-minded children (established in Jacksonville in 1865 and moved there in 1878); Lincoln college (Presbyterian; founded 1865); and the Illinois Odd Fellows' Orphans' home. It is the shipping point for large quantities of grain and other farm products. Principal manufactured products are chinaware, caskets and garments. There are coal mines in the vicinity. Lincoln was founded in 1835 and chartered in 1857. It was named after Abraham Lincoln before he became famous, while he was practising law in Springfield. He helped plan the city, and did the legal work connected with its incorporation. The old courthouse in which he practised is still standing.

LINCOLN, the capital city of Nebraska, U.S.A., and the county seat of Lancaster county, 55 mi. S.W. of Omaha, on Salt creek. It is on federal highways 6, 34 and 77; and is served by the Burlington, the Chicago and North Western, the Missouri Pacific, the Rock Island and the Union Pacific railways. The population was 54,948 in 1920, of whom 7,198 were foreign-born white and 896 were Negroes; and was 81,984 in 1940 by federal census.

The city has a land area of 24.3 sq.mi. on a gentle swell of the prairie, rising from the valley at its western border, and an altitude of 1,167 ft. at the state capitol. It is regularly laid out, with wide streets, beautifully shaded by trees which have all been planted since the founding of the city. Boulevards add to the attractiveness of the residential section, and a zoning plan is in operation. There are 21 city parks with a total of 1,321.25 ac. The assessed valuation of property in 1940 was $98,398,490.

The state capitol, which was completed in 1932, is one of the most impressive architectural achievements of America. From a massive base (of two stories) rises a central tower 400 ft. high, surmounted by the figure of a sower. The architect was Bertram Grosvenor Goodhue; the sculptor, Lee Lawrie; the interior mural decorations are by Augustus Vincent Tack and Miss Hildreth Miere; the inscriptions and symbols were chosen by Hartley B. Alexander. At the western approach to the capitol grounds is a statue of Abraham Lincoln by Daniel Chester French.

The University of Nebraska (*q.v.*) covers 75 ac. on the north edge of the business section and includes Nebraska Memorial stadium, seating 40,000. The state agricultural college covers 320 ac. 2 mi. northeast of the downtown campus. Nebraska Wesleyan university (chartered 1887), Union college (Seventh Day Adventist; 1891), Lincoln Airplane and Flying school and three business colleges are located there. Lincoln is the home of the widely famed Great Cathedral choir, headquarters of the Nebraska Art association and has a fine symphony orchestra.

State institutions include the penitentiary, an insane hospital, a men's reformatory, a home for dependent children and an orthopaedic hospital. The state fair grounds are there, and salt-water bathing is available at Capital beach, in a lake formed from one of the old salt basins.

Lincoln ships large quantities of grain and has one of the country's largest flour mills. Its extensive wholesale and jobbing trade amounted to $33,314,000 in 1939. The retail section is among the midwest's finest; retail trade is estimated at $40,000,000 annually. Factory output in 1939 was valued at $14,496,016.

Leading manufactures are flour, railroad freight cars, meat products, brick and tile and printing materials. One of the world's largest creameries is located there. Bank clearings for 1940 totalled $148,365,267.

In 1838 the salt basins of Lancaster county (smooth floors of hard clay, covered with a glistening layer of crystallized salt) were described by a commissioner sent by the U.S. Government to settle some Indian disputes; and in 1856 they were brought prominently to public notice by Government surveyors, and attracted the first permanent settlers to this region. Several small salt works did a thriving business in the early '60s, but the industry died out when the railroads brought into competition salt produced by the cheaper methods of the eastern manufacturers. In 1886 the State sank a deep test-well, with disappointing results, and no serious efforts have been made since to use the deposits for the production of salt; but one of the largest basins has been converted into a salt lake and developed as a pleasure resort. A small village called Lancaster, which served as the county seat, remained from the early experiments.

In 1867 the first legislature of the State of Nebraska, in the Capital Removal Act, designated a commission to select a site for a new capital city, to be named Lincoln. The commission, on July 29, 1867, decided on this hamlet of Lancaster, a cluster of ten stone and log-houses on the bare prairie, 100 m. from the nearest railroad. From the sale of building lots in September they raised $53,000 (later increased to $78,000) for the construction of the capitol; and in spite of tremendous obstacles (architect, contractors and labour were difficult to find, and all materials had to be hauled by team 40 to 60 m.) they had the building ready for the opening of the next legislature on Jan. 1, 1869. The city was incorporated, and formally declared to be the county seat, in 1869. In 1870 the population was 2,300. The first railroad (the Burlington and Missouri River) reached Lincoln in July 1870, and was soon followed by several others. In 1880 the population was 13,003; in 1890, 55,154; in 1900 it dropped to 40,169; by 1920 it had again reached the high point of 1890. Recent annexations to the city include University Place and Bethany, 1926; College View, 1929; Havelock, home of the Burlington railroad shops, 1930. The most discouraging part of Lincoln's history was 1872–76, when for four successive seasons a scourge of locusts and grasshoppers devastated the region.

Lincoln was the home of William Jennings Bryan from 1887–1921, and there he published *The Commoner.*

LINCOLN HIGHWAY, an American highway 3,384 m. in length, connecting New York with San Francisco, Calif. It was organized in 1913 as a memorial to Abraham Lincoln. Its development has helped advance the State and Federal highway systems of the United States. It is improved, hard or paved throughout and traverses impressive mountain, desert and prairie territories. The highway serves Philadelphia and Pittsburgh, Pa., Akron, O., South Bend, Ind., Chicago, Ill., Cedar Rapids and Council Bluffs, Ia., North Platte, Neb., Cheyenne and Rock Springs, Wyo., Salt Lake City, Utah, Ely, Reno and Carson City, Nev., and Sacramento, Calif.

LINCOLN JUDGMENT, THE. In this celebrated English ecclesiastical contest, the bishop of Lincoln (Edward King) was cited before his metropolitan, the archbishop of Canterbury (Dr. Benson), to answer charges of various ritual offences committed at the administration of Holy Communion in the diocese of Lincoln in Dec. 1887. The question at issue related to certain details in the celebration of Holy Communion: especially whether it was lawful for the celebrant (as the bishop had done) to mix water with the wine in the chalice during the service; to take the eastward position (facing the altar); and to make the sign of the cross in the air. The validity of the archbishop's jurisdiction was upheld by the judicial committee of the privy council, and Dr. Benson heard the case, and in the end pronounced no admonition or condemnation on the bishop. His action was confirmed by the judicial committee. The case is now mainly of historical interest, questions of a more fundamental character having arisen in the interval. (See *The Church and the Law Courts,* under article ENGLAND, CHURCH OF.)

LINCOLNSHIRE, an eastern county of England, bounded north, by the Humber, east by the North sea and the Wash, south-east for 3 m. by Norfolk, south by Cambridge and Northamptonshire, south-west by Rutland, west by Leicestershire and Nottinghamshire, and north-west by Yorkshire. The area is 2,662.9 sq.mi. It is the second largest county in England. The main structural features lie across the county from north to south, the two chief being the limestone escarpment of Oolitic rocks in the west (with the Inferior Oolite, extending from the boundary of Rutland, due north past Lincoln to the Humber, and forming the sharp westward-facing scarp of the Lincoln Edge) and the chalk escarpment of the Wolds in the east. Between these two, in order from west to east, run the parallel belts of Middle and Upper Oolite, consisting of Oxford clay, Corallian and Kimmeridge clay, and a narrow fringe of lower greensand. Beyond the limestone to the west, stretches of plain consisting of (1) Triassic Keuper with gypsum in the Isle of Axholme and the valley of the Trent, with red clay, often worked for bricks and with Rhaetic beds at the junction of the Trias and Lias; (2) a broad stretch of Lias rocks, with valuable ironstone deposits in the Lower Lias. The Middle Lias, which enters the county at Woolsthorpe, has iron ores at Dinton and Caythorpe, and the Upper Lias entering at Stainby, passes by Grantham and Lincoln, where it is worked for bricks. Building stone also is quarried at Lincoln and freestone at Ancaster. The remaining belt is a coastal marshland extending from the Humber and passing into the Fens (formed of silt and peat) in the Isle of Axholme on the north-west, the vale of Ancholme on the north, and most of the country south-east of Lincoln. Whiting is made from the chalk near the Humber and lime is made on the Wolds. Sandy shores on the North sea have given rise to the health resorts of Cleethorpes, Skegness, Mablethorpe and Sutton-on-Sea. Boulder clay is plentiful on the chalk, especially in the north of the county, where there is also much glacial sand. The drainage pattern of the county is simple on the whole, being mostly longitudinal (the Trent—only partly in Lincolnshire—the Ancholme, the Witham— except in its middle section—and the Langworth—a tributary of the Witham). Some streams draining from the chalk are consequent in their lower courses. A striking feature is the gap at Lincoln, through which the Trent waters formerly flowed out, until captured at Newark (Notts.) by a subsequent stream working back from the Humber.

History.—Lincolnshire is not rich in pre-historic finds. There are very few traces of Palaeolithic man in the county, though flint implements of Palaeolithic type have been found at Lincoln. At the dawn of the Metal age, Beaker folk, using the Humber entry penetrated south along the Jurassic belt and built round barrows. In the pre-Roman or Romano-British Iron age, Lincoln was evidently a military site, since bronze clasps often associated with such settlements have been found there. Of the details of the English conquest of the district little is known, but at some time in the 6th century Engle and Frisian invaders appear to have settled in the country north of the Witham, where they became known as the Lindiswaras. In the 7th century the supremacy over Lindsey alternated between Mercia and Northumbria, but few historical references to the district are extant until the time of Alfred. At this period the Danish inroads upon the coast of Lindsey had already begun, and in 873 Healfdene wintered at Torksey, while in 878 Lincoln and Stamford were included among the five Danish boroughs.

The origin of the three main divisions of Lincolnshire is anterior to that of the county itself, and the outcome of purely natural conditions, Lindsey being in Roman times practically an island bounded by the swamps of the Trent and the Witham on the west and south, and on the east by the North sea, while Kesteven and Holland were respectively the regions of forest and of fen.

The shire court for Lincolnshire was held at Lincoln every 40 days, the lords of the manor attending with their stewards, or in their absence the reeve and four men of the vill. The ridings were each presided over by a riding-reeve, and wapentake courts were held in the reign of Henry I. 12 times a year, and in the reign of Henry III. every three weeks, while twice a year all the freemen of the wapentake were summoned to the view of frankpledge or tourn held by the sheriff. The boundaries between Kesteven and Holland were a matter of dispute as early as 1389 and were not finally settled until 1816.

Lincolnshire was originally included in the Mercian diocese of Lichfield, but, on the subdivision of the latter by Theodore in 680, the fen-district was included in the diocese of Lichfield, while the see for the northern parts of the county was placed at "Sidnacester," generally identified with Stow. Subsequently both dioceses were merged in the vast West-Saxon bishopric of Dorchester, the see of which was afterwards transferred to Winchester, and by Bishop Remigius in 1072 to Lincoln. Benedictine foundations existed at Ikanho, Barrow, Bardney and Partney as early as the 7th century, but all were destroyed in the Danish wars, and only Bardney was ever rebuilt. The revival of monasticism after the Conquest resulted in the erection of ten Benedictine monasteries, and a Benedictine nunnery at Stainfield.

The Cistercian abbeys at Kirkstead, Louth Park, Revesby, Vaudey and Swineshead, and the Cistercian nunnery at Stixwould were founded in the reign of Stephen, and at the time of the Dissolution there were upwards of a hundred religious houses in the county.

In the struggles of the reign of Stephen, castles at Newark and Sleaford were raised by Alexander, bishop of Lincoln, against the king. The seizure of Lincoln by Stephen in 1141 was accompanied with fearful butchery and devastation. In the baronial outbreak of 1173 Roger Mowbray, who had inherited the Isle of Axholme from Nigel d'Albini, garrisoned Ferry East, or Kinnard's Ferry, and Axholme against the king, and, after the destruction of their more northern fortresses in this campaign, Epworth in Axholme became the principal seat of the Mowbrays. In the struggles between John and his barons Lincoln in 1216 made peace with the king by surrendering hostages for the payment of a fine of 1,000 marks, but after the landing of Louis the city was captured by Gilbert de Gant, then earl of Lincoln. After his disastrous march to Swineshead Abbey, John journeyed through Sleaford to Newark, where he died, and in the battle of Lincoln in 1217 Gilbert de Gant was captured and the city sacked. At the time of the Wars of the Roses the county, owing to territorial influence, was mainly Lancastrian, and in 1461 the Yorkist strongholds of Grantham and Stamford were sacked to such effect that the latter never recovered. In the Civil War of the 17th century, Lindsey for the most part declared for the king. Lord Willoughby of Parham was a prominent Parliamentary leader, and the Isle of Axholme and the Puritan yeomanry of Holland declared for the parliament. In 1643 Cromwell won a small victory near Grantham, and the Royalist garrisons at Lynn and Lincoln surrendered to Manchester. In 1644, however, Newark, Gainsborough, Lincoln, Sleaford and Crowland were all in Royalist hands, and Newark only surrendered in 1646.

At the time of the Domesday survey there were between 400 and 500 mills in Lincolnshire; 2,111 fisheries producing large quantities of eels; 361 salt-works; and iron forges at Stow, St. Mary and at Bytham. Lincoln and Stamford were flourishing centres of industry, and markets existed at Kirton-in-Lindsey, Louth, Old Bolingbroke, Spalding, Barton and Partney. The early manufactures of the county are all connected with the woollen trade, Lincoln being noted for its scarlet cloth in the 13th century, while an important export trade in the raw material sprang up at Boston. The deforestation of Kesteven in 1230 brought large areas under cultivation, and the same period is marked by the growth of the maritime and fishing towns, especially Boston (which had a famous fish-market), Grimsby, Barton, Saltfleet, Wainfleet and Wrangle. The Lincolnshire towns suffered from the general decay of trade in the eastern counties which marked the 15th century, but agriculture was steadily improving, and with the gradual drainage of the fen-districts culminating in the vast operations of the 17th century, over 330,000 acres in the county were brought under cultivation, including more than two-thirds of Holland. The fen-drainage resulted in the extinction of many local industries, such as the trade in goose-feathers and the export of wild fowl to the London markets. Other historic industries of Lincolnshire are the breeding of horses and dogs and rabbit-snaring.

As early as 1295 two knights were returned to parliament for the shire of Lincoln, and two burgesses each for Lincoln, Grimsby and Stamford. In the 14th century Lincoln and Stamford were several times the meeting-places of parliament or important councils, the most notable being the Lincoln parliament of 1301, while at Stamford in 1309 a truce was concluded between the barons, Piers Gaveston and the king. Stamford discontinued representation for some 150 years after the reign of Edward II.; Grantham was enfranchised in 1463 and Boston in 1552. Under the act of 1832 the county was divided into a northern and southern division, returning each two members, and Great Grimsby lost one member. Under the act of 1868 the county returned six members in three divisions and Stamford lost one member. Under the act of 1885 the county returned seven members in seven divisions; Lincoln, Boston and Grantham lost one member each and Stamford was disfranchised.

Architecture.—At the time of the suppression of the monasteries in the reign of Henry VIII. there were upwards of 100 religious houses; and among the Fens rose some of the finest abbeys held by the Benedictines. The Gilbertines were a purely English order which took its rise in Lincolnshire, the canons following the Austin rule, the nuns and lay brothers that of the Cistercians. These houses were at Alvingham, Catley, Holland Brigg, Lincoln, before the gate of which the first Eleanor Cross was erected by Edward I. to his wife, Newstead in Lindsey, Sempringham, the chief house of the order, founded by St. Gilbert of Gaunt in 1139, of which the Norman nave of the church is in use, Stamford (a college for students) and Wellow. There were nunneries of the order at Haverholme, Nun Ormsby and Tunstall.

The following are a few of the most famous abbeys. Barlings (Premonstratensian), northeast of Lincoln, was founded 1154, for 14 canons. The tower, Decorated, with arcading pierced with windows, and the east wall of the south wing remain. The Benedictine Mitred abbey of Crowland (*q.v.*) existed in 1051. Part of the church is still in use. Thornton abbey (Black Canons) in the north near the Humber was founded in 1139. There remain a fragment of the south wing of the transept, two sides of the decagonal chapter house (1282) and the beautiful west gate-house, Early Perpendicular (1332–1388), with an oriel window on the east. Kirkstead abbey (Cistercian) was founded in 1139. Little remains beyond an Early English chapel of singular beauty.

In the Parts of Lindsey several churches present curious early features, particularly the well-known towers of St. Peter, Barton-on-Humber, St. Mary-le-Wigford and St. Peter at Gowts, Lincoln, which exhibit work of a pre-Conquest type. Stow church for Norman of various dates, Bottesford and St. James, Grimsby, for Early English, Tattershall and Theddlethorpe for Perpendicular are fine examples of various styles.

In the Parts of Kesteven the churches are built of excellent stone which abounds at Ancaster and near Sleaford. The church of St. Andrew, Heckington, is the best example of Decorated architecture in the county; it is famed for its Easter sepulchre and fine sedilia. The noble church of St. Wulfram, Grantham, with one of the finest spires in England, is also principally Decorated; this style in fact is particularly well displayed in Kesteven, as in the churches of Caythorpe, Claypole, Navenby and Ewerby.

The finest churches are principally in the Parts of Holland although the district is composed wholly of marsh land and is without stone of any kind: the churches of the south part of this district probably owe their origin to the munificence of the abbeys of Crowland and Spalding. The church of Long Sutton, besides its fine Norman nave, possesses an Early English tower and spire which is comparable with the very early specimen at Oxford cathedral. Whaplode church also has fine Norman work; the churches of Kirton-in-Holland, Pinchbeck and Weston have good Early English work; for Decorated those at Donington and Spalding should be noted, and for Perpendicular, Gedney, together with parts of Kirton church. Of the two later styles, however, by far the most splendid example is the famous church of St. Botolph, Boston (*q.v.*), with its magnificent lantern-crowned tower or "stump."

There are few remains of mediaeval castles. Those of Lincoln and Tattershall are the most noteworthy, and there are also fragments at Boston and Sleaford. The city of Lincoln is remarkably rich in remains of domestic architecture from the Norman period onward.

Agriculture and Industries.—Lincolnshire is one of the principal grain-producing counties, about 86% of total area of 1,699,791 ac., being under cultivation in 1939. Wheat at 237,579 ac. was the largest grain crop, being greater than that of oats and barley combined; both cattle and sheep are raised in large numbers (244,361 and 472,736 respectively in 1939), and horses have long been famous. Apart from mining, the industries are largely agricultural, and agricultural machinery is made at Lincoln, Boston, Gainsborough and Louth. Iron-smelting at Scunthorpe, and the increase of shipping and of commerce—based on timber from the Baltic and dairy-produce from Denmark—at Grimsby and Immingham, are recent developments. In mediaeval times the coast was important for salt, and the small harbours were much used for fishing. Boston became important in connection with the Hanseatic trade. At the present day, fishing is chiefly carried on by companies owning deep-sea trawlers. In the marshlands stock-raising and dairying are important. There is market gardening on the loamy soils. Bone-crushing, tanning, the manufacture of oil-cake, and rope-making are carried on in various places. Gainsborough has considerable traffic on the Trent, and Sutton Bridge is a lesser port on the Wash. The National Trust owned only 7 ac. in Lincolnshire in 1942.

Communications.—Lincoln was an important meeting place of Roman roads, and today it is a great railway centre. Except for a branch line on the L.M.S. railway from Newark to Lincoln and a joint line of the L.M.S. railway and L.N.E. railway from Sutton Bridge through Spalding to Melton Mowbray (Notts.), the country is served entirely by the L.N.E. railway. The main line from Peterborough to Doncaster passes through the south-west of the county, while a branch line links up Spalding, Boston, Louth, Grimsby, Barton and other places near the coast. From Lincoln lines radiate in all directions to Gainsborough, Barton, Louth and the coast, Boston, Spalding, Stamford, etc. Canals connect Louth with the Humber, Sleaford with the Witham, and Grantham with the Trent near Nottingham; the great rivers and many of the drainage cuts are navigable.

Population and Administration.—The geographical county is divided into three trithings or ridings—the Parts of Holland, Kesteven and Lindsey. Each is a separate administrative county and their areas in square miles are 418.5, 724.2 and 1,520 respectively, with populations estimated in 1938 at 95,560, 114,400 and 427,570. Lincolnshire, though an east coast county, lost only 1% of its population through wartime population movements, caused mainly by evacuation, between Sept. 1939 and Feb. 1941. The Parts of Lindsey contain two county boroughs, Grimsby and Lincoln, 13 wapentakes, 2 sokes and 2 hundreds, besides the liberty of Lincoln. Kesteven, exclusive of the soke and borough of Grantham and the borough of Stamford, has 9 wapentakes; and Holland, 3 wapentakes. The county is in the Midland circuit and is divided into 20 petty sessional divisions, of which 2 are in Holland and 4 in Kesteven. In Lindsey the boroughs of Grimsby and Lincoln have each a distinct commission of the peace and a separate court of quarter sessions, and the municipal borough of Louth has a separate commission of the peace. In Kesteven the municipal boroughs of Grantham and Stamford have each a separate commission of the peace and separate courts of quarter sessions. In Holland, Boston has a distinct commission of the peace. For parliamentary purposes the county is divided into seven divisions, namely, in the Parts of Kesteven, Grantham, Rutland and Stamford, and the parliamentary county of Holland with Boston; in the Parts of Lindsey, Brigg, Gainsborough, Horncastle and Louth, and the parliamentary boroughs of Grimsby and Lincoln, each returning one member.

See *Victoria County History, Lincolnshire;* Thomas Allen, *The History of the County of Lincoln* (2 vols., 1834); C. G. Smith, *A Translation of that portion of the Domesday Book which relates to Lincolnshire and Rutlandshire* (1870); G. S. Streatfield, *Lincolnshire and the Danes* (1884); *Chronicle of the Rebellion in Lincolnshire, 1470,* edit. J. E. Nicholls, Camden Society, *Camden Miscellany,* vol. i. (1847); *The Lincolnshire Survey, temp. Henry I.,* edit. James Greenstreet (1884); *Lincolnshire Notes and Queries* (Horncastle, 1888).

LINCOLN TUNNEL: *see* HOLLAND AND LINCOLN VEHICULAR TUNNELS.

LIND, JAMES (1716–1794), Scottish physician, who has been called the "founder of naval hygiene in England," took his M.D. at Edinburgh in 1748. He was physician to the Royal Naval Hospital at Haslar (1758–83), and then physician to the royal household at Windsor. When Lind went to Haslar scurvy was rife in the navy, and he had as many as 350 cases in a ten-weeks' voyage. As early as 1593 Sir Richard Hawkins had discovered the utility of orange and lemon juice in the sailors' diet. Lind revived it; an admiralty order prescribed the use of lemon juice (1795), and scurvy disappeared from the navy. He also studied typhus (then known as jail fever), recommending disinfection by the smoke of wood; suggested the use of hospital ships for sick sailors in tropical ports; arranged (1761–62) for the distillation of sea-water for drinking purposes; and secured many important and beneficial changes in life on board ship. Lind died on July 13, 1794. His three classical works are: *A Treatise on the Scurvy* (1754); *On the most effectual means of preserving the Health of Seamen* (1757); and *Essay on Diseases of Europeans in Hot Climates* (1768).

LIND, JENNY (1820–1887), the famous Swedish singer, was born at Stockholm on Oct. 6, 1820, the daughter of a lace manufacturer. Mlle. Lundberg, an opera-dancer, first discovered her musical gift, and induced the child's mother to have her educated for the stage; during the six or seven years in which she was what was called an "actress pupil," she occasionally appeared on the stage, but in plays, not operas, until 1836, when she made a first attempt in an opera by A. F. Lindblad. She was regularly engaged at the opera-house in 1837. Her first great success was as Agathe, in Weber's *Der Freischütz,* in 1838, and by 1841, when she started for Paris, she had already become identified with nearly all the parts in which she afterwards became famous. But her celebrity in Sweden was due in great part to her histrionic ability, and her wonderful vocal art was only attained after a year's hard study under Manoel Garcia.

Her first appearance in England was as Alice in Meyerbeer's *Robert le Diable* at His Majesty's Theatre (May 4, 1847). The furore she created was prodigious. She sang in several of her favourite characters, and in that of Susanna in Mozart's *Figaro,* besides creating the part of Amalia in Verdi's *I Masnadieri,,* written for England and performed on July 22. In the autumn she appeared in operas, in Manchester and Liverpool, and in concerts at many provincial centres. At Norwich began her acquaintance with the bishop, Edward Stanley (1779–1849), which was said to have led to her final determination to give up the stage as a career.

After four more appearances in Berlin, and a short visit to Stockholm, she appeared in London in the season of 1848, when she sang in Donizetti's *L'Elisire d'amore* and Bellini's *I Puritani,* in addition to her older parts. At the beginning of the season of 1849 she intended to give up operatic singing, but a compromise was effected by which she was to sing the music of six operas, performed without action, at Her Majesty's Theatre; but the first, a concert performance of Mozart's *Il Flauto magico,* was so coldly received that she felt bound, for the sake of the manager and the public, to give five more regular representations, and her last performance on the stage was on May 10, 1849, in *Robert le Diable.* In 1850, just before leaving for America, she sang the soprano music in *The Messiah* at Liverpool with superb art. She remained in America for nearly two years, being for a great part of the time engaged by P. T. Barnum. In Boston, she married (1852) Otto Goldschmidt (1829–1907), whom she had met at Lübeck in 1850.

For some years after her return to England, her home for the rest of her life, she appeared in oratorios and concerts, and her dramatic instincts were as strongly and perhaps as advantageously displayed in these surroundings as they had been on the stage, for the grandeur of her conceptions in such things as the scene of the widow in *Elijah* and the religious fervour of "I know that my Redeemer liveth," could not have found a place in opera. In her later years she took an active interest in the Bach Choir, conducted by her husband, and not only sang herself in the chorus, but gave the benefit of her training to the ladies of the society. For some years she was professor of singing at the Royal College of Music. Her last public appearance was at Düsseldorf on Jan. 20, 1870, when she sang in *Ruth,* an oratorio composed by her husband.

She died at Malvern on Nov. 2, 1887. The supreme position which she held so long in the operatic world was due not only to the glory of her voice, and the complete musicianship which distinguished her above all her contemporaries, but also the naïve simplicity of her acting in her favourite parts, such as Amina, Alice or Agathe. In these and others she had the precious quality of conviction, and identified herself with the characters she represented with a thoroughness rare in her day. Unharmed by the perils of a stage career, she was a model of rectitude, generosity and straightforwardness, carrying the last quality into a certain blunt directness of manner that was sometimes rather startling.

See S. Dorph, *Jenny Lindiana till hundraårsminnet* (Uppsala, 1919) and *Jenny Linds triumftäg genom nya världen och övriga leonadsöden* (Uppsala, 1918); J. T. H. Norlind, *Jenny Lind;* Scott Holland & W. S. Rockstro, *Jenny Lind the Artist* (London, 1891; abridged, 1893).

LIND-AF-HAGEBY, EMELIE AUGUSTA LOUISE (1878–), British writer, born in Sweden on Sept. 20, 1878, was educated in Stockholm and at Cheltenham college, England. From 1896 onwards she lived in England, and in 1912 became a naturalized British subject. She worked actively for the movement towards the emancipation of women. She was a strong opponent of vivisection, and founded several societies, including the international federation of anti-vivisection and animal protection societies (1909). At the outbreak of World War I her three hospitals for wounded horses were authorized by the French government (the Purple Cross), and two years later she opened a sanatorium for French and Serbian soldiers, and children who had suffered through the war, at Carqueiranne. She became a well-known public speaker, and wrote numerous books and pamphlets on humanitarian subjects.

Her works include *August Strindberg* (1913); *Mountain Meditations* (1917); *Marriage and the New Woman* (1920); *Women's Right to Work* (1920); *Be Peacemakers* (1924); *The Great Fox-Trot* (1938).

LINDAU, PAUL (1839–1919), German dramatist and novelist, the son of a Protestant pastor, was born at Magdeburg on June 3, 1839. He was educated at the gymnasium in Halle, and then studied in Leipzig, Berlin and Paris. Lindau was one of the most brilliant journalists of his day. He began as correspondent to the German press while he was a student in Paris. He founded *Das Neue Blatt* (Leipzig, 1870), and the famous monthly *Nord und Süd* (1878), which he edited until 1904. Many of his contributions to the press were collected in a series of entertaining volumes. He was appointed intendant of the court theatre at Meiningen in 1895, but removed to Berlin in 1899, where he became manager of the Berliner Theater, and subsequently, until 1905, of the Deutsches Theater. *Marion* (1868) was the first of a long series of plays in which he showed a mastery of the stage and a command of witty and lively dialogue. Among the more famous were *Maria und Magdalena* (1872), *Tante Therese* (1876), *Gräfin Lea* (1879), *Die Erste* (1895), *Der Abend* (1896), *Der Herr im Hause* (1899), *So ich dir* (1903), and he adapted many plays by Dumas, Augier and Sardou for the German stage. Five volumes of his plays have been published (1873–88). His work also includes some volumes of short stories, a novel-sequence with the general title, *Berlin,* and many other novels, all of them popular. He died in Berlin on Jan. 31, 1919. *See* his admirable and entertaining *Nur Erinnerungen* (1917).

LINDAU, a town and pleasure resort in the *Land* of Bavaria, Germany, central point of the transit trade between Bavaria and Switzerland, situated on two islands off the northeastern shore of Lake Constance. Pop. (1939) 17,475. On the site now occupied by the town there was a Roman camp, the *castrum Tiberii,* and the authentic records of Lindau date back to the end of the 9th century. In 1274, or earlier, it became a free imperial town. In 1804 it lost its imperial privileges and passed to Austria, being transferred to Bavaria in 1805.

LINDBERGH, CHARLES A. (1902–), American aviator, and the first flyer to make a New York to Paris non-stop flight, was born on Feb. 4, 1902, at Detroit, Mich. When about two months old Lindbergh's parents took him to Little Falls, Minn., where he later graduated from high school. His interests led him to study engineering at the University of Wisconsin for three semesters and to enroll in a flying school in Lincoln, Neb.

On March 19, 1924, he enlisted as a flying cadet in the air service of the War Department at Kelly field, Texas, and in the spring of 1925 was commissioned second lieutenant. In Nov. 1925 he enlisted in the 110th squadron of the 35th Division Missouri National Guards as first lieutenant and in the following November was made a captain in the Officers Reserve Corps. On April 15, 1925, he entered upon his duties as an air-mail pilot on the route from St. Louis to Chicago, and it was while flying this route that he decided to compete for the $25,000 prize offered by Raymond B. Orteig for a New York to Paris non-stop flight.

In St. Louis he found men to finance the building of the plane "Spirit of St. Louis." He left San Diego for New York city, via St. Louis, at 3.55 P.M. Pacific time, on May 10; arrived at Curtiss field, L.I., at 5.33 P.M. on May 12, making a record for an overland flight. At 7.52 A.M. of May 20 he left Roosevelt field, L.I., for Paris, and arrived there, at Le Bourget, at 10 P.M. Paris time, on the evening of the 21st. He was awarded the French cross of the Légion d'honneur, the British royal air force cross and, in the United States, the distinguished flying cross and the Congressional medal. He was promoted to colonel. Following his enthusiastic reception in Washington and New York city, he made an air tour of 78 cities and every state in the union. Upon invitation from President Calles of Mexico he made a non-stop flight from Washington, D.C., to Mexico City Dec. 13–14, 1927. The "good-will" mission continued to Central America, northern South America and the West Indies—in all, 16 countries. For this flight of 7,860 mi. he was awarded the Woodrow Wilson medal and $25,000. He returned to St. Louis on Feb. 13, 1928, and subsequently became chairman of the technical committee of the Transcontinental Air Transport. In 1933 he flew from America to Copenhagen by way of Greenland, Iceland and the Shetland Isles. In 1929 he married Anne Morrow, daughter of Dwight W. Morrow. The kidnapping of their first child, Charles Augustus, Jr., attracted world-wide attention. In 1935 the Lindberghs left the U.S. for England and returned in 1939. Lindbergh resumed his work in the U.S. air corps, but resigned in April 1941 when Pres. Roosevelt criticized his opposition to U.S. intervention in World War II prior to the country's entry into the war. He joined the America First committee in April 1941 and on Dec. 10 of the same year volunteered his services to the U.S. air corps. Later he was associated with the Ford Motor company as a research engineer in war production.

Anne Lindbergh revealed considerable ability in her books *North to the Orient* (1935); *Listen! The Wind* (1938); and *Wave of the Future* (1941). The latter was assailed for its alleged sympathetic views on totalitarianism. Lindbergh wrote *We,* an autobiography (1927).

LINDENTHAL, GUSTAV (1850–1935), American engineer, was born at Brünn, Austria, May 21, 1850, and was educated there, and at Vienna. After some experience in railway and bridge work in Austria and Switzerland, he went to the United States in 1871. He was engineer at the Centennial Exposition, Philadelphia, 1874–77, and then practised in Pittsburgh as consulting engineer in railway and bridge construction till 1890, when he moved to New York City. In 1902–03 he was commissioner of bridges for the City of New York. He designed and acted as consulting engineer for the steel arch bridge spanning the East river at Hell Gate, which was opened for traffic March 1917. With its approaches, it is about 3½ mi. in length, and at the date of completion contained the longest steel arch in the world (1,017 feet). Its cost was approximately $18,500,000.

LINDESAY, ROBERT, of Pitscottie (*c.* 1530–*c.* 1590), Scottish historian, of the family of the Lindesays of the Byres, was born at Pitscottie, in the parish of Ceres, Fifeshire, which he held in lease at a later period. His *Historie and Cronicles of Scotland,* covering the period from 1437 to 1456, the only work by which he is remembered, is described as a continuation of that of Hector Boece, translated by John Bellenden. Sir Walter Scott made use of it in *Marmion.*

The *Historie and Cronicles* was first published in 1728. A complete edition of the text (2 vols.), based on the Laing ms. No. 218 in the University of Edinburgh, was published by the Scottish Text Society in 1899 under the editorship of Aeneas J. G. Mackay. The ms. formerly in the possession of John Scott of Halkshill, is fuller, and, though in a later hand, is, on the whole, a better representative of Lindesay's text.

LINDET, JEAN BAPTISTE ROBERT (1749–1825), French revolutionary, was born at Bernay (Eure), and was an *avocat* at Bernay. Appointed deputy to the Legislative Assembly and then to the Convention, he furnished a *Rapport sur les crimes imputés à Louis Capet* (Dec. 10, 1792), and voted for the death of Louis without appeal or respite. As member of the Committee of Public Safety he successfully organized the food supply of the army in the face of great difficulties. Without being formally opposed to Robespierre, he did not support him, and he was the only member of the Committee of Public Safety who did not sign the order for the execution of Danton and his friends. He opposed the Thermidorian reaction, and defended Barère, Billaud-Varenne the Collot d'Herbois on March 22, 1795. Himself denounced on May 20, 1795, he was defended by his brother Thomas (Constitutional bishop and member of the Convention) but escaped condemnation by the vote of amnesty of the 4th Brumaire, year IV. (Oct. 26, 1795). He was minister of finance from June 18 to Nov. 9, 1799, but refused office under the consulate and the empire. In 1816 he was proscribed by the Restoration government as a regicide, and left France until just before his death on Feb. 17, 1825.

See Amand Montier, *Robert Lindet* (1899).

LINDLEY, JOHN (1799–1865), English botanist and horticulturist, was born Feb. 5, 1799, at Catton, near Norwich, where he was educated. In 1820 he published an original *Rosarum Monographia* with descriptions of new species, and drawings executed by himself, and in 1821 *Monographia Digitalium,* and "Observations on Pomaceae," contributed to the Linnean society. Shortly afterwards he went to London, where, while writing the descriptive portion of the *Encyclopaedia of Plants,* he became convinced of the superiority of the "natural" system of A. L. de Jussieu, as distinguished from the "artificial" system of Linnaeus followed in the *Encyclopaedia.* The conviction found expression in *A Synopsis of the British Flora, arranged according to the Natural Orders* (1829) and in *An Introduction to the Natural System of Botany* (1830). In 1829 Lindley accepted the chair of botany in University college, London, which he retained till 1860. He died at Turnham Green on Nov. 1, 1865.

His works also include *An Outline of the Structure and Physiology of Plants* (1832), *A Natural System of Botany* (1836), *The Fossil Flora of Great Britain* (with W. Hutton, 1831–37), *Flora Medica* (1838), *Theory of Horticulture* (1840), *The Vegetable Kingdom* (1846), *Folia Orchidacea* (1852–59), *Descriptive Botany* (1858). He was editor of the *Botanical Register* and *Gardeners' Chronicle.*

LINDLEY, NATHANIEL LINDLEY, Baron (1828–1921), English judge, son of John Lindley (*q.v.*), was born at Acton Green, Middlesex, on Nov. 29, 1828, and educated at University college school and University college, London. Called to the bar at the Middle Temple in 1850 he began practice in the court of chancery, and became a Q.C. in 1872. In 1875 he was appointed a justice of common pleas, and in pursuance of the changes made by the Judicature Acts, became a justice of the common pleas division of the High Court of Justice, and in 1880 of the queen's bench division. In 1881 he was raised to the Court of Appeal and made a privy councillor; in 1897 he succeeded Lord Esher as master of the rolls, and in 1900 was made a lord of appeal in ordinary, with a life peerage and the title of Baron Lindley. He resigned the judicial post in 1905, and died at East Carlton, near Norwich, on Dec. 9, 1921. Lord Lindley was the last serjeant-at-law appointed. His reputation is mostly a professional one. He was at home throughout the law; a brilliant example of his judgments will be found in *Colls* v. *Home and Colonial Stores* (1904, A.C. 179). He published *An Introduction to the Study of Jurisprudence* (1855), a translation of Thibaut's *System des Pandekten-Rechts: Treatise on the Law of Partnership* (2 vols., 1860), with a supplement in 1862. This work has since been developed into two text-books, *Lindley on Companies* and *Lindley on Partnership.*

See *The Times* (Dec. 12, 1921); *Law Journal* (Dec. 17, 1921); *Dict. Nat. Biog.* (Supp: 1912–21).

LINDLEY, WILLIAM (1808–1900), English engineer, was born in London on Sept. 7, 1808. He was engaged for a time in railway work in various parts of Europe, and then settled in Hamburg, as engineer-in-chief to the Hamburg-Bergedorf railway. His first achievement was to drain the Hammerbrook marshes, and so add some 1,400 ac. to the available area of the city. His real opportunity, however, came with the great fire which broke out on May 5, 1842, and burned for three days. The strong measures he adopted to prevent the spread of the fire, including the blowing-up of the town hall, brought his life into danger with the mob, who professed to see in him an English agent charged with the destruction of the port of Hamburg. Lindley was then appointed consulting engineer to the senate and town council, to the Water Board and to the Board of Works. He constructed a complete sewerage system, and designed, between 1844 and 1848 the water-works of the city, the intake from the Elbe being at Rothenburgsort. In 1846 he erected the Hamburg gas-works; public baths; wash-houses were built, and large extensions to the port executed according to his plans in 1854; and he supervised the construction of the Altona gas and water-works in 1855. Among other services he rendered to the city were the trigonometrical survey executed between 1848 and 1860, and the conduct of the negotiations which in 1852 resulted in the sale of the "Steelyard" on the banks of the Thames belonging to Hamburg jointly with the two other Hanseatic towns, Bremen and Lübeck.

In 1860 he left Hamburg, and during the remaining 19 years of his professional practice he was responsible for many engineering works in various European cities, among them Frankfort-on-the-Main, Warsaw, Pesth, Düsseldorf, Galatz and Basel. In Frankfort he constructed sewerage works on the same principles as those he followed in Hamburg, and the system was widely imitated in Europe and America. He advised the New River Company of London on the adoption of the constant supply system in 1851; and he was commissioned by the British Government to carry out various works in Heligoland, including the big retaining wall "Am Falm." He died at Blackheath, London, on May 22, 1900.

LINDO, MARK PRAGER (1819–1879), Dutch prose writer, of English-Jewish descent, was born in London on Sept. 18, 1819. He settled in Holland, taught English, studied at Utrecht, and made translations from the works of the classic English novelists. He also wrote humorous original sketches and novelettes in Dutch, which he published under the pseudonym of De Oude Herr Smits ("Old Mr. Smits"). Lindo's serious original Dutch writings he published under his own name, the principal one being *De Opkomst en Ontwikkeling van het Engelsche Volk* ("The Rise and Development of the British People," 2 vols, 1868–1874)—a valuable history. Lindo was appointed an inspector of primary schools in the province of South Holland in 1865, a post he held until his death at The Hague on March 9, 1879.

LINDSAY, the family name of the earls of Crawford. The family is one of great antiquity in Scotland, the earliest to settle in that country being Sir Walter de Lindesia, who attended David, earl of Huntingdon, afterwards King David I., in his colonization of the Lowlands early in the 12th century. His descendants divided into three branches, whose heads sat as barons in the Scottish parliament for more than 200 years before the elevation of the chief of the house to an earldom in 1398. The Lindsays held the great mountain district of Crawford in Clydesdale, from which the title of the earldom is derived, from the 12th century till the close of the 15th, when it passed to the Douglas earls of Angus. *See* Crawford, Earls of.

See A. W. C. Lindsay, afterwards earl of Crawford, *Lives of the Lindsays, or a Memoir of the Houses of Crawford and Belcarres* (3 vols., 1843 and 1858).

LINDSAY, SIR COUTTS, 2nd Bart. (1824–1913), English artist, was born on Feb. 2, 1824 and died at Kingston on May 7, 1913. He entered the army, where he commanded the 1st Regt. of the Italian Legion during the Crimean War. Between 1862 and 1874 he exhibited many pictures, and in 1877 founded the Grosvenor Gallery, London, which exhibited the works of the pre-Raphaelite group and other artists outside the academic circle.

LINDSAY, NICHOLAS VACHEL (1879–1931), American writer, was born at Springfield (Ill.), Nov. 10, 1879. In 1897 he entered Hiram college, Ohio, but left after three years to study art in Chicago and New York. For several winters he was a Y.M. C.A. lecturer, and during 1909–10 lectured for the Anti-Saloon League in his native State. Meanwhile he had begun during the summers a series of wanderings on foot which carried him through many States, reciting or singing his own verses like an ancient minstrel, and delivering an occasional lecture in return for food and lodging. He has published *General William Booth Enters Into Heaven, and Other Poems* (1913); *The Congo, and Other Poems* (1914); *Adventures While Preaching the Gospel of Beauty* (1914, prose); *The Chinese Nightingale, and Other Poems* (1917); *The Golden Book of Springfield* (1920, prose); *The Golden Whales of California, and Other Rhymes in the American Language* (1920); *Going-to-the-Sun* (1923); *Going-to-the-Stars* (1926); *Every Soul is a Circus* (1929). He died Dec. 5, 1931.

His *Collected Poems* (rev. ed. 1925) contains autobiographical material. *See* also "Salvation with Jazz" in Carl Van Doren's *Many Minds* (1924) and Stephen Graham's *Tramping with a Poet in the Rockies* (1922).

LINDSAY, NORMAN (1879–), Australian artist, was born at Creswick, Victoria, on Feb. 23, 1879. He began to draw for a Melbourne newspaper at 16, and in 1901 moved to New South Wales. He became the chief cartoonist of the Sydney *Bulletin,* a post which he retained for many years. His chief characteristics are imaginative power, grim strength, marked individuality of style and a certain coarseness. All of these qualities are apparent in his illustrations to Theocritus, Boccaccio, Casanova and Petronius, the best of which have been collected in *The Pen Drawings of Norman Lindsay* (1918). Among his other published works are *Redheap* (1931), *Saturdee* (1933), *Pan in the Parlour* (1934) and *Age of Consent* (1938). He illustrated many books and was the joint founder of the Endeavour Press.

LINDSAY, a town and port of entry of Ontario, Canada, and capital of Victoria county, on the Scugog river, 69 mi. N.E. of Toronto by rail, on the Canadian Pacific and Canadian National railways. Pop. (1941) 8,403. It has steamboat communication, by way of the Trent canal, with Lake Scugog and the ports on the Trent system. It contains saw and grist mills, agricultural implement and other factories.

LINDSEY, BENJAMIN BARR (1869–1943), American judge, was born at Jackson, Tenn., on Nov. 25, 1869. He was educated in the public schools and attended Notre Dame (Indiana) university and the Southwestern Baptist university, Jackson, Tennessee. At the age of 16 he began to earn his livelihood in Denver, continuing his studies in a law office. He was admitted to the Colorado bar in 1894. In Jan. 1899 he was appointed public guardian and administrator of Denver. He was instrumental in securing the passage of the Colorado juvenile court law of April 12, 1899, which led to the reform of juvenile court procedures in treating delinquent children. He was judge of that court from 1900 to 1927, and then moved to California, where he was elected judge of the superior court in 1934. He was an internationally known jurist and lecturer, and was an advocate of "companionate marriage," for which he was widely publicized. He was also the author of the first parental laws in the United States making the juvenile court a parental and family court as well, and also of the "chancery court procedure" in dealing with adult offenders. He wrote *Problems of the Children* (1903); *The Beast* (with Harvey O'Higgins) (1910); *Children in Bondage* (with George Creel) (1914); *Pan-Germanism in America* (1919); *The Doughboy's Religion* (with Harvey O'Higgins) (1920); *The Revolt of Modern Youth* (with Wainwright Evans) (1925); *Childhood, Crime, and the Movies* (1926); *The Companionate Marriage* (with Wainwright Evans) (1927); *The Dangerous Life* (1931), an autobiography; and many brochures on juvenile delinquency, domestic relations and crime. He died in Los Angeles, Calif., March 26, 1943. (*See* CHILDREN'S COURTS.)

LINDSTROM, GUSTAF (1829–1901), Swedish palaeontologist, was born at Wisby in Gotland on Aug. 27, 1829. In 1848 he entered the university at Uppsala, and in 1854 he became interested in the zoology of the Baltic, and published several papers on the invertebrate fauna, and on the fishes. He described the fossils of the Silurian rocks in Gotland; also remains of the fish *Cyathaspis* from Wenlock beds, and (with T. Thorell) a scorpion *Palaeophonus* from Ludlow beds at Wisby. He determined the true nature of the operculated coral *Calceola;* and while he described organic remains from other parts of northern Europe, he worked especially at the Palaeozoic fossils of Sweden. In 1876 he was appointed keeper of the fossil Invertebrata in the State museum at Stockholm, where he died on May 16, 1901.

See obituary (with portrait), by F. A. Bather, *Geol. Mag.* (1901).

LINDUS, one of the three cities of Rhodes, before their synoecism, situated at Vroulia on the east coast with a finely placed acropolis and good natural harbour. Danish excavators have discovered the early temple of Athena Lindia on the Acropolis, and splendid Propylaea, resembling those at Athens; other early temples, rock-inscriptions, a theatre and rock-tombs. The sculptors of the Laocoon are among the priests of Athena Lindia. On the Acropolis is a castle, built like many houses in the town by the Knights of St. John in the 14th century.

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LINE, primarily of thread or cord, a succession of objects in a row, a mark or stroke, a course in any particular direction.

In mathematics several definitions of the line may be framed. The synthetical genesis of a line from the notion of a point is the basis of Euclid's definition, (γραμμὴ δὲ μῆκος ἀπλατές "a line is widthless length"), and in a subsequent definition he affirms that the boundaries of a line are points. The line appears in definition 6 of the *Elements* as the boundary of a surface. Another synthetical definition, also treated by the ancient Greeks, but not by Euclid, regards the line as generated by the motion of a point, and, in a similar manner, the surface was regarded as the flux of a line, and a solid as the flux of a surface. Analytical definitions, although not finding a place in the Euclidean treatment, have advantages over the synthetical derivation. Thus the boundaries of a solid may define a plane, the edges a line, and the corners a point; or a section of a solid may define the surface, a section of a surface the line, and the section of a line the point. The line has only extension and is unidimensional; and the point, having only position has no dimensions.

The definition of a straight line is a matter of much complexity. Euclid defines it as the line which lies evenly with respect to the points on itself. Archimedes defines it as the shortest distance between two points. The definition, "a straight line is one which when rotated about its two extremities does not change its position," is essentially due to Heron of Alexandria (*q.v.*).

In analytical geometry the right line is always representable by an equation, or equations, of the first degree; thus in cartesian co-ordinates of two dimensions the equation is of the form $Ax+By+C=0$, in triangular co-ordinates, $Ax+By+Cz=0$. In three-dimensional co-ordinates, the line is represented by two linear equations. (*See* ANALYTIC GEOMETRY; LINE GEOMETRY; CURVE; CURVES, SPECIAL.)

LINEAL, in law the relationship of persons directly descended from a common ancestor, as distinguished from collateral relationship or consanguinity. *See* COLLATERAL.

LINEAR ALGEBRAS, number systems whose elements combine under addition and multiplication and which are also n-dimensional linear spaces of geometry. The co-ordinates of the points of the space are assumed to be quantities of any field F. (*See* FIELDS for the definition of an arbitrary field and the definition of many other terms used in this article.)

The general n-dimensional linear space over an arbitrary field F may be defined by postulates but may be thought of most simply as any mathematical equivalent of the space consisting of sequences $u=(a_1, \ldots, a_n)$ with elements $a_1, \ldots, a_n$ in F. The elements a_i are called the co-ordinates of u and we call u a *vector* in n-dimensional linear space.

If $v=(b_1, \ldots, b_n)$ we define the sum of the vectors u and v to be $u+v=(a_1+b_1, \ldots, a_n+b_n)$. The elements of F are frequently called *scalars* and we define the *scalar product* $cu=uc$ of a vector u by a scalar c to be $cu=(ca_1, \ldots, ca_n)$.

A set of vectors $u_1, \ldots, u_m$ of a linear space L over F is said to form a *basis* of L if every vector of L can be expressed in one and only one way as a linear combination $a_1u_1+ \ldots +a_m u_m$ with coefficients a_i in F. Then m is the same for all bases of L and is called the *dimension* or *order* of L. It is actually the integer n above.

A subset M of L is said to form a linear *subspace* of L if $au+bv$ is in M for every a and b of F, u and v of M. Then M is a linear space of order $m \leqq n$ over F and M=L if and only if $m=n$.

We are finally ready to define linear algebras. A *linear algebra* A of order n over F is a linear space of order n over F such that the product uv of any two elements of A is in A and the distributive law holds. If $u_1, \ldots, u_n$ form a basis of A over F the products u_iu_j must be in A for $i, j=1, \ldots, n$. Then we may make any linear space into an algebra by prescribing a set of n^3 elements g_{ijk} in F such that $u_iu_j=g_{ij1}\, u_1+ \ldots +g_{ijn}\, u_n$. The remaining products $(a_1u_1+ \ldots +a_nu_n)\ (b_1u_1+ \ldots +b_nu_n)$ may then be obtained by use of the distributive law.

The multiplication constants g_{ijk} which define an algebra are quite arbitrary. When they are all zero the algebra is called a *zero algebra* and every product $uv=0$. An algebra of order one is either a zero algebra or is mathematically equivalent to F itself.

When conditions are imposed on an algebra the multiplication constants are, of course, restricted. We note that all algebras satisfy the commutative and associative laws for addition, the subtraction law, and the distributive law. If the commutative law for multiplication is satisfied we call the algebra a *commutative algebra;* if the associative law for multiplication is satisfied, we call the algebra an *associative algebra,* and if the division law is satisfied we call the algebra a *division algebra.*

Algebras with an infinite basis have been studied but are not of as great interest as the algebras defined above. The major interest in linear algebras to 1934 was in associative algebras, particularly division algebras. However there has been a strong interest in various types of nonassociative algebras after that time.

The simplest example of an algebra is the commutative associative division algebra A of order n over F. These are the algebraic extensions of degree n over F. (*See* FIELDS.) These algebras are generalizations of the special case of the field of all complex numbers considered as an algebra of order two over the field of all real numbers. This algebra is a cyclic field defined by the equation $x^2+1=0$ whose roots are i and $-i$. Its numbers may be represented as vectors (directed line segments from the origin) on the two dimensional Euclidean plane, and the chief geometric advantage of this representation is that the usual pair of formulas for the rotation of axes through an angle θ may be replaced by the complex number product formula $x+yi=(x'+y'i)(\cos\theta+i\sin\theta)$.

Quaternions.—Soon after complex numbers were applied to the study of directed lines in a plane, attempts were made to find numbers for directed lines in Euclidean space of three dimensions. What was desired was a commutative associative division algebra of order three over the field of all real numbers. However, no such algebra exists. Indeed no commutative associative division algebra over the real field exists except the field of complex numbers.

In 1843 Sir William Rowan Hamilton announced his discovery of "quaternions." This is the algebra of order four over the field of real numbers. It has a basis of elements $1, i, j, k$ where 1 behaves as a unity element, that is, $1a=a1=a$ for every element a of the algebra. Also $k=ij=-ji$, $i^2=j^2=-1$ and these relations together with the associative law complete the definition of multiplication.

The reader will have noticed that the algebra is a noncommutative algebra since ij and ji are not equal. It is the only associative division algebra over the field of all real numbers other than that field (an algebra of order one) and the field of all complex numbers.

A linear subspace B of an algebra A is a subalgebra of A if uv is in B for every u and v of B. The algebra of real quaternions defined above (the term "real" indicates that the coefficient field is the field of all real numbers) contains three subalgebras with respective basis $1, i$ and $1, j$ and $1, k$. Each of these algebras is equivalent to the field C of all complex numbers. Indeed if q is any quaternion not a scalar multiple of the quaternion 1 the subalgebra F $[q]$ with basis $1, q$ is equivalent to C.

If F is any field of characteristic not two we may define an algebra with a basis $1, i, j, ij$ such that $ji=-ij$ and $i^2=a$, $j^2=b$, $(ij)^2=-ab$, where a and b are in F. Such an algebra is called a *generalized quaternion algebra.* A *rational* generalized quaternion algebra is a generalized quaternion algebra over the field of all rational numbers. Such algebras have important connections with certain theorems of the elementary theory of numbers. They are division algebras if and only if b is not expressible in the form c^2-ad^2 for c and d in F.

Cyclic Algebras.—In 1905 Leonard Eugene Dickson defined a class of algebras called *cyclic* or *Dickson* algebras. He generalized the quadratic field F $[i]$ of quaternions to be an arbitrary cyclic field $Z=F(x)$ of degree n over F defined by a root x of an equation $f(x)=0$ whose roots are the iteratives $P^i(x)$ of a polynomial $P(x)$. He then imbedded Z in an algebra A of order n^2 over F with a basis consisting of the power products x^iy^j $(i, j=0, 1, \ldots, n-1)$ of two generating elements x and y. Then every element of such an algebra can be expressed uniquely as the formal sum $h_0(x)+h_1(x)y+ \ldots +h_{n-1}(x)y^{n-1}$ where the polynomials $h_i(x)$ are in Z. Two such sums may be multiplied by the use of the distributive law and the formulas

$$y^jh(x)=h[P^j(x)]y^j,\ y^n=g\neq 0\ (j=1, \ldots, n),$$

where g is in F.

Every cyclic algebra is associative and conditions that a cyclic algebra be a division algebra are known.

Crossed Products.—*Crossed products* are further generalizations of quaternions. Instead of a cyclic field Z a normal field defined by a root of an equation $f(x)=0$ is employed. The roots of this equation are then polynomials $P_1(x)=x$, $P_2(x)$, $\ldots$, $P_n(x)$ and $P_i[P_j(x)]=P_k(x)$ for some k. The crossed product is now an algebra whose elements are uniquely expressible in the form $h_1(x)y_1+h_2(x)y_2+ \ldots +h_n(x)y_n$ such that

$$y_jh(x)=h[P_j(x)]y_j,\ y_iy_j=g_{ij}(x)y_k,$$

where the $g_{ij}(x)$ are all not zero and are in Z. The quantities g_{ij} are not arbitrary in the sense that the algebra will not even be associative unles certain restrictions are imposed on them. Crossed products of order 16 have been constructed which are associative division algebras and which are not cyclic algebras.

Direct Sums and Products.—If M and N are linear subspaces of a linear space L and every element of L is uniquely expressible as a sum $u+v$ where u is in M and v is in N we call L the sum of M and N and write L=M+N. The order of L is the order of M plus the order of N. If an algebra A=B+C where B and C are subalgebras of A such that $uv=vu=0$ for every u in B and v in C we call A the direct sum of B and C and write $A=B\oplus C$. We call B and C the components of A. The result may be generalized to direct sums $B_1\oplus B_2\oplus \ldots \oplus B_t$.

An algebra A is called the direct product of two of its subalgebras B and C and we write $A=B\times C$ if every element of A can be expressed as the sum $b_1c_1+ \ldots +b_rc_r$ of a finite number of terms b_ic_i with b_i in B and c_i in C, the products $bc=cb$ for every b of B and c of C, and the order of A is the product of the order of B by the order of C. The concept of a direct product has turned out to be a very important tool in the theory of algebras. A notable result is that the direct product of two cyclic algebras of relatively prime orders is a cyclic-algebra.

Matric Algebras.—The set of all n-rowed square arrays (matrices) with elements in F forms an algebra M of order n^2 over F. It can be shown that the matrices e_{ij} with one in the i-th row and j-th column and zeros elsewhere form a basis of M and that multiplication of matrices is defined by

$$e_{ij}e_{jk}=e_{ik},\ e_{ij}e_{tk}=0\ (j\neq t,\ i,\ j,\ k,\ t=1,\ldots,n).$$

This associative algebra is called the *total matric* algebra of degree n over F.

A cyclic algebra with $g=1$ is a total matric algebra. A crossed product with all the quantities $g_{ij}=1$ is a total matric algebra. If the coefficient field of the real quaternion algebra is extended to be the complex field the algebra becomes a total matric algebra of degree two. The direct product of a total matric algebra of degree n and a total matric algebra of degree m is a total matric algebra of degree nm.

Every algebra A can be represented by an equivalent subalgebra of the total matric algebra whose degree n is either the order of A or one more than that order. Thus the theory of linear associative algebra may be regarded as a part of the theory of matrices.

The Wedderburn Theory.—A linear subspace M of an algebra A is called an ideal of A if ma and am are in M whenever a is in A and m is in M. Hence an ideal consists either of zero alone and is the zero ideal, or is a subalgebra of A with the property that when we multiply any element of the subalgebra by an element in the main algebra the product falls back into the subalgebra.

An algebra N is called a nilpotent algebra if there is an integer k called the index of N such that every product of k elements of N is zero and at least one product of $k-1$ elements of N is not zero. We call an ideal a nilpotent ideal if it is a nilpotent algebra and an ideal of A.

The radical of an algebra A is the nilpotent ideal of A having largest order. It can be shown to contain all nilpotent ideals of A.

An algebra is called a semisimple algebra if its radical is the zero ideal. It is called a simple algebra if it is not a zero algebra of order one and if its only ideals are itself and the zero ideal.

In the years before 1907, the field of reference for nearly all work on linear algebras was either the field of all real numbers or the field of all complex numbers. The subject seemed to be nearly devoid of interest when the 1907 paper of Joseph Henry MacLagen Wedderburn on the structure of algebras over an arbitrary nonmodular field appeared. He proved the following results:

Every linear associative algebra A over a nonmodular field F is either semisimple or nilpotent or is expressible as the sum K+N of its radical N and a semisimple algebra K. Any two determinations of K are equivalent.

Every semisimple algebra K is expressible as the direct sum of uniquely determined simple components.

Every simple algebra S is expressible as a direct product M×D of a total matric algebra M and a division algebra D. Any two determinations of M, D are equivalent.

The latter two theorems hold also for a modular field, and the first theorem holds under an additional hypothesis. The results of Wedderburn gave new life and interest to the subject of linear algebras. It essentially reduced all questions on the structure of algebras to those on the multiplicative relations of the algebras K and N, the structure of nilpotent algebras, and the structure of division algebras. Major emphasis has always been placed on the last topic since such algebras are much closer to the number systems of elementary algebra.

Central Simple Algebras and Division Algebras.—The centre of a simple algebra S is the set C of all elements c in S such that $cs=sc$ for every element s of S. Then C is a field and S may be expressed as an algebra over C. If C=F we call S a central simple algebra. There is no need to consider anything but central simple algebras since we may always select the centre as our reference field F.

Total matric algebras are central simple. The direct product of two central simple algebras is central simple. The order of a central simple algebra S is the square of an integer n called the degree of S. Write S=M×D where M is a total matric algebra and D is a division algebra. Then the centre of S is the centre of D and S is central simple if and only if D is a central division algebra.

If S=M×D and T=M_0×D where M and M_0 are total matric algebras and D is a division algebra the algebras S and T are said to be similar. Every central simple algebra is similar to a crossed product. This vital theorem implies that we may theoretically construct all division algebras by constructing all crossed products and then removing total matric algebras as direct factors.

All central division algebras of degree two are generalized quaternion algebras and hence cyclic; all of degree three are also cyclic. All central division algebras of degree four are crossed products and need not be cyclic algebras. It is not yet known whether or not there exist central division algebras of degree five over an arbitrary field F which are not cyclic algebras.

The most remarkable theorem in the theory of division algebras is the stating that all central division algebras over an algebraic number field are cyclic algebras. This was proved in 1932 by Abraham Adrian Albert, Richard Brauer, Emmy Noether and Helmut Hasse as a consequence of algebraic theorems of Albert, Brauer and Noether and algebraic number theorems of Hasse and his students (notably W. Grunwald).

Riemann Matrices.—If $f(u_1,\ldots,u_p)$ is a meromorphic function of p independent complex variables $u_1,\ldots,u_p$ with $2p$ independent period systems these systems form a period or Riemann matrix

$$W=(w_{jk})\ (j=1,\ldots,p;\ k=1,\ldots,2p).$$

Let W′ be the result of interchanging the rows and columns of W and $\overline{W}'$ be the result of then replacing each element of W′ by its complex conjugate. Then W is characterized by the existence of a rational skewsymmetric matric C such that $WC\overline{W}'=O$, and $\sqrt{-1}\,WC\overline{W}'=(g_{hk})$ for numbers g_{hk} such that

$$x_1g_{11}\bar{x}_1+\cdots+x_h\,g_{hk}\bar{x}_k+\cdots+x_{2p}g_{2p,\,2p}\bar{x}_{2p}$$

is positive for all complex numbers $x_1,\ldots,x_{2p}$.

An important problem in the theory of period matrices with applications to algebraic geometry is that of determining all $2p$-rowed square matrices D with rational elements such that EW=WD where E has p rows of complex number elements. The set of all such matrices D then forms a linear associative algebra over the field of all rational numbers called the multiplication algebra of W.

The properties of a Riemann matrix W are such that it may be replaced at any time by an isomorphic matrix gWG where g and G are nonsingular matrices, g has complex elements, G has rational elements. The multiplication algebra of W is always semisimple and is a division algebra if and only if W is pure, that is, not isomorphic to a Riemann matrix

$$\begin{pmatrix} W_1 & O \\ O & W_2 \end{pmatrix},$$

where W_1 and W_2 are Riemann matrices, the zeros are matrices with elements all zero. This result due to Henri Poincaré reduces the study of multiplication algebras to the multiplication algebras of pure Riemann matrices.

The centre of the (division) multiplication algebra of a pure Riemann matrix is a field K. Then K may be equal to F where F=R(y), R is the field of all rational numbers, $f(y)=O$, the complex roots of $f(y)=O$ are all real numbers $y_1,\ldots,y_t$. This F is what is called a totally real field. If X=F the only possible multiplication algebra of a pure Riemann matric of this kind is either F or a generalized quaternion algebra over F. If K≠F then K=F(x) where $x^2=q$ in F, $q(y_1),\ldots,q(y_t)$ are all negative. In this case the multiplication algebra is a cyclic algebra of arbitrary degree n over K defined by a cyclic field which is the direct product of K and a totally real cyclic field of degree n over F.

Nonassociative Algebras.—The theory of nonassociative algebras is a subject containing many theories each as elaborate as the theory of associative algebras. Among these perhaps the most important is the theory of Lie Algebras. These are algebras connected with the theory of continuous groups. Nonassociative algebras all have some properties in common with associative algebras and the Wedderburn theory can be applied to yield some results on nonassociative algebras.

Nonassociative division algebras are of great interest and the theory of real nonassociative division algebras has some importance for topology (*q.v.*). It is known that the order of every division algebra over the field of all real numbers is a power of two and a division algebra of order eight (necessarily nonassociative) was constructed by Arthur Cayley in 1843. This algebra consists of elements $a+bw$ where a and b are quaternions. If $a=a_1+a_2i+a_3j+a_4k$ define $\bar{a}=a_1-a_2i-a_3j-ak$. Then the Cayley algebra is defined by the multiplication law $(a+bw)\ (c+dw)=(ac-\bar{d}b)+(da+b\bar{c})w$. The algebra is not associative since $i(jw)=(\bar{i}\bar{j})w=-(ij)w$. It is not yet known whether or not there exist division algebras of order 16 or n>16 over the real field.

Bibliography.—For a complete exposition of the modern theory of associative algebras *see* A. A. Albert, *Structure of Algebras* (1939) with the necessary preliminary theory presented in his *Modern Higher Algebra* (1937). *See* also M. Deuring, *Algebren* (Berlin, 1935) and N. Jacobson, *Theory of Rings* (1943). Applications to the theory of numbers are given in L. E. Dickson, *Algebren und ihre Zahlentheorie* (Zurich, 1927). For the pre-Wedderburn special theories *see* J. B. Shaw, *Synopsis of Linear Associative Algebra* (1907), as well as L. E. Dickson, *Linear Algebras* (1914). For properties of general non-associative algebras *see* A. A. Albert's "Non-Associative Algebras," *Annals of Mathematics,* vol. 43 pp. 685–723 (1942). (A. A. At.)

LINE ENGRAVING, the process of incising lines in a metal plate from which it is intended to take an impression or print. It differs from other reproductive process in that: (1) the engraved line is that part which is printed, *i.e.,* it is intaglio as opposed to surface printing (employed in woodcut, *q.v.*); (2) the line is incised without the use of chemical action (employed in

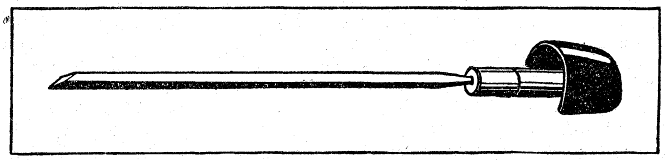


FIG. 1.—THE BURIN OR GRAVER USED FOR INCISING LINES INTO THE METAL PLATE

etching, *q.v.*); (3) the line is incised with a burin or graver (fig. 1), a sharp chisel-like tool of quadrangular section, which is pushed *forward* and removes a small shaving, leaving the edges at the furrow comparatively clean (as opposed to drypoint [*q.v.*], where the line is scratched by a needle drawn towards the operator, which in its passage leaves minute ridges on either side of the line, called burr). In line engraving the infinitesimal burr which is left by the graver (shown enlarged in fig. 2) is removed (as in fig. 3) by a sharp instrument called a scraper (fig. 4), whereas the effect produced by the burr is of the essence of drypoint.

The method of printing from an engraved plate is the same as from an etched plate. (*See* ETCHING.)

HISTORY AND TECHNIQUE

There is very little doubt that engraving was first practised north of the Alps, but at what place or at what exact time must remain a matter of uncertain conjecture. That it was evolved in the workshops of the goldsmiths, subsequently to the more obvious process of woodcut, is generally admitted; a date somewhere between 1410 and 1430, and a place somewhere between the Alps and the North sea, in the basin of the Rhine, may be regarded as probable. The earliest engravings have generally been considered to be those of an artist named, from the subject of his most striking work, the Master of the Playing Cards. The place where this engraver, who was almost certainly a goldsmith, worked was probably South Germany or Switzerland. Engraving, in his hands, was already an elaborate medium, presupposing a previous development of some years. The Master of the Flagel-

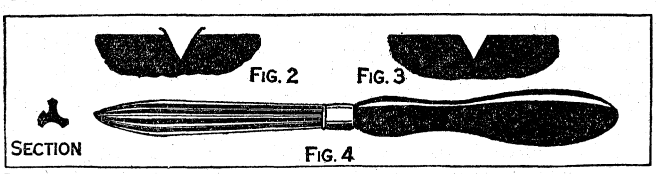


FIG. 2.—ENLARGEMENT SHOWING BURR LEFT BY THE GRAVER
FIG. 3.—ENLARGEMENT SHOWING ENGRAVED LINE AFTER BURR HAS BEEN REMOVED BY A SCRAPER
FIG. 4.—THE SCRAPER

lation of 1446, the first engraving to bear a date, worked in a very similar style and may be assumed to be the pupil of the Master of the Playing Cards. Contemporary with the latter, or possibly even earlier, is an engraver who worked in the Netherlands or Burgundy, known as the Master of the Death of Mary. His ideas of distance and perspective were less advanced than those of his German contemporary, but this may have been an individual weakness not necessarily implying an earlier date. There were other engravers working about the same time or a little later whose work can be distinguished and localized in Burgundy or Flanders.

With the Master who signed with the initials E.S., and some of whose works are dated 1466 and 1467, engraving in Germany had reached a further stage of development. The dates on his engravings mark the end of what was probably a long career, and his earlier works show his derivation from the Master of the Playing Cards. The number of his surviving engravings, something over 300, implies that he was, at any rate, primarily an engraver by profession, and the influence of his style and technique on all subsequent engraving north of the Alps and even in Italy, can hardly be exaggerated. Martin Schongauer of Colmar (d. 1491) clearly derives from the Master E.S., and may even have been his pupil. He has developed from E.S.'s still rather tentative technique a regular system of cross hatching admirably suited to his purposes, and the precision and delicacy of his technical equipment, combined with the distinction and real power of his design, go to make his engravings among the most beautiful achievements of the 15th century. Contemporary with Schongauer, and the only engraver of the period at all comparable to him in importance, is the anonymous artist known as the Master of the Hausbuch (or of the Amsterdam cabinet), who probably worked somewhere in the neighbourhood of Mainz and is known as a painter and draughtsman; he was presumably, unlike Schongauer, only secondarily an engraver. His work has almost the freedom and some of the character of drypoint and is very different in style from Schongauer's.

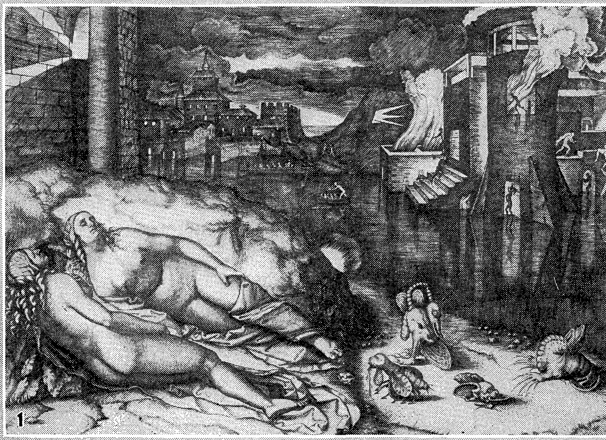
The last quarter of the 15th century in Germany is a period prolific in engravers. Schongauer's immediate scholars and imitators, whose names or initials it is not necessary to enumerate here, are numerous. The course of engraving in the Netherlands after the middle of the 15th century runs more or less parallel with that in Germany, though there are no artists of equal importance with E.S. and Schongauer.

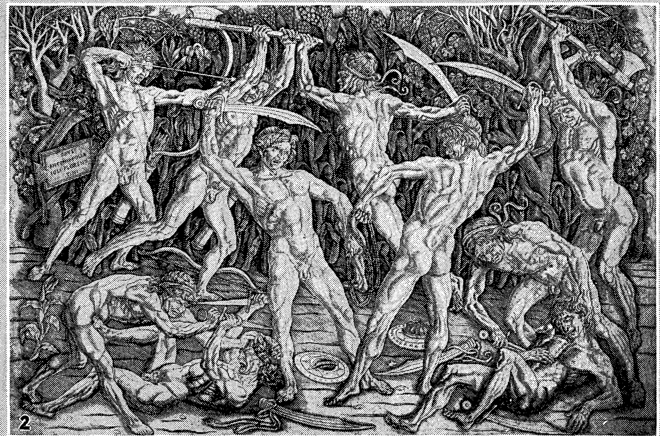
Albrecht Dürer of Nuremberg (1471–1528) who, though not actually Schongauer's pupil as an engraver, is his virtual successor, carries on the Gothic tradition and later develops it, in contact with the Italian renaissance and by the power of his own fantastic and thoughtful temperament, into that grand and most significant expression of the Teutonic genius which we recognize in such engravings as the "Knight, Death and the Devil," the "Melancolia" and the "St. Jerome." Dürer was more than an engraver, but it was in this medium, perhaps, that his genius found the most perfect expression; he must be considered in view of this absolute fitness of means to expression as one of the greatest, if not the greatest, of the world's engravers.

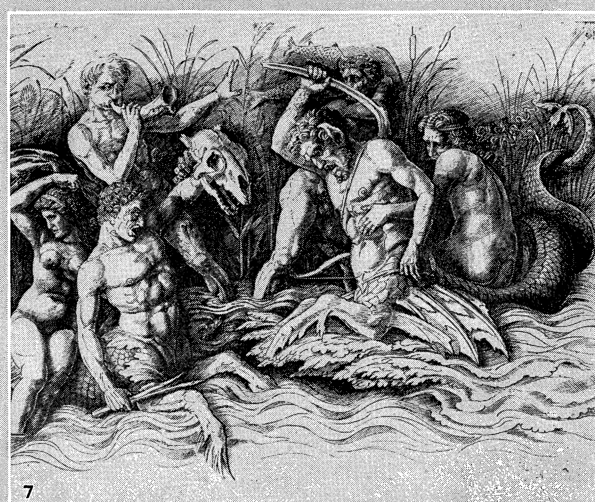
Lucas van Leyden (1494–1533) in Holland, was in his own time placed on a level with Dürer, but posterity will hardly endorse this contemporary view, though his earlier engravings, beginning with the "Mahomet and the Monk Sergius" dated 1508 in his 15th year, have a naïve directness and lucidity of expression which are admirable. His engraving further marks an increase in the delicacy of tone values, which even Dürer had not attained. His later work shows a surrender, first to the influence of his great German contemporary, then to that of Raphael's works as interpreted by Marcantonio Raimondi.

Italy.—Vasari's statement that the art of engraving was invented by Maso Finiguerra about the year 1460 has long been disproved. Not only, as we have seen, was engraving known and practised north of the Alps some decades earlier, but even in Italy itself examples dating from at least ten years before Finiguerra's alleged discovery, can be found. These earliest Italian engravings, which emanate most probably from the workshops of Florentine goldsmiths, are in marked contrast to contemporary German productions, showing a much lower level of technical skill both in the actual engraving and in the printing. A first small group of Florentine engravings dating from about 1450 was succeeded by another group which may with very great probability be associated with the name of Maso Finiguerra (1426–1464). There is every reason to credit the tradition that he was an engraver, and the style of this second group is closely related to that of works in intarsia authenticated as his, and to that of a large group of works in niello (*q.v.*), an art of which he was reputed to be the greatest master. Closely connected with, and probably executed in Finiguerra's workshop after the master's death, are a number of

LINE ENGRAVING







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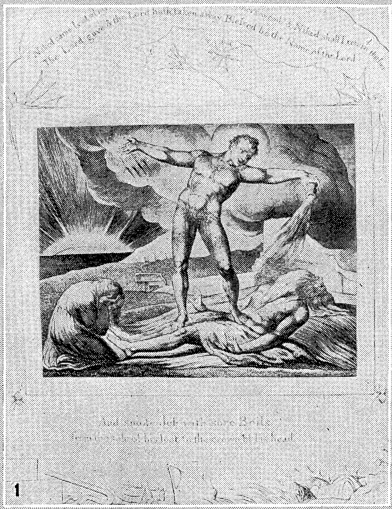
EARLY ENGRAVINGS FROM ITALY AND THE COUNTRIES NORTH OF THE ALPS

1. "Raphael's Dream" by Marcantonio Raimondi (*c.* 1480–*c.* 1530), an Italian artist who did much of his best work in association with Raphael between 1510 and 1520
2. "Battle of the Nudes," the only engraving by the Florentine painter and sculptor, Antonio Pollaiuolo (1429–98)
3. Study by the artist known as "The Master of the Playing Cards," generally considered to be the first engraver. He probably worked in South Germany or Switzerland between 1410 and 1430
4. Landscape after Rubens by *Schelte a Bolswert* (*c.* 1586–1659), one of the best of the engravers in the Rubens school
5. "St. Jerome in his Study," engraved in 1514 by Albrecht Dürer of Nuremberg (1471–1528)
6. "Joseph in Prison" by Lucas van Leyden (1494–1533), a Netherlander whose work is marked by naïve directness and delicacy of tone value
7. The right portion of the frieze, "The Battle of the Sea Gods," by Andrea Mantegna (1431–1506), Italian engraver and painter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LINE ENGRAVINGS OF THE 15TH TO THE 20TH CENTURY

1. Illustration by William Blake (1757–1827) for the book of Job. 2. "Les Adieux" engraved (1777) by N. de Launay, the younger, after a design by J. M. Moreau, the younger (1741–1814). 3. One of the 300 engravings by the Master E. S., 15th century, German. 4. "A Woman of Scanno" by Robert Austin (1895–   ), English. 5. "Mercury and Argus" engraved by J. T. Willmore (1800–63) after J. M. W. Turner (1775–1851). 6. "The Nativity" by Martin Schongauer (*c.* 1446–1488), German. 7. "Frockas, Count de Feria" one of the series known as Van Dyck's "Iconography." Engraved by Paul Pontius (1603–58). 8. "The Cumaean Sybil" by Andrea Mantegna (1431–1506), Italian. 9. "Louis II., Prince de Conde" Aug. 1662, engraved by Robert Nanteuil (1623–28), French

other engravings, such as the series of the "Prophets and Sibyls." These, with the engravings actually attributed to Finiguerra, are usually grouped together as Florentine engravings in the Fine Manner as opposed to a more important group distinguished as in the Broad Manner. These, which are mostly later in date than the fine manner prints, some being copies from the latter, aim at reproducing the effect of pen drawings and derive their inspiration in part from Botticelli. Baccio Baldini who, Vasari states, engraved Botticelli's designs, may be the engraver of some of them.

The first great Florentine painter actually to use the graver himself was Antonio Pollaiuolo; his only engraving, the "Battle of the Nudes," is stylistically to be included in the group of prints in the broad manner. In Andrea Mantegna (1431–1506), Italy produces her first really great engraver, great rather as an artist than as a craftsman. The "Virgin and Child," probably one of his earlier works, the great Entombment and the frieze of the "Battle of the Sea Gods" are as noble expressions of the great painter's genius as any of his pictures. A whole group of engravers was inspired by Mantegna and worked after his designs. Their work owes most of its worth to Mantegna, though they are competent workmen in the same manner. No greater contrast could be found with Mantegna's style than that of Jacopo de' Barbari (d. after 1512), a Venetian, who assimilated the northern technique of engraving and used it to express a rather charming vein of his own.

By the beginning of the 16th century we find quite a number of known engravers working in the north of Italy, such as Benedetto Montagna of Vicenza (about 1470 to after 1540), who continues the style of his more important father, the painter Bartolommeo, the gifted Giulio Campagnola in Venice (about 1482 to after 1514), whose work, executed in a curious dot manner akin to the later stipple, shows the nearest approach in engraving to the effects Giorgione was aiming at in painting, and others.

But it is to Rome by way of Bologna that we must now turn. Marcantonio Raimondi (*c.* 1480–*c.* 1530), trained in the workshop of the goldsmith-painter, Francia, in the latter city, at first engraved solely after drawings by or in the style of his master. Marcantonio's powers and his technique gradually improved with study and by copying Dürer and Lucas van Leyden, and after a stay in Florence and Venice he betook himself about 1510 to Rome. Here he came into contact with Raphael, who supplied the engraver with sketches from which to work. It is this contact which has given to Marcantonio his enormous, perhaps exaggerated reputation. We possess Raphael's drawings for "The Massacre of the Innocents," Marcantonio's most famous engraving, and can consequently judge of it not only on its merits, but in relation to Raphael's conception, and it stands the test triumphantly. With Raphael's death, in 1520, the life went out of Marcantonio's work; he continued to engrave after his paintings, but there is an obvious deterioration.

Sixteenth Century Engraving.—The influence exercised by Raphael, especially through the engravings made by Marcantonio and his followers, over European art south and north of the Alps, can hardly be exaggerated, though, in Germany, the victory of the Raphaelesque was not so overwhelming or so sudden. The so-called Little Masters, the two Behams, Bartel (1502–1540) and Hans Sebald (1500–1550) and George Pencz (*c.* 1500–1550) of Nuremberg, together with Jacob Binck (d. about 1569) and Heinrich Aldegrever (1502–after 1555) continued the tradition of original engraving, along the lines which Dürer had inaugurated, and added something to the sum of the engraver's achievement, and in Ratisbon Albrecht Altdorfer (*c.* 1480–1538), of a previous generation, was the chief exponent of a quite individual style. But with about the year 1550, engraving, as well as the other arts in Germany, has passed its prime and the second half of the century is a decline, redeemed by fewer and fewer works of originality.

With the middle of the century engraving in the Netherlands has become commercialized. Engravers are employed by publishing firms, like that of Jerome Cock at Antwerp, to reproduce works, Netherlandish and Italian alike, for which there appears to be a demand. Even works engraved by Italians are published in the Netherlands, while Netherlandish engravers at the same time work in Italy, so that the sharp lines formerly delimiting the national styles are blurred. The tendency is for the technique of Italian engraving, which from the first owed something to northern models, to assume an even more northern character, while the influence of Italy is a general one on all northern art and only incidentally on engraving. The output of engraving in what is now Belgium, especially in Antwerp, during the two middle quarters of the century is enormous, but its character uninteresting; after about 1570 the centre shifts to Holland and it is the school of Hendrik Goltzius, Jacob Matham and Jan Saenredam, who continue and exaggerate the mannerisms of Lucas van Leyden's later style, which is most characteristic of the period and has the most influence on the subsequent development of engraving.

In Italy the school which Marcantonio had founded comprised a number of skilful engravers who continued the work of popularizing the paintings of Raphael and his pupils. But it was the Marcantonio in his latest and least satisfactory phase, who was their model, and the pupils rather than Raphael himself their inspiration. By about 1560 the art is mainly represented in the persons of foreign engravers like Cornelius Cort, and it is in this school that Lodovico Carracci and other Italian artists were trained.

In France, the 16th century produced one outstanding artist of small accomplishment as an engraver, but a remarkable genius, Jean Duvet (1485–*c.* 1561), and a group of engravers working at Lyons in the first half of the 16th century produced work of some decorative charm, while the portrait engravers foreshadow the great school of portrait engraving that followed in the 17th century.

The Seventeenth Century.—By the beginning of the 17th century engraving has come definitely to be regarded as a reproductive medium. Original engraving is now an exceptional phenomenon. Generally speaking, however, during this and the succeeding centuries the engravers are either independent or employed by publishing firms to engrave after miscellaneous artists, some living and some deceased. A feature of the 17th century is the increasing popularity of portrait engraving, which now became practically the most important branch of the art. (*See* SCULPTURE: *Portrait.*)

The engravers formed in the school of Rubens derive technically from Goltzius and his successors. Their brilliant but formal and inelastic technique, though sponsored by the master himself, was, it must be admitted, unsuited for the rendering of the spontaneity and exuberance of Rubens. The engravings are, in fact, dull, certainly the one fault of which Rubens himself could not be accused. But the best of these engravers, Pieter Soutman (1580–1657), Lucas Vorsterman the elder (1595–*c.* 1675), and his pupil, Paul Pontius (1603–1658), and the brothers Boëtius (*c.* 1580–1634) and Schelte (*c.* 1586–1659), a Bolswert, are admirable engravers in their way. Some of these also contributed to the famous series of engravings known as Van Dyck's *Iconography*. Eighteen of these plates were in the first place etched by Van Dyck himself, to be finished in some examples but not improved by the regular engravers. These elaborated plates suffer in contrast to Van Dyck's masterly etchings, but they are, in fact, sound examples of engraving, and exercised a considerable influence on subsequent engravers of portrait. In Holland, at the same time, an interesting and important school of portrait engraving came into existence, which was not without influence on the French school of engravers.

It was in France, and mainly in the special branch of portrait, that engraving in the 17th century attained its greatest perfection. The 16th century Netherlandish style of portrait engraving practised by T. de Leu, Leonard Gaultier and others, survived into the beginning of the 17th century. It was the influence of painting as practised by Rubens, Van Dyck and Philippe de Champaigne, which altered the conception of portrait painting, and consequently of portrait engraving. The earliest engravers to show the new influences at their fullest extent were Jean Morin (d. 1650) and Claude Mellan (1598–1688), though the former's work is mainly etched. Mellan, in particular, founding his technique on that of the engravers of the Italian school, evolved a very distinctive and effective style from which cross-hatching was entirely eliminated, and which depended on the variation in the breadth of the individual parallel lines. Robert Nanteuil (1623?–1678), unlike Morin and Mellan, not only engraved, but himself drew the vast majority of his portraits, which adds greatly to their liveliness and lifelikeness. His style, deriving from that of Mellan and the engravers of the school of Rubens in the first place, was later improved by the addition of elements borrowed from engravers like Morin. He models his faces in a series of small wedge shaped strokes, cunningly contrived to reproduce the desired texture. Gerard Edelinck (1640–1707), though lacking Nanteuil's extraordinary sincerity, is an engraver of great ability, and his interpretation of pictures by Lebrun and portraits by Rigaud and Largillière are typical examples of the art of the *grand siècle* at its *apogée,* while Antoine Masson (1636–1700) may be regarded as the third great portrait engraver of the century.

The 17th century in England produced one engraver of a merit, not comparable to that of Nanteuil, but still considerable, William Faithorne the elder (about 1616–1691), whose models are Claude Mellan, and later Nanteuil. But line-engraving in England was superseded in popularity towards the end of the century by the newly-invented process of mezzotint (*q.v.*), and Faithorne formed no school and had few successors of lasting influence.

The Eighteenth Century.—The pre-eminence of French engraving in the 17th is still more marked in the succeeding century. France has now become the artistic centre of Europe. The technique developed by Gerard Edelinck and Gerard Audran is continued and, if possible, further refined by the Drevet family, their scholars and successors, until engraving has been reduced to an almost mechanical formula, perfect in its way, but without life or individuality.

Portrait painting is not considered, however, as the most important product of the 18th century. It is in the engraving of society *genre* that we have to seek what is newest and most typical of the century. Watteau's elegant world of society, its most characteristic creation, is faithfully reflected in contemporary engraving. A number of skilful engravers were employed by Watteau's friend, Julienne, to engrave the master's complete works after his death. These engravers succeed in rendering in line the shimmer and the grace of Watteau's painting, as far as this was translatable.

The style of engraving which was formed in the interpretation of Watteau's works was obviously well adapted for illustration, which now begins to have an importance which it had not enjoyed since the 16th century. There arose at the same time, in cultivated and fashionable society, a new desire to possess beautifully illustrated volumes, and new editions of standard works illustrated by the leading engravers of the day found a ready sale. It was the professional engravers in the Watteau tradition who were employed not only to engrave but also to design these illustrations. In many, if not in most cases, indeed, pressure of work made it impossible for them actually to engrave what they had designed, and they were necessarily forced to employ others to do this. But even in the latter case so close is the connection between the designer, who is an engraver himself, and the executant engraver, that engraving has ceased to be merely reproductive and has again become a medium of direct and original expression. A characteristic of reproductive line-engraving from the beginning of the 18th century onward (it is especially important in the case of the French illustrators and of the engravers of the Turner school) is the use of etching for the preliminary laying in of the design subsequently gone over and completed with the graver. The number of able illustrators who worked in France during the latter part of the century is very large and their excellence extremely uniform. Two artists may be singled out for especial mention, J. M. Moreau the younger (1741–1814), and Augustin de St. Aubin (1736–1807).

Italy, in the 18th century, has nothing to show in engraving at all comparable. The most original work was that produced in Venice by Giovan Marco Pitteri (1703–1786), in a style resembling that of Mellan. The work of Giovanni Volpato (1733–1803), and his famous pupil, Raphael Morghen (1758–1833), with all its prodigious skill, is decidedly devoid of life and character.

In England excellent work was done in engraving by Sir Robert Strange (1721–1792), who learnt his art in Paris, by William Woollett (1735–1785), whose landscapes after Richard Wilson especially form a real contribution to engraving, and by William Sharp (1749–1824), whose works after English portrait painters are of particular excellence.

Nineteenth Century.—Illustration in England, though it had never attained the distinction which had marked it in France, was not brought to a sudden end, as it was on the other side of the Channel, by the Revolution. A great deal of work, much of it, however, wholly or in part in stipple, was produced in this line in England at the end of the 18th and beginning of the 19th century.

The name which stands out at the period is that of William Blake (1757–1827), who, trained as a regular engraver, still executed his most characteristic and distinguished work in other mediums. The illustrations to the *Book of Job* and Young's *Night Thoughts,* wonderful as their conception is and worthy of Blake's genius, are carried out with much of the monotonous accomplishment of contemporary work, and lose, rather than gain, by the skill which Blake had acquired as a professional engraver. The popularity of Turner is reflected in the very numerous landscape engravings which were made by such engravers as W. B. and G. Cooke, John Pye, R. Brandard, E. Goodall and others, after his water colour drawings. They are usually in the form of illustrations and on a small scale, but engraving seems hardly suited to the rendering of the peculiar qualities of the great landscape painter, and, amazing as is the skill with which Turner's obviously untranslatable creations are interpreted, the dullness of entire efficiency engrosses them. This blight, and the beginning of the use of mechanical means such as machine ruling, lies over all the work produced in England, and indeed, in Europe and America, in the middle of the century. Merely reproductive as its purpose was, engraving obviously had no future in competition with the rapidly perfected photographic processes, and by the end of the century had died out almost completely.

Engraving of a less elaborate form, its technique deriving from that of the age of Dürer, had pursued its humble course almost uninterrupted through the 17th, 18th and 19th centuries in the hands of engravers of heraldic bookplates. Craftsmen like C. D. Sherborn (1831–1912) in England, did sound work in this field, and form a link which connects the recent revival of engraving since the World War within the great tradition. It is too early yet to speak of the permanence or importance of this movement, which, if partly archaistic in tendency, still derives its chief strength from the realization that the engraved line has a particular incisive beauty and character of its own, a character more circumscribed and more exacting than that which the etched line possesses. Engravers like Pieter Dupont (1870–1911) in Holland, who was perhaps the earliest rather isolated resuscitator of the medium, E. Laboureur in France, whose work in line, however, differs singularly little from his etched work, and in England younger men like Stephen Gooden, R. S. Austin and Job Nixon are doing work of originality and character. (*See* ENGRAVING.)

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LINE GEOMETRY. In geometry, curves and other loci are frequently regarded as generated by a point, the position of which is defined by certain conditions. A straight line however may be thought of as the generating element, such as a tangent to a curve, or as a generator of a cone. That branch of geometry in which the line is regarded as the generating element is called line geometry.

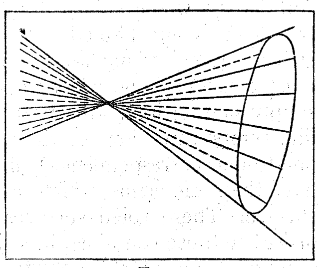

FIG. 1

A point in space is determined by its distances from three planes which intersect in one point (*i.e.*, by its *co-ordinates*), and a plane is defined by the totality of the points the co-ordinates of which satisfy a linear equation. The coefficients of the co-ordinates in the equation are called *plane co-ordinates*. A point and a plane are in united position when their co-ordinates satisfy a certain bi-linear equation (*i.e.*, linear in the co-ordinates of the point, and also linear in the co-ordinates of the plane). The principle of duality (*q.v.*) asserts that for every theorem involving points, obtained from properties of point co-ordinates, there is another involving planes, and conversely. These properties remain true if each point co-ordinate is replaced by any linear fractional homogeneous expression in four numbers x_1, x_2, x_3, x_4 with common denominator and non-vanishing determinant. The numbers x_i are called *projective point co-ordinates*. Similarly, u_1, u_2, u_3, u_4 may be taken as *projective plane co-ordinates*, and the condition for united position may be expressed by the equation $\Sigma\ u_i x_i = 0$.

In the plane, the projective co-ordinates, x_1, x_2, x_3, may be defined either as point co-ordinates or as line co-ordinates, thus giving rise to point-line duality in the plane. In space a straight line is self dual; it is uniquely determined by any two distinct points on it, or by any two distinct planes through it. The line itself may be regarded as an element; for many purposes in kinematics, in dynamics, and in optics this is more advantageous than to have it defined indirectly in terms of points or planes.

Line Co-ordinates.—Given two points $(x_1, x_2, x_3, x_4) = (x)$, $(y_1, y_2, y_3, y_4) = (y)$ on a line, the six expressions of the form $x_i y_k - x_k y_i$ are called its *homogeneous line co-ordinates* p_{ik}. Apart from a constant factor common to all, they are independent of what two distinct points are chosen. Among them there is a quadratic relation which is identically satisfied $P \equiv 0$. All the relations between two lines, such as distance, angle or condition for intersection, or any other relation, can be expressed in terms of their co-ordinates. A line meets two distinct planes each in one point, finite or infinite, and a point in each is determined when its two co-ordinates are fixed. Thus it follows that a line is determined by four independent co-ordinates, or there exist ∞^4 lines in space.

When the co-ordinates p_{ik} satisfy one equation, there are ∞^3 lines singled out, which constitute a *complex;* if they satisfy two such equations, the ∞^2 lines constitute a *congruence;* if they satisfy three, the ∞^3 lines belong to a *ruled surface;* if they satisfy four, there will be only a finite number of lines. The linear complex $\Sigma a_{ik} p_{ik} = 0$ can, by a proper choice of a system of co-ordinates, be reduced to the form $xy' - x'y + k(z - z') = 0$, in which x, y, z and x', y', z' are the cartesian co-ordinates of any two points on a line. If $k = 0$, the complex is special; it now consists of all the lines which meet the fixed line $x = 0$, $y = 0$, the *axis*. If k is not zero, the line $x = 0$, $y = 0$ is still called the axis but not all the lines of the complex meet it. The complex can be visualized in various ways. It is identical with the null system of mechanics, *i.e.*, the totality of those axes of rotation with regard to which a system of forces in space have a moment of rotation zero. In a linear complex there is, associated with every point P (pole) (*see* POLE AND POLAR) a plane π (polar) passing through it which contains a pencil of lines with vertex at P. Dually, the lines of a linear complex lying in a plane pass through a point called the pole of the plane. As P describes a line l, its polar plane as to a linear complex $A = 0$ describes a pencil with axis a line l'. Dually, every plane π' through l has a pole P' on l'. Two such lines l, l' are called *conjugate polars* as to $A = 0$. When l is a line of $A = 0$, $1 = l'$. Any line of $A = 0$ which meets l will also meet l' and every line which meets both l and l' is a line of $A = 0$. By this transformation a linear complex $B = 0$ is changed into a linear complex $B' = 0$. If A and B are in involution, $B = B'$. The six co-ordinate complexes $x_i = 0$ in the Klein system are mutually in involution.

A geometric picture can be obtained as follows: let a be the axis, and π any plane perpendicular to a. If the plane be moved parallel to itself, and rotated into itself about a, the translation and the tangent of the angle of rotation being in proportion, then every point P of π will describe a right circular helix. The lines of the complex are the normals to these ∞^2 helices.

The lines which belong to two linear complexes $A = 0$, $B = 0$ belong to every complex of the system $\lambda\ A + \mu B = 0$ for every value of λ and μ. Within this system are two special complexes $A' = 0$, $B' = 0$, and the linear congruence may be defined as the ∞^2 lines which meet two given lines, called the directrices of the congruence. They may be distinct, coincident or imaginary. When they are coincident, the congruence consists of ∞^1 pencils of lines with vertices P on the directrix d, and lying in planes π through d, such that P, π are projectively related.

Two complexes $A = 0$, $B = 0$ are in involution when on every line p of the complex, the poles of an arbitrary plane through p in $A = 0$, $B = 0$ are harmonic (*i.e.*, with cross ratio $= -1$; *see* PROJECTIVE GEOMETRY: *Cross-Ratio*) as to the intersections of p with the axes of the two special complexes $A' = 0$, $B' = 0$ in the system.

The lines which belong to three linear complexes $A = 0$, $B = 0$, $C = 0$ constitute the ∞^1 lines of a regulus, *i.e.*, one system of generators of a quadratic surface; if they are real, they form a hyperboloid of one sheet, or a hyperbolic paraboloid. These lines also belong to every linear complex of the form $\lambda A + \mu B + \nu C = 0$. The other system of generators belongs to three independent linear complexes, each of which is in involution with $A = 0$, $B = 0$, $C = 0$.

The lines belonging to four linear complexes are the two transversals of the axes of the four independent special linear complexes contained in the system. They may be distinct, co-incident or imaginary. These ideas had been recognized in part by various writers, but they were first put into systematic form in terms of co-ordinates by Arthur Cayley in 1860. The results attracted the attention of several mathematicians, in particular of Julius Plücker, who soon contributed a number of notes leading to their further development. Eight years later appeared the first part of Plücker's book on line geometry.

By means of a simple transformation of the line co-ordinates p_{ik}, the quadratic identity $P \equiv 0$ can be reduced to the sum of six squares, $\Sigma x_i^2 = 0$. These x_i are called *Klein co-ordinates;* they furnish one of the most striking examples in mathematics of the power and the ease of obtaining results in consequence of a proper notation.

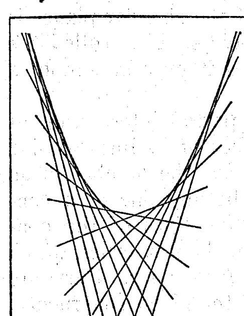

FIG. 2

The Line-sphere Transformation.—The p_{ik} or the x_i can also be interpreted as the co-ordinates of a sphere, since the co-ordinates of the centre and the length of the radius furnish four independent quantities which determine a sphere. By making the co-ordinates homogeneous, and by expressing the length of the radius in terms of the coefficients in the equation of the sphere, the quadratic identity appears. Two lines which intersect are thus transformed into two spheres which touch each other. The points of space (spheres of zero radius) are the images of the lines of a certain complex; the planes of space (spheres whose radii become infinite) are the images of the lines of a certain special linear complex. A linear equation in sphere co-ordinates (linear complex of spheres) defines the ∞^3 spheres which cut a fixed sphere at a constant angle.

The line-sphere transformation together with its projective generalizations, is a powerful weapon in the study of certain curves and ruled surfaces. Thus, all the sextic ruled surfaces (120 types) and those of order seven having a straight line directrix (about 300 types) have been determined by this method.

Mapping on Hyperspace.—If the p_{ik} (or the x_i) are thought of as homogeneous point co-ordinates in space of five dimensions, the quadratic identity $P=0$ becomes the equation of a quadric variety, hence line geometry may be interpreted as the geometry on a quadric variety in five-way space. A linear complex is then the section of the quadric by a linear four-way space, and hence it defines a three-dimensional quadratic variety in space of four dimensions. By stereographic projection this can be mapped on the points of three-way space, hence there is a one-to-one correspondence between the points of ordinary space and the lines of any linear complex.

The Cylindroid.—The axes of the complexes of a pencil describe a ruled cubic surface, the cylindroid, which is of value in the application of line geometry to dynamics, as is shown in the treatise of Ball. It may be generated as follows: Given a line d, and on it two points P, P'. Through P draw any line p perpendicular to d, and through P' draw a line p' perpendicular to d and to p. Now as a variable point G moves along d from P to P', associate with it a line g always passing through G, perpendicular to d, and such that the distance from P is proportional to the cosine of double the angle that g makes with the plane d, p. At P, g coincides with p, at P', g coincides with p' and when G is in the middle of the segment PP', g makes an angle of 45° with the plane d, p. Then think of a second line g' doing the same thing, but winding in the other direction. The line d is a double line on the resulting surface. The planes containing the pairs of intersecting lines g, g' are all parallel to a fixed plane; they intersect in an ideal line d' which also lies on the surface.

By taking d for the z axis, $x-y=0$, $z=h$ for p, $x+y=0$, $z=-h$ for p', the equation has the form

$$z(x^2+y^2)=2hxy.$$

Every ruled cubic with two distinct directrix lines can be projected into this form.

The General Complex.—An algebraic equation homogeneous and of order n in p_{ik}, together with the identity $P=0$ defines a complex of order n. By holding one point (y) fixed, the points (x) which satisfy the equation all lie on a cone of order n, having (y) as vertex. Similarly, the lines of the complex which lie in a fixed plane all touch a curve of class n. For an arbitrary point, the complex cone has no multiple or cuspidal generators, and in an arbitrary plane the complex curve has no double or inflexional tangents. A point (y) which is the vertex of a cone having a double generator is called a *singular point*. The locus of the singular points is a surface. Similarly, the plane (u) which contains a complex curve with a double or inflexional tangent is called a *singular plane*. The envelope of the singular planes is identical with the locus of the singular points. It is called the *surface of singularities;* in particular cases it may be simply a curve.

A congruence may be the complete or partial intersection of two complexes. If it is algebraic the number of its lines passing through an arbitrary point is called its *order*, the number in an arbitrary plane is called its *class*. Let p be any line of a congruence, the distance from p to consecutive lines of the congruence is a certain differential expression of the first order, which vanishes to the third order for two points P, P' on p. These are called *foci*, and their locus, as p describes the given congruence, is the *focal surface*, to which p is a bitangent. P and P' may describe the same surface, or different surfaces, or either or both may describe a curve. In the last case the congruence consists of the lines which intersect both curves. Congruences of lines are of particular importance in differential geometry (*q.v.*), both metric and projective, *e.g.*, that formed as lines of curvature, asymptotic lines, etc., and that formed by the tangents to one parameter systems of curves on a surface, as by the normals to a surface. They are also of importance in optics.

The complete or partial intersection of three complexes is a *ruled surface*. The number of its lines which meet a given line is its *order*, which is also its *class*. For every order greater than two, a con-conical ruled surface must have one or more double curves. Every plane section is either proper or, if composite, must consist of one proper curve and of straight lines, counted simply or multiply. All the plane sections, apart from straight-line components, are birationally equivalent (their points are in one-to-one correspondence), hence if the surface is algebraic all have the same genus, which may be called the genus of the ruled surface. These ruled surfaces of maximum gênus for a given order are those contained in a linear congruence. If all the generators of a ruled surface are tangents to a curve C, the surface is called a *developable surface*. Then C appears on the surface as a cuspidal curve. The surface also contains double curves, if the order of the curve C is greater than 3.

Every generator of a non-developable ruled surface of order n meets $n-2$ other generators.

The Quadratic Complex.—If $\phi=0$ is the equation of the complex of order 2, then the lines belonging to it satisfy the equation $\phi+\lambda P=0$ for every value of λ. When the discriminant of this form has six distinct roots λ_i, the equation can be reduced to $\phi=\Sigma\lambda_i x_i^2=0$ when $P=\Sigma x_i^2=0$. The surface of singularities is in this case the most general Kummer surface of order and class 4, with 16 double points and 16 singular planes, *i.e.*, planes which touch the surface at every point of a conic. Each conic passes through six double points, and each double point lies on six such conics. The same surface is also a complete focal surface for six congruences of order and class 2, namely those defined by $\phi=0$, $x_i=0$ $(i=1, 2, \ldots, 6)$.

The surface is invariant under the operation of interchanging the points of contact of the lines of each congruence; these generate a finite group of order 32, of which 16 are harmonic homologies, and 16 are involutorial correlations. For particular forms of ϕ, corresponding particularities exist in the Kummer surface. Thus, if $\phi=\Sigma a_{ik}p^2_{ik}=0$, the complex consists of lines which intersect two given quadrics harmonically. The surface of singularities is now the tetrahedroid. The six nodes on each conic are in involution. It is a projective generalization of the wave surface of Fresnel. This complex is known as Battaglini's complex. Another particularization is that in which the λ-discriminant is a square and each λ_i makes every first minor vanish. The complex consists of the lines which meet the faces of a fixed tetrahedron in projective tetrads. The surface of singularities consists of the faces of the tetrahedron. This complex is called the *tetrahedral complex*. The first systematic study of the quadratic complex was made by Battaglini, who assumed, erroneously, that the most general one could be expressed as a linear function of the squares of the p_{ik}.

The correction of this error led to the complete classification according to the form of the λ-discriminant, thus affording one of the early applications to the theory of elementary divisors. The Kummer surface also furnished one of the first illustrations of a surface which remains invariant under an infinite number of distinct birational transformations, but this property is shared by the focal surface of many other congruences. Line geometry shows close connection among various branches of mathematics.

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vol. ii.2 (1922), pp. 990–1,039; and the same title in the *Encyklopädie der mathematischen Wissenschaften,* vol. iii.2, C 8 (1922). This important report of about 250 pages cites over 1,500 titles, practically all the bibliography, and brings the development of the subject down to the time at which it was written. (V. Sn.)

LINEN AND LINEN MANUFACTURES. Under the name of linen are included all the yarns spun and fabrics woven from flax fibre. (*See* Flax.)

From the earliest periods of human history till almost the close of the 18th century linen manufacture was one of the most extensive and widely disseminated of the domestic industries of European countries. The industry was most largely developed in Russia, Austria, Germany, Holland, Belgium, the northern provinces of France, and certain parts of England, in the north of Ireland, and throughout Scotland; and in these countries its importance was generally recognized by the enactment of special laws, having for their object the protection and extension of the trade. The inventions of Arkwright, Hargreaves and Crompton in the later part of the 18th century, benefiting almost exclusively the art of cotton-spinning, and the unparalleled development of that branch of textile manufactures, largely due to the ingenuity of these inventors, gave the linen trade as it then existed a fatal blow. Domestic spinning, and with it hand-loom weaving, immediately began to shrink; the trade which had supported whole villages and provinces entirely disappeared, and the linen manufacture, in attenuated dimensions and changed conditions, took refuge in special localities, where it resisted, not unsuccessfully, the further assaults of cotton, and, with varying fortunes, rearranged its relations in the community of textile industries. The linen industries of the United Kingdom were the first to suffer from the aggression of cotton; more slowly the influence of the rival textile reached other countries.

In 1810 Napoleon I. offered a reward of 1,000,000 francs to any inventor who should devise the best machinery for the spinning of flax yarn. Within a few weeks thereafter Philippe de Girard patented in France important inventions for flax spinning by both dry and wet methods. His inventions, however, did not receive the promised reward and were neglected in his native country. In 1815 he was invited by the Austrian Government to establish a spinning mill at Hirtenberg, near Vienna, which was run with his machinery for a number of years, but it failed to prove a commercial success. In the meantime English inventors had applied themselves to the task of adapting machines to the preparation and spinning of flax. The foundation of machine spinning of flax was laid by John Kendrew and Thomas Porthouse, of Darlington, who, in 1787, secured a patent for "a mill or machine upon new principles for spinning yarn from hemp, tow, flax or wool." By innumerable successive improvements and modifications, the invention of Kendrew and Porthouse developed into the perfect system of machinery with which, at the present day, spinning-mills are furnished; but progress in adapting flax fibres for mechanical spinning, and linen yarn for weaving cloth by power-loom was much slower than in the corresponding case of cotton.

Modern Methods of Manufacture.—The modern manufacture of linen divides itself into two branches, spinning and weaving, to which may be added the bleaching and various finishing processes, which, in the case of many linen textures, are laborious undertakings and important branches of industry. The flax fibre is received in bundles from the scutch mill, and, after having been classed into various grades according to the quality of the material, is labelled and placed in the store ready for the flax mill. The whole operations in yarn manufacture comprise (1) hackling, (2) preparing, and (3) spinning. For commoner types of yarn, a process known as carding replaces that of hackling.

Hackling.—This first preparatory process consists not only in combing out, disentangling and laying smooth and parallel the separate fibres, but also serves to split up and separate the strands of fibre which, up to this point, have been agglutinated together. The hackling process was originally performed by hand, and it was one of fundamental importance, requiring the exercise of much dexterity and judgment. The broken, ravelled and short fibres, which separate out in the hackling process, form tow, an article of inferior value to the spinner. A good deal of hand-hackling is still practised, especially in Irish and continental mills; and it has not been found practicable, in any case, to dispense entirely with a rough preparation of the fibre by hand labour. In hackling by hand, the hackler takes a handful or "strick" of rough flax, winds the top end around his hands, and then, spreading out the root end as broad and flat as possible, by a swinging motion dashes the fibre into the hackle teeth or needles of the rougher or "ruffer." The rougher is a board plated with tin and studded with spikes or teeth of steel about 7in. in length, which taper to a fine sharp point. The hackler draws his strick several times through this tool, working gradually up from the roots to near his hand, till in his judgment the fibres at the root end are sufficiently combed out and smoothed. He then seizes the root end and similarly treats the top end of the strick. The same process is again repeated on a similar tool, the teeth of which are 5in. long and much more closely studded together, and for the finer counts of yarn a third and a fourth tool may be used, of still increasing fineness and closeness of teeth. In dealing with certain varieties of the fibre, for fine spinning especially, the flax is, after roughing, broken or cut into three lengths—the top, middle and root ends. Of these the middle cut is most valuable, being uniform in length, strength and quality. The root end is more woody and harsh, while the top, though fine in quality, is uneven and variable in strength. From some flax of extra length it is possible to take two short middle cuts; and, again, the fibre is occasionally only broken into two cuts. Flax so prepared is known as "cut line," in contradistinction to "long line" flax which is the fibre unbroken. The subsequent treatment of line, whether long or cut, does not present sufficient variation to require further reference to these distinctions.

In the case of hackling by machinery, the flax is first roughed and arranged in stricks, as above described under hand hackling. In the construction of hackling machines, the general principles of those now most commonly adopted are identical. The machines are known as vertical sheet hackling machines, their essential features being a set of endless leather bands or sheets revolving over a pair of rollers in a vertical direction. These sheets are crossed by iron bars, to which hackle stocks, furnished with teeth, are screwed. The hackle stocks on each separate sheet are of one size and gauge, but each successive sheet in the length of the machine is furnished with stocks of increasing fineness, so that the hackling tool at the end where the flax is entered is the coarsest, say about four pins per inch, whereas that to which the fibre is last submitted has the smallest and most closely set teeth. The finest tools may contain from 45 to 60 pins per inch. Thus the whole of the endless vertical revolving sheet presents continuous series of hackle teeth, and the machines are furnished with a double set of such sheets revolving face to face, so close together that the pins of one set of sheets intersect those on the opposite stocks. Overhead, and exactly centred between these revolving sheets, is the head or holder channel, from which the flax hangs down while it is undergoing the hackling process on both sides. The flax is fastened in a holder consisting of two heavy flat plates of iron, between which it is spread and tightly screwed up. The holder is 11in. in length, and the holder channel is fitted to contain a line of six, eight or 12 such holders, according to the number of separate bands of hackling stocks in the machine. The head or holder channel has a falling and rising motion, by which it first presents the ends and gradually more and more of the length of the fibre to the hackle teeth, and, after dipping down the full length of the fibre exposed, it slowly rises and lifts the flax clear of the hackle stocks. By a reciprocal motion all the holders are then moved forward one length; that at the last and finest set of stocks is thrown out, and place is made for filling in an additional holder at the beginning of the series. Thus with a six-tool hackle, or set of stocks, each holder full of flax from beginning to end descends into, and rises from, the hackle teeth six times in travelling from end to end of the machine. The root ends being thus first hackled, the holders are shot back along an inclined plane, the iron plates unclamped, the flax reversed, and the top ends are then submitted to the same hackling operation. The tow made during the hackling process is carried down by the pins of the sheet, and is stripped from them by means of a circular brush placed immediately under the bottom roller. The brush revolves in the same direction as, but quicker than the sheet, consequently the tow is withdrawn from the pins. The tow is then removed from the brush by a doffer roller, from which it is finally removed by a doffing knife. This material is then carded by a machine similar to, but finer than, the one described under JUTE (*q.v.*). The hackled flax, however, is taken direct to the preparing department. In the machine just described the work is usually performed by four operatives, who feed in the holders, remove them at the opposite end, and change the stricks of flax—end for end—in the holders. The automatic hackling machine does all this work except that of the first feed. The holders are removed, the nuts unscrewed, the flax turned, the nuts screwed tight and the furnished folder replaced in the machine by ingenious mechanism. Further, in some machines, the hackled stricks are mechanically fed into the spread-board—a type of drawing frame.

Preparing.—The various operations in this stage have for their object the proper assortment of dressed line into qualities fit for spinning, and the drawing out of the fibres to a perfectly level and uniform continuous ribbon or sliver, containing throughout an equal quantity of fibre in any given length. From the hackling the now smooth, glossy and clean stricks are taken to the sorting room, where they are assorted into different qualities by the "line sorter," who judges by both eye and touch the quality and capabilities of the fibre. So sorted, the material is passed to the spreading and drawing frames, a series or system of machines all similar in construction and effect. The essential features of the spreading frame are: (1) the feeding cloth or creeping sheet, which delivers the flax to (2) a pair of "feed and jockey" rollers, which pass it on to (3) the gill frame or fallers. The gill frame consists of a series of narrow hackle bars, with short closely studded teeth, which travel between the feed or retaining rollers and the drawing or "boss and pressing" rollers to be immediately attended to. The fallers are moved forward, at a slightly greater speed than that of the retaining rollers, by means of spiral screws, and the flax fibres are drawn out or attenuated by the drawing rollers; meanwhile the fibres are straightened between the gill pins of the fallers. When the fallers successively approach within a short distance of the drawing rollers, they are pushed downwards into a lower plane to be carried backwards by a similar but coarser spiral screw to a point near the retaining roller, when they are pushed upwards to repeat the cycle. They thus form a field of pins or an endless moving level toothed platform for carrying away the flax from the feed rollers. This is the machine in which the fibres are, for the first time, formed into a continuous length termed a sliver. In order to form this continuous sliver, it is necessary that the short lengths of flax should overlap each other on the spread sheet or creeping sheet. This sheet contains four or six divisions, so that four or six lots of overlapped flax are moving at the same time towards the first pair of rollers—the boss rollers or retaining rollers. The fibre passes between these rollers and is immediately caught by the rising gill pins which carry the fibre towards the drawing rollers. The pins of the gills should pass through the fibre so that they may have complete control over it. The fibre is thus carried forward to the drawing rollers, which have a surface speed of from ten to 30 times that of the retaining rollers. The great difference between the speeds of the retaining and drawing rollers results in each sliver being drawn out to a corresponding degree. Finally all the slivers are run into one and in this state are passed between the delivery rollers into the sliver cans. Each can should contain the same length of sliver, a common length being 1,000yd. A bell is automatically rung by the machine to warn the attendant that the desired length has been deposited into the can. From the spreading frame the cans of sliver pass to the drawing frames, where from four to 12 slivers combined are passed through feed rollers over gills, and drawn out by drawing rollers to the thickness of one. A third and fourth similar doubling and drawing may be embraced in a preparing system, so that the number of doublings the flax undergoes, before it arrives at the roving frame, may amount to from 1,000 to 100,000, according to the quality of yarn in progress. Thus, for example, the doublings on one preparing system may be $6 \times 12 \times 12 \times 12 \times 8 = 82{,}944$. The slivers delivered by the last drawing frame are taken to the roving frame, where they are passed singly through feed rollers and over gills, and, after drafting to sufficient tenuity, they are slightly twisted by flyers and wound on bobbins, in which condition the material—termed "rove" or "rovings"—is ready for the spinning frame.

The preparation of tow for spinning differs in essential features from the processes above described. Tow from different sources, such as scutching tow, hackle tow, etc., differs considerably in quality and value, some being very impure, filled with woody shives, etc., whereas other kinds are comparatively open and clean. A preliminary opening and cleaning is necessary for the dirty, much-matted tows, and in general thereafter they are passed through two carding engines called respectively the breaker and the finisher cards till the slivers from their processes are ready for the drawing and roving frames. In the case of fine clean tows, on the other hand, passing through a single carding engine may be sufficient. The processes which follow the carding do not differ materially from those followed in the preparation of rove from line flax.

Spinning.—The spinning operation, which follows the roving, is done in two principal ways, called respectively dry spinning and wet spinning; the first being used for the lower counts or heavier yarns, while the second is exclusively adopted in the preparation of fine yarns. There is also a demi-sec method of spinning employed in some mills. The spinning frame does not differ in principle from the throstle spinning machine used in cotton manufacture. The bobbins of flax rove are arranged in rows on each side of the frame (the spinning frames being all double) on pins in an inclined plane. The rove passes downwards through an eyelet or guide to a pair of nipping or retaining rollers between which and the final drawing rollers, placed in the case of dry spinning from 18in. to 22in. lower down, the fibre receives its final draft while passing over and under cylinders and guide-plate, and attains that degree of tenuity which the finished yarn must possess. From the last rollers the now attenuated material, in passing to the flyers, receives the degree of twist which compacts the fibres into the round hard cord which constitutes spun yarn; and from the flyers it is wound on the more slowly rotating spool within the flyer arms, centred on the top of the spindle. The amount of twist given to the thread at the spinning frame varies from 1·5 to 2 times the square root of the count. In wet spinning the general sequence of operations is the same, but the rove, as unwound from its bobbin, first passes through a trough of water heated to about 150° F.; and the interval between the two pairs of rollers in which the drawing out of the rove is accomplished is very much shorter. The influence of the hot water on the flax fibre appears to be that it softens the gummy substance which binds the ultimate fibres together, and thereby allows these fibres to a certain extent to be drawn out without breaking the continuity of the fibre; and further it makes a finer, smoother and more uniform strand than can be obtained by dry spinning. The extent to which the original strick of flax as laid on the feeding roller for (say) the production of a 50 lea yarn is by doublings and drawings extended, when it reaches the spinning spindle, may be stated thus: 35 times on spreading frame, 15 times on first drawing frame, 15 times on second drawing frame, 14 times on third drawing frame, 15 times on roving frame and 10 times on spinning frame, in all 16,537,500 times its original length, with $8 \times 12 \times 16 = 1{,}536$ doublings on the three drawing frames. That is to say, 1yd. of hackled line fed into the spreading frame is spread out, mixed with other fibres, to a length of about 9,400m. of yarn, when the above drafts obtain. The drafts are much shorter for the majority of yarns.

The next operation is reeling from the bobbins into hanks. By act of parliament, throughout the United Kingdom the standard measure of flax yard is the "lea," called also in Scotland the "cut" of 300 yards. The flax is wound or reeled on a reel having a circumference of 90in. ($2\frac{1}{2}$yd.) making "a thread," and 120 such threads form a lea. The grist or count of all fine yarns is estimated by the number of leas in 1lb.; thus "50 lea" indicates that there are 50 leas or cuts of 300yd. each in 1 lb. of the yarn so denominated. With the heavier yarns in Scotland the quality is indicated by their weight per "spyndle" of 48 cuts or leas; thus "3 lb. tow yarn" is such as weighs 3 lb. per spyndle, equivalent to "16 lea," because jute count $\times$ lea count $= 48 \therefore \frac{48}{16}$ lea $= 3$ lb. per spyndle.

The hanks of yarn from wet spinning are either dried in a loft with artificial heat in one of the many modern hank-drying machines or exposed over ropes in the open air. When dry they are twisted back and forward to take the wiry feeling out of the yarn, and made up in bundles for the market as "grey yarn." English spinners make up their yarns into "bundles" of 20 hanks, each hank containing 10 leas; Irish spinners make hanks of 12 leas, $16\frac{2}{3}$ of which form a bundle; Scottish manufacturers adhere to the spyndle containing 4 hanks of 12 cuts or leas.

Commercial qualities of yarn range from about 6 lb. tow yarns (8 lea) up to 160 lea line yarn. Very much finer yarn up even to 400 lea may be spun from the system of machines found in many mills; but these higher counts are only used for fine thread for sewing and for the making of lace. The highest counts of cut line flax are spun in Irish mills for the manufacture of fine cambrics and lawns which are characteristic features of the Ulster trade. Exceedingly high counts have sometimes been spun by hand, and for the preparation of the finest lace threads it is said the Belgian hand spinners must work in damp cellars, where the spinner is guided by the sense of touch alone, the filament being too fine to be seen by the eye. Such lace yarn is said to have been sold for as much as £240 per pound. In the Great Exhibition of 1851, yarn of 760 lea, equal to about 130m. per lb. was shown which had been spun by an Irish woman 84 years of age. In the same exhibition there was shown by a Cambray manufacturing firm hand-spun yarn equal to 1,200 warp and 1,600 weft or to more than 204 and 272m. per lb. respectively.

Bleaching.—A large proportion of the linen yarn of commerce undergoes a more or less thorough bleaching before it is handed over to the weaver. Linen yarns in the green condition contain such a large proportion of gummy and resinous matter, removable by bleaching, or by benzine previous to bleaching, that cloths which might present a firm close texture in their natural unbleached state would become thin and impoverished in a perfectly bleached condition. Nevertheless, in many cases it is much more satisfactory to weave the yarns in the green or natural colour, and to perform all bleaching operations in the piece. Many manufacturers allow about 20 to 25% of loss in weight of yarn in bleaching from the green to the fully bleached stage, but some bleachers can obtain the desired degree of whiteness with a much lower percentage of loss; and the intermediate stages of boiled, improved, duck, cream, half bleach and three-quarters bleach, all indicating a certain degree of bleaching, have corresponding degrees of loss in weight. The differences in colour resulting from different degrees of bleaching are taken advantage of for producing patterns in certain classes of linen fabrics.

Linen thread is prepared from the various counts of fine bleached line yarn by winding the hanks on large spools, and twisting the various strands, two, three, four or six cord, as the case may be, on a doubling spindle similar in principle to the yarn spinning frame, excepting, of course, the drawing rollers. A large trade in linen thread has been created by its use in the machine manufacture of boots and shoes, saddlery and other leather goods, and in heavy sewing-machine work generally. The thread industry is largely developed at Lisburn, near Belfast, at Johnstone, near Glasgow, Bridport, Dorsetshire, and at Paterson, N.J., United States. Fine cords, net twine and ropes are also twisted from flax.

Weaving.—The difficulties in the way of power-loom linen weaving, combined with the obstinate competition of hand-loom weavers, delayed the introduction of factory weaving of linen fabrics for many years after the system was fully applied to other textiles. The principal difficulty arose through the hardness and inelasticity of the linen yarns, owing to which the yarn frequently broke under the tension to which it was subjected. Competition with the hand-loom against the power-loom in certain classes of work is conceivable, although it is absolutely impossible for the work of the spinning wheel to stand against the rivalry of drawing, roving and spinning frames. To the present day, in Ireland especially, a great deal of fine weaving is done by hand-loom. Warden states that power was applied on a small scale to the weaving of canvas in London about 1812; that in 1821 power-looms were started for weaving linen at Kirkcaldy, Scotland; and that in 1824 Maberly and Company, of Aberdeen, had two hundred power-looms erected for linen manufacture. The power-loom has been in uninterrupted use in the Broadford factory, Aberdeen, which then belonged to Maberly and Company, down to the present day, and that firm may be credited with being the effective introducers of power-loom weaving in the linen trade.

The various operations connected with linen weaving, such as winding, warping, dressing, beaming and drawing-in, do not differ in essential features from the like processes in the case of cotton weaving, etc., neither is there any significant modification in the looms employed. (*See* WEAVING.) Dressing is a matter of importance in the preparation of linen warps for beaming. It consists in treating the spread yarn with flour or farina paste, applied to it by flannel-covered rollers, the lowermost of which revolves in a trough of paste. The paste is equalized on the yarn by brushes, and dried by passing the web over steam-heated cylinders before it is finally wound on the beam for weaving.

Fabrics.—Linen fabrics are numerous in variety and widely different in their qualities, appearance and applications, ranging from heavy sail-cloth and rough sacking to the most delicate cambrics, lawns and scrims. The heavier manufactures include as a principal item sail-cloth, with canvas, tarpaulin, sacking and carpeting. The principal seats of the manufacture of these linens are Dundee, Arbroath, Forfar, Kirkcaldy, Aberdeen and Barnsley. The medium weight linens, which are used for a great variety of purposes, such as tent-making, towelling, covers, outer garments for men, linings, upholstery work, etc., include duck, huckaback, crash, tick, dowlas, osnaburg, low sheetings and low brown linens. Plain bleached linens form a class by themselves, and include principally the materials for shirts and collars and for bed sheets. Under the head of twilled linens are included drills, diapers and dimity for household use; and damasks for table linen, of which two kinds are distinguished—so-called single or five-leaf damask, and double or eight-leaf damask, the pattern being formed by the intersection of warp and weft yarns at intervals of five and eight threads of yarn respectively. The fine linens are cambrics, lawns and handkerchiefs; and lastly, printed and dyed linen fabrics may be assigned to a special though not important class. In a general way it may be said regarding the British industry that the heavy linen trade centres in Dundee and the adjoining counties; medium goods are made in most linen manufacturing districts; damasks are chiefly produced in Belfast, Dunfermline and Perth; and the fine linen manufactures have their seat in Belfast and the north of Ireland. Leeds and Barnsley are the centres of the linen trade in England.

Linen fabrics have several advantages over cotton, resulting principally from the microscopic structure and length of the flax fibre. The cloth is much smoother and more lustrous than cotton cloth; and, presenting a less "woolly" surface, it does not soil so readily, nor absorb and retain moisture so freely, as the more spongy cotton; and it is at once a cool, clean and healthful material for bed-sheeting and clothing. Bleached linen, starched and dressed, possesses that unequalled purity, gloss and smoothness which make it alone the material suitable for shirt-fronts, collars and wristbands; and the gossamer delicacy, yet strength, of the thread it may be spun into fits it for the fine lace-making to which it is devoted. Flax is a slightly heavier material than cotton, while its strength is about double.

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LINENFOLD, a panel decoration of the late Gothic period common in north Europe and England, especially used in woodwork, for wainscots, screens, chests, etc., and consisting of a representation of folded or pleated cloth or parchment, with the folds vertical. Certain 14th century French woodwork already shows panels thickened at the centre, with concave surfaces at each side; this thickness is terminated at top and bottom by curved lines. An additional scrolling or pleating of the surface developed this simple type into the elaborate linenfold decoration of the following century. Linenfold panels are especially common in the flamboyant work of France and in late Gothic in Flanders; it is probably through Flemish influence that they were introduced into England.

LINEN-PRESS, a contrivance, usually of oak, for pressing sheets, table-napkins and other linen articles, resembling a modern office copying-press. Linen-presses were made chiefly in the 17th and 18th centuries, and are now chiefly interesting as curiosities of antique furniture.

LINER, a colloquial term used to describe large ocean-going passenger ships. (*See* SHIP.)

LING, PER HENRIK (1776–1839), Swedish medical-gymnastic practitioner, was born at Ljuna. After taking his degree in divinity in 1797 he travelled abroad, earning a precarious living by teaching. In 1804 he returned to Sweden and became teacher of fencing at the University of Lund. He then took the medical course and elaborated a system of gymnastics, divided into four branches: (1) pedagogical, (2) medical, (3) military, (4) aesthetic. In 1813 Ling became principal of the Royal Gymnastic Central Institute opened in Stockholm for the training of gymnastic instructors. In recognition of his introduction of gymnastics for therapeutic purposes, popularly known as the "movement cure" or Swedish massage, the Swedish General Medical Association elected him a member in 1831. Ling's collected works (*Samlade Arbeten*) were published in 3 vols. (1859–65).

LING (*Molva molva*), a food fish of the cod family, elongate in form, with terminal mouth, strong canines in the lower jaw, a short first dorsal fin, a long second dorsal and anal, and a rounded caudal.

It is a deep-water fish, ranging from Iceland and northern Europe to the Bay of Biscay; it is piscivorous, and reaches a length of 7 feet.

LING: *see* ERICACEAE; HEATH.

LINGARD, JOHN (1771–1851), English historian, was born on Feb. 5, 1771 at Winchester. Educated at the English college at Douai, where he spent some time as tutor in the family of Lord Stourton, in Oct. 1794 he settled along with seven other former members of the old Douai college at Crook hall near Durham, where on the completion of his theological course he became vice-president of the reorganized seminary. In 1795 he was ordained priest, and soon afterwards undertook the charge of the chairs of natural and moral philosophy. In 1808 he accompanied the community of Crook hall to the new college at Ushaw, Durham, but in 1811, after declining the presidency of the college at Maynooth, he withdrew to the secluded mission at Hornby in Lancashire, where for the rest of his life he devoted himself to literary pursuits. In 1817 he visited Rome, where he made researches in the Vatican Library. In 1821 Pope Pius VII. created him doctor of divinity and of canon and civil law; and in 1825 Leo XII. is said to have made him cardinal *in petto*. He died at Hornby on July 17, 1851.

Lingard wrote *The Antiquities of the Anglo-Saxon Church* (1806), of which a third and greatly enlarged edition appeared in 1845 under the title *The History and Antiquities of the Anglo-Saxon Church; containing an account of its origin, government, doctrines, worship, revenues, and clerical and monastic institutions;* but the work with which his name is chiefly associated is *A History of England, from the first invasion by the Romans to the Commencement of the reign of William III.* (8 vols., 1819–30).

See the notice by Tierney prefixed to vol. x. of the 6th ed. of the *History* (1854–55); and M. Haile and E. Binney, *Life and Letters of John Lingard* (1911).

LINGAYATS. An independent Saiva sect, or, indeed, the only strictly Saiva sect, are the *Vīra Saivas,* more commonly called *Lingayats* (popularly Lingaits) or *Lingavats,* from their practice of wearing on their person a phallic emblem of Siva, made of copper or silver, and usually enclosed in a case suspended from the neck by a string. Apparently from the movable nature of their badge, their *Gurus* are called *Jangamas* ("movable"). This sect counts numerous adherents in southern India. The reputed founder, or rather reformer, of the sect was Basava (or Basaba), a Brahmin of the Belgaum district who seems to have lived in the 11th or 12th century. According to the Basava-purana he early in life renounced his caste and went to reside at Kalyana, then the capital of the Chalukya kingdom, and later on at Sangamesvara near Ratnagiri, where he was initiated into the Vīra Saiva faith which he subsequently made it his life's work to propagate. His doctrine, a kind of reaction against the severe sacerdotalism of Sankara, has spread over all classes of the southern community, most of the priests of Saiva temples there being adherents of it; whilst in northern India its votaries are only occasionally met with, and then mostly as mendicants, leading about a neatly caparisoned bull as representing Siva's sacred bull *Nandi.*

LINGAYEN, a municipality (with administrative centre and 23 *barrios* or districts) and capital of the province of Pangasinan, Luzon, Philippine islands, about 110 mi. N. by W. of Manila, on the south shore of the Gulf of Lingayen, and on a low and fertile island in the delta of the Agno river. Pop. (1939) 30,655. Palay (rice) is the principal crop. Fishing is also a leading industry, and wine is made from the nipa palm. The Pangasinan language is the vernacular. Of the inhabitants between the ages of 6 to 19 inclusive, 44·5% in 1939 attended school. Of the population 10 years old and over, 56·4% was reported as literate. Lingayen was a principal landing point for Japanese troops in their drive southward to Manila in Dec. 1941.

LINGEH, a port of Persia on the shores of the Persian gulf in 26° 33′ N., 54° 53′ E., about 300 m. S.E. of Bushire; with the tract immediately around it, it forms part of the administrative district of the "Gulf Ports." The old port was at Kung, seven m. E. where the Portuguese had a "factory" and exercised political and commercial influence long after the loss of Hormuz (*q.v.*) until 1711. During the reign of the Zand dynasty, Lingeh was seized by Arabs from Ras-al-Khaimah who retained possession till 1887 when the Persian Government reestablished their authority. The population is estimated at 8,000 during the summer rising to 12,000 after the return of the pearling fleet in winter. The town, comparatively well built and of pleasing appearance from the sea, extends for about a mile along the shore but, with the exception of an extensive belt of date palms, the surroundings are extraordinarily arid and the hills at the back of the town, which rise to 1,200 metres, render communications with Lar and the hinterland difficult. There is no harbour for larger vessels and the anchorage is about three-quarters of a mile off-shore in 5 fathoms. Lingeh has a good reputation for boat-building and repairing. At one time it rivalled Bahrein as a centre for the collection and export of pearls; but the headquarters of the trade is now on the Arabian coast. The tonnage of trade in 1925–26 was 14,906, then showing an upward tendency, and the number of steam-vessels calling was 96, of which 90 were British. Exports were fresh and dried fruits, carpets, skins, flax, tobacco, gum and assafoetida, chiefly to India. Steamers of the British India Steam Navigation Company call fortnightly in each direction. There is a wireless station which communicates with the rest of the world through Henjam.

BIBLIOGRAPHY.—L. Pelly, "Report on the Persian Gulf," in the *Transactions* of the Bombay Geographical Society (vol. xvii., 1863), and "A visit to Lingah" in the *Journal* of the Royal Geographical Society (vol. xxxiv., 1864); Lord Curzon, *Persia,* vol. ii. (2 vols., 1892); *The Persian Gulf Pilot* (published by the Admiralty, Hydrographic Dept., 7th ed. 1924). (P. Z. C.)

LINGEN, town in the Prussian province of Hanover, Germany on the Ems canal, 43 mi. N.N.W. of Münster. Pop. (1939) 13,987. It has manufactures of paper, sausages and a trade in cattle. Among its other industries are weaving and ore mining. Lingen was the seat of a university from 1685 to 1819. The county of Lingen in 1508 was divided into an upper and a lower county, but the two were united in 1541. A little later Lingen was sold to the emperor Charles V., and passed in 1597 to Maurice, prince of Orange. After the death of the English king, William III., in 1702, it passed to the king of Prussia, and in 1815 the lower county was transferred to Hanover, only to be united again with

Prussia in 1866.

LINGUA FRANCA, a term used in different parts of the world of languages used over wide areas as secondary to the indigenous form of speech, thus enabling intercourse to be developed. English is frequently called the lingua franca of the whole world as, at one time, French was the lingua franca of diplomacy. English, in various degrees of distortion, is spoken all over the world, but in special areas are found examples of a lingua franca such as (1) the so-called Mandarin Chinese, (2) Malay, (3) Hindustani, and (4) Swahili.

Mandarin Chinese.—This language, properly *kuan hua* (literally "speech of officials"), is the lingua franca of the old Chinese empire and the modern republic, with the multiplicity of dialects of Chinese, some almost forming distinct languages. Mongols, Tibetans, Manchus, Koreans, Tungus peoples and others of different language stocks who were or are under Chinese governance learned *kuan hua,* which is the simplified speech of North China, in order that they might transact business and conduct official enquiries in any part of China. (*See* CHINESE LANGUAGE.)

Malay.—This simple tongue from early times became "the commercial language of the East Indies." The simplest of the many tongues in Indonesia (*q.v.*), it spread until peoples of nearly 40 different nationalities speak it to the exclusion of their mother-tongue. (*See* MALAY LANGUAGE.)

Hindustani.—A common name for the "popular" speech of North India. It is used by Bengalis, Gujaratis, Panjabis and many other peoples as a lingua franca. (*See* HINDOSTANI LANGUAGE.)

Swahili (*q.v.*).—This important Bantu language has spread widely and is the lingua franca of Bantu Africa. (*See* BANTU LANGUAGES.)

See O. Jespersen, *Language* (1922); A. Meillet, *Linguistique Historique et Linguistique Générale* (1926).

LINGUET, SIMON NICOLAS HENRI (1736–1794), French journalist and advocate, was born on July 14, 1736, at Rheims. He was admitted to the bar in 1764, where he became one of the most famous pleaders of his century, but was dismissed in 1775 on account of his bitter attacks against his fellow advocates, especially against Gerbier (1725–88). He then founded the *Journal de politique et de littérature,* but was compelled to resign and leave the country after the publication of a sarcastic article on the French Academy. After some years as a free-lance abroad, publishing the *Annales politiques, civiles et littéraires* in London and Brussels, he attempted to return to France in 1780, and was imprisoned for two years for an attack on the duc de Duras (1715–89). After a further period abroad he returned to France in 1786 as an Austrian councillor of state, and obtained 24,000 livres from the duc d'Aiguillon for legal services rendered some 15 years earlier. His fame at the time surpassed that of his rival Beaumarchais. He then visited the emperor at Vienna to plead the case of Van der Noot and the rebels of Brabant. On his return to Paris in 1791 he defended the rights of San Domingo before the National Assembly; his last work was written in defence of Louis XVI. He retired to Marnes, near Ville d'Avray to escape the Terror, but was captured and guillotined at Paris on June 27, 1794, on the charge of "having flattered the despots of Vienna and London."

Linguet's writings include *Histoire du siècle d'Alexandre le Grand* (Amsterdam, 1762); *Histoire impartiale des Jésuites* (Madrid, 1768, condemned to be burned); *Fanatisme des philosophes* (Geneva and Paris, 1764); *Histoire des révolutions de l'empire romain* (1766–68); *Théorie des lois civiles* (an attack on the politics of Montesquieu, London, 1767); *Mémoires sur la Bastille* (London, 1789, Eng. trans. Dublin, 1783 and Edinburgh, 1884–87). His best legal treatise is *Mémoire pour le comte de Morangies* (1772). *See* J. Cruppi, *Un avocat journaliste au 18e siècle, Linguet* (1895); A. Philipp, *Linguet, ein Nationalökonom des XVIII. Jahrhunderts* (Zurich, 1896); A. Lichtenberger, *Le Socialisme utopique* (1898), pp. 77–131.

LINKAGES, in mechanics, are an assemblage of rods hinged together so that the parts may move among themselves, being generally intended to perform some particular kind of useful motion. Nearly all machinery consists of linkages either obvious or disguised. The piston rod, crank and connecting rod of a steam engine is a linkage. A pantograph is another. Linkage is used also in biology, to denote the coupling of two hereditary characters (*see* HEREDITY).

A linkage may consist of any number of rods, and their motion may take place in a space of three dimensions or in one of two dimensions (a plane). A crank shaft out of alinement would still work, provided the joints permitted it, and would be working in three dimensions. It is, however, only plane linkages which have received much notice, and of them the most attention has been paid to the one which consists of four rods jointed together to form a deformable quadrilateral. Considering one bar as fixed, it can be removed and replaced by fixed pivots about which the bars that were jointed to it can rotate. This has caused the mechanism to receive the name "three bar linkage."

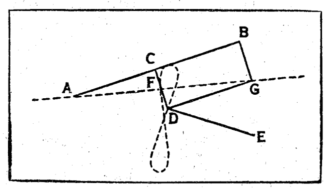


FIG. 1

Watt's Parallel Motion.—The subject of three bar motion appears to have originated in 1784 with the invention by James Watt of his so-called "parallel motion." Writing to his partner, Bolton, in June of that year, he says: "I have started a new hare. I have got a glimpse of a method of causing a piston rod to move up and down perpendicularly by only fixing it to a piece of iron upon the beam without chains or perpendicular guides or untowardly frictions, arch heads or other pieces of clumsiness. I think it a very probable thing to succeed and one of the most ingenious simple pieces of mechanism I have contrived." A visit to the science museum at South Kensington will show the sort of "clumsinesses" which Watt's invention superseded. It was essentially three bar motion, *ACDE* (fig. 1), the links of which were so adjusted in length and disposition as to cause a point *F* on the traversing link *CD* to describe a figure of 8. The portion of the curve near the point of inflexion is nearly straight for an appreciable length. If the two links *AC* and *DE* which rotate about the fixed points *A* and *E* are of equal length and the point *F* is in the middle of *CD,* the figure of 8 is symmetrical; but if they are of unequal lengths, one limb of the curve is straighter than the other and is straightest when the point *F* is taken so that *CF:FD* as *DE:AC.* If the head of the piston rod were fixed at *F* it is clear that the point *E* would be at an inconvenient distance from the rest of the engine; so Watt added two more links, *BG* and *DG,* forming a parallelogram, and it will be seen that *ACDGB* forms a pantograph in which the usual tracing point and fixed centre have changed places; and now if *AC:CB* as *CF:FD,* the point *G* will describe a curve similar to that described by *F.* The head of the piston rod was attached to *G.*

Peaucellier Cell.—Several attempts were made in the early part of the 19th century to improve upon Watt's parallel motion, among which we may mention those of Scott Russell and Kaulbach. The "Grasshopper" engine (now shown in the science museum at South Kensington) was one of them. But it was reserved to Peaucellier, a lieutenant in the French army, to invent the first exact parallel motion. In 1864 he produced his famous Peaucellier cell, consisting of six links, which converts rotatory motion into a truly straight line. It seems, however, to have completely escaped notice. Prof. Tchebichoff of the University of St. Petersburg (Leningrad) had been very interested in parallel motion without having arrived at any solution. But a pupil of his, named Lipkin, rediscovered the Peaucellier cell. The invention was introduced into England where it caused great admiration and interest, forming the subject of an address by Prof. Sylvester at the Royal Institution in 1874 (*Collected Works,* vol. iii.). It consists of four equal bars, *FL, LM, MH, HF,* and two other longer equal bars *KH* and *KL,* jointed together as shown in fig. 2. The outstanding property of this simple mechanism is that during its deformation *KF·KM* remains constant; so that if *K* is fixed, the curves traced out by *F* and *M* are inverse curves. If *F* describes a circle, *M* will describe the inverse circle; but if the centre of the *F* circle is at a distance from

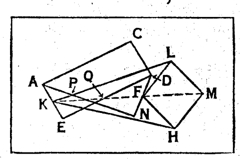


FIG. 2

K equal to its radius, then the radius of the M circle becomes infinite; *i.e.*, M describes a straight line. This form of parallel motion is stated to have been used in an engine installed for the purpose of ventilating the Houses of Parliament before the introduction of electric fans.

Crossed Parallelogram.—After Sylvester's lecture, a period arose in England during which much attention was paid to the subject of linkages, notably by Sir A. B. Kempe and H. Hart. Tchebichoff had proved to his own satisfaction that no linkage of five bars could accurately convert circular motion into rectilinear motion; but in 1877 Hart produced one (*Proc. Lond. Math. Soc.*), thus showing the danger of trying to prove a negative. He had also previously invented one of four links (*Messenger of Mathematics*, 1875). This mechanism consisted of a crossed parallelogram $EAND$ (fig. 2), formed by rotating the triangle ACD about the diagonal AD. If any straight line KF be drawn parallel to AD or EN, cutting the links AN and ED in P and Q, then $KP{\cdot}KQ$ is a constant; so that if K is fixed, the points P and Q describe inverse curves. If the link AE is fixed and K is the midpoint of AE, F will describe the inverse of a conic; and if we add a Peaucellier cell $KLMHF$, M will describe the conic. If $ED{:}EA$ as $1{:}\sqrt{2}$, F describes a lemniscate and M a rectangular hyperbola.

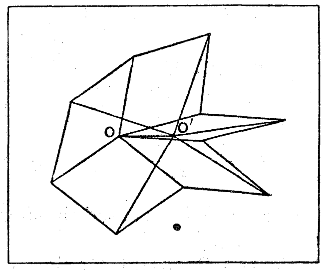


FIG. 3

Other Linkages.—Linkages can thus be made to describe other curves. One of the most interesting is that devised by G. H. Darwin (*Proc. Lond. Math. Soc.*, vol. vi.) for the purpose of drawing the equipotential curves of a system of electrically charged points. If we take two equal Peaucellier cells and pivot their two K points together, and pivot the F point of one and the M point of the other at a fixed distance apart, and ensure (as can be done mechanically in several ways) that the two cells are always equally deformed, then K describes a Cassinian oval with foci at the fixed pivots, for then the product of the focal distance of a point on the curve is constant.

M. Saint Louis showed how the solution of a numerical cubic equation can very simply be found by a three-bar linkage (*Comptes Rendus*, 1874), and as pointed out by Kempe (*Proc. Lond. Math. Soc.*, vol. vii.), an algebraic equation of any degree with numerical coefficients can be solved by linkages of many bars.

The bars AC, AN, DC, DN, DE (fig. 2), with fixed pivots at A and E forms what is called a kite linkage. A great impetus was given to the subject of the three-bar linkages by Darboux (*Bull. des Sci. Mathémat.*, 2° séries, tome iii.). He shows that if a number of kite linkages revolving about the same fixed points are joined together so that the AN of the second coincides with the AC of the first, and so on, and that if the last AC link happens to coincide with the first AN, it will do so in any state of deformation of the compound linkage. The linkage is then said to "close." In his demonstration he employs elliptic functions, the application of which to three-bar motion, originally suggested by Cayley (*Phil. Trans. Roy. Soc.*, 1861) greatly facilitates the solution of problems of closure. Fig. 3 gives a very simple form of closed kite linkages and fig. 4 is a photographic reproduction of one derived from a combination of the innumerable vector formulae which arise from the theorems given by Col. Hippisley in *Proc. Lond. Math. Soc.*, series 2, vol. xiii. In both these linkages all the bars will revolve through 360° when the linkages are deformed, though they both appear to be rigid. (*See* MATHEMATICAL MODELS.) (R. L. H.)

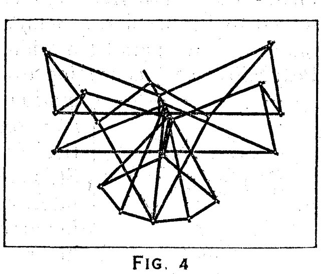


FIG. 4

LINKÖPING, a city of Sweden, the seat of a bishop, and chief town of the district (*län*) of Östergötland. Pop. (1943) 43,463. Linköping was a bishop's see in 1082 and it was at a council held in the town in 1153 that the payment of Peter's pence was agreed to at the instigation of Nicholas Breakspeare, afterwards Adrian IV. The coronation of Birger Jarlsson Valdemar took place in the cathedral in 1251; and in the reign of Gustavus Vasa several important diets were held in the town. It is situated 142 m. by rail S.W. of Stockholm, and communicates with Lake Roxen ($\frac{1}{2}$ m. to the north) and the Göta and Kinda canals by means of the navigable Stångå. The cathedral (1150–1499) is a Romanesque building with a beautiful south portal and a Gothic choir. It contains an altar-piece by Martin Heemskerck (d. 1574). In the church of St. Lars are some paintings by Per Horberg (1746–1816), the Swedish peasant artist. Other buildings of note are the episcopal palace (1470–1500), afterwards a royal palace, and the old gymnasium founded by Gustavus Adolphus in 1627, which contains a valuable library of old books and manuscripts and a museum. There is also the Östergötland Museum. The town has manufactures of tobacco, cloth and hosiery.

LINLEY, THOMAS (1733–1795), English musician and father of a large family of musicians, was born at Badminton on Jan. 17, 1733. He studied music at Bath, and afterwards settled there as a singing-master and conductor. From 1774 he was engaged in the management of the oratorios performed at Drury Lane theatre, London. He composed or compiled the music for many of the dramatic pieces played there, including *The Duenna*, by his son-in-law Richard Brinsley Sheridan. In 1777 he was elected a member of the Royal Society of Musicians. He died in London on Nov. 19, 1795.

LINLITHGOW, a royal and small burgh and the county town of West Lothian or Linlithgowshire, Scotland. Pop. (1938) 3,550. It lies in a valley on the south side of a loch, $17\frac{1}{2}$ mi. W. of Edinburgh by the L.N.E. railway. In the 19th century its antique appearance was much changed by rebuilding. About 4 mi. S. by W. lies the old village of Torphichen where the Knights of St. John of Jerusalem had their chief Scottish preceptory. The parish kirk is built on the site of the nave of the church of the establishment, but the ruins of the transept and of part of the choir still exist. The industries include shoemaking, tanning and currying, manufactures of paper, glue and soap, and distilling. There are shale works and stone quarries in the neighbourhood. An old tower-like structure near the railway station is traditionally regarded as a mansion of the Knights Templars. There are some fine fountains including the Cross Well in front of the town house, originally built in the reign of James V, but rebuilt in 1807; and one surmounted by the figure of St. Michael, the patron saint of the burgh.

The fine ruins of Linlithgow palace rise above the green knolls of the promontory which divides the lake into two nearly equal portions. In plan it is almost square, enclosing a court in the centre of which stands the ruined fountain of which an exquisite copy was erected in front of Holyrood palace by the prince consort. At each corner there is a tower with an internal spiral staircase, that of the northwest angle being crowned by a little octagonal turret known as "Queen Margaret's Bower," from the tradition that it was there that the consort of James IV watched and waited for his return from Flodden. The west side is supposed to date in part from the time of James III, who later took refuge in one of its vaults from his disloyal nobles; but the larger part of the south and east side belongs to the period of James V, about 1535; and the north side was rebuilt in 1619–20 by James VI. The palace was reduced to ruins by General Hawley's dragoons, who set fire to it in 1746. A few yards to the south of the palace is the fine church of St. Michael, a Gothic (Scottish Decorated) building with an embattled tower, probably founded by David I in 1242, but mainly built by George Crichton, bishop of Dunkeld (1528–1536). In it are found some fine stained glass, including a window dedicated to the memory of Sir Charles Wyville Thomson (1830–1882), the naturalist, who was born in the parish. (See *Palace of Linlithgow*, H.M.S.O., Edinburgh, 1933.)

Linlithgow was made a royal burgh by David I. Edward I encamped here the night before the battle of Falkirk (1298), wintered here in 1301, and next year built a castle which in 1313 was captured by the Scots. In 1369 the customs of Linlithgow yielded more than those of any other town in Scotland, except Edinburgh. Robert II granted it a charter of immunities in 1384. The palace became a favourite residence of the kings of Scotland, and often formed part of the marriage settlement of their consorts.

LINLITHGOWSHIRE: *see* WEST LOTHIAN.

LINNAEUS [CARL VON LINNÉ] (1707–1778), Swedish botanist, was born on May 13, O.S. (May 23, N.S.), 1707, at Råshult, in Småland, the son of a pastor. He was educated at Wexiö, Lund and Uppsala, where Olaf Celsius (d. 1756) engaged him to assist in the compilation of his *Hierobotanicon*. A review of S. Vaillant's *Sermo de Structura Florum* (1718) and Wallin's *Gamos Phyton* (1729) led him to examine the stamens and pistils of flowers, and, convinced of the importance of these organs, he formed the idea of basing a system of arrangement upon them. Two years after his appointment as lecturer in botany at Uppsala he explored Lapland in 1732 for the Academy of Sciences and published the scientific results in his *Flora Lapponica* (Amsterdam, 1737); his own account was published in English by Sir J. E. Smith, under the title *Lachesis Lapponica*, in 1811. After a further journey through Dalecarlia, he proceeded to Harderwijk, where he took his M.D. In the same year Jan Fredrik Gronovius (1690–1762), who was visiting him, was so struck by the ms. of the *Systema naturae* that he published it at his own expense. This famous system, artificial as it was, largely made its way by the lucid and admirable laws, and comments on them, which were issued almost at the same time. (*See* BOTANY.) After a visit to England in 1736, Linnaeus published his *Genera Plantarum*, a volume which must be considered the starting-point of modern systematic botany, and in the following year, 1738, his *Classes Plantarum*. Returning to his native country by way of France, he settled as a physician in Stockholm. He was soon appointed naval physician, with minor appointments, and in June 1739 married Sara Moraea. In 1741 he was appointed to the chair of medicine at Uppsala, but in 1742 exchanged it for that of botany. In the same year, previous to this exchange, he travelled through Öland and Gothland, by command of the state, publishing his results in *Oländska och Gothländska Resa* (1745). Its index shows the first use of specific names in nomenclature.

Henceforward his time was taken up by teaching and the preparation of other works. He issued his *Flora Suecica* in 1745 and *Fauna Suecica* in 1746; his two volumes of observations made during journeys in Sweden, *Wästgöta Resa* (1747) and *Skånska Resa* (1751); his *Hortus Upsaliensis* (1748); his *Philosophia Botanica* (1751) and his important *Species Plantarum* (1753), in which the specific names are fully set forth. In 1755 he declined an invitation from the king of Spain to settle in that country, with a liberal salary, and full liberty of conscience. In 1761 he was granted a patent of nobility, antedated to 1757, from which time he was styled Carl von Linné. To his great delight the tea plant was introduced alive into Europe in 1763. An apoplectic attack in 1774 greatly weakened him, and he died on Jan. 10, 1778 at Uppsala, in the cathedral in which he was buried.

Linnaeus delighted in devising classifications, and not only systematized the three kingdoms of nature, but even drew up a treatise on the *Genera Morborum*. He was the first to enunciate the principles for defining genera and species, and to adhere to a uniform use of specific names.

Of his 180 odd works those published during his lifetime were enumerated in R. Pulteney's *General View of the Writings of Linnaeus* (1781). His *epistolae ineditae* appeared at Groningen in 1830. His widow sold his collections and books to Sir J. E. Smith, the first president of the Linnean Society of London. When Smith died in 1828 a subscription was raised to purchase the herbarium and library for the Society, whose property they became.

See T. M. Fries, *Linné, Lefnadsteckning* (2 vols., Stockholm, 1903, Eng. version, 1923, with full bibliography); O. Levertin, *Carl v. Linné* (Stockholm, 1907); J. M. Hulth, *Bibliographia Linnaeana* (Uppsala, 1907); O. Hjelt, *Carl v. Linnés betydelse såsom naturforskare och idkare* (*ib.* 1907, Germ. trs., 1908) and W. Junk, *Linné im Lichte neuerer Forschung* (1925).

LINNET, *Carduelis cannabina*, a common song-bird, frequenting almost the whole of Europe south of lat. 64°, and in Asia extending to Turkestan. It is a winter visitant to Egypt and Abyssinia, and is abundant at all seasons in Barbary, as well as in the Canaries and Madeira. Though the fondness of this species for the seeds of flax (*Linum*) has given it its common name in many European languages, it feeds chiefly on the seeds of Compositae. The males in spring have a handsome crimson-red breast and crown to the head. The song is pleasant but apt to be monotonous. The linnet begins to breed in April, the nest being generally placed in a bush at no great distance from the ground. It is a neat structure of fine twigs, roots or bents, lined with wool or hair. The eggs, four to seven in number, are of a very pale blue marked with reddish or purplish brown. Two broods are raised in a season.

The plumage of this small finch varies much with age, sex and season, some even pied or nearly white; each phase may have a different common name, such as red linnet, gray linnet. The name mountain linnet is applied to the yellow-billed *C. flavirostris*, which never has crimson on crown or breast. Green linnet is a common name for the greenfinch (*q.v.*).

In the southwestern United States linnet is a name for the house finch (*Carpodacus mexicanus frontalis*), familiar, nesting about houses and a good singer; and to the desert house finch (*C. m. solitudinis*), British Columbia to Nevada and eastern California. (G. F. Ss.)

LINOLEUM, a term originally coined by Frederick Walton for material of his own invention, now used indiscriminately to describe any floorcovering having a base of solidified oil adhering to a jute canvas foundation.

Technically there are three distinct classes of floorcovering described commonly as linoleum:—

(*a*) *Floorcloth*, which is made by building up (trowelling) on both sides of the canvas successive layers of paint, until the desired thickness is obtained. It is then printed with a pattern and varnished.

(*b*) *Linoleum proper*, made by rolling or pressing on to the canvas an incorporated mass of linoleum "cement," cork dust, woodflour and pigments.

(*c*) *Cork Carpet and Corticine*, made in the same way as linoleum but with polymerized oil, cork dust and pigments.

Linoleum was first produced in England, in which country most of the subsequent developments of importance have taken place. The earliest patent in 1636, for "Painting with oyle cullers upon wollen-cloath, etc." was followed by the use of various mixtures of oils and resins; and, in 1751, by the incorporation of india-rubber or gum lastic. Three years later Nathan Smith established a factory at Knightsbridge for the manufacture of floorcloth, by applying a mixture of rosin, pitch, Spanish brown, beeswax and linseed oil in a melted state to canvas, and rolling it in by pressure. Subsequent improvements to cheapen the product resulted in modern floorcloth.

Walton's Patent.—It was not until 1844 that the next step towards the manufacture of linoleum proper was taken by Elijah Galloway, who softened india-rubber by heating and incorporating it with cork dust. This was rolled into sheets and marketed as "kamptulicon" which at first was cemented down, but later was rolled on to a canvas backing. Owing to the high price of rubber, however, it proved to be costly; and in 1860 Frederick Walton invented a process (Eng. Pat. 209) for oxidizing linseed oil to produce a cheap rubber-like substitute. In principle, the methods used today are essentially the same as those covered by his inventions.

The manufacture of linoleum involves the following operations:—

(1) The production of solidified linseed oil by "Walton" or other methods (*see* below).

(2) The manufacture of "cement" in the case of "Walton" goods, *i.e.*, true linoleum.

(3) The incorporation of ground cork or woodflour and pigment with the "cement" to produce "linoleum material."

(4) The application of this mixture to a canvas backing of jute.

(5) Seasoning or curing of the sheeted material.

(6) The painting (backing) of the underside to preserve the

canvas.

(7) The trimming of the finished cloth.

Solidified Oil.—The four chief methods for obtaining the solidified oil are:—

(*1*) *"Scrim" Process.*—Linseed oil, boiled with driers, is pumped to the top of sheds kept at 100° F, where it is mechanically flooded every 24 hours over sheets of cotton fabric (scrim). These are usually 3ft. wide by 25ft. long, and are hung about 4in. apart. After some weeks' treatment, when the skins have grown to about 1in. thick, they are cut down.

(*2*) *"Shower Bath" Process.*—The oil is heated with driers (manganese borate) in a steam-jacketed pan, on which there rests a tower about 20ft. high, surmounted by a tank having a perforated bottom. The oil is pumped into the tank and falls in a shower and is re-circulated thus for days. It is then transferred to a "smacker," which is a steam-heated horizontal drum, fitted axially with a rapidly revolving shaft to which blades are attached. It is half filled with the oil, whiting is added and air is blown through. The final product is run out into trays and sets to a dough-like consistency, and is stoved at about 130° F.

(*3*) *"Wood and Bedford" Process.*—The oil is run directly into a machine similar to the "smacker" previously described, and treated in much the same manner, but generally without whiting.

(*4*) *"Taylor Parnacott" Process.*—The oil is boiled with driers and agitated by compressed air until it is thick, at which stage it is transferred to smaller boilers, and the treatment continued until it becomes "stringy." The nature of this product renders unnecessary its conversion into "cement."

Linoleum Material.—The solidified oil obtained by any of the first three processes is ground between rollers and heated in a steam-jacketed pan (cement pot), together with rosin (colophony) and kauri gum. The resulting mass is a dark, homogeneous thick liquid, which, on cooling in thin layers, becomes a sticky rubber-like mass. By incorporating the "cement" with cork dust, woodflour, whiting and pigments, "linoleum material" is obtained. This mixture is intimately ground by passing it through a series of rolls and "germans" (which resemble large sausage machines) or through Pfleiderer mixers as used in paint mixing or bread manufacture. From these it is fed continuously into the "scratcher," a machine consisting of two rolls, one steam-heated and the other cold, to which the material adheres, forming a thick layer. Adjacent to this a third roll, fitted with hundreds of sharp spikes, revolves at high speed and scratches off small particles from the layer, thus converting it to a granular or mealy form.

All types of linoleum pass through these mixing stages—the nature of the finished product being determined by the subsequent treatment of the granulated material.

Linoleum can be divided into two broad classes: (a) Plains, and (b) Inlaids. These can again be further sub-divided, from the manufacturing point of view, into—(1) Plains, Printed, Jaspés, Granites and Moires. (2) Inlaids—Moulded, Straight-line, Granites, Parquetries and Marbles.

Plain and Printed Linoleums.—The granulated material is calendered on to the canvas backing by heavy steam-heated rolls. The same type of material is used for plain and printed goods, but the latter are usually thinner, and have the pattern printed on in oil colours afterwards. Granites, Jaspés and Moires are, with modifications, made in the same way, the variously coloured scratched materials being blended before calendering. Cork Carpet and Corticine too are made similarly, but have a base of polymerized (Taylor) oil incorporated with cork dust and pigments.

Inlaid Linoleum.—When produced by the moulding process, the granulated material of different colours is sifted through stencils on to canvas lying on a table. A separate stencil, having perforations corresponding to the desired position in the pattern, is used for each colour, the scratched material being thrown on and the perforations filled. The completed pattern is afterwards put through a flat hydraulic "making press," to consolidate it, and the face is perfected by passing through a "finishing press." This method gives very fine carpet and floral effects.

Straight-line Inlaids.—For these two processes are used. (a) Hand-made: the stencils in the moulding process are in this case replaced by pieces of previously sheeted material, cut to the desired shape, and laid on to form the pattern required. The rest of the operations are as in the moulding process. Parquetries, Marbles and Tile patterns are made in this way. (b) Machine-made: in this process the scratched material is rolled into a continuous sheet, and led, together with the backing, under a revolving "cutting cylinder." In the periphery of the cylinder steel knives are embedded, forming a complete pattern. Between the knives plungers operate selectively from the inside and place on the canvas the tesserae of the particular part of the pattern required. The pieces not required are carried round between the knives and are ejected.

A series (up to six) of such rolls and cylinders are used to place the different coloured pieces into position, where they are maintained by pins projecting through the backing until the "pressing cylinder" is reached. This machine consolidates the pattern and presses it on to the canvas.

Linoleum obtained by any of the above processes is still in a soft (green) condition, and requires to be hardened by seasoning. This is carried out in drying rooms; the stoves are heated from 90 to 170° F for 2–60 days according to the type of linoleum. Linoleums are usually made 2, 3 and 4 yards wide (metres in European countries) and the thickness may vary from 1·9mm. to 8mm. for plains, and 1·4mm. for inlaids.

It is computed that the world's output of linoleum is in the region of 200,000,000 sq. yds. per annum.

Important developments have taken place in the last few years, in an endeavour to improve the quality of linoleum, by using materials other than linseed oil as a base.

Nitro-cellulose.—In common with all industries using drying oils, great progress has been made in attempting to replace the linseed oil in linoleum with a nitro-cellulose base. In Germany, large quantities of linoleum are being produced containing nitro-cellulose and plasticizers as the binding material. The most recent of these products contains also a proportion of linseed oil "cement." In the U.S., practically all types of linoleum produced are now coated on the surface with a nitro-cellulose composition, which has the advantage of giving a nonmarking, glossy finish, highly resistant to soap and soda.

Felt Base.—Felt, impregnated with bituminous composition, is being used as a substitute for linoleum material. It is coated and then printed with a pattern. Such printed felts are being produced in the United States and Europe on a large scale and rival the production of printed linoleum.

Bibliography.—The literature on linoleum is relatively small, but the following may be consulted:—*Society of Arts Journal* (1862) Walton; *The Society of Chemical Industry Journal,* Reid (1896) 75; Ingle (1904) 1197; Jones (1919) 26T; Martin, *Industrial Organic Chemistry* (1913); *Industrial & Engineering Chemistry Journal,* de Waele (1917) 9.6.18; Livache & McIntosh, *Manufacture of Varnishes,* Vol. I., (1919) 232; Alder Wright, *Oils, Fats and Waxes* (1921); Lewkowitsch & Warburton, *Chemical Technology of Oils, Fat & Waxes,* Vol. III. (1923); Fischer, *Geschichte, Eigenschaften und Fabrikation des Linoleums* (1924); *The Industrial Chemist* (Sept. 1925); *The American Exporter* (Oct. 1925); *Die Tapete* (Aug., Oct. 1925); Walton, *The Infancy & Development of Linoleum Floorcloth* (1925); Morrell & Wood, *The Chemistry of Drying Oils,* 1925; A.-D. Luttringer (1928), *La Linoxyne et le Linoléum.*

LINOTYPE: *see* Printing.

LINSANG, a civet-like carnivorous mammal (*Prionodon linsang*), found from upper Burma through the Malay peninsula to Borneo and Java. Linsangs are slender in build, with short legs and long, banded tail. Their general colour is pale buff, the forehead and muzzle are brown and five broad black or brown transverse bands cross the back. Other longitudinal markings occur on neck and sides. This species is about 30 in. long. (*See* Carnivora.)

(J. E. Hl.)

LINSEED. The seed of the common flax (*q.v.*) or lint, *Linum usitatissimum,* a native of Central Asia. Linseed is chiefly grown to yield oil seeds in Argentina, India, the United States, Canada and Russia. The seeds, the linseed of commerce, are of a lustrous brown colour externally, of an elongated oval form with a slight beak or projection at one extremity. The brown testa contains, in the outer of the four coats into which it is microscopically distinguishable, an abundant secretion of mucilaginous matter; and it has within it a thin layer of albumen, enclosing a pair of large oily cotyledons. The seeds when placed in water for some time become coated with glutinous matter from the exudation of the mucilage in the external layer of the epidermis; and by boiling in sixteen parts of water they exude sufficient mucilage to form with the water a thick pasty decoction. The cotyledons contain the valuable linseed oil referred to below. (*See* Linseed Oil.) Linseed grown in tropical countries is much larger and more plump than that obtained in temperate climes, but the seed from the colder countries yields a finer quality of oil. Linseed formed an article of food among the Greeks and Romans, and it is said that the Abyssinians at the present day eat it roasted. The oil is to some extent used for food in Russia and in parts of Poland and Hungary. The still prevalent use of linseed in poultices for open wounds is entirely to be reprobated. It has now been abandoned by practitioners. The principal objection to this use of linseed oil is that it specially favours the growth of micro-organisms. There are numerous clean and efficient substitutes which have all its supposed advantages and none of its disadvantages. There are now no medicinal uses of this substance. Oil cake (*q.v.*), the mass left after the expression of the oil, is a most valuable feeding substance for cattle. (*See* Flax.)

LINSEED OIL. A most valuable drying oil obtained by expression from linseed, with or without the aid of heat. Preliminary to the operation of pressing, the seeds are crushed and ground to a fine meal. Cold pressing of the seeds yields a golden-yellow oil, which is often used as an edible oil. Larger quantities are obtained by heating the crushed seeds to 160° (71°C.), and then expressing the oil. So obtained, it is somewhat turbid and yellowish-brown in colour. On storing, moisture and mucilaginous matter gradually settle out. After storing several years it is known commercially as "tanked oil," and has a high value in varnish-making. The delay attendant on this method of purification is avoided by treating the crude oil with 1 to 2% of a somewhat strong sulphuric acid, which chars and carries down the bulk of the impurities. For the preparation of "artist's oil," the finest form of linseed oil, the refined oil is placed in shallow trays covered with glass, and exposed to the action of the sun's rays. Numerous other methods of purification, some based on the oxidizing action of ozone, have been suggested, but have not yet superseded the older methods. The yield of oil from different classes of seed varies, but from 23 to 30% of the weight of the seed operated on should be obtained.

Commercial linseed oil has a peculiar, rather disagreeable sharp taste and smell; its specific gravity is given as varying from 0·928 to 0·953, and it solidifies at about −27°. It deposits stearine at 25° and melts at 16°–20°. By saponification it yields a number of fatty acids—palmitic, myristic, oleic, linolic, linolenic and isolinolenic. Appreciable quantities of stearic acid and traces of arachidic acid are also said to be present. Exposed to the air in thin films, linseed oil absorbs oxygen and forms "linoxyn," a resinous semi-elastic, caoutchouc-like mass, of uncertain composition. The oil, when boiled with small proportions of litharge and minium, undergoes the process of resinification in the air with greatly increased rapidity.

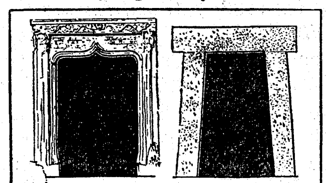
Its most important use is in the preparation of oil paints and varnishes. By painters both raw and boiled oil are used, the latter forming the principal medium in oil painting, and also serving separately as the basis of all oil varnishes. Boiled oil is prepared in a variety of ways—that most common being by heating the raw oil in an iron or copper boiler, which, to allow for frothing, must only be about three-fourths filled. The boiler is heated by a furnace, and the oil is brought gradually to the point of ebullition, at which it is maintained for two hours, during which time moisture is driven off, and the scum and froth which accumulate on the surface are ladled out. Then by slow degrees a proportion of "dryers" is added—usually equal weights of litharge and minium being used to the extent of 3% of the charge of oil; and with these a small proportion of umber is generally thrown in. After the addition of the dryers the boiling is continued two or three hours; the fire is then suddenly withdrawn, and the oil is left covered up in the boiler for ten hours or more. Before sending out, it is usually stored in settling tanks for a few weeks, during which time the uncombined dryers settle at the bottom as "foots." Besides the dryers already mentioned, lead acetate, manganese borate, manganese dioxide, zinc sulphate and other bodies are used.

Linseed oil is also the principal ingredient in printing and lithographic inks. The oil for ink-making is prepared by heating it in an iron pot up to the point where it either takes fire spontaneously or can be ignited with any flaming substance. After the oil has been allowed to burn for some time according to the consistence of the varnish desired, the pot is covered over, and the product when cooled forms a viscid tenacious substance which in its most concentrated form may be drawn into threads. By boiling this varnish with dilute nitric acid vapours of acrolein are given off, and the substance gradually becomes a solid non-adhesive mass the same as the ultimate oxidation product of both raw and boiled oil.

Linseed oil is subject to various falsifications, chiefly through the addition of cotton-seed, niger-seed and hemp-seed oils; and rosin oil and mineral oils also are not infrequently added. Except by smell, by change of specific gravity, and by deterioration of drying properties, these adulterations are difficult to detect. (*See* Oils, Fats and Waxes.)

LINSINGEN, ALEXANDER VON (1850–1935), Prussian general, was born on Feb. 10, 1850 at Hildesheim. From 1909 to 1914 he was in command of the II. Army Corps. In Jan. 1915 he was given command of the German Southern Army, which he exchanged in July of the same year for the Army of the Bug, to which was added in the following Sept. the German-Austrian south-eastern group (Army Group L), with which he foiled the Russian attempts to break through in that and the following two years. In March 1918 Linsingen led the advance into the Ukraine, and in the following June was appointed chief-in-command in the Mark, *i.e.*, the province of Brandenburg including Berlin. On Nov. 9, 1918, the troops under his command made common cause with the revolution.

LINTEL, in architecture, a horizontal beam supported at its two ends, especially the horizontal stone or timber over a door, window or other opening. Post-and-lintel construction is that in which all weights, such as those of roofs or upper storeys, are carried entirely by a simple system of vertical supports and horizontal beams.



Lintel: (left) English half timber type, (right) an example from an Etruscan tomb

LINTH or **LIMMAT,** a river of Switzerland, one of the tributaries of the Aar. It rises in the glaciers of the Tödi range, and has cut out a deep bed which forms the Grossthal that comprises the greater portion of the cantons of Glarus. A little below the town of Glarus the river, keeping its northerly direction, runs through the alluvial plain which it has formed, towards the Lake of Zürich. In order to regulate the flow of the river over this plain it has been canalised and dykes protect the riparian lands. These works were begun in 1807 and the first portion of the undertaking was completed in 1811, and received the name of the "Escher canal," the river being thus diverted into the Walensee. The second portion, known as the "Linth canal," regulated the course of the river between the Walensee and the Lake of Zürich and was completed in 1816. Many improvements and extra protective works were carried out after 1816, the date of the completion of the work being 1911. On issuing from the Lake of Zürich the Linth alters its name to that of "Limmat," and, keeping the north-westerly direction, joins the Aar a little way below Brugg, and just below the junction of the Reuss with the Aar.

LINTON, WILLIAM JAMES (1812–1897), English wood-engraver, republican and author, was born in London. He was educated at Stratford, and in his 16th year was apprenticed to the wood-engraver G. W. Bonner. His earliest known work is to be found in Martin and Westall's *Pictorial Illustrations of the Bible* (1833). After working as a journeyman engraver with two or three firms, losing his money over a cheap political library called the "National," and writing a life of Thomas Paine, he went into partnership (1842) with John Orrin Smith. The firm was immediately employed on the *Illustrated London News,* just then projected. The following year Orrin Smith died, and Linton, who had married a sister of Thomas Wade, editor of *Bell's Weekly Messenger,* found himself in sole charge of a business upon which two families were dependent.

In 1844 he took a prominent part in exposing the violation by the English post-office of Mazzini's correspondence. This led to a friendship with the Italian revolutionist, and Linton threw himself with ardour into European politics. He carried the first congratulatory address of English workmen to the French Provisional Government in 1848. He edited a twopenny weekly paper, *The Cause of the People,* published in the Isle of Man, and he wrote political verses for the Dublin *Nation,* signed "Spartacus." He helped to found the "International League" of patriots, and, in 1850, with G. H. Lewes and Thornton Hunt, started *The Leader,* an organ which, however, did not satisfy his advanced republicanism, and from which he soon withdrew. The same year he wrote a series of articles propounding the views of Mazzini in *The Red Republican.* In 1852 he took up his residence at Brantwood, which he afterwards sold to John Ruskin, and from there issued *The English Republic,* first in the form of weekly tracts and afterwards as a monthly magazine. Most of the paper, which never paid its way and was abandoned in 1855, was written by himself. In 1852 he also printed for private circulation an anonymous volume of poems entitled *The Plaint of Freedom.*

After the failure of his paper he returned to his proper work of wood-engraving. In 1857 his wife died, and in the following year he married Eliza Lynn. In 1864 he retired to Brantwood, his wife remaining in London. In 1867, pressed by financial difficulties, he determined to try his fortune in America, and finally separated from his wife. With his children he settled at Appledore, New Haven, Connecticut, where he set up a printing-press. Here he wrote *Practical Hints on Wood-Engraving* (1879), *James Watson, a Memoir of Chartist Times* (1879), *A History of Wood-Engraving in America* (1882), *Wood-Engraving, a Manual of Instruction* (1884), *The Masters of Wood-Engraving,* for which he made two journeys to England (1890), *The Life of Whittier* (1893), and *Memories,* an autobiography (1895). He died at New Haven on Dec. 29, 1897. As an engraver on wood Linton reached the highest point of execution in his own line. He carried on the tradition of Bewick, fought for intelligent as against merely manipulative excellence in the use of the graver, and championed the use of the "white line" as well as of the black, believing with Ruskin that the former was the truer and more telling basis of aesthetic expression in the wood-block printed upon paper.

See W. J. Linton, *Memories;* F. G. Kitton, article "Linton" in *English Illustrated Magazine* (April 1891); G. S. Layard, *Life of Mrs. Lynn Linton* (1901). (G. S. L.)

LINTON, a city of Greene county, Ind., U.S.A.; 43 mi. S.E. of Terre Haute; served by the Chicago, Milwaukee, St. Paul and Pacific, the Illinois Central and the Pennsylvania railways. The population in 1930 was 5,085; in 1940, 6,263. Linton is in an agricultural and coal-mining region. It was founded about 1850 and was incorporated as a city in 1902.

LINTOT, BARNABY BERNARD (1675–1736), English publisher, was born at Southwater, Sussex, on Dec. 1, 1675, and started business as a publisher in London about 1698. He published for many of the leading writers of the day, notably Vanbrugh, Steele, Gay and Pope. The latter's *Rape of the Lock* in its original form was first published in *Lintot's Miscellany,* and Lintot subsequently issued Pope's translation of the *Iliad* and the joint translation of the *Odyssey* by Pope, Fenton and Broome. Pope quarrelled with Lintot with regard to the supply of free copies of the latter translation to the author's subscribers, and in 1728 satirized the publisher in the *Dunciad,* and in 1735 in the *Prologue to the Satires.* Lintot died on Feb. 3, 1736.

LINUM, a genus of the family Linaceae. There are some 200 species of plants found in temperate and subtropical regions especially the Mediterranean. There are 4 species in the British Flora, *Linum catharticum* (purging flax), with white flowers, which is common, also *L. perenne* (perennial flax), *L. angustifolium* (narrow-leaved flax), and *L. usitatissimum* (flax or linseed) which has been introduced and is cultivated especially in Ireland. Flax is the fibre of the last named species obtained by the removal of the softer tissues by retting; the shorter fibres form tow. The seeds (linseed) yield an oil by pressure and the cake left is a cattle food. About 30 species are native to North America. Among these are *Linum virginianum* (slender yellow flax), of the eastern States; *L. floridanum* (Florida yellow flax), of the south-eastern States; *L. rigidum* (large-flowered yellow flax), of the interior prairie region; *L. Lewisii* (wild blue flax), widely distributed from Wisconsin to Alaska and southward to California and Texas; and *L. californicum* (white-flowered flax), of the Coast ranges. *L. grandiflorum* (flowering flax), a native of North Africa, with large red flowers, and *L. flavum,* with golden-yellow flowers, native to Europe, are grown as ornamental plants. (*See* FLAX.)

LINUS, one of the saints of the Gregorian canon, whose festival is celebrated on Sept. 23. His name appears as the immediate successor of Peter in all ancient lists of the bishops of Rome. Irenaeus (*Adv. Haer.* iii, 3. 3) identifies him with the Linus mentioned by St. Paul in 2 Tim. iv, 21. According to the *Liber Pontificalis,* Linus suffered martyrdom, and was buried in the Vatican.

LINUS. A name abstracted from the ancient ritual cry *αἴλινος,* the refrain of a dirge, supposed Phrygian by Euripides,[1] but probably of Semitic origin (*ai lanu,* "woe to us"). It is as old as Homer,[2] and how much older we do not know. To account for this lament for Linus (Gr. Λίνος), as it was supposed to be, two principal stories were told: (1) *Argive.*—Linus, child of Apollo and Psamathe, was exposed at birth and was torn in pieces by dogs. In revenge, Apollo sent a *Poine* or avenging spirit, which destroyed the Argive children. The hero Coroebus killed her, and a festival, Arnis, otherwise called Dog-killing Day (κυνοφτνίσο), was instituted, in which stray dogs were killed, sacrifice made, and Linus and Psamathe mourned for.[3] (2) *Theban.*—Linus was the son of Urania and Amphimarus, and a great musician. He invented the Linus song, but was put to death by Apollo for setting up as his rival.[4] A later, half-burlesque story, says that he was Heracles' music master, and killed by his pupil, whom he tried to correct.[5] He had a cult on Mt. Helicon. Later tradition rationalized him into an ancient poet, prophet or the like.

This and similar figures (Adonis, Maneros, Narcissus) are plausibly explained as originating ultimately in the ceremonial laments for the dead corn spirit.

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LINZ, formerly capital of Upper Austria, was the third largest town in Austria. Pop. (1939) 131,423. On the Danube it lies at the intersection of the east-west routes with the shortest rail connection between Hamburg and Trieste, and is therefore an important railway junction and river port with an active transit trade supplemented by traffic in the products of local industries, *e.g.,* boats, iron and steel goods, agricultural implements, tobacco and cloth. Linz is famous for its examples of Baroque architecture and has a cathedral in the Gothic style.

LION, since the earliest times, one of the best-known animals. In prehistoric times the modern lion (*Panthera leo*) was distributed over the greater part of Europe and within the historic period it inhabited Africa, western Asia, and, very possibly, Greece. At the present day it is found in most parts of Africa, in Mesopotamia, and in Gujarat in northwest India. The Amer-

[1] Eurip., *Orest.*, 1395.
[2] Hom., *Il.*, xviii, 570.
[3] Pausanias, i, 43, 7; Conon, *narrat.*, 19.
[4] Paus., ix, 20, 6.
[5] Apollodorus, ii, 63. There are also other variants.

ican "mountain lion" is the puma, *Felis concolor.*

Lions have been divided into local races, depending upon the colour of the fur and the condition of the mane. They differ from the other large Felidae (except the puma, *q.v.*) in the uniform coloration of the adult and in the possession by the male of a mane on the head, neck and shoulders. There is also a tuft of hair on the tail. The usual colour is yellowish gray. In size, the lion is only equalled or excelled among existing Felidae by the tiger; it may measure 10 ft. from nose to tip of tail; the lioness is about a foot less. The internal structure hardly differs from that of the other Felidae (*see* CARNIVORA). The voice is a loud and characteristic roar.

Lions live chiefly in sandy plains and rocky places, where there are thorn thickets; and in the tall grasses and reeds that grow beside streams. They are in the main nocturnal and catch their prey bounding from an ambush or by a careful stalk. Over a short distance they can gallop very rapidly. Their principal food consists of the larger herbivores—buffaloes, antelopes, zebras and giraffes, but they are not above eating carrion. In cultivated districts they frequently take sheep and cattle, and occasionally human beings. Confirmed man-eaters are, however, usually old animals that have not sufficient activity to kill wild creatures. Lions have been known to jump considerable obstacles carrying a goat or other prey in their mouths. Their strength is phenomenal. Very conflicting reports are given as to their courage; the truth seems to be that not only do individual lions differ in this respect, but that the behaviour of a lion depends upon his condition, a hungry, ill-fed animal being bolder than a full-fed specimen. But unless hungry or molested, the lion, like all large animals, thinks discretion the better part of valour. Both parents display the greatest solicitude in training their young.

See Martin Johnson, *Lion* (1929); Cherry Kearton, *In the Land of the Lion* (1929).

LION FISH (*Pterois volitans*), a tropical marine fish of the family Scorpaenidae, reaching a length of about 1 ft., notable for its very high spinous dorsal and large pectoral fins. The spines of the dorsal, and to a less extent rays of the pectoral fin, stand separate from one another. It is marked with an intricate and striking pattern of light and dark cross stripes, the fin rays and spines banded—a sluggish, ornamental creature. Its spines are said to inflict a poisonous sting, though not as severe as that of the poison fish. The lion fish is found in the Indian ocean, East Indies, and eastward into Polynesia (*see* POISON FISH, SCORPION FISHES). (J. T. N.)

LIONNE, HUGUES DE (1611–1671), French statesman, was born at Grenoble on Oct. 11, 1611, of an old family of Dauphiné. Early trained for diplomacy, his abilities attracted the notice of Cardinal Mazarin, who sent him as secretary of the French embassy to the congress of Münster, and, in 1642, on a mission to the pope. From that time he filled high offices. He helped to negotiate the Peace of the Pyrenees (1659), which secured the marriage of Louis XIV to the infanta Maria Theresa. At Mazarin's dying request he was appointed his successor in foreign affairs, and, for the next ten years, continued to direct French foreign policy. Among his most important diplomatic successes were the treaty of Breda (1667), the treaty of Aix-la-Chapelle (1668) and the sale of Dunkirk. He died in Paris on Sept. 1, 1671, leaving memoirs.

See Ulysse Chevalier, *Lettres inédites de Hugues de Lionne . . . précédées d'une notice historique sur la famille de Lionne* (Valence, 1879); J. Valfrey, *La diplomatie française au XVIIIe siècle: Hugues de Lionne, ses ambassadeurs* (2 vols., Paris, 1877–81). For further works *see* Rochas, *Biogr. du Dauphiné* (Paris, 1860), tome ii, p. 87.

LIOTARD, JEAN ÉTIENNE (1702–1789), Swiss painter, was born at Geneva. He began his studies under Gardelle and Petitot. He went to Paris in 1723, studying under J. B. Massé and F. le Moyne on whose recommendation he was taken to Naples by the Marquis Puysieux. In 1735 he was in Rome, painting the portraits of Pope Clement XII and several cardinals. Three years later he accompanied Lord Duncannon to Constantinople, from where he went to Vienna in 1743 to paint the portraits of the imperial family. His eccentric adoption of oriental costume secured him the nickname of "the Turkish painter." Still under distinguished patronage he returned to Paris in 1744; visited England, where he painted the princess of Wales in 1753, and went to Holland in 1756, where, in the following year, he married Marie Fargues. Another visit to England followed in 1772, and in the next two years his name figures among the Royal Academy exhibitors. He returned to his native town in 1776 and died at Geneva in 1789.

Liotard was an artist of great versatility, and though his fame depends largely on his graceful and delicate pastel drawings, of which "La Liseuse," the "Chocolate Girl," and "La Belle Lyonnaise" at the Dresden Gallery are delightful examples, he achieved distinction by his enamels, copperplate engravings and glass painting. He wrote a *Treatise on the Art of Painting,* and was an expert collector of paintings by the old masters. Amsterdam, Berne and Geneva are particularly rich in examples of his paintings and pastel drawings. A picture of a Turk seated is at the Victoria and Albert Museum, London, while the British Museum owns two of his drawings. The Louvre has, besides 22 drawings, a portrait of General Hérault, and a portrait of the artist is in the Uffizi Gallery, Florence.

See *La Vie et les oeuvres de Jean Etienne Liotard (1702–1789), étude biographique et iconographique,* by E. Humbert, A. Revilliod, and J. W. R. Tilanus (Amsterdam, 1897); Band-Bovy, *Peintres génevois* (Geneva, 1903–04); François Tosca *Liotard* (1928).

LIOUVILLE, JOSEPH (1809–1882), French mathematician, was born at St. Omer and died at Paris. He graduated in 1827 from l'École Polytechnique where, in 1833, he became professor. At the unusually early age of 30 he was elected to the Académie des Sciences (Paris), and presently was appointed professor at the Sorbonne and the Collège de France, and director of the Bureau des Longitudes. In 1836 he founded the *Journal des Mathématiques Pures et Appliquées,* of which he was editor for 40 years. This great journal did much to raise and maintain the standard of French mathematics throughout the 19th century. It was saved from extinction after World War I by international effort, largely American.

Liouville was a prolific and boldly original mathematician. His works, never collected, comprise about 400 memoirs and notes, more than 200 on the theory of numbers alone. His earlier work, which proved abortive by current standards, concerned generalized differentiation (fractional) and integration. In 1832–33, he investigated criteria for the analytic character of integrals of algebraic functions. Liouville was the first, in 1844, to prove the existence of transcendental numbers, and he constructed an infinite class of such numbers. He worked also in differential equations and boundary-value problems. His methods in this department became of capital importance in 20th century mathematical physics, as well as in the theory of integral equations. In differential geometry, he contributed notably to the theories of applicability of surfaces and conformal transformations. The concept of geodesic curvature was introduced by Liouville. Nearly all of his work on the theory of numbers (1857–82) was published without indication of the means by which he had obtained his striking results, relating mostly to numerical functions, representation in quadratic forms, and general formulas in parity functions. All have since been proved. In analysis, Liouville was the first to deduce the theory of doubly periodic functions from general theorems, including his own, in the theory of analytic functions of a complex variable. (E. T. B.)

LIPA, a municipality (with administrative centre and 45 *barrios* or districts), of the province of Batangas, Luzon, Philippine islands, about 90 mi. S. by E. of Manila, on high ground at the intersection of old Spanish military roads, east of the lake of Taal and near the railway running to Batangas. Pop. (1939) 45,175. It is one of the largest and wealthiest inland municipalities of the archipelago. Sugar, corn, cacao and tobacco are among the principal products. Coffee was formerly produced in considerable quantity, but many of the trees were destroyed during the insurrection of 1899–1902; others were destroyed by insects. Jusi cloth is woven in Lipa, and tied abacá (Manila hemp) is marketed in considerable volume. Tagalog is the vernacular. Of those aged 6 to 19 inclusive, 32.8% in 1939 attended school, while 52.8% of the inhabitants 10 years old and over were literate.

LIPARI ISLANDS, a group of volcanic islands north of the eastern portion of Sicily (anc. Αἰόλου νῆσοι or *Aeoliae Insulae*),— Lipari (*Lipara,* pop. in 1936, 14,156), Stromboli (Strongyle), Salina (*Didyme,* pop. in 1931, 3,505), Filicudi (*Phoenicusa*), Alicudi (*Ericusa*), Vulcano (*Hiera, Therasia* or *Thermissa*), the mythical abode of Hephaestus, and Panarea (*Euonymus*). The area of the islands is 44 sq.mi. Pop. (1931) 17,606. The island of Aiolie, the home of Aiolos, lord of the winds, has generally been identified with one of this group, and they are now called Isole Eolie. A colony of Cnidians and Rhodians was established on Lipara in 580–577 B.C. The inhabitants, allies of the Syracusans, were attacked by the Athenian fleet in 427 B.C., and by the Carthaginians in 397 B.C., while Agathocles plundered a temple on Lipara in 304 B.C. During the Punic Wars the islands were a Carthaginian naval station until the Romans took possession in 252 B.C. Sextus Pompeius also used them as a naval base. Under the Empire, as under fascism, the islands served as a place of banishment for political prisoners. In the middle ages they frequently changed hands. Lipari contains the chief town (population in 1936, 4,530), which bears the same name and had municipal rights in Roman times. It is the seat of a bishop. The isle contains sulphur springs and vapour baths, which were known and used in ancient times. It has a ruined 16th century castle. Pumicestone is mined and exported, and the obsidian of Lipari was much exported in prehistoric times, and has even been found at Knossos.

Stromboli, 22 mi. N.E. of Lipari, is constantly active, ejecting gas and lava at brief intervals, and always visible at night. Salina, 3 mi. N.W. of Lipari, consisting of the cones of two extinct volcanoes, that on the southeast, Monte Salvatore (3,155 ft.), being the highest point in the islands, is the most fertile of the whole group and produces good Malmsey wine: it takes its name from the saltworks on the south coast. Vulcano, ½ mi. S. of Lipari, contains a still smoking crater, which erupted in 1888–90 and did much damage.

See Archduke Ludwig Salvator of Habsburg, *Die Liparischen Inseln,* 8 vols. (for private circulation) (Prague, 1892–1896); G. Libertini, *Isole Eolie* (Florence, 1921).

LIPETSK, a town in Tambov province, Russia, on the right bank of the Voronezh river, in 52° 37′ N., 39° 35′ E., and on the railway. The river here is not navigable for steamers. Pop. (1939) 66,625. It has flour mills, a brandy distillery and leather and tobacco works. Its chalybeate mineral springs have been famous since the time of Peter the Great. The town has a municipal electricity and water supply.

LIPKA, JOSEPH (1883–1924), U.S. mathematician, was born at Briessin, Poland, in 1883. He emigrated to the U.S. as a child and was educated at Columbia university (A.B., 1905; A.M., 1906; Ph.D., 1912). He was instructor in mathematics at the University of California 1907–08, and afterward instructor 1908–17, assistant professor 1917–23 and associate professor 1923–24 of mathematics at the Massachusetts Institute of Technology. His earlier work, done under the influence of Prof. Kasner of Columbia, was chiefly in the field of applying differential geometry to dynamics and developing in Euclidean spaces of two or three dimensions the geometric properties of dynamical trajectories and related systems of curves. One of his notable earlier achievements was the establishing of the validity in all cases of the Thomson-Tait criterion for a natural family. This was already proved to hold for a Euclidean space of three dimensions, but Lipka established it first for four and then for n dimensions and finally for a general curved space. In 1921 he went abroad for study under various European mathematicians, especially Levi-Civita of Italy. He subsequently published a group of papers revolving about Levi-Civita's notion of parallelism. He generalized Levi-Civita's conception by replacing the geodesics at the basis of it by the trajectories of a natural family, which suggested a new type of parallelism called "conformal parallelism," an idea of great value in the study of problems in dynamics. By introducing conformed parallelism he developed a new set of invariants which yield corresponding results bearing on trajectories. His papers are models of clear thinking and clear expression, and his early death at Boston on Jan. 24, 1924, cut short a career of great promise.

See W. Graustein, "Scientific Work of Joseph Lipka," *Amer. Math. Soc. Bull.,* vol. xxx (1924) and N. Wiener, "In Memory of Joseph Lipka," *Jour. of Math. and Physics,* vol. iii (1924), both of which articles contain bibliographies of his writings.

LI PO or **LI TAI PO** (李白,李太白, 701–762), considered by many critics as China's greatest poet, was born in Pa-hsi (巴西) in Szechwan. He was a descendant, in the ninth generation, of the emperor Hsing-Sheng. At his birth, his mother had a dream in which she saw the planet, Chang-kêng (長庚星, Venus) and because of this omen he was named Po or "The Bright." At ten, he learned the *Book of Odes* and the *Book of History.* He was fond of fencing and developed a taste for drink, a passion for poetry, and a desire for adventure. After the age of 20, he wandered as far as Shantung, and then retired to the Min mountains (岷山) living the life of a *hsien* (仙, an immortal endowed with divine powers as an angelic man) together with five other sympathetic companions, King Chao, Han Chun, Pei Chêng, Chang Shuming and Tao Mien. Their coterie was known as the Six Idlers of the Bamboo Streams (竹溪六逸). Li Po was then summoned by the provincial examination board, who wished to award him governmental preferment, but he made no response. When Su Ting, the governor of Ichou, was introduced to him, he was struck by the poet's genius and said, "This man has conspicuous natural talents. If he had more learning, he would become a second Ssuma Hsiangju" (司馬相如, 126 B.C., the greatest poet of the Han dynasty).

About 742, he reached the capital, Changan (長安), where his poetry aroused the admiration of Ho Chihchang (賀知章), the minister of the emperor and the president of the Hanlin academy (翰林學院). About this time, there was a Korean messenger with an imperial document written in Korean. This nobody could read but Li Po. After being many times summoned by the emperor Ming Huang, Li Po appeared before him to receive promotion. At one time, while Li Po was drinking in low taverns, the emperor sent for him to compose a song; but Li Po was so drunk that his head and face had to be washed repeatedly with cold water before he could go to the pavilion. While the emperor played the flute, Yang Kueifei (楊貴妃), the court mistress, accompanied him on the guitar and Li Po drank and wrote verses, not returning to the Hanlin academy until after midnight.

Once, when Li Po was very drunk the emperor ordered Kao Lishih to take off the poet's shoes; Kao felt humiliated and persuaded Yang Kueifei that some of Li Po's poems were derogatory to her. She therefore dissuaded the emperor whenever he wanted to give high rank to the poet. His official failure was thus brought about. Finally the poet petitioned the emperor that he be allowed to go away, and he was given money and an imperial edict which enabled him to obtain wine free of charge wherever he should go. Li Po, together with Ho Chihchang, Li Shihchih, Li Chin, Tsui Tsungchih, Chu Chin, Chang Hsu and Chio Sui then went away, forming a new coterie called the Eight Immortals of the Wine Cup (酒中八仙).

Afterward Li Po drifted into the service of Prince Lin of Yung who, when he failed in certain of his designs, blamed Li Po. But he forgave him and the poet set out to go to his kinsman, Li Yanping. On his way he fell from the boat in which he was travelling while trying to kiss the reflection of moonlight in the water, and was drowned.

Li Po's style is unmatched for purity. He deals mainly with the themes, wine and women, and where emotions enter his verse they go deep into the heart of the reader. His work has strong imaginative and aesthetic appeal with an exquisite exactness of touch and extreme dexterity. Philosophy, religious or social, has no place in his work; to him the poet is no teacher or prophet, but a creator revealing beauty for its own sake.

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LIPPE, one of the smaller of the *Länder* of the German Reich, bounded northwest, west and south by the Prussian province of Westphalia and northeast and east by the Prussian provinces of Hanover and Hesse-Nassau, and Waldeck-Pyrmont. It also possesses three small enclaves—Kappel, Lipperode and Grevenhagen in Westphalia. The area is 469 sq.mi., and the population (1939) 188,596, showing a density of 404 to the sq.mi. The state is hilly and consists chiefly of the basin of the Werre, which from Lage northward flows in a wide valley. From here the land rises to the higher hills which encircle it on the east, south and west (the Teutoburger Wald) borders. The forests of Lippe produce abundance of excellent timber, and consist mostly of deciduous trees, beech preponderating. The valleys contain good arable land, the tillage of which employs the greater part of the inhabitants. Small farms, the larger proportion of which are under 2½ ac., are numerous, and their yield shows a high degree of prosperity among the peasant farmers. The principal crops are potatoes, beetroot (for sugar), hay, rye, oats, wheat and barley. Cattle, horses, sheep and swine are also reared. The industries are small and consist mainly in the manufacture of starch, paper, sugar, tobacco, meerschaum wares, and in weaving and brewing. Salzuflen is famous for its brine-springs. Each year, in spring, brickmakers leave the principality to return home in the late autumn. The roads are good. A railway intersects the country from Herford (on the Cologne-Hanover main line) to Altenbeken; and another from Bielefeld to Hameln traverses it from west to east. About 95% of the population are Protestants. The constitution was drawn up in 1920. It provided for a representative chamber (*Landtag*) of twenty-one members, and an executive chamber (Landes präsidium) of three. The courts of law were centred at Detmold. After 1933 the constitution was superseded by the administration of a National Socialist district leader (*Gauleiter*) appointed by Hitler.

History.—Lippe was inhabited in early times by the Cherusii, whose leader Arminius (Hermann) annihilated in A.D. 9 the legions of Varus in the Teutoburger Wald. It was afterward occupied by the Saxons and was subdued by Charlemagne. The founder of the princely family, one of the most ancient in Germany, was Bernard I (1113–1144), who received a grant of the territory from the emperor Lothiar, and assumed the title of lord of Lippe (*edler Herr von Lippe*). From Count Simon VI (1555–1613) descended the Counts of Lippe-Biesterfeld and Lippe-Weissenfeld, and the Princes of Schaumburg-Lippe. On the death of Prince Woldemar of Lippe in 1895, a dispute arose as to the succession between the various branches of the Lippe family, which was only definitely settled in 1905, when Count Leopold of Lippe-Biesterfeld became Prince of Lippe. Lippe, which had been made a principality in 1720 (confirmed in 1789) became a Republic in common with the rest of Germany in Nov. 1918.

LIPPE, a river of Germany, a right-bank tributary of the Rhine. It rises near Lippspringe under the western slope of the Teutoburger Wald, and, after being joined by the Alme, the Pader and the Ahse on the left, and by the Stever on the right, flows into the Rhine near Wesel, after a course of 154 mi. It is navigable, by the aid of 12 locks, downward from Lippstadt, for boats and barges drawing less than 4 ft. of water. The river is important for the transport facilities it affords to the rich agricultural districts of Westphalia.

LIPPI, the name of three distinguished Italian painters of the 15th, 16th and 17th centuries.

I. Fra Filippo Lippi (1406–1469), commonly called Lippo Lippi, one of the most renowned painters of the Italian quattrocento, was born in Florence. In 1421 he was registered in the community of the Carmelite friars of the Carmine in Florence. Here he remained till 1432, and his early faculty for fine arts was probably developed by studying the works of Masaccio in the chapel of the Brancacci. It is not known who his master was. Berenson suggests that he may have been Lorenzo Monaco. The influence of Fra Angelico can be traced in his early work. Between 1430 and 1432 he executed some works in the monastery, which were destroyed by a fire in 1771; they are specified by Vasari, and one was particularly marked by its resemblance to Masaccio's style. Eventually Fra Filippo left his convent, but it appears that he was still bound by some religious vow. In 1452 he was appointed chaplain to the convent of S. Giovannino in Florence, and in 1442 rector (Rettore Commendatario) of S. Quirico at Legnaia.

Except through Vasari nothing is known of Fra Filippo's visits to Ancona and Naples, and his intermediate capture by Barbary pirates and enslavement in Barbary, from which his skill in portrait-sketching availed to release him. This relates to a period, 1431–37, when his career is not otherwise clearly accounted for and modern biographers doubt the accuracy of Vasari's account. Toward June 1456 Fra Filippo was settled in Prato to fulfil a commission to paint frescoes in the choir of the cathedral. Before undertaking this work he set about painting in 1458 a picture for the convent chapel of S. Margherita of Prato, and there saw Lucrezia Buti, a Florentine, who was under the nuns' guardianship. Lippi asked that she might be permitted to sit to him and abducted her to his own house. The fruit of their love was a boy, who became the celebrated painter Filippino Lippi (*see* below). The Virgin in the fine picture in the Pitti gallery is said to be the portrait of Lucrezia Buti.

The frescoes in the choir of Prato cathedral, being the stories of the Baptist and of St. Stephen, represented on the opposite walls, are Fra Filippo's most important and monumental works. At the end wall of the choir are S. Giovanni Gualberto and S. Alberto, and on the ceiling the four evangelists. The close of Lippi's life was spent at Spoleto, where he was commissioned to paint, for the apse of the cathedral, some scenes from the life of the Virgin. In the semidome of the apse is Christ crowning the Madonna, with angels, sibyls and prophets. This series was completed by Fra Diamante after Lippi's death. Lippi died in Spoleto about Oct. 8, 1469. He lies buried in Spoleto, with a monument erected to him by Lorenzo the Magnificent; he was zealously patronized by the Medici family, beginning with Cosimo, Pater Patriae. Jacopo de Sellaio, Francesco di Pesello (called Pesellino) and Sandro Botticelli were among his most distinguished pupils.

In 1441 Lippi painted an altarpiece for the nuns of S. Ambrogio, now in the Uffizi at Florence, which has been celebrated by Browning. It represents the coronation of the Virgin among angels and saints, of whom many are Bernardine monks. One of these, placed to the right, is a half-length portrait of the abbot, pointed out by an inscription upon an angel's scroll "Is perfecit opus." For the church of San Lorenzo he painted an "Annunciation." In the Uffizi is a "Virgin Adoring the Infant Christ" and a "Nativity"; in the National Gallery, London, an "Annunciation" and "Seven Saints"; in the Louvre, Paris, a "Madonna and Angels," painted for S. Spirito in Florence. The museum of Berlin has three early works. There is an early "Adoration of the Magi" in Sir Herbert Cook's collection at Richmond. In the Vatican gallery is a triptych representing "Coronation, Saints and Donors," and in the Palazzo Venezia, Rome, an "Annunciation" from the Hertz collection.

Lippo Lippi's pictures show the naïveté of a strong, rich nature. He approaches religious art from its human side. He was perhaps the greatest colourist of his time, with good draughtsmanship—a naturalist, with much genuine episodical animation. He was fond of ornamenting pilasters and other architectural features. Vasari says that Lippi was wont to hide the extremities in drapery to evade difficulties.

With Vasari's account of Lippo Lippi, the work of Crowe and Cavalcaselle should be consulted. Also E. C. Strutt, *Fra Filippo Lippi* (1906); B. Supino, *Fra Filippo Lippi* (1902) and *Les deux Lippi* (1904); Henriette Mendelsohn, *Fra F. Lippi* (1909); and P. G. Konody, *Fra F. Lippi* (1911).

II. Filippino Lippi (1457–1504), was the natural son of Fra Lippo Lippi and Lucrezia Buti, born at Prato. Losing his father at an early age, the boy was placed in charge of Fra Diamante.

He studied under Sandro Botticelli. His powers developed early, for we find him an accomplished artist by 1480, when he was commissioned to paint an altarpiece, the "Vision of St. Bernard," for the Badia of Florence. Soon afterward (*c.* 1482–90) he began work on the frescoes of the Brancacci chapel in the Carmine, commenced by Masolino and Masaccio many years before. He finished Masaccio's "Resurrection of the King's Son," and was the sole author of "Paul's Interview with Peter in Prison," the "Liberation of Peter," the "Two Saints before the Proconsul" and the "Crucifixion of Peter," modestly adapting his style to that of Masaccio. The portrait of his master Botticelli and those of various others are in this series. In 1485 he executed the great altarpiece of the "Virgin and Saints," now in the Uffizi gallery. Another of his leading works is the altarpiece for the Nerli chapel in S. Spirito—the "Virgin Enthroned," with splendidly living portraits of Nerli and his wife and a fine landscape background.

In 1489 Filippino was in Rome, painting in the church of the Minerva, having first designed the monument for his father in the cathedral of Spoleto. Some of his principal frescoes in the Minerva in celebration of St. Thomas Aquinas are still extant. In 1496 Filippino painted the "Adoration of the Magi" now in the Uffizi. In 1498 he was at Prato; in 1502 he completed the frescoes in the Strozzi chapel, in the church of S. Maria Novella in Florence—"Drusiana Restored to Life by St. John the Evangelist," "St. John in the Cauldron of Boiling Oil" and two subjects from the legend of St. Philip. These are somewhat lively and excited, full of ornate architecture and contrasting colours. The best reputed of his scholars was Raffaellino del Garbo.

Like his father, Filippino had a marked original genius for painting. The father displayed more of sentiment and candid sweetness of motive; the son more of richness, variety and lively pictorial combination. He was admirable in all matters of decorative adjunct, such as draperies, landscape backgrounds and accessories. The National Gallery, London, possesses a good specimen of Filippino, the "Virgin and Child between Sts. Jerome and Dominic." A fine tondo representing the "Holy Family" is in Mrs. Warren's collection at Boston.

Crowe and Cavalcaselle, supplemented by the writings of Berenson, should be consulted as to this painter. An album of his works is in Newnes' Art-library. *See* also A. H. Layard, *The Brancacci Chapel* (Arundel Society, 1868), and B. Supino, *Les deux Lippi* (1904).

III. Lorenzo Lippi (1606–1664), painter and poet, was born in Florence. He studied painting under Matteo Rosselli, the influence of whose style, and more especially of that of Santi di Tito, is to be traced in Lippi's works, which are marked by a strong turn for portrait-like naturalism. His maxim was "to poetize as he spoke, and to paint as he saw." After exercising his art for some time in Florence, Lippi went as court painter to Innsbrück. There he wrote his humorous poem named *Malmantile Racquistato,* published under the anagrammatic pseudonym of "Perlone Zipoli," in 1688. Lippi is more generally remembered by this poem than by his painting.

See Lanzi for Lorenzo Lippi's pictorial work, and Tiraboschi and other literary historians for his writings. Also A. Alterocca, *Lorenzo Lippi* (1914).

LIPPINCOTT, SARA JANE CLARKE (1823–1904), U.S. author and journalist, born Sept. 23, 1823, in Pompey, N.Y., was the daughter of Dr. Thaddeus and Deborah (Baker) Clarke. Educated in public and private schools, she published occasional verse at an early age and at nineteen was a contributor to *Godey's Lady Book.* Best known as "Grace Greenwood," she was the Washington correspondent for the *New York Times* and also the *New York Tribune,* one of the first women to hold such a position. She contributed to many periodicals, including *Godey's, Graham's,* the *New Mirror, Harper's, The Independent* and *The Atlantic Monthly.*

In 1853 she married Leander K. Lippincott and with him edited the *Little Pilgrim* for 12 years. She was the author of 18 books, including children's tales, historical sketches and travel books. Her last work, *Stories and Sketches,* was published when she was 70 years old. Her best known volumes are *Greenwood Leaves* (1850), a collection of articles and stories, and *Haps and Mishaps of a Tour in Europe* (1854) which, as a contemporary reviewer says, "with its freshness of feeling imparts to her letters the charm and fascination of a private conversation."

She lectured during the Civil War, using the proceeds for disabled soldiers and their families, and was a frequent visitor to camp and hospitals, thus earning Lincoln's accolade of "Grace Greenwood, the Patriot." She died at New Rochelle, N.Y., at the age of eighty-one.

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LIPPSPRINGE, a town and watering-place in the Prussian province of Westphalia, Germany, near the western slope of the Teutoburger Wald, 5 mi. N.E. of Paderborn. Pop. (1933) 5,160. It is mentioned in chronicles as early as the 9th century, and here in the 13th century the order of the Templars established a stronghold. It received civic rights about 1400. The springs, for which it is famous, are saline waters of a temperature of 70° F., used for bathing and drinking.

LIPPSTADT, a town in the Prussian province of Westphalia, Germany, on the river Lippe, 20 mi. by rail W. by S. of Paderborn, on the main line to Düsseldorf. Pop. (1939) 23,721. Lippstadt was founded in 1168 by the lords of Lippe, the rights over one half of the town passing subsequently to the counts of the Mark, which in 1614 was incorporated with Brandenburg. In 1850 the prince of Lippe-Detmold sold his share to Prussia. The Marien Kirche dating from the 13th century is built in the Transitional style. The manufactures include cigar making, distilling, carriage building and metalworking. During World War II the town was bombed several times by the British R.A.F.

LIP-READING: *see* Sign Language.

LIPSCHITZ, RUDOLF OTTO SIGISMUND (1832–1903), German mathematician, was born in Königsberg, East Prussia, on May 14, 1832. In 1847 he graduated from the Gymnasium and entered the University of Königsberg. Later he was attracted to the University of Berlin by P. G. Lejeune Dirichlet, and on Aug. 9, 1853 he received his doctor's degree there with a thesis on the magnetic field excited in an ellipsoid by induction. About this time he married Ida Pascha, a childhood playmate. He spent his probationary year at the Gymnasium at Königsberg and then taught at the Gymnasium of Elbing. In 1857 he became privatdocent at Bonn; in 1862 he went to Breslau as ausserordentlicher professor, and in 1864 he returned to Bonn as ordinarius. In 1873 he received an offer from Göttingen, but he declined it and remained at Bonn until his death on Oct. 7, 1903. He devoted himself zealously to the duties of his faculty and for the year 1874–1875 was chosen unanimously as rector. He was a corresponding member of numerous scientific academies, including those at Paris, Berlin, Göttingen and Rome.

The mathematical work of Lipschitz was many-sided, including contributions ranging from the theory of numbers to mathematical physics. He did important work in the calculus of variations, Bessel's functions, Fourier series, potential theory and analytical mechanics. The direction of his thought was determined largely by Dirichlet and by the 1854 *Habilitationsschrift* of G. F. B. Riemann. Fundamentally an algebraist, he was yet interested in the foundations of mathematics, and in his *Lehrbuch der Analysis* (2 vols., Bonn, 1877–1880) he sought to develop the subject from fundamental concepts. Following the lead of A. L. Cauchy, he formulated the well-known Lipschitz (or Cauchy-Lipschitz) condition in connection with the existence theorem for solutions of the differential equation $y'=f\ (x, y)$.

Lipschitz contributed numerous papers to scientific periodicals, especially Crelle's *Journal* and the *Comptes Rendus.* His other works include: *Bedeutung der theoretischen Mechanik* (1866); *Wissenschaft und Staat* (1874); and *Untersuchungen über die Summen von Quadraten* (1886). (C. B. Br.)

LIPSIUS, JUSTUS (1547–1606), the Latinized name of Joest (Juste or Josse) Lips, Belgian scholar, born on Oct. 18 (Nov. 15, according to Amiel), 1547, at Overyssche, a small village in Brabant, near Brussels. He studied at the University of Louvain. In 1567 he published *Variarum Lectionum Libri Tres,* dedicated to Cardinal Granvella, who took him to Rome, where he stayed two years studying mss. and inscriptions. On his return he published *Antiquarum Lectionum Libri Quinque* (1575), which shows an advance forward, a sounder system of emendation by collation. He wandered over Europe a good deal, taught at Jena, Cologne, Louvain and Antwerp and finally became professor of history of Leyden. These changes must have involved some elasticity in the religions he professed, varying between Catholic at Cologne and Calvinist at Leyden. The 11 years at Leyden were his most productive period. It was then that he prepared his *Seneca,* perfected, in successive editions, his *Tacitus* and brought out a series of works, some of pure scholarship, others collections from classical authors, others again of general interest. Of this latter class was a treatise on politics (*Politicorum Libri Sex,* 1589), which caused trouble by his reactionary views on religious toleration, which was with difficulty smoothed down by the university authorities. In the spring of 1590 he went to Mainz, where he was reconciled to the Roman Catholic Church. The event deeply interested the Catholic world, and invitations poured in on Lipsius from the courts and universities of Italy, Austria and Spain. But he preferred to remain in his own country, and finally settled at Louvain, as professor of Latin in the Collegium Buslidianum. He continued to publish dissertations as before, the chief being his *De militia romana* (Antwerp, 1595) and *Lovanium* (Antwerp, 1605; 4th ed., Wesel, 1671), intended as an introduction to a general history of Brabant. He died at Louvain on March 23 (some give April 24) 1606.

Lipsius' knowledge of classical antiquity was extremely limited. His greatest work was his edition of Tacitus. This first appeared in 1575, and was five times revised and corrected—the last time in 1606, shortly before his death. His *Opera Omnia* appeared in 8 vols. at Antwerp (1585, 2nd ed., 1637).

A full list of his publications will be found in van der Aa, *Biographisch Woordenboek der Nederlanden* (1865), and in *Bibliographie Lipsienne* (Ghent, 1886–88). In addition to the biography by A. le Mire (Aubertus Miraeus) (1609), the only original account of his life, *see* M. E. C. Nisard, *Le Triumvirat littéraire au XVI^e siècle* (1852); A. Räss, *Die Convertiten seit der Reformation* (1867); P. Bergman's *Autobiographie de J. Lipse* (1889); L. Galesloot, *Particularités sur la vie de J. Lipse* (1877); E. Amiel, *Un Publiciste du XVI^e siècle. Juste Lipse* (1884); and L. Müller, *Geschichte der klassischen Philologie in den Niederlanden.* The articles by J. J. Thonissen of Louvain in the *Nouvelle Biographie générale,* and L. Roersch in *Biographie nationale de Belgique,* may also be consulted.

LIPSIUS, RICHARD ADELBERT (1830–1892), German Protestant theologian, son of K. H. A. Lipsius (d. 1861), who was rector of the Thomasschule at Leipzig, was born at Gera on Feb. 14, 1830. He studied at Leipzig, and eventually (1871) settled at Jena as professor. He helped to found the Evangelical Protestant Missionary union and the Evangelical Alliance, and from 1874 took an active part in their management. He died at Jena on Aug. 19, 1892. Lipsius wrote principally on dogmatics and the history of early Christianity from a liberal standpoint. His chief works are *Philosophie und Religion* (1885) and *Lehrbuch der evang.-prot. Dogmatik* (1876; 3rd ed., 1893).

His other works include *Die apokryphen Apostelgeschichten* (1883–90), *Hauptpunkte der christl. Glaubenslehre im Umriss dargestellt* (1889), and commentaries on the Epistles to the Galatians, Romans and Philippians in H. J. Holtzmann's *Handkommentar zum Neuen Testament* (1891–92). *See* A. Neumann, *Grundlagen und Grundzüge der Weltanschauung von R. A. Lipsius* (1896).

LIPTON, SIR THOMAS JOHNSTONE, 1ST BART. cr. 1902 (1850–1931), British merchant, was born at Glasgow on May 10, 1850, of Irish parents. He was employed as errand boy to a Glasgow stationer; at fifteen he emigrated to America, where he worked in a grocery store, was a tramcar driver in New Orleans, a traveller for a portrait firm and worked on a plantation in South Carolina. Eventually he returned to Glasgow and opened a small provision shop. In time Lipton had provision shops first all over Scotland and then all over the United Kingdom. To supply his retail shops on the most favourable terms, he purchased extensive tea, coffee and cocoa plantations in Ceylon, and provided his own packing house for hogs in Chicago, and fruit farms, jam factories, bakeries and bacon-curing establishments in England. In 1898 his business was converted into a limited liability company. In 1898 he was knighted, and in 1902 was made a baronet. He was a keen yachtsman, and made repeated attempts to win the "America's" Cup (*see* YACHTING).

LIQUEFACTION OF GASES. It is somewhat uncertain when the idea that gases could be liquefied first arose. Lavoisier certainly expressed the view that if the earth were cooled to the temperature of outer space, part, at least, of its atmosphere would liquefy, but he made no attempt to liquefy any known gas. His associates, Monge and Clouet, were actually the first to succeed in this direction, liquefying sulphur dioxide by passing it into a glass tube cooled with a mixture of ice and salt. About the same time van Marum and Paets van Troostwyk (1790), compressing ammonia to see whether it obeyed Boyle's Law, found that when a certain pressure was reached the volume suddenly decreased rapidly, and drops of liquid appeared. In the year 1799 Guyton de Morveau liquefied ammonia by cooling the gas to the temperature of a mixture of ice and calcium chloride. In 1805 Northmore compressed gases mechanically up to 15 atmospheres, and he appears to have liquefied chlorine.

The Early Work of Davy and Faraday.—No further experimental investigations can be traced till the year 1823, when papers were read before the Royal Society by Sir H. Davy and his assistant M. Faraday (*Phil. Trans.,* 1923), describing experiments carried out at the Royal Institution. In Faraday's first experiments chlorine hydrate, obtained by cooling chlorine water, was heated in a sealed tube to 100° C, when "chlorine was evolved from it under such pressure that it assumed the liquid form, appearing of a bright yellow colour, and sinking in the warm water without any tendency to mix with it." In a second paper he describes experiments with the apparatus shown in figure 1. Compounds which liberated such gases as chlorine, or sulphuretted hydrogen, were placed in the short limb of the glass tube, which was hermetically sealed. The substance was heated, and the long limb of the tube was cooled in ice or in a freezing mixture, and in it the gases liquefied. A few weeks later Davy described the liquefaction of sulphuretted hydrogen, and hydrochloric acid by compression, giving data for the pressures required to liquefy these gases at different temperatures. His paper is of importance, as it shows that in 1823 Davy had already installed apparatus for the compression and liquefaction of gases at the Royal Institution. Ill health prevented him from continuing his researches in this direction.

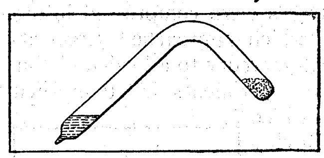


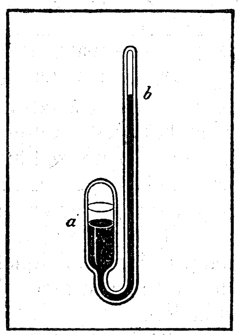
FIG. 1.—FARADAY'S EXPERIMENT

Large Scale Liquefaction.—In 1834 Thilorier developed a method already in vogue for the manufacture of soda water, and applied it to the condensation of carbon dioxide in large quantity. Two stout metal vessels, at first made of cast iron, but, after an accident, of copper, and lined with lead, served as the generator and receiver in Faraday's experiments. One of these was fitted with a cap which could be removed, and a cock, and in it was placed solid bicarbonate of soda and a vessel containing sulphuric acid. The other vessel was fitted with a stopcock only, and the two vessels were joined by a connecting tube which could be detached. The generator was charged, and closed, and then rotated, so as to mix the acid and soda. It was then connected with the receiving vessel, which was cooled in ice, and in this the gas liquefied. The stopcocks were then closed, the vessels were separated, and, by re-charging the generator a second and third charge of gas could be condensed in the receiver. Thilorier observed that the liquid expanded rapidly when heated. He also found that when the liquid was allowed to escape through a jet into a box lined with nonconducting material a snowlike solid was formed. His observation that this solid carbon dioxide mixed with ether was a much more efficient refrigerant than the solid alone was a valuable contribution to the experimental side of the subject.

Faraday's Later Experiments.—The first to apply the results of Thilorier's work, which was carried out from a technical standpoint, to scientific investigations, was Faraday. His method of investigation was as follows. The mixture of solid carbon dioxide and ether was contained in an earthenware vessel of 100 cu.cm. capacity, which fitted into a larger earthenware vessel, three or four folds of dry flannel intervening. The temperature measured by an alcohol thermometer was $-78°$ C, but by placing the apparatus under the receiver of an air pump, and reducing the pressure to 1.2 in. of mercury, a temperature of $-110°$ C was reached.

There seems to be no definite evidence as to when the idea first originated that a pure liquid possessed a definite vapour pressure at a definite temperature. Dalton, early in the 19th century, had shown that the vapour pressure of water was independent of the presence of air in the space above it, and had measured the vapour pressures between the ice point and boiling point. Davy (*loc. cit.*) had observed that "the elasticity of vapours in contact with the liquids from which they are produced, under high pressures increases in higher ratio than the arithmetical one of temperature; but the exact law is not determined," and he had determined the relation of temperature and pressure for certain condensed gases. Faraday now took the subject up at the point at which Davy dropped it, and he determined the vapour pressures of all the gases which could be liquefied at temperatures above $-110°$ C, and at pressures up to 50 atmospheres. (*Phil. Trans.*, 1845.) Faraday was unable to liquefy hydrogen, oxygen, nitrogen, nitric oxide, and carbonic oxide, and the failure of others to succeed by using higher pressures gave rise to the idea that these gases were *permanent,* the term being still used, with recognized qualifications. An interesting investigation with the same object was that of Natterer (*Sitzungsberichte d. Wiener Akad., Ann. d. Phys., 1844–55*). Gases were compressed into a wrought iron vessel, the pressure, which approached 3,000 atmospheres, being transmitted through mercury to a loaded piston, which acted as a manometer. The experiments failed in their object; but indicated the extent to which the permanent gases departed from Boyle's Law regarding the relation between pressure, volume and temperature.

The Critical State.—We must now go back to 1822 when Cagniard de la Tour (*An. de Ch. et de Ph.* 21 and 22) proved that when a liquid was heated above a certain temperature it was completely converted into vapour. He used the glass apparatus shown in fig. 2, the liquid being contained in the wide limb of the U-tube over mercury, the narrow limb serving as a manometer, the pressure being calculated from the volume of the air. The apparatus was heated in an air bath. He obtained the following results:



FROM M. W. TRAVERS, "STUDY OF GASES" (MACMILLAN)

FIG. 2.—CAGNIARD DE LA TOUR'S EXPERIMENT

	Temperature of volatilization	Pressure
Ether	175° C	38 Atms.
Carbon bisulphide . .	258° C	71 Atms.

The experiments of Cagniard de la Tour are an example of the excellent work carried out by French physicists of the period. They were, however, completely lost sight of, and it was not till 1860 that the experiment was repeated by Andrews, and the fundamental principle associated with it was discovered. Andrews' discovery that for each substance there is a critical temperature above which it cannot be liquefied was first made public in the 1863 edition of Miller's *Chemical Physics* and in 1869 formed the subject of a Bakerian lecture under the title, "On the continuity of the gaseous and liquid states of matter."

Research of Andrews.—Andrews had attempted to liquefy the permanent gases by applying high pressures at temperatures down to $-110°$ C. Failing to liquefy them, he turned his attention to the study of the process of liquefying carbon dioxide, with a view to throwing light on the general problem of the liquefaction of gases. For this purpose he used an apparatus, now in the South Kensington museum, of which a diagram is shown in fig. 3. It consisted of twin steel tubes, flanged and capped at both ends, and connected laterally. Through glands in the upper caps glass tubes passed, of capillary bore above and closed at the top, the part inside the steel apparatus being 2.5 mm. bore, and open below. The tubes contained respectively carbon dioxide and air, over mercury with which the steel apparatus was filled, the air tube serving as a manometer, the pressure being assumed to be inversely proportional to the volume. Steel screw plungers passing through glands in the bottom of the apparatus served to regulate the volume and pressure. The glass tubes projecting outside the apparatus were surrounded by a water bath with glass sides. He found that at temperatures below 31° C liquid appeared in the tube containing the carbon dioxide when the air manometer indicated a definite pressure for each particular temperature, and that when liquefaction had commenced, the gas could be completely condensed without increase of pressure, except such as could be attributed to the presence of traces of air in it. Near 31°, which he was the first to call the critical point, the space which had been occupied by the liquid at lower temperatures became filled with a "homogeneous fluid, which, when the pressure was slightly reduced, or the temperature slightly lowered, exhibited a peculiar appearance of moving or flickering striae throughout its entire mass." At temperatures above 31° he found that the gas could be reduced in volume to that which it should occupy as liquid with complete continuity, and without exhibiting a visible surface, hence the title under which the results of the work were published. The results obtained are represented by the simple curves in fig. 4. These curves, called isothermals, representing the relationship of pressure and volume for a series of constant temperatures, are in heavy line. An isothermal for a temperature below the critical temperature represents the volume of the gas as diminishing as the pressure increases till the vapour pressure is reached, and the gas begins to liquefy. The volume then decreases without increase in pressure till the gas is completely liquefied, this part of the curve being a horizontal straight line. As the liquid is only slightly compressible the curve then ascends steeply. The part of the diagram within and below the dotted line represents conditions under which liquid and vapour can co-exist. The critical isothermal has no horizontal portion, since the volumes of liquid and vapour are identical. Above the critical point the curves approach rapidly to the form of the hyperbola.

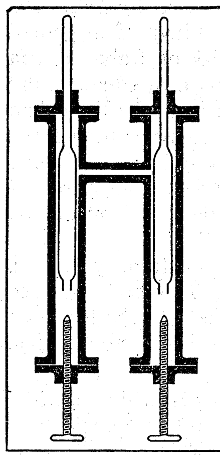


FIG. 3.—ANDREWS' APPARATUS, USED IN INVESTIGATIONS ON THE CRITICAL STATE

The experiments of Andrews fully explained his own failures, and those of Faraday and earlier investigators, to liquefy the so-called permanent gases. The significance of his work, can, however, only be appreciated when we consider the theoretical investigations to which it gave rise. Since the work of Regnault had first shown that the known gases departed more or less from the laws of Boyle and Gay-Lussac as expressed by the equation,

$$\frac{pv}{T}=R, \text{ a constant,}$$

T being the temperature on the scale of a thermometer filled with the gas itself, approximately equivalent to the temperature on the absolute scale, to which reference will be made later. Many attempts had been made to modify the formula to accord with the facts so far as they were known. These, however, only included the volume and pressure relations of the gas, but in view of the discoveries of Andrews it was now obvious that the theoretical investigation must also take into account the existence of the liquid phase.

Van der Waals's Equation of State.—In 1873 there was published in Leyden a dissertation with the same title as Andrews' Bakerian lecture—"On the continuity of the liquid and gaseous states," by J. D. Van der Waals. The title has not, however, the same significance, and is used in a more exact sense than by Andrews. It implies that while the isothermals for temperatures which differ by a very small interval above and below the critical temperature are practically identical in form, the isothermal for the higher temperatures represents the gaseous state only, and that for the lower temperatures relates also to the liquid state. This was the first original paper published by the author who had for some years been engaged upon mathematical investigations, based upon the kinetic theory of gases and Laplace's theory of capillarity, and upon this work he based the theory which made him famous. Assuming the molecules of any particular gas to be all exactly similar hard elastic spheres of radius r, the volume occupied by n molecules in volume v is

$$b' = \tfrac{1}{6} n r^3 \pi$$

In accordance with the assumption as to the form of the molecule, the gas equation thus becomes

$$p(v-b) = RT,$$

where $b = 4b'$.

Now, while the molecules in the interior of a mass of gas are subjected to attractions by other molecules which are equal in all directions, so that the resultant attraction is negligible, the resultant attraction on the molecules in the surface layer is directed inward, and varies as the square of the volume. Allowing for the effect thus produced the equation now becomes:—

$$\left(p + \frac{a}{v^2}\right)(v-b) = RT.$$

This is known as the Van der Waals equation.

It may first be pointed out that the equation may also be written in cubic form

$$v^3 - v^2\left(\frac{RT}{p} + b\right) + \frac{va}{p} - \frac{ab}{p} = 0.$$

One of the three roots of this equation must always be real, and the other two may be real or imaginary, so that for every value of p there may be one or three values of v. In a certain region, for the isothermals below the critical point, there are three real values of v for each value of p, so that the curves do not have the simple form indicated by the heavy lines but follow the sinuous lines.

The latter do not exhibit the discontinuity shown by the former, in which, for one particular value of p only, the vapour pressure, there are two values of v, corresponding to the volumes of saturated vapour and of the liquid. This pressure and the corresponding volumes are indistinguishable on the Van der Waals curve, but at the same time, if the relations of volume, pressure, and temperature under which the liquid and vapour phases are in equilibrium are known, the constants in the Van der Waals equation can be calculated from them with the same accuracy as from the data obtained from the compressibility of the gas. The meaning of the continuous curve has been the subject of much speculation. It has been suggested that the portion of it on the extreme right represents a condition of super-saturated vapour, and that on the left a state in which liquid exists at a pressure below its vapour pressure. The central portion must in any case be without physical significance as it represents the pressure and volume as increasing together and decreasing together. As a matter of fact the Van der Waals equation is based upon the consideration of the behaviour of a single phase, which may change continuously into a second phase, but it does not contemplate discontinuity, or equilibrium between liquid and vapour. The form of the curve has no physical significance at all, but is merely a consequence of the mathematical treatment of the subject.

At the point C, the critical point $\frac{\partial p}{\partial v} = 0$ and a line drawn parallel to the volume axis is tangential to the isothermal. At this point the three values of V are real and equal, and by a simple algebraical process we can obtain the values of the critical temperature, the critical pressure, and the critical volume in terms of the constants of the equation:—

$$T_c = \frac{8a}{27bR}; \quad p_c = \frac{a}{27b^2}; \quad v_c = 3b; \quad p_c v_c = 0{\cdot}375 RT_c.$$

The following are the values of a and b for some of the common gases, when pressures are reckoned in atmospheres, and the volumes in litre-moles:

Gas	a	b
Hydrogen H_2	0.19	0.023
Oxygen O_2	1.36	0.0316
Carbon dioxide CO_2	3.61	0.0428
Sulphur dioxide SO_2	6.69	0.0565

The fundamental ideas which are expressed by the Van der Waals equation are undoubtedly true, but it could hardly be expected that from the simple assumptions upon which it was based it would be possible to develop a complete theory of the gaseous and liquid state. The equation does not enable us to connect in a quantitative manner the properties of gases at low pressures. The ratio $p_c v_c / T_c$ is not 0.375 pv/T, being generally nearer to 0.27 R/R. It is not possible to trace the isothermals

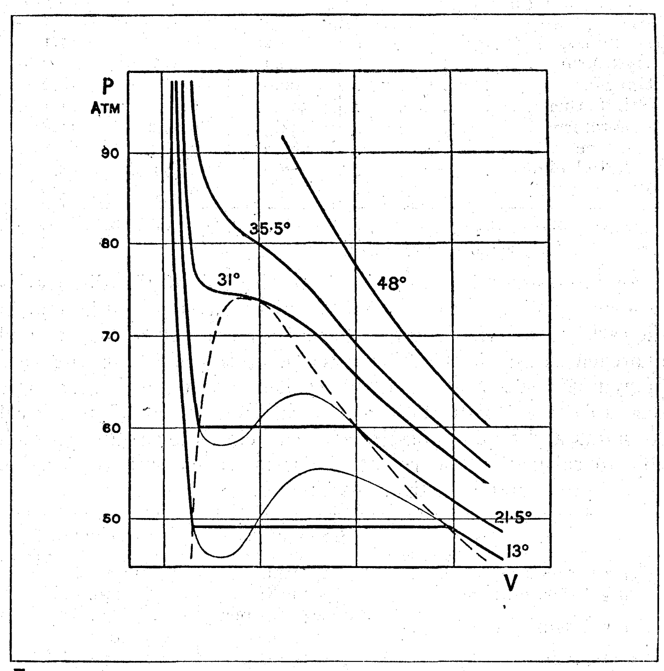


FIG. 4.—P.-V.-T. DIAGRAM FOR CARBON DIOXIDE. ILLUSTRATING THE WORK OF ANDREWS AND OF VAN DER WAALS

for any distances by means of data calculated from the critical constants. However, the Van der Waals equation, even without modification, has been of very great value as a means of calculating the physical constants for gases and liquids approximately.

The Law of Corresponding States.—A second discovery which was made by Van der Waals is known as the law of corresponding states. This is really a mathematical consequence following on the assumption that the properties of the systems with which we are dealing can be represented by an equation with two constants a and b, R depending merely on the quantity of material in this system, molar or otherwise. If then a series of diagrams are drawn like fig. 4, but representing the properties of different materials, such as carbon dioxide, benzene, etc., it will be seen that they are very similar, and they can actually be made identical by altering the vertical and horizontal scales on which they are drawn. This may be done if we change the units from absolute units of temperature, pressure, and volume, and represent these dimensions in terms of fractions or multiples of the values of the critical constants, thus,

for T we write $T/T_c = \theta$ the *reduced temperature*.
" p " " $p/p_c = \pi$ the *reduced pressure*.
" v " " $v/v_c = \phi$ the *reduced volume*.

Equal values of θ, π, and ϕ for different substances represent what are known as corresponding states. By substituting the reduced values in the equation it becomes

$$\left(\pi+\frac{3}{\phi^2}\right)(\phi-\tfrac{1}{3})=\frac{8\theta}{3}.$$

It will be noticed that the constants, a, b, and R have vanished, and therefore all substances in corresponding states should behave alike. For instance, the isothermals of all gases represented in this manner should be identical. The law of corresponding states leads directly to certain useful approximations. The boiling point T_b of most liquids is approximately a corresponding temperature, since

$$T_b/T_c=0.62 \text{ (about)}$$

and as it can be shown that the latent heat of liquefaction L should be identical for liquid-gas systems at corresponding temperatures it follows that

$$L/T_b=\text{constant}.$$

It was found by Trouton (*Phil. Mag.*, 1899) that for many liquids this rule holds good, thus:—

Liquid	T_b	L	L/T_b
†Helium	4.29	22	5.1
†Hydrogen	29.4	214	10.5
†Oxygen	90.6	1,664	18.2
Ethyl ether	307	6,466	21.1
Chloroform	334.5	6,972	20.85
Benzene	353.2	7,370	20.85
‡Ethyl alcohol	357.2	9,972	28.40
‡Water	373	9,660	25.9

Trouton's rule does not hold good for liquids at very low temperatures†, nor for associating liquids‡.

An interesting instance of the application of the discoveries of Van der Waals was that of the Polish physicist Witkowski in the early 1880s. He determined the compressibility of oxygen and hydrogen down to the lowest temperatures which in the case of hydrogen was that of liquid oxygen. From the data, he was then able to calculate the constants in the equation. The critical constants and boiling point of oxygen being known, he was then able to calculate these constants for hydrogen with remarkable accuracy, as later investigations showed.

	Calculated	Experimental
Critical pressure	13 atm.	12.8 atm.
Critical temperature	−240°C	−239.9°C
Critical density	0.033 grams per cu.cm.	0.031 grams per cu.cm.
Boiling point	−250°C	−252.8°C

Later, Kammerlingh Onnes used a similar process to estimate the constants for helium. Again, Ramsay and Young (*Phil. Mag.*, 1886) discovered a simple relationship between the vapour pressures of pairs of liquids, which holds good for associating liquids, but tends to break down at very low temperatures. If T_x and T_y, $T_{x'}$ and $T_{y'}$, are the absolute temperatures at which a pair of liquids have vapour pressures p and p', then

$$T_x/T_y=T_{x'}/T_{y'}+k\,(T_x-T_{x'})$$

when k is a constant for each pair of liquids. This formula enables us to calculate the vapour pressure for any substance over a wide range of temperatures, when the vapour pressures corresponding to two or more temperatures are known. The following is an illustration of the use of the method. The case is taken in which the vapour pressure of krypton was to be determined and water was the reference substance. The values in columns 1 and 2 were the result of observation.

1 P(mm)	2 T_{kr}	3 T_{aq}	4 T_{kr}/T_{aq}
386.6	112.7	353.1	0.3174
11,970	170.9	474.3	0.3603
30,837	201.0	525.1	0.3828

The values in column 3 are the temperatures for water corresponding to the pressures in column 1. The values in column 4 are the ratios of the values 2/3. We then plot the values in column 4 against those in column 3, and draw a straight line through the points set out. Values of T_{aq} in column 6, equivalent to any derived pressure indicated in column 5, are then readily

5 p(mm)	6 T_{aq}	7 T_{kr}/T_{aq}	8 T_{kr}
600	366.5	0.3229	118.35
4,000	427.2	0.3449	147.3
30,000	523.6	0.3801	199.0

selected, and from the graph the corresponding values of T_{kr}/T_{aq} in column 7 are read off. Multiplying the values in column 6 by those in column 7 we obtain the values in column 8. Thus we can calculate the vapour pressures over any range, up to the critical point.

Modifications of Van der Waals' Equation.—Various attempts have been made to modify the Van der Waals' equation, and a very large number of equations, nearly all of which are empirical, have been put forward. Thus Clausius proposed an equation

$$\left\{p+\frac{a}{T(v+c)^2}\right\}(v-b)=RT$$

to represent the experimental results of Amagat at very high pressures. This, and other equations, were carefully examined by Kammerlingh Onnes and all were found to be unsatisfactory. D. Berthelot (*Bureau Int. des Poids et Mesures*, 1907, vol. xiii) proposed an equation which, in the reduced condition, and for low pressures, may be written

$$\left(\pi+\frac{16}{3}\cdot\frac{1}{\theta\phi^2}\right)\left(\phi-\frac{1}{4}\right)=\frac{32}{4}\theta.$$

From this equation we obtain

$$\frac{\partial(\pi\phi)}{\partial\pi}=\frac{1}{4}\left(1-\frac{6}{\theta^2}\right);$$

while from the Van der Waals equation

$$\frac{\partial(\pi\phi)}{\partial\pi}=\frac{1}{3}\left(1-\frac{27}{8\theta}\right).$$

The former expression enables us to calculate the values of $\frac{d(pv)}{dp}$ over a very wide range of temperature with a surprising degree of accuracy, the results showing deviations from experimental values which are comparable with experimental errors. These constants are of importance in evaluating the deviations of the gas scale from the thermodynamic scale of temperature.

Dieterici, whose work has been reviewed by F. H. MacDougall (*J. of Am. Ch. Soc.* 1916), has put forward equations, which, like the equations of Van der Waals, have a true physical meaning. We will consider his second equation, which is based on the following reasoning. In the interior of a fluid the attractive forces between molecules are balanced; at the surface there are unbalanced forces, of which the resultant effect is directed inward. Molecules of low velocity are unable to reach the surface, therefore the surface layer will decrease in density from the interior outward to the surface, where the density will depend on the exterior pressure. Only molecules having a velocity above a certain value will penetrate this inhomogeneous layer, and exert pressure on the walls of the containing vessel. If, now, we determine what fraction of the total molecules has a velocity greater than this value, then the external pressure will be that same fraction of the internal pressure. Omitting the details of the reasoning, from this assumption he arrives at the formula:—

$$p=\frac{RT}{v-b}e^{\frac{-A}{RT}}$$

where e is the base of a natural logarithm, b is a function similar to the Van der Waals b and A is a cohesion function measured by the work done by a molecule in penetrating to the surface. Making the simple assumption that A is proportional directly to the volume, the equation becomes

$$p = \frac{RT}{(v-b)} e^{\frac{-a}{vRT}}$$

This equation differs materially from that of Van der Waals in that a and b are really variable with the volume, which makes it very difficult to apply. In some respects it represents a real advance upon the work of Van der Waals, and from it we can derive the expression:—

$$p_c v_c = 0.27\, RT_c$$

which accords with experiment. Recent attempts to apply modern concepts of atomic structure to the derivation of an equation of state have not led to any noteworthy success.

Thermodynamical Treatment of the Subject.—The experiments of Andrews paved the way for the work of Van der Waals, and after describing those experiments, which open a new period in the history of our subject, it was convenient to describe the theoretical developments to which they gave rise. Before dealing with the next phase in the experimental study of liquid-vapour systems it is convenient to consider the process involved from the standpoint of thermodynamics. The starting point is now the law of conservation of energy, also known as the first law of thermodynamics. To illustrate this law we will suppose that when we supply a quantity of heat Q to a gas, the heat is utilized in increasing the internal energy of the gas by an amount U. If the gas expands it must overcome resistance; in other words it must do work W; and if Q, U and W, are expressed in the same units we may write:—

$$Q = U + W.$$

It is obvious that the heat is drawn from the surroundings, and that work is done on the surroundings, and the energy U, which remains associated with the gas, is now the difference between the quantities W and Q. We will now consider what changes take place in the values of W, Q and U when the gas undergoes changes in temperature, pressure and volume. So long as a system, which may be a gas, or liquid, or may contain both gas and liquid, undergoes no such change its internal energy must remain constant, and under certain conditions the internal energy may remain constant when the system undergoes change. This is illustrated by the well known experiment of Gay-Lussac (1806), afterward perfected by Joule (1844). Two large vessels, connected by a stopcock, are immersed in a water bath, one vessel being exhausted and the other containing gas under pressure. When the temperature is constant, the stopcock is opened, so that the gas can distribute itself between the two vessels. After an interval, the temperature of the water bath is observed, and it is found to be unchanged. The gas has expanded, and though this may be at first sight contrary to experience, its temperature has remained unchanged. Now the experiment is arranged so that the gas expanding into a closed exhausted space, produces no external effect, mechanical or thermal, so that, if we assume the truth of the first law, since

$$W = 0 \text{ and } Q = 0, \text{ it follows that } U = 0.$$

The result obtained in the Gay-Lussac-Joule experiment would always be observed in the case of an ideal gas which obeys the simple law, $pv = RT$, and gases such as air approximate to this very closely at moderate pressures. For the general elementary treatment of problems in thermodynamics it is often convenient, and permissible, to assume that we are dealing with a perfect gas, and that the internal energy at constant temperature is independent of the volume, which is expressed by

$$\left(\frac{\partial U}{\partial v}\right)_T = 0.$$

In the case of an actual gas, which obeys a more complicated law such as that of Van der Waals, the internal energy depends on the distance between the molecules, *i.e.*, on the volume, and a change of temperature is expected when it expands without doing external work. This may be either a cooling or a heating, and can be observed in a modification of the experiment, which will be described later. In any case the internal energy, U, is a unique function of the pressure, p, and temperature, T.

The relation above applies to a perfect gas during any change of volume at constant temperature. Suppose the gas expands in a cylinder with perfectly conducting walls, so that the temperature is kept rigorously constant while the gas does work through the piston. If the volume increases by dv at pressure p we can represent the work done by

$$W = \int p\,dv.$$

Since $pv = RT$
$$W = RT\int_{v_2}^{v_1} \frac{dv}{v} = RT\log_e \frac{v_1}{v_2}$$
$$= RT\log_e \frac{p_2}{p_1}.$$

If W the work done and Q the heat supplied were measured we should find that $Q = W$ and that the gas had served merely as a means of converting heat into work, the internal energy remaining constant. Since the mechanism in this hypothetical experiment is supposed to be perfect, the work done is now the maximum work which can be done by the gas when expanding isothermally.

When a liquid evaporates at constant temperature the volume increases at constant pressure, and the external work done is again expressed by:

$$W = \int p\,dv.$$

The total quantity of heat absorbed in the process is

$$Q = H_2 - H_1 = U_2 - U_1 + \int p\,dv,$$

where U_2 and U_1 are the internal energies of the gas and liquid, respectively. The quantity, $H = U + \int p\,dv$, calculated from some standard initial condition (*e.g.*, liquid at its normal boiling point), is called the total heat. Like the internal energy, it is a definite function of pressure and temperature in the gas phase. It is a convenient quantity in which to express energy changes in refrigeration processes, and has been tabulated for all gases of interest. In the case of the evaporating liquid, the change of internal energy is much larger than the work of expansion. Thus, use of a liquid for refrigeration allows a greater exchange of energy than a gas, for a given change of volume.

Adiabatic Expansion.—We may now consider what happens when a gas is allowed to expand, doing work, but in such a manner that no heat is absorbed, that is to say adiabatically. This actually happens in the high-pressure vessel in the Gay-Lussac-Joule experiment, and it becomes obvious when in a modification of the experiment by Joule, the vessels are contained in separate water baths. Though the temperature of the water in the bath enclosing both vessels has not altered, in the modified experiment, the water around the high-pressure vessel generally becomes cooled, and the water around the low pressure vessel generally becomes equally heated. If the cock is closed the moment expansion has taken place, when the temperature has finally become uniform, the pressure in the high-pressure vessel is found to be less than in the low-pressure vessel. The gas which remains in the high-pressure vessel may be supposed to do work in imparting kinetic energy to that part of the gas which flows into the low-pressure vessel. As the change takes place very rapidly no heat is absorbed. The kinetic energy of the moving mass of gas reappears as heat energy when the gas is brought to rest in the second vessel.

In order to analyze this problem we must first consider the change which takes place when a gas is heated. Suppose that one gram molecule of a gas is heated from T to $T + dT$, so that the pressure remains constant, the heat absorbed by the gas can be represented by: $dQ = C_p dT$, where C_p is the (molar) specific heat at constant pressure. If now we first of all consider the gas to be heated through an interval dT at constant volume, the increase in the internal energy is given by:

$$\left(\frac{\partial U}{\partial T}\right)_v dT = C_v dT,$$

C_v being the specific heat of the gas at constant volume. If now the gas is allowed to expand, doing maximum work, till the original pressure is reached, the work done is:

$$dW = p\ dv = RdT.$$

Then since $dQ = dU + dW$,

$$C_p dT = C_v dT + RdT$$
$$C_p = C_v + R.$$

Now since in any adiabatic process $dQ = O$,

$$C_v dT + p\ dv = O.$$

Substituting $p = RT/v$, and integrating:—

$$C_v \log_e T + R \log_e v = \text{Constant}$$

Writing γ for C_p/C_v, and substituting $C_p - C_v$ for R,

$$\log_e T + (\gamma - 1) \log_e v = \text{Constant},$$

or $$Tv^{(\gamma-1)} = \text{Constant},$$

and writing gas equation in the form:—

$$\log_e P + \log_e v - \log_e T = \text{Constant},$$

we obtain $$\log_e P + \gamma \log_e v = \text{Constant}$$

or $$pv^\gamma = \text{Constant}$$

This equation, which gives the form of the adiabatic curves for a perfect gas, shows that these, when represented on a pv diagram, are steeper than the isothermal curves, indicated by full lines (fig. 5). Suppose that a gas is compressed isothermally, so that the p–v relations are represented by the isothermal ab. When the point bb' is reached the gas is allowed to expand adiabatically. If the adiabatic curve (pv^γ= const.) passes within the region p–v on the diagram which represents conditions under which liquid can exist, as at d, partial liquefaction will result, as happened in the case of the experiments of Cailletet.

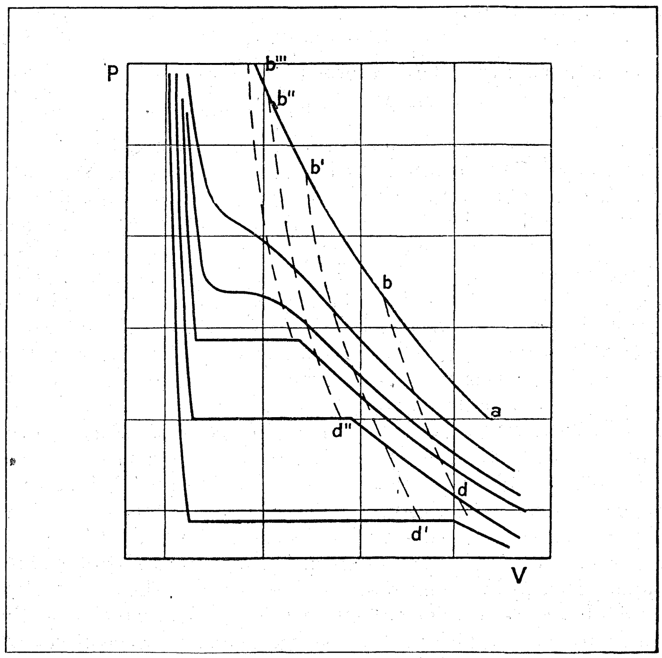


FIG. 5.—ADIABATIC AND ISOTHERMAL CURVES FOR PURE GASES

Liquefaction by Adiabatic Expansion.—When liquefaction does not take place the fall of temperature resulting on expansion from pressure p_1 to pressure p_2 is given by the following expression derived from the above.

$$\frac{T_1}{T_2} = \left(\frac{p_1}{p_2}\right)^{\frac{\gamma-1}{\gamma}}$$

The next experimental work of importance following the work of Andrews, and to which the theory which we have just considered applies, is that of Louis Cailletet. He used an apparatus, similar in principle to that of Andrews. The gas was confined over mercury in a glass tube, the capillary part of which projected outside a steel chamber, the lower part of which also contained mercury to which pressure was transmitted by means of water from a compression pump. The first gas to be investigated was acetylene, which was liquefied by pressure alone at the air temperature (critical temperature 35° C). However, on one occasion when the acetylene had been compressed to a degree insufficient to liquefy it, the release valve on the compression pump was opened, and immediately, as the gas within expanded, the capillary tube was seen to be filled with a dense mist. Cailletet did not at first realize that the cause of the appearance of the mist was the adiabatic cooling and partial liquefaction of the acetylene, and he put it down to the presence of impurity in the gas. As a second experiment with acetylene, prepared with great care, yielded the same result, he next filled the apparatus with nitrous oxide, and again observing the formation of mist on expanding the gas, he came to the conclusion that the phenomenon was due to the actual liquefaction of the gas. It was difficult to realize that such intense cooling could be effected by expanding so small a quantity of gas in a capillary tube, but having realized that this could be done, Cailletet at once proceeded to attack the problem of liquefying the so-called permanent gases. Methane, carbon monoxide and oxygen were in turn compressed to 300 atmospheres in the same apparatus, cooled to −29° C in a bath of sulphur dioxide boiling under reduced pressure, and then allowed to expand by releasing the pressure. In each case the tube was seen to fill with the dense mist, indicating that liquefaction had taken place, though no liquid was actually seen. This is not surprising, for in the case of diatomic gases having the value 1.4 for C_p/C_v, the theoretical cooling would be given by

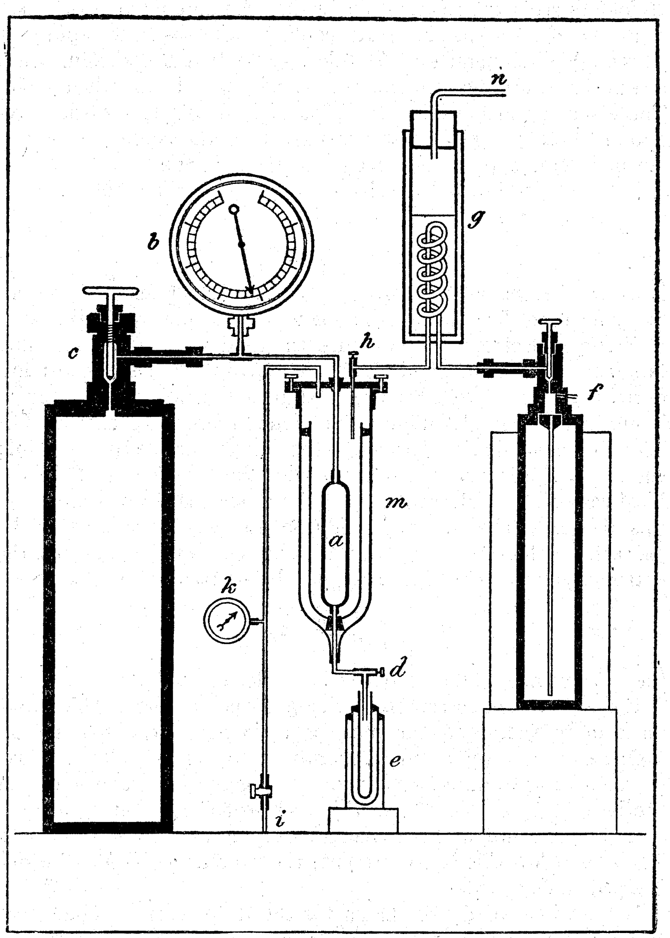
$$(273-29)/T = 300^{(1\cdot4-1)/1\cdot4};$$
$$T = 48°\ \text{A.,}\quad \text{or}\quad -225°\ \text{C.}$$

This is equivalent to a fall of temperature of just under 200° C.

Early Researches on Mechanical Refrigeration.—At the same time similar experiments were being carried out by R. Pictet, a Swiss engineer, and pioneer of the process of mechanical refrigeration by the continuous liquefaction and evaporation of sulphur dioxide, and other gases which were easily condensed. To this work reference will be made later; for the moment suffice it to say that by condensing sulphur dioxide under three atmospheres pressure and evaporating the liquid *in vacuo* he reached −65° C. At this temperature he condensed carbon dioxide, and by evaporating the solid *in vacuo* he obtained a temperature which he stated to be −130°. To this temperature he cooled oxygen in a steel tube, connected with a steel retort in which it was generated under a pressure of 200 atmospheres by heating potassium chlorate. On allowing the cooled oxygen to escape at a pin valve he observed a jet of liquid oxygen, surrounded by a white cloud, which he took to be solid oxygen. The result was published almost simultaneously with that of Cailletet. Later he generated hydrogen under pressure in the same apparatus by heating potassium formate with caustic potash, and, on opening the pin valve, he thought that he saw a metallic steel blue substance issue from it, and strike the floor making a noise like a discharge of shot. Probably, the gas contained much carbon monoxide, which liquefied on expansion. On the authority of Pictet, many were led to believe that solid hydrogen would prove to be a metal, a suggestion which certain of its chemical properties seemed to support.

Liquefaction of Oxygen.—In 1883 the Polish chemists Wroblewski and Olszewski repeated Cailletet's experiment in a modified form, bending the capillary tube of the compression apparatus so that it could be immersed in a cooling medium. Also they attained an initial temperature lower than that which had been previously used, by cooling and condensing ethylene by means of solid carbon dioxide, and evaporating the ethylene *in vacuo*. The lowest temperature reached was now −136° C, and this temperature was measured by means of a hydrogen thermometer. Liquid oxygen was now seen for the first time in a static condition, and it was possible to measure its vapour pressure between $-136°$ C, and the critical point, $-119°$ C. Two years later, using a more perfect system of heat insulation, and evaporating ethylene under 10 mm. of mercury pressure, a temperature of $-152°$ C was reached, and both nitrogen and carbon monoxide were liquefied.

In 1885, using the same method, but with larger condensation tubes Olszewski liquefied larger quantities of oxygen, nitrogen and carbon monoxide, obtaining as much as 12 to 15 cu.cm. of liquid at the critical points and two to three cu.cm. of liquid at the boiling points. By evaporating a very small quantity of liquid nitrogen *in vacuo* he obtained solid nitrogen, and by reducing the pressure to six mms. of mercury the temperature indicated by the hydrogen thermometer was $-225°$ C, the lowest temperature recorded to a much later date. In 1886 Dewar, at the Royal Institution, obtained 22 cu.cm. of liquid oxygen by compressing the gas into a copper coil, cooled in liquid ethylene, from which it was allowed to expand through a pin valve into a glass vessel, also cooled in liquid ethylene. He then proceeded to construct a plant on the lines of Pictet's original apparatus with cycles for carbon dioxide and ethylene, and in 1892 obtained as much as a pint of liquid oxygen. Reference will be made to this work later. In the meantime Olszewski had extended his investigations, and though he apparently never obtained more than 100

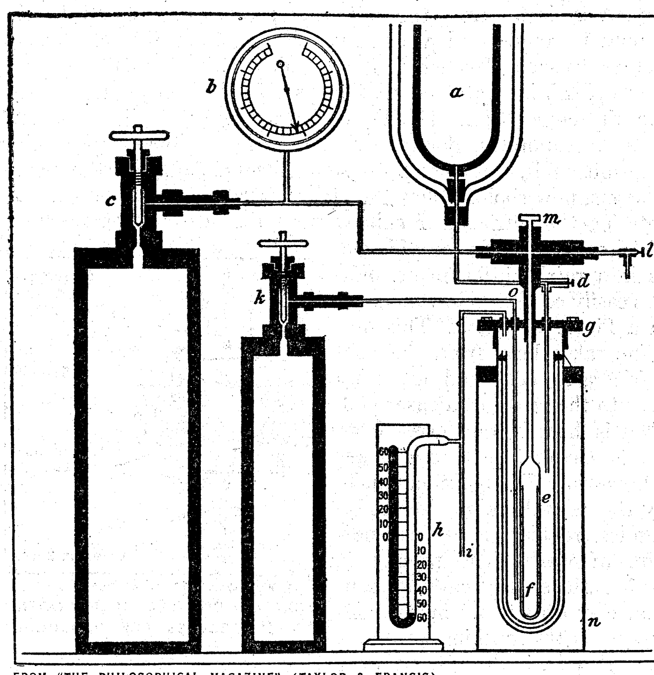


FROM "THE PHILOSOPHICAL MAGAZINE" (TAYLOR & FRANCIS)

FIG. 6.—OLSZEWSKI'S LIQUID OXYGEN APPARATUS

(a) a steel cylinder in which oxygen is compressed and cooled, (b) pressure gauge, (c) compressed oxygen reservoir, (d) expansion valve for oxygen, (e) receiver for liquid oxygen, (f) steel cylinder containing liquid ethylene, (g) coil surrounded by a mixture of carbon dioxide and ether evaporating *in vacuo*, (h) expansion valve for ethylene, (m) vessel surrounding (a) in which ethylene is liquefied and evaporated *in vacuo*

cu.cm. of liquid oxygen, his work is of particular interest on account of the methods used, and also because his investigations provided reliable measurements of critical constants and vapour pressures which are, in some cases, still accepted. His work is described in a paper in the *Philosophical Magazine* for the year 1895. The apparatus is shown in fig. 6. The cylinder *f* contains ethylene, and is cooled in a freezing mixture. The liquid ethylene flows through the coil in the vessel *g*, which contains a mixture of solid CO_2 and ether at $-78°$ C. The cooled liquid flows through a pin valve into a chamber *m*, made up of concentric



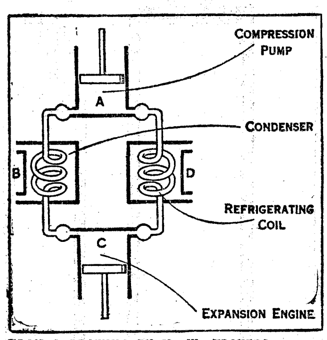
FROM "THE PHILOSOPHICAL MAGAZINE" (TAYLOR & FRANCIS)

FIG. 7.—OLSZEWSKI'S LIQUID HYDROGEN APPARATUS

(a) steel vessel in which oxygen is compressed and cooled, (b) pressure gauge, (c) reservoir for compressed hydrogen, (d) expansion valve for oxygen, (e) receiver for liquid oxygen which is evaporated *in vacuo*, (f) vessel in which hydrogen is compressed and cooled by liquid oxygen, (l) expansion valve for hydrogen, (i) pipe leading to vacuum pump, (h) vacuum gauge

glass vessels, and in *m* it evaporates at a very low pressure maintained by a large exhaust pump connected with it through the tube *i*. Inside *m* is a steel vessel *a* connected with a cylinder *c* containing compressed oxygen. The oxygen liquefies under pressure in *a* at the temperature of the liquid ethylene boiling *in vacuo*, and the progress of liquefaction is observed by the movements of the gauge *b*. When the gauge comes to rest the vessel *a* is full of liquid. The valve on the steel vessel *c* is then closed, the pin valve *d* is opened, and the liquid runs from *a* into *e*, where it boils under atmospheric pressure, a considerable portion of it evaporating in the process. In this way about 100 cu.cm. of liquid oxygen were obtained, sufficient to enable experiments to be carried on for an hour. Olszewski applied the methods and technique which he had developed in researches on the vapour pressure and critical constants of all important gases, and though the data which they furnished has been largely superseded this work must be placed among the classics. It remains to refer to his attempts to liquefy hydrogen. The apparatus is shown in fig. 7; the lower part of the liquid oxygen vessel is shown at *a*. Both vessels *c* and *k* contained compressed hydrogen, the former communicating with the glass tube *f*, the latter connecting with a copper tube leading to the bottom of the chamber *e*. A stream of hydrogen passed through the liquid oxygen in *e*, and made it boil evenly *in vacuo*. The tube *f* contained a light inner shell to insulate the contents. Hydrogen was compressed into it at a series of increasing pressures up to 140 atmospheres and was then allowed to expand and when the pressure had fallen to 20 atmospheres in each case the phenomenon of liquid in ebullition was observed. Olszewski certainly saw hydrogen in the liquid condition for the first time, but his conclusion that the critical pressure was over 20 atmospheres was not justified.

Development of Mechanical Refrigeration.—While physicists were endeavouring to liquefy the so-called permanent gases, engineers were developing methods of mechanical refrigeration by the continuous condensation and evaporation of volatile liquids. In the ideal plant the liquid and vapour circulate continuously through a system which is illustrated by the diagram in fig. 8. The cylinders a and c are connected through coils of pipe b and d so that circulation can take place in the direction $abcd$. When the piston in a is operated mechanically, vapour is drawn from the coil d, and on the return stroke the vapour is compressed, we can suppose adiabatically, and enters the condenser coil b, where it is condensed isothermally at temperature T', by water circulating outside the coil at, let us say, the air temperature. The liquid flows into the cylinder c, and here it evaporates, doing work adiabatically, the energy being transmitted by the piston to some machine outside the plant. The gas, now cooled below the air temperature to temperature T, entering the refrigerator coil d, cools the surrounding medium, which may be a solution of brine, as in a refrigerating plant, or a less easily condensable vapour, as in a Pictet gas plant. This machine takes heat from the cold refrigerator coil, and gives up heat to the warm condenser coil. That is, heat is transferred from a low temperature T to a higher temperature T', an action which, by the second law of thermodynamics, requires a net expenditure of work. The process is cyclic, since the working substance returns to its initial condition. If the machine were perfect, that is, if the pistons were frictionless and if there were no exchange of heat except in the coils b and d, it would also be thermodynamically reversible. Reversing the direction of flow, liquid could be drawn from the cold coil d and forced into b under pressure. The warm coil b would then act as the boiler of a steam engine; in it the liquid would absorb heat and evaporate, still under pressure. In this case there would be a net gain of work, at the expense of the heat absorbed in the boiler b.



FROM A DRAWING BY M. W. TRAVERS

FIG. 8.—DIAGRAM ILLUSTRATING CYCLIC PROCESS FOR PRODUCING COLD

Possibly the most important process in which the liquefaction of gases plays a part is mechanical refrigeration, which is the subject of a separate article. Next in importance comes the liquefaction of gases for transport. Easily liquefied gases, such as ethyl chloride, methyl chloride and sulphur dioxide, may be stored and transported in glass containers, metal containers being used for substances which condense at higher pressures at atmospheric temperature. Among these must be reckoned carbon dioxide, nitrous oxide, acetylene (which is condensed with a solvent such as acetone in a steel container filled with an absorbent such as kieselgur), ammonia, chlorine, hydrochloric acid and sulphuretted hydrogen. In the case of gases which exert a corrosive action in presence of water, care must be taken to exclude moisture. The pumps and coils must be made of material which is not attacked by the gas to be condensed.

In a practical mechanical refrigerator, or in the continuous liquefaction of easily condensed gases, the adiabatic expansion in the engine c is omitted. The liquid, condensed under high pressure in the coil b, passes directly to the cold coil d, which it enters through a throttle valve. At this valve the pressure drops nearly to atmospheric, and some of the liquid evaporates, without doing external work. This cools the remainder of the liquid to its boiling point under the lower pressure. The cold liquid collected in d can be used for refrigeration, or can be drawn off in the liquid form. The passage through the throttle valve is not reversible, and there is some waste energy, which is compensated by a gain in simplicity and practicability.

Theory of Continuous Production of Cold.—In the ideal reversible process described above let Q be the amount of heat taken away from the cold coil, which is at absolute temperature T; Q represents the useful cooling. Let Q' be the heat given up to the warm coil, at temperature T', and let W be the net amount of work done on the system. In the ideal process there is no other exchange of energy, and so

$$Q'=W+Q, \text{ or } W=Q'-Q.$$

It can be proved, as a consequence of the second law of thermodynamics, that the reversible process is the most efficient possible for given temperatures T and T'. That is, the ratio Q/W, of useful cooling to work required, is the greatest possible. Further, it can be proved that

$$\frac{Q}{T}=\frac{Q'}{T'}, \text{ or } \frac{Q}{W}=\frac{Q}{Q'-Q}=\frac{T}{T'-T}.$$

T and T' are here temperatures on Kelvin's absolute thermodynamic scale, which is independent of the working substance. This scale cannot be realized directly, but it can be proved that it is the same as that of a thermometer which uses the hypothetical perfect gas. The behaviour of a perfect gas can be determined from that of real gases, such as hydrogen and helium, which obey the gas law closely, by measuring their expansions under different pressures, and extrapolating to zero pressure. Thus the corrections necessary to reduce a hydrogen or helium thermometer to the absolute scale can be determined. The absolute zero, $T=0$, corresponds to a temperature of $-273.16°$ C., or

$$T=t+273.16.$$

It follows from the relation above that the amount of work necessary to effect a certain useful cooling increases very rapidly at extreme low temperatures. It follows also that the absolute zero can never be attained, for no heat can be withdrawn when $T=0$. The efficiency increases if $T'-T$ is kept small; less work is required to attain a given low temperature if the cooling is carried out in several steps, rather than in a single machine.

If heat Q is absorbed or given up by the working substance at absolute temperature T, the quantity

$$\phi-\phi'=Q/T$$

is called the change of entropy. The absolute values of the entropy need not be considered, as it is necessary only to deal with differences. Entropy is a definite thermodynamic function, and tables have been compiled giving the entropy values of most important gases, reckoned from a standard condition, *e.g.*, from liquid at the normal boiling point. Since there is no exchange of heat in an adiabatic expansion, the entropy remains constant; such a change is also called isentropic. Since $Q/T=Q'/T'$ in the ideal reversible refrigerator, there is no net change of entropy in this process. The general condition for any reversible cyclic process, in which the temperature varies continuously, is that the entropy remains constant. This may be written

$$\int\frac{Q}{T}dT=0,$$

the integral being taken around the cycle.

It is convenient to represent changes, such as those which take place in refrigeration machines, on a diagram in which the coordinates are entropy and temperature. In fig. 9, point 1 corresponds to the working substance entering the refrigerator coil at the lower temperature T. In this coil heat Q is taken in at constant temperature, and the change is represented by the line 1–2. The area below this line represents the product $(\phi-\phi')T$, which is equal to Q.

If the values of ϕ are known for the states corresponding to 1 and 2, Q can be calculated. The process of adiabatic compression in the cylinder a involves no heat transfusion, so that entropy is constant, and we pass along the vertical line from 2 to 3. The process of isothermal compression is represented by the horizontal line 3–4, and the heat rejected in the process by $-(\phi'-\phi)T'=Q'$ which is the area of the space below the line. The shaded space between the lines thus represents the work W done in transporting a quantity of heat Q from a lower temperature T to a higher temperature T'. The unshaded space represents the corresponding refrigerating effect, so that overall efficiency of the process is represented by the ratio of the unshaded area to the shaded area. The efficiency of a completely reversible cycle of the kind which we have considered is independent of the nature of the working substance, and the elementary theory would suggest that, by regulating the compression and expansion, the temperature on the cold side could be completely controlled, the quantity of heat transferred being dependent upon the quantity of gas circulated and the absolute temperatures between which the cycle was worked. However, when we deal with problems from the practical standpoint, we at once find that a plant in which the working substance is air must necessarily be larger than one working with ammonia, which circulates mainly as a liquid.

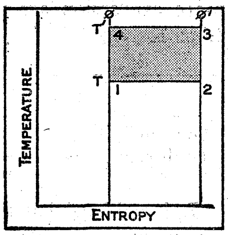


FIG. 9.—TEMPERATURE-ENTROPY DIAGRAM FOR REFRIGERATING CYCLE

The Cascade Process for Liquefaction of Oxygen.—The first process for the continuous production of liquid oxygen or liquid air in quantity, as used by Dewar and by Kammerlingh Onnes, employed a series of gases of successively lower boiling points, as in Olszewski's experimental liquefier. For this reason it is commonly known as a cascade process. The apparatus is illustrated in fig. 10. By the compressor A methyl chloride or carbon dioxide is pumped into the condenser coil B, which is cooled by water circulation. Since the methyl chloride is below its critical temperature, it is liquefied by this isothermal compression. The liquid then passes through the throttle valve C into the evaporator D_1, where its pressure drops to approximately atmospheric. Some of the liquid evaporates, and this cools the remainder to its normal boiling point. The compressor A_1 circulates ethylene, which is liquefied under pressure in the coil B_1, at the temperature of boiling methyl chloride. The liquid ethylene passes through the throttle valve C_1, and is cooled at the expense of partial evaporation. The pressure in the ethylene evaporator D_2 is reduced to 1 to 2 cm. of mercury by a vacuum pump. At this pressure the boiling point of ethylene is less than the critical temperature of oxygen ($-119°$ C.). Thus oxygen compressed by the pump A_2 into the condenser B_2, immersed in the boiling ethylene, is liquefied in its turn. Finally, the liquid oxygen is drawn off through the valve C_2, and is cooled to its normal boiling point by partial evaporation.

Each stage of the cascade liquefier is identical in principle with the simple ammonia refrigerator. As in the latter, there is a non-reversible process involved at each throttle valve, and a consequent loss of efficiency. However, the loss is not serious because the working substance passes through the throttle valve in the form of mixed liquid and vapour. The change of volume is small, and the work which might be saved if the expansion were made adiabatic is also small. Actually the theoretical overall efficiency is high, because the cooling is carried out in steps, with a small temperature drop in each step, so that for each step $T/(T'-T)$ is comparatively large. The cascade liquefier is not used at present for the commercial production of liquid oxygen, but its possibilities should not be forgotten.

The amount of high pressure liquid which has to be evaporated in order to cool the remainder to the temperature of the refrigerator coil is easily estimated. Considering the methyl chloride stage, let q be the fraction of the gas circulated which is yielded as liquid at atmospheric pressure. This fraction is cooled from the temperature T' of the condenser to the temperature T, in the liquid state. It loses heat $qC_l(T'-T)$, where C_l is the average specific heat of liquid in equilibrium with its vapour, over the temperature range concerned. This loss of heat is given up to the fraction $1-q$, which is vaporized in the throttling process. Therefore,

$$qC_l(T'-T)=(1-q)L,$$

where L is the latent heat of vaporization at temperature T. Solving for q gives the result

$$q=\frac{L-C_l\,(T'-T)}{L}.$$

For methyl chloride, with a temperature drop from 20° to $-24°$ C., the yield of liquid is about 83%. In the ethylene and oxygen stages, with higher temperature drops, it is somewhat less. In the first two stages the useful cooling, the amount of heat Q which can be absorbed from the incoming gas of the next stage, is the latent heat of the liquefied fraction:

$$Q=qL=L-C_l(T'-T),$$

per gram of gas circulated.

The Joule-Thomson Effect and Porous Plug Experiment.—It has already been pointed out that the Gay-Lussac-Joule

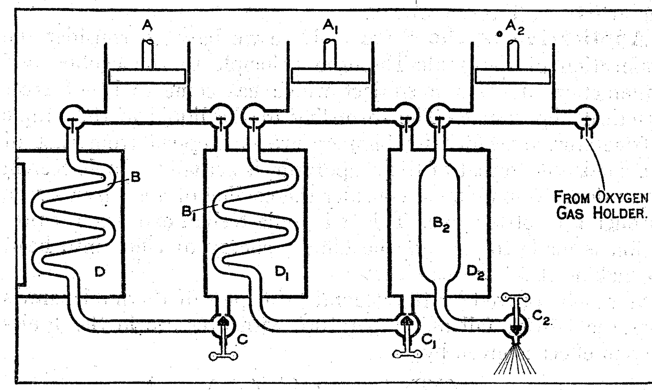


FIG. 10.—DIAGRAM OF THE CASCADE SYSTEM OF LIQUEFYING OXYGEN
The oxygen is compressed into B_2, which is cooled by liquid ethylene, liquefied and evaporated in the cycle A_1 B_1 C_1 D_2. The ethylene is cooled and liquefied by means of carbon dioxide circulated in the system A, B, C, D_1, and the carbonic acid is in turn cooled by water passing through D, and further by expansion and partial evaporation in D_1

experiment was not sufficiently sensitive to detect a change of temperature in a gas expanding without producing external effect, as the heat capacity of the containing vessels and water bath was so large compared with that of the gas that only a change of temperature of several degrees in the gas would produce a noticeable rise in the temperature of the water. The determination of the magnitude of any temperature change which might occur was, however, important. In 1848 Prof. W. Thomson, afterward Lord Kelvin, had shown that the reversible thermodynamic cycle led to a method of defining temperature which was independent of any property of any material. Temperatures measured in this manner are referred to the absolute or Kelvin scale, and the nearest approach to the realization of this scale of temperature is the scale of a thermometer containing a gas whose properties approach to those of the perfect gas. Now in the Gay-Lussac-Joule experiment a perfect gas would undergo no change of temperature, and the change of temperature in any known gas, combined with certain other physical data, would make it possible to determine the departure of the scale of the thermometer containing that gas from the scale of the perfect gas thermometer, and would lead to a practical realization of the absolute scale.

In 1853 Thomson devised his classical porous plug experiment in which the difficulties arising in the Gay-Lussac-Joule experiment were practically eliminated, and he carried it out in conjunction with Joule. The improvement consisted in making the expansion of the gas continuous, instead of intermittent. The gas was pumped through a long coil of pipe immersed in a constant temperature water bath, and passed under pressures of between one and six atmospheres into the expansion apparatus, which consisted of a boxwood tube, a part of the length of which was plugged with cotton wool or silk fibre, slightly compressed between perforated brass plates 2.7 in. apart. The gas expanded to atmospheric pressure in passing through the porous plug. The gas enters at constant pressure p_1, and volume v_1 per unit mass, so that the work done when unit mass is forced through the plug is p_1v_1. Emerging at constant pressure p_2, the gas does work p_2v_2. Therefore the net work done on the gas is $p_1v_1-p_2v_2$, which must appear as an increase in the internal energy U. Thus

$$p_1v_1-p_2v_2=U_2-U_1, \text{ or } p_1v_1+U_1=p_2v_2+U_2,$$

that is, the total heat H is constant. For a perfect gas $p_2v_2=p_1v_1$, and U is independent of volume at constant temperature, so that there is no change of temperature in the porous plug experiment. For real gases there is either an increase or decrease of temperature, according as $pv+U$ decreases or increases in an expansion at constant temperature. At ordinary pressures and temperatures the effect is a heating for hydrogen and helium, a cooling for all other common gases. At very high temperatures or pressures all gases are warmed. In recent years Roebuck and his collaborators have repeated the Joule-Thomson experiment very carefully for a number of gases, in order to correct the gas thermometer scale to absolute temperature. The methods employed are described in the article on THERMOMETRY.

Application of the Effect.—Here we have to consider the application of the Joule-Thomson principle to the cooling and liquefaction of gases, a subject which has come to be of great practical importance. The throttling of the liquid in the simple refrigerator, by which its temperature is dropped from that of the condenser to that of the evaporator, is actually a Joule-Kelvin expansion. Now we must consider the cooling of a gas by passage through a throttle valve. This is a Joule-Kelvin expansion if provision is made to convert the kinetic energy of efflux into heat, by making the flow turbulent.

It can be proved by the general principles of thermodynamics that the rate of fall of temperature with pressure in the Joule-Kelvin effect is given by

$$k=-\left(\frac{\partial T}{\partial p}\right)_H=-\frac{1}{C_p}\left\{T\left(\frac{\partial v}{\partial T}\right)_p-v\right\}.$$

It is simpler, however, to assume that the gas obeys Van der Waals' equation, and to calculate the Joule-Kelvin coefficient k in terms of the constants of that equation. We can write

$$pv=RT-\frac{a}{v}+bp+\frac{ab}{v^2}$$

and by neglecting the last term

$$p_2v_2-p_1v_1=R(T_2-T_1)-a\left(\frac{1}{v_2}-\frac{1}{v_1}\right)+b(p_2-p_1).$$

The change in internal energy for a change in temperature dT is

$$-U=-\int\left(\frac{\partial U}{\partial T}\right)dT-\int\left(\frac{\partial U}{\partial v}\right)dv.$$

For the first term we can substitute $-C_v(T_2-T_1)$. We can obtain an expression for the second in terms of work against cohesion, of which a/v^2 in the Van der Waals equation is a measure, so that

$$\int\left(\frac{\partial U}{\partial v}\right)dv=\int_{v_1}^{v_2}\frac{a}{v_2}dv=-a\left(\frac{1}{v_2}-\frac{1}{v_1}\right).$$

We have therefore

$$-U=C_v(T_2-T_1)+a\left(\frac{1}{v_2}-\frac{1}{v_1}\right),$$

and the whole change is represented by

$$-C_v(T_2-T_1)=R(T_2-T_1)-2a\left(\frac{1}{v_2}-\frac{1}{v_1}\right)+b(p_2-p_1),$$

or approximately

$$C_p(T_2-T_1)=\left(\frac{2a}{RT_1}-b\right)(p_2-p_1);$$

finally, in degrees per atmosphere fall of pressure,

$$k=\frac{1}{C_p}\left(\frac{2a}{RT}-b\right).$$

If the units are litres, atmospheres, gram-moles and calories, the term within the bracket must be multiplied by 24.2, to convert litre-atmospheres into calories. We have then for oxygen and hydrogen the following values for the constants:—

	C_p	a	b
Oxygen	6.97	1.36	.0316
Hydrogen . . .	6.84	0.19	.023

In the following table the values of k calculated from the approximate expression are put down against the results of Joule and Lord Kelvin.

	t°C	k(calc)	k(found)	t°C	k(calc)	k(found)
Oxygen .	17.1°	0.281	0.255	91.6°	0.202	0.203
Hydrogen	6.8°	−0.021	−0.030	90.3°	−0.036	−0.044

It is evident that there should be an inversion of the effect at a temperature t_i given by

$$t_i+273=T_i=2a/Rb.$$

That is, there should be a cooling at temperatures less than t_i and a heating at higher temperatures. For hydrogen the calculated inversion temperature is −73° C., compared with an experimental value of −80° C. For oxygen the inversion temperature is about 620° C. According to the simple theory, the coefficient k and the inversion temperature should be independent of pressure. Actually k decreases with increase of pressure, and for pressures greater than about 12 times the critical pressure, there is no inversion, so that the effect is always a heating.

Cooling and Liquefaction by Free Expansion.—The suggestion to utilize the Joule-Kelvin cooling effect for liquefying gases appears to have been first attempted independently by C. Linde in Germany and W. Hampson in England. The first Linde plant was worked successfully in May 1895, and it produced several litres of liquid air per hour. This may be reckoned as the starting point from which important commercial developments followed. Hampson's apparatus was first exhibited in England in March 1896. His process is the simpler; it is admirably suited for the production of liquid air in small quantity for experimental purposes; and it has been very widely used in university and research institutions.

The success of liquefiers which depend for cooling on the Joule-Kelvin effect is due to the introduction of another equally important principle, that of regenerative cooling in a heat exchanger. The high pressure air enters through a closely wound coil of copper pipe, and expands through a throttle valve at the bottom. The expanding air is cooled by Joule-Kelvin effect, and the cool low-pressure air returns through the spaces between the copper coil, where it cools the incoming high-pressure air. This in turn expands and cools, and the temperature at the bottom of the coil becomes progressively lower. After a time a steady state is reached wherein the temperature at the bottom is low enough that the incoming high-pressure air can condense. Liquid then begins to form, and can be collected after passing through the throttle valve. With a properly designed heat exchanger, the temperature of the low-pressure air leaving the top is only about one degree lower than that of the high-pressure air entering the coil, and nearly all the heat exchange takes place between the two streams of air, very little being absorbed from the surrounding atmosphere.

Hampson's Air Liquefier.—A section of the Hampson apparatus is shown in fig. 11. The compressed gas enters at A and passes to the gauge, shown in elevation, through B to C, where the pipe forms four branches which are wound together to form the regenerator coil. The four pipes unite at D below the valve N, which is controlled by the spindle OO. The compressed air expanding at N is partially liquefied, the liquid collecting in E, and the vapour passing back between the coiled pipes of the regenerator, and escaping through an outlet P. Liquid air is drawn off through the valve G, which is operated by F. The gauge H contains glycerol, and is connected below and above the level of the liquid in E by pipes K and M. The height to which the glycerol rises in M indicates the depth of the liquid in E. The efficiency of the process is of course dependent on the temperature at which the air enters the coil, the pressures at the inlet and at the outlet and the mean value of k for the inlet temperature, and the range of pressure involved. In a well-constructed apparatus the difference of temperature at the inlet and outlet is of the order of one degree, and may be neglected. If the gas were simply allowed to expand without passing back through the coil, the fall in temperature would be given by

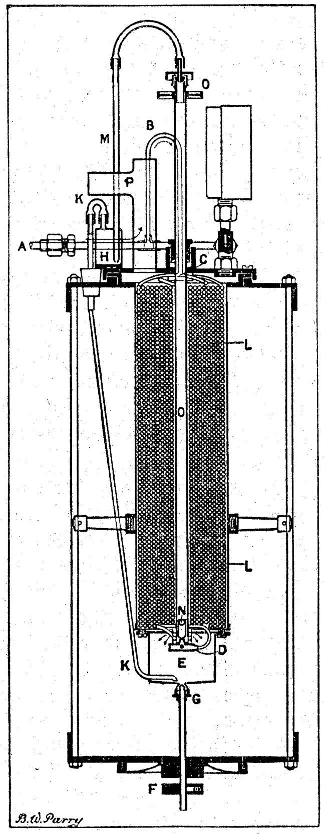
$$C_p \times k \times (P_1 - P_2).$$

If the gas returned through the coil and q per cent of it liquefied the heat absorbed in the process would be

$$(C'_p(T'-T)+L)q/100$$

when C'_p is the mean (molar) specific heat between the initial temperature and the boiling point of the gas, and L is the (molar) heat of evaporation. Equating these expressions in the case of oxygen compressed to 180 atmospheres, with $T'-T=200°$ and $k=0.25$, the expected yield is about $9\frac{1}{2}\%$. Bradly and Rowe (*Phys. Review,* 1904) found the yield of a Hampson liquefier to be 8.5% of the air passed through it.

Linde's Air Liquefier.—The Linde system depends upon the same principle as the Hampson system, but differs in that the air is not expanded to the atmospheric pressure, but to an intermediate pressure of about 17 atmospheres. The unliquefied fraction returns through the heat exchanger at this pressure, and re-enters the compressor at the second stage. Thus the work of compression is reduced to a little more than half, because most of the air has only to be re-compressed from 17 to 180 atmospheres, and only enough to replace the fraction liquefied has to be taken in at atmospheric pressure. The yield is about the same, since the reduction in cooling effect caused by the smaller pressure drop is compensated by smaller values of $T'-T$ and L. Hence, there is an important gain in efficiency, as we should expect, since the ratio $T/(T'-T)$ is smaller. If the final product is to be liquid air at atmospheric pressure, there is a loss of liquid in the throttling from 17 to 1 atmosphere, but this does not outweigh the advantages. Many industrial liquid air plants, and plants for the separation of oxygen from air, use the Linde process. In large plants it is usual to precool the compressed air entering the heat exchanger by a methyl chloride or ammonia refrigerator. This further increases the efficiency, because the irreversible Joule-Kelvin cooling is replaced by the relatively efficient refrigeration process over just that part of the temperature range where the coefficient k is smallest. However, there is no advantage in merely cooling the gas at the inlet to the heat exchanger, since the expanded gas would leave the plant at a temperature below that to which the compressed gas was cooled by the carbon dioxide. This difficulty is overcome by utilizing the cold gas to cool the compressed gas before it enters the carbon dioxide refrigerator. The arrangement of the apparatus is illustrated by the diagram (fig. 12). The air is compressed in two stages by the cylinders a and b, and the returned air from the liquefier re-enters the compressor at the intermediate stage at c. The compressed air at 180–200 atmospheres passes through a water separator d, and a purifier e, to the heat exchanger f, in which it is cooled by the cold compressed air from the liquefier. From f the compressed air passes through g, where it is cooled by the circulation of carbon dioxide, as in the cascade system already described. It then enters the main heat exchanger, a short section of which is represented by h. It consists of a triple coil of copper pipes. Through the inner pipe passes the high-pressure air. Through the middle space, the air at 17 atmospheres pressure returns to the compressor, very effective exchange of heat being obtained between these streams of compressed air flowing in opposite directions. Through the outer space flows a stream of the coldest air at atmospheric pressure, serving as a heat insulating layer. At the valve m expansion takes place, and here the pressure falls to 17 atmospheres. When the steady state is reached, partial liquefaction takes place, the liquid collecting in l and the unliquefied air passing by m to the middle pipe of the regenerator coil. The liquid flows through the valve n, and the pressure falling to atmospheric pressure in o, it is partially evaporated, the vapour passing by p to the outer pipe of the heat exchanger, the liquid being drawn off through q. The air returning through the outer pipe of the coil amounts to about one-fifth of the whole; it passes out of the system at r, but actually may be used to cool part of the incoming air by passing it through a subsidiary heat exchanger, similar to f. The air entering the middle section of the regenerator coil by m passes to s, and from there to the heat exchanger f, and to the intermediate pipe of the pump c.



FROM M. W. TRAVERS, "STUDY OF GASES" (MACMILLAN)

FIG. 11.—DIAGRAMMATIC CROSS SECTION OF LIQUID-AIR MACHINE
Compressed air passes downward through regenerator coil LL, expands at valve N, expanded gas passing upward outside coil. Progressive cooling partially liquefies the air. Liquid air collects in E, and is drawn off at bottom of apparatus

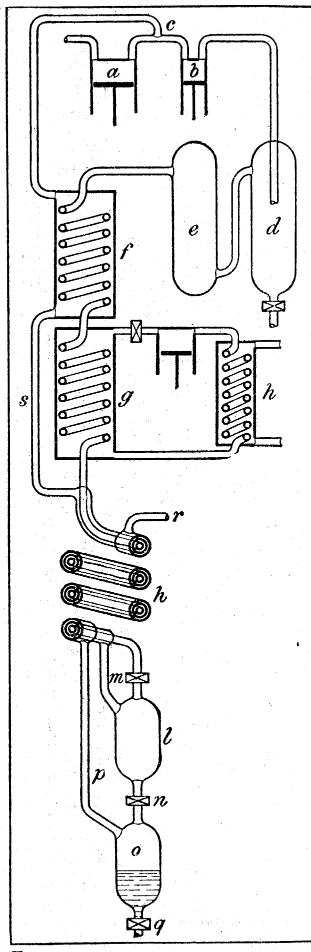


FIG. 12.—THE DIAGRAM ILLUSTRATES THE PROCESS OF LIQUEFYING AIR BY FREE EXPANSION AFTER PRELIMINARY COOLING ON THE CASCADE PRINCIPLE

The immediate result of the development of a process for liquefying air continuously on a large scale was the invention by Linde of a practical method of fractional distillation of the liquid air for the production of oxygen, which will be described later.

Claude and Claude-Heylandt Liquefiers. — Another method of increasing the efficiency of an air liquefier, which was first suggested by Lord Rayleigh, involves a return to the principle of the ideal reversible refrigerator, by the introduction of an expansion cylinder or turbine into the system in place of the expansion valve, thus making the gas do external work. In May 1902, Claude succeeded in building such a machine, and in liquefying air by adiabatic expansion in the cylinder of an expansion engine. The liquid was actually formed inside the engine, and a method was devised for collecting it from the exhaust. However, the method proved impractical because, apart from the difficulty of collecting the liquid, the amount of work done in the expansion engine becomes small when the liquefaction point is reached, and an unwieldy engine is necessary in order to obtain a reasonable yield. Claude's machine was therefore soon modified into what is known as the *Claude-Heylandt liquefier.* Claude-Heylandt and Linde machines, between them, now produce nearly all the liquid air consumed in industry.

The Claude-Heylandt process makes use of an expansion engine for most of the cooling, followed by a throttle valve expansion for the actual liquefaction. The principle is shown in fig. 13. Air at about 40 atmospheres pressure enters the first heat exchanger X_1, where it is cooled to about $-70°$ C. by returning cold air. After leaving X_1 the high pressure stream divides, and about 80% passes into the cylinder of the expansion engine E. The air expanding in the engine does work, and is thereby cooled to about $-125°$ C. The cold air from the exhaust of the engine passes into the bottom of the second exchanger X_2, where it cools the remaining 20% of the incoming air. The exhaust air then continues upward through the first exchanger, to cool the whole mass of incoming air to the temperature of the engine intake. The 20% fraction of the incoming air continues downward through a third exchanger X_3 to the valve V_4, where it expands without doing work, and is cooled to the liquefaction point by the cumulative Joule-Kelvin effect. Unliquefied air from the expansion valve returns through all three heat exchangers, so that its cooling effect will not be wasted. Thus the cooling from intake temperature to $-125°$ C. is effected by the nearly reversible expansion in the engine, and from $-125°$ to the liquefaction point, the range where adiabatic expansion is relatively ineffective, the Joule-Kelvin effect is used. The liquid is collected in a vacuum flask L, from which it can be drawn off through the valve V_3. V_1 and V_2 are valves controlling the proportion of air which passes through the expansion engine; while the column is being cooled down, V_1 is kept closed until the exchanger X_2 has reached its proper temperature. Valve V_5 admits new air to the intake of the compressor, to replace the air liquefied. W is an after-cooler on the compressor, so that air entering the exchangers is cooled at least to the temperature of cold water. T, T, T are gas thermometers attached to the bottom of each exchanger coil. The overall efficiency of the Claude-Heylandt process is high, especially in large plants, as shown by the following figures (from Greenwood, *Industrial Gases*, 1920):—

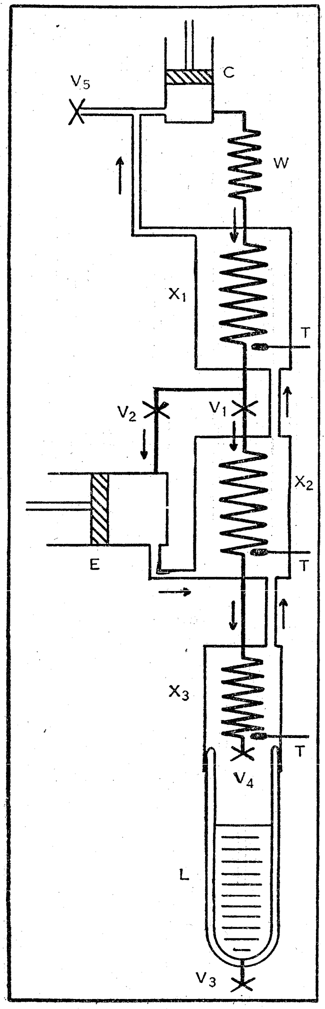


FIG. 13.—CLAUDE-HEYLANDT LIQUEFIER, USING COMBINATION OF ADIABATIC AND FREE EXPANSIONS

Capacity of Machine in Litres per hour		5	50
Output in litres per kilowatt hr.	by Linde process	—	0.45
	by Linde process, with pre-cooling	0.35	0.64
	by Claude-Heylandt process	0.36	0.93

The expansion engine is usually a reciprocating engine, although Kapitza in 1940 described a large experimental plant in Russia, in which a high-speed turbine was used. The amount of work recovered in the expansion engine is small, and it is not practical to return it to help drive the compressor; it is sometimes used to generate electricity for lighting. Lubrication of the engine is a problem on account of the low temperature. Claude first tried light petroleum, and then the liquid air itself. Modern practice is to use an unlubricated piston, with soft leather or graphite rings. During World War II, small Claude-Heylandt liquefiers were brought to a high degree of efficiency, for the production of oxygen gas in small quantities, where transport of gas cylinders was difficult. The low pressure required is an especial advantage in such plants.

Purification of Air Before Liquefaction.—For any continuous liquefaction process the gas entering the heat exchangers must be free from any vapours which would condense and freeze at the cold end of the column. Those usually present in air are water vapour and carbon dioxide, which have to be removed by passing the air through a series of towers containing caustic potash. The purifiers may be located either on the intake of the compressor, or in the high-pressure pipe leading from the compressor to the first exchanger. In order to save as much as possible of the purification, the returning unliquefied air, which is already pure, is re-circulated. In spite of this, the purifiers add greatly to the weight and bulk of a liquid air machine. In some of the small liquefiers mentioned above, the purifiers have been eliminated by using a reversing heat exchanger in the first stage. In this device the incoming and outgoing pipes are of the same size, and are soldered together along their length to ensure good heat conduction. Impure air enters the machine through one pipe, and is cooled by the outgoing cold air in the other pipe. The impurities condense in the pipe, and in time block it. After a certain interval the flow through the pipes is reversed by an automatic valve. The outgoing gas then collects and carries away the impurities which were deposited in the first pipe.

Liquefaction of Hydrogen.—The early attempts to liquefy hydrogen have already been described. The first to obtain liquid hydrogen in quantity for experimental purposes was Dewar at the Royal Institution. His earliest experiments were carried out in 1895, and were described in a paper read before the Chemical Society in 1898. Hydrogen from a cylinder of compressed gas was cooled first by a freezing mixture of solid carbon dioxide and ether, and then by liquid air, to about $-180°$ C. At this temperature, hydrogen is well below the inversion point of the Joule-Kelvin effect ($-80°$ C.). The gas then passed through a heat exchanger to an expansion valve, where it was cooled by free expansion. The cold gas returned through the heat exchanger, to cool the incoming gas. Thus the principle was the same as that of the Hampson air liquefier. Dewar does not seem to have obtained static liquid with this apparatus, but the temperature fell very low. For insulation he used his beautiful invention, the vacuum vessel, which is described later, and which is an outstanding contribution to low temperature technique. Dewar then built a large hydrogen liquefier, of which a description was never published. In referring to it he wrote: "the arrangement appeared so promising that in the next two years there was laid down in the laboratories of the Royal Institution a large plant (it weighs two tons and contains 3,000 ft. of pipe), which is designed on precisely the same principles, though far more elaborate." With this plant he obtained first small quantities and afterward large quantities of liquid hydrogen. In 1898 he published the first quantitative observations on the boiling point and density of the liquid. In 1899 he succeeded in manufacturing a litre of the liquid. In the year 1900 M. W. Travers published an account of a laboratory apparatus, embodying the same principles, but weighing less than 30 lb., and which could be operated in connection with a compressor, or by means of hydrogen compressed into cylinders at 125 atmospheres, and which was capable of producing half a litre of liquid hydrogen after pre-cooling with about five litres of liquid air. Olszewski improved this apparatus, of which a convenient form is shown in diagram (fig. 14). The hydrogen under pressure, after passing through a cylinder containing solid potash, enters the apparatus by the pipe a, which is of solid drawn copper of $\frac{1}{8}$-in. bore. Passing inside the casing o, the pipe divides, one

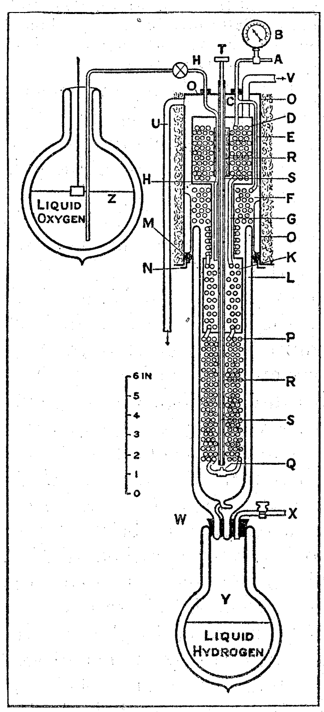
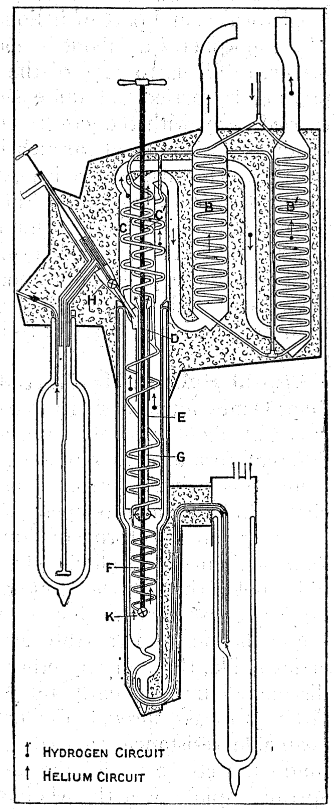


FIG. 14.—TRAVERS' HYDROGEN LIQUEFIER AS MODIFIED BY OLSZEWSKI

Compressed hydrogen cooled to liquid temperature is further cooled by free expansion and partially liquefied branch forming the coil in the chamber *d,* and continuing as *g* to form one of the twin coils in the chamber *k.* The other branch *e* leads through *c* to form the coil *f,* and continues as the other of the twin coils in *k.* Below *k* the tubes are wound closely together to form the regenerator coil *pp,* and unite in the valve *q,* which is operated by the rod *ss* passing right through the liquefier in the casing *r,* and operated by wheel *t.* The lower part of the apparatus is enclosed in the vacuum vessel *ll.* An exhaust pump is connected with the outlet *v* from the chambers *k* and *d,* which are connected by a constricted neck. By this means liquid air or oxygen can be drawn from the vessel *z* through the pipe *h* into *k,* where it evaporates under reduced pressure, the vapour passing upward through the chamber *d.* All the compressed hydrogen passes through the twin coils in *k* and is cooled at least to $-150°$, and economy of liquid air is effected by using its vapour to cool that fraction of the incoming hydrogen which passes through the coil in *d.* After expanding at the valve *q* the unliquefied hydrogen passes upward through the interstices of the regenerator coil, then between the vacuum vessel and the outside of the chamber *k,* and through the interstices of the coil *f,* cooling that part of the hydrogen entering the apparatus by this route, before it enters the other of the twin coils in *g.* The expanded hydrogen leaves the apparatus by the pipe *u.* At *mn* is shown the rubber ring and gland which connect the glass vacuum vessel with the metal parts of the apparatus. Liquid collected in the bottom of *l* passes into the vacuum vessel *y* when the tap *x* is opened to release the gas. Most subsequent hydrogen liquefiers have used Olszewski's method, with only mechanical improvements. One difficulty has always been to obtain sufficiently pure gas. In particular, it is very difficult to remove the last traces of nitrogen, which solidifies and plugs the expansion valve. In 1932 Kapitza and Cockcroft described a hydrogen liquefier in which this difficulty is almost eliminated. Very pure hydrogen is circulated in a system similar to that of Olszewski, and is liquefied. Commercial hydrogen at a pressure a little above atmospheric is passed through a coil immersed in the pure liquid. The impure hydrogen liquefies at the expense of evaporating the pure liquid. The pure gas is then recirculated through the liquefier proper. Since the quantity of impure gas liquefied is practically equal to that of pure liquid evaporated, there is very little loss of efficiency. The impurities collect as solids in the liquid hydrogen container, and settle to the bottom. Liquid hydrogen can be kept for a few hours, and transported, in a vacuum vessel, surrounded by an outer vessel of liquid air. Poured into an open vessel it evaporates very rapidly; and while the vapour can be ignited, solid air condenses and crusts the bottom of the vessel. A litre of the liquid weighs only 60 grams. When the pressure is reduced to 55 mm. of mercury the hydrogen solidifies; the solid having a glassy appearance and melting at $-259°$. Pressure raises the melting point by $0.4°$ per atmosphere.



BY COURTESY OF THE UNIVERSITY OF LEIDEN

FIG. 15.—ONNES' HELIUM LIQUEFIER

Helium is liquefied by cooling to liquid hydrogen temperature, followed by free expansion

Liquefaction of Helium.—The liquefaction of helium was ultimately achieved by Onnes in July 1908. His final liquefier is shown in fig. 15. The principle was identical with that of the apparatus used for liquefying hydrogen; and just as the hydrogen in the liquefier was cooled to liquid air temperature before entering the regenerator coil, the helium was precooled to the temperature ($-258°$ C.) of liquid hydrogen boiling *in vacuo.* The helium under a pressure of 30 atmospheres entered from the compression apparatus at the top, and divided so as to pass through two coils *B* and *B′*, which were cooled externally by the currents of cold hydrogen and helium leaving the apparatus. The coils in *B* and *B′* unite at their lower ends, and the pipe through which the helium flows passes to the top of the apparatus, where it again divides, forming two separate coils which pass through the chambers *C* and *C′*, through which flow the cold hydrogen and helium. The coils again unite at the bottom of the chambers *CC′*, and from *D* a single coil enters the chamber *E,* into which liquid hydrogen is drawn from the vacuum vessel shown on the left of the apparatus through the valve *H.* A vacuum is maintained in *E* by an exhaust pump connected with the outlet of the chamber *B,* the hydrogen gas under low pressure following the path indicated by the arrow. The compressed helium now enters the regenerator coil *F,* expands at the valve *K,* passes back through the interstices of the regenerator, through the chambers *C′* and *B′* to the outlet. A single vacuum vessel surrounded the whole of the lower part of the apparatus, and the liquid helium collecting in this vessel was forced (in later experiments), into the receiving vessel shown on the right of the apparatus. This was surrounded by a series of concentric vessels containing in order liquid hydrogen, liquid air and alcohol. The boiling point under atmospheric pressure was found later to be $-268.9°$ C.

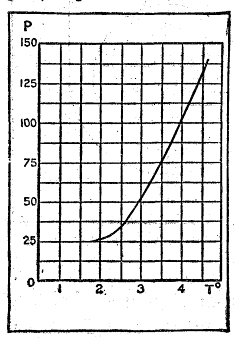


FIG. 16.—MELTING POINT CURVE OF SOLID HELIUM

Onnes immediately set to work to attempt to solidify helium by boiling the liquid under reduced pressure. On the day on which helium was first liquefied (July 1908) the first attempt was made, the pressure being reduced to about 7 mm. Finally using a battery of condensation pumps, the ultimate method for producing a high vacuum, when a pressure of 0.013 mm. and an estimated temperature of $0.82°$ absolute was reached, the "helium still remained a thin liquid." But it was not for Onnes to achieve the final triumph, which was accomplished by his colleague and successor, Prof. Keesom. Just as the melting point of hydrogen is raised by increasing the pressure, it was possible that by increasing the pressure on the helium the melting point might be brought within the range of temperature already attained. Helium was therefore compressed into a glass tube (a metal contrivance was first used) containing a piece of iron rod, which could be moved by a magnet outside the apparatus. The glass tube was cooled to a series of very low temperatures, and, although it was impossible to differentiate visually between solid and liquid helium, it was quite clear that under certain conditions of temperature and pressure the piece of iron became fixed in the tube. Thus, on June 26, 1926, every known substance had been liquefied and solidified. The relationship of these pressures and temperatures is shown in the diagram. It will be seen that the curve does not meet the vapour pressure curve for the liquid, which lies too close to the horizontal axis to be represented. It is now evident that, at pressures less than 22 atmospheres, helium would remain liquid even to the absolute zero. On the other hand, in 1929 Simon produced solid helium under a pressure of 5,800 atmospheres at a temperature of $-231°$ C., far above the critical temperature of the liquid. It appears that the critical state applies to the liquid phase only, since the same has been found true for solid hydrogen and solid neon.

Kapitza's Helium Liquefier.—The necessity of producing large quantities of liquid hydrogen in order to liquefy helium is a great inconvenience, and introduces an element of danger. In 1934 P. Kapitza designed a helium liquefier in which the liquid hydrogen is eliminated by using an adiabatic expansion of helium gas to bridge the gap between the temperature of liquid nitrogen and the inversion point of the Joule-Kelvin effect in helium

($-243°$ C.). Helium at a pressure of 20–30 atmospheres is pre-cooled to $-208°$ C. by liquid nitrogen boiling at reduced pressure. It is then liquefied in a cycle which works on the same principle as the Claude-Heylandt air liquefier. The system of heat exchangers is shown in fig. 17. The compressed helium enters at the top, and passes first through exchanger *A,* where it is cooled by the return flow of evaporated nitrogen and cold low-pressure helium. It then passes through a coil which is attached to the liquid nitrogen chamber *N,* and is cooled to $-208°$ C. Leaving this coil, it is further cooled in exchanger *B* by returning low-pressure helium. The incoming stream is then divided, so that part passes through the expansion engine *E,* where it does work, and is cooled to about $-263°$ C. The cold exhaust helium from the expansion engine cools the remainder of the incoming stream in the exchanger *C.* Finally, this fraction passes through an expansion valve at the bottom, and is partially liquefied by a Joule-Kelvin expansion, combined with regenerative cooling in the heat exchanger *D.* The whole apparatus is surrounded by a vacuum jacket for thermal insulation, and the liquid helium reservoir is further protected by a copper shield which is attached to the liquid nitrogen chamber. The liquid helium is drawn off for use in experiments through another valve, connecting to a double-walled, vacuum insulated delivery pipe. The expansion engine presents some interesting features. The engine cylinder, $1\frac{1}{4}$ inches in diameter, is located in the centre of the apparatus, surrounded by the exchanger coils for protection from atmospheric heat. It is connected by a long rod, which passes up through the centre of the liquefier, to the piston of a small water pump, to absorb the work of expansion. It is designed to have a quick expansion stroke, and a slow return, so that the cold helium gas will not be expelled at a velocity too high to absorb heat from the exchangers. Liquid lubrication is obviously impossible; instead, a small clearance is left between the piston and the cylinder wall, where high-pressure gas accumulates and forms a cushion. The leakage of gas past the piston is reduced by making it relatively long, and by cutting grooves around it, so that the flow will be highly turbulent. The liquefier produces about 2 litres of liquid helium per hour, and requires about 3 litres per hour of liquid nitrogen, with an additional 10 litres for the preliminary cooling.

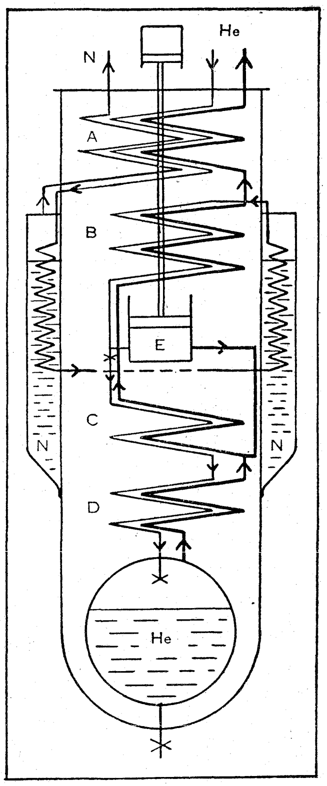


FIG. 17.—KAPITZA'S HELIUM LIQUEFIER

Simon's Method for Liquid Helium.—In 1927 F. Simon described for the first time a simple method of producing liquid helium for experimental purposes. It represents, in fact, a return to the principle of Cailletet's early experiments, in that a single adiabatic expansion is used. However, whereas Cailletet could only produce a mist of liquid oxygen, the fact that liquid helium is comparable in density with the gas at easily attainable pressures makes the yield of liquid very much greater in this case. The method is illustrated in fig. 18. Helium gas at about 150 atmospheres is passed through coils *A* and *F* into a container *B,* which is suspended by fine wires inside an outer vessel *C.* The whole is immersed in liquid hydrogen in a vacuum flask *D,* and the space *C* is filled with helium gas at low pressure. The temperature is reduced as low as possible by pumping off the hydrogen vapour, the gas in *C* allowing the removal of heat from the compressed helium in *B.* When *B* is cooled to the temperature of the liquid hydrogen, *C* is evacuated through the pipe *E* to the best possible vacuum. The helium in *B* is then allowed to expand adiabatically, and part of it liquefies. Starting with helium gas at 150 atmospheres at about $-260°$ C, enough liquid can be condensed to fill up to 80% of the volume of the vessel *B.* The expansion is carried out quite slowly, so that liquid will not be carried away with the gas stream, and the approach to adiabatic conditions is obtained through the excellence of the thermal insulation. This also makes it possible to keep liquid helium in the apparatus for several hours. Simon's method is especially adapted for experiments at liquid helium temperatures when the mass of other material to be cooled is small. The liquefier chamber can be built into the experimental apparatus, and many different forms have been used. On occasion, over a litre of liquid helium has been produced, and transfer to another vacuum vessel is possible if necessary.

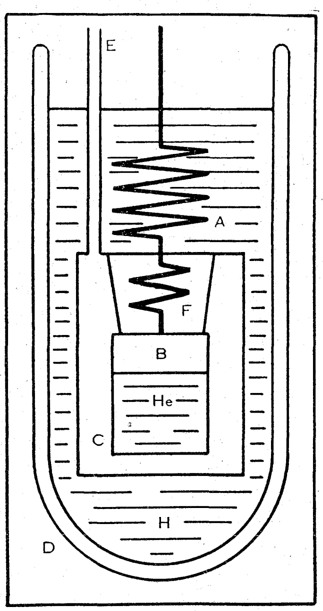


FIG. 18.—SIMON'S SINGLE EXPANSION METHOD FOR LIQUID HELIUM

Liquid Helium II.—In studying the properties of liquid helium, Onnes found a sharp maximum in the density-temperature curve at about 2.2° absolute, and that it was necessary to use different formulae to represent the vapour pressures above and below this point. Keesom found that other physical properties changed at the same temperature, and he came to the conclusion that there are two forms of liquid helium, which he called helium I and helium II. The liquid changes from form I to form II when it is cooled through the temperature 2.19° absolute, but there is no true phase change, since there is no latent heat of transition. Liquid helium II is a truly extraordinary substance, with properties unlike those of any other fluid. Its most striking property, discovered independently by Allen and Kapitza in 1938, is its ability to pass through the finest capillary tubes, with almost negligible resistance, so that it has been described as a superfluid. It wets any solid surface with which it is in contact, and spreads rapidly over the whole surface as a thin film. If an open vessel containing helium II is suspended inside the vacuum flask, the film spreads over the outside as well, and the liquid creeps over the edge, and drops off the bottom of the vessel. When a temperature difference is set up between the ends of a tube containing helium II, a kind of convective flow takes place, by which large quantities of heat energy are transported, producing an apparent thermal conductivity many times that of copper.

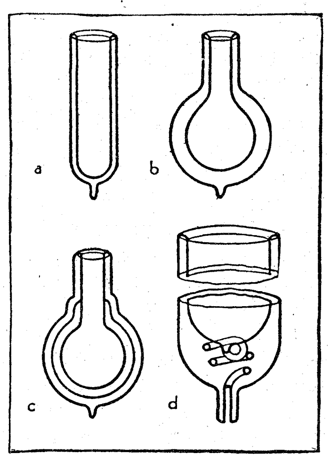


FIG. 19.—DEWAR VACUUM VESSELS

Dewar's Vacuum Vessel.—The invention of the vacuum vessel by Dewar has been of inestimable service to investigation at low temperatures. These pieces of apparatus are double walled vessels of glass or other material, the space between the walls being exhausted, and the walls either polished or silvered. The transfer of heat through a gas-filled space such as that between the walls of a Dewar flask (fig. 19, a) takes place in the following ways: (1) by radiation, which is proportional to $sa(T^4_1 - T^4_2)$ where s is the area and a the emissivity of the surfaces, and T_1, T_2

are the absolute temperatures; (2) by conduction through the gas, proportional to T_1-T_2 for moderate temperature differences; (3) by conduction in the walls of the container; (4) by convection currents in the gas (*see* HEAT: *Conduction in Gases and Liquids*). In a perfect vacuum gas conduction and convection currents would be completely eliminated; they are very small at gas pressures, less than 10^{-6} cm. of mercury. For a polished metal surface, the emissivity a is only a small fraction of its maximum value, that for a dull black body. Thus by polishing or silvering the warm wall the radiation emitted is decreased; by polishing the cold wall also much of the remaining radiation is reflected. There remains conduction by the walls; this can be reduced by using a long narrow neck, made of the thinnest material consistent with adequate strength. Dewar's original vacuum flasks were made of silvered glass, usually of the forms shown at *a* and *b* (fig. 19). Glass flasks are still used for certain scientific purposes, and a great variety of forms have been made. A flask with an extra wall, further to reduce radiation, is shown at *c* (fig. 19), one with a springlike outlet tube is shown at *d*. For most purposes, and especially for the storage and transport of liquefied gases, metal vacuum containers are now used almost exclusively. A form which is common for transport purposes is shown in fig. 20. This consists of two spheres of polished copper, connected only at the top of a long neck. An absorbent, charcoal or silica gel, is placed in a chamber attached to the inner sphere, but open to the vacuum space. When the container is filled, the charcoal is cooled by the cold liquid, and then absorbs much of the air still remaining in the vacuum, so that the efficiency of the insulation is greatly improved. For transport purposes the evacuated sphere is often suspended by heavy steel springs inside a protecting steel jacket. In a properly evacuated flask of this type, of 25 or 50 litres capacity, the loss of liquid air by evaporation is 4 to 6% of the capacity per day.

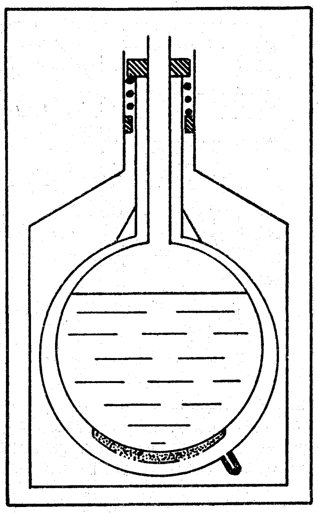


FIG. 20.—METAL VACUUM VESSEL

Physical Measurements at Low Temperatures.—The solution of problems relating to the liquefaction of gases demands the determination of their physical properties at low temperatures, and particularly the following: (1) boiling point and vapour pressures, (2) densities of liquid and vapour, (3) critical constants, (4) compressibilities, (5) specific heats. These investigations demand in the first place the means of maintaining sufficiently large spaces at constant temperature. This may be done conveniently by liquefying pure gases and allowing the liquid to evaporate in vacuum vessels under constant pressure. In this way the following ranges of temperatures may be maintained:—

	C C
Sulphur dioxide	−10° to −73°
Methyl chloride	−24° to −85°
Methyl dichlordifluoride ("Freon")	−28° to −90°
Carbon dioxide and ether constant at	−78.3°
Ethylene	−104° to −150°
Methane	−161° to −184°
Oxygen	−183° to −200°
Nitrogen	−196° to −210°
Hydrogen	−253° to −260°
Helium	−269° to −272°
Paramagnetic salts	below 1° absolute

The study of the physical properties of matter of all kinds down to the lowest possible temperatures has become a matter of prime importance in scientific inquiry. The technique of experimentation at low temperatures was largely developed at the Leyden Cryogenic laboratory, under Kammerlingh Onnes, through the years 1908–23. In 1923 a helium liquefier was built at Toronto; in 1939 there were at least 11 in operation: 4 in the U.S., 3 in Great Britain, and one each in Holland, Canada, the U.S.S.R. and Germany. Low temperature experiments have to be designed so that the apparatus can be enclosed in a cryostat filled with the cooling liquid. For liquid air and lower temperatures the cryostat has to be a vacuum vessel, and for liquid helium temperatures it is usually protected by an outer vessel of liquid air. Liquid air also finds many practical uses, both in the laboratory and in industry; for example, in chemical processes which require the condensation of other gases. It is also used in the production of high vacua, by introducing into the system a tube of charcoal cooled by liquid air, to prevent oil and mercury vapour from diffusing into the vacuum.

The Measurement of Low Temperatures.—In all cryogenic work the aim is to reduce temperature measurements to the absolute scale. Down to the boiling point of hydrogen the standard thermometer is the constant volume hydrogen or helium gas thermometer, with a pressure of 1,000 mm. of mercury at 0° C (*see* THERMOMETRY). The corrections necessary to reduce gas thermometer temperatures to the absolute scale are based on the principle that the latter scale would be realized by a perfect gas. Many experiments have been carried out in standardization laboratories to determine the deviations of hydrogen and helium from the perfect gas law, in order to correct the thermometer. Methods used have been: measurements under different pressures and extrapolation to zero pressure; measurements of the compressibilities; measurements of the Joule-Kelvin effect and calculation of the deviations. These experiments have served to fix the principal boiling and melting points on the absolute scale. For practical purposes electrical resistance thermometers, calibrated at the standard points, are very useful down to −250° C. In the liquid helium region the standard is a helium gas thermometer with a pressure of less than 1 mm. of mercury, the pressure being measured by a hot wire manometer. In the liquid hydrogen and liquid helium regions the usual practice is to use the vapour pressure of the liquid itself as a working thermometer. For this purpose the vapour pressures of hydrogen and helium have been carefully measured at Leyden, in terms of the low pressure gas thermometer.

Temperature, Pressure and Volume Relationships.—The relationship of temperature, pressure and volume for important gases has been determined over a wide range of pressures and down to very low temperatures by workers in the Cryogenic laboratory, Leyden and also in Berlin, and in Boston (Mass.), U.S. The method consists in compressing a known volume of gas into an apparatus similar to a gas thermometer, but much stouter, and measuring the pressure. When the pressure is large a considerable correction must be applied for the extension of the apparatus, and when the temperature of the bulb is far below that of the air, there is also a large correction for the volume of gas in the stem, and in the space above the mercury in the manometer. Owing to difficulty of estimating these corrections accurately the results obtained by different observers do not agree as closely as is desirable.

The volumes of saturated vapours and of the liquefied gases have been determined by a similar method, the liquid from a known volume of gas being condensed in a similar glass apparatus. However, errors are liable to creep in in the neighbourhood of the critical state, where the rate of change of volume with pressure is a maximum. Fortunately, the critical data can be determined by separate experiments. The critical temperature is observed by compressing the gas in a glass tube, and observing the appearance and disappearance of the gas-liquid boundary as the temperature is slowly changed, the volume being varied slightly at the same time. The critical pressure is observed in the same tube, when part of it is below the critical temperature and part above. The critical volume, which is the most difficult to measure, can be determined by measuring the specific volumes of the liquid and of the saturated vapour at temperatures a little below the critical, taking the average of these, and extrapolating the average to the critical temperature.

Measurement of the vapour pressures is also of the utmost importance, and reference has already been made to the comparison of the vapour pressures of hydrogen and helium with the standard gas thermometer. The vapour pressure can usually be represented by a formula of the form

$$\log p = a + bT - c/T,$$

where T is the absolute temperature, and a, b, c are empirical constants. This constant is partly based on integration of the Clapeyron equation (*see* below), and partly on empirical considerations.

Thermal Properties.—Values of the specific heats and latent heats of vaporization and fusion are also required. Specific heats at low temperatures are usually measured by means of a vacuum calorimeter. A sample of known mass is placed in a container, which is insulated from the liquid in the cryostat by a vacuum jacket. A known amount of heat is supplied to the sample electrically, and the rise of temperature is observed, usually by means of a resistance thermometer. The necessary correction for cooling is determined by observing the rate of fall of temperature after the electric current is shut off. The latent heats of vaporization and of fusion can be calculated from the Clausius-Clapeyron equation, which is a direct deduction from the second law of thermodynamics:

$$L=T(V-v)(dp/dT),$$

where L is the latent heat at temperature T, $V-v$ is the change of specific volume in passing from vapour to liquid or liquid to solid, and dp/dT is the slope of the vapour pressure or melting point curve. The latent heat of vaporization can also be measured by observing the amount of liquid vaporized by an electric current. When all these quantities have been determined, tables of entropy and total heat can be drawn up, and are of great value in the design of refrigerating machinery.

The Approach to Absolute Zero.—It is a principle of general thermodynamics that it is impossible to cool a body to the absolute zero of temperature, for an infinite amount of work would be required. However, the approach has been closer and closer with advances in scientific knowledge and experimental technique. In 1908 Onnes attained 0.82° Abs. by the rapid evaporation of liquid helium, and for many years this record was exceeded by only a few hundredths of a degree. In 1926 Debye and Giauque independently suggested that the attainable range of temperatures might be extended much further by making use of the so-called magneto-caloric effect (*see* MAGNETISM). When a substance is magnetized, work is done upon it, and conversely, when the magnetizing field is removed it loses energy, and is cooled if no heat is supplied to it. The effect depends on the rate of change $d\chi/dT$ of the magnetic susceptibility χ with temperature. At ordinary temperatures it is observable only for the ferromagnetic materials, and is of little practical importance. However, there are many paramagnetic materials which have very small susceptibilities at ordinary temperatures, but which obey approximately Curie's law,

$$\chi=\text{constant}/T.$$

If this law is still obeyed at liquid helium temperatures, both the susceptibility and the rate of change become large, and the estimated magneto-caloric cooling is of the order of a degree.

In 1933 Giauque successfully carried out the experiment, using the paramagnetic salt gadolinium sulphate, and reached an estimated temperature of 0.25° Abs. In 1935 De Haas reached the present record of 0.0034° Abs., using potassium chrome alum mixed with a non-magnetic salt, since diluting the salt causes it to follow Curie's law more closely. The salt is enclosed in a double-walled capsule, with a small pressure of helium between the walls. It is cooled to about 1.2° Abs. by liquid helium, and then magnetized in a field of about 25,000 gauss. The helium gas allows the heat generated by magnetization to be conducted away. The external field is then removed, the magnetized salt loses energy, and is cooled. It is not necessary to remove the helium from the capsule, because the temperature promptly falls so low that it is almost completely condensed. The temperature reached is determined by leaving a small magnetic field on the sample, and measuring the susceptibility. This allows the absolute temperature to be calculated if the specific heat is known over the temperature range concerned. The specific heat was therefore one of the first quantities to be measured when the method of cooling proved successful. This can be done by supplying energy to the salt at a known rate, and observing the rate of increase of temperature. One successful method of supplying the energy was irradiation of the salt with γ-rays from radium. A small quantity of added material can be cooled along with the salt in the capsule, so that other materials can be studied below 1° Abs., but technical difficulties have so far prevented any but the simplest experiments. The absolute zero cannot, of course, be reached; it is thermodynamically impossible for Curie's law to hold at the lowest temperatures, and $d\chi/dT$ must become zero eventually.

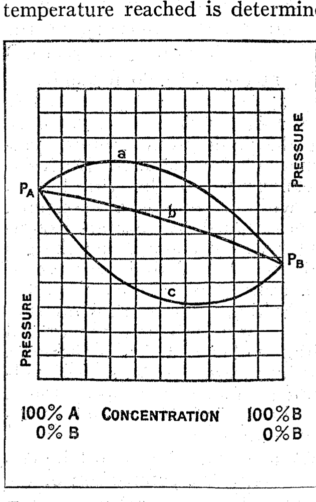


FIG. 21.—VAPOUR PRESSURE-CONCENTRATION CURVES FOR MIXTURES OF TWO LIQUIDS AT CONSTANT TEMPERATURE

Mixtures of Gases.—One of the most important applications of liquefaction of gases is to the separation of mixtures such as air by fractional distillation of the liquid. The vapour pressure of a pure substance depends only on the temperature; that of a mixture depends also on the composition. Further, the composition of the vapour in equilibrium with a mixed liquid is not, in general, the same as that of the liquid. The vapour pressures of a mixture of two gases A and B, at a constant temperature, may be shown on a pressure-concentration diagram (fig. 21), by a curve which terminates in the points P_a, P_b, the vapour pressures of the pure substances. For a certain range of temperatures the curves have the form *b*, lying wholly between horizontals through the end points. Curves can also be drawn showing the equilibrium compositions of the liquid and vapour, at a constant pressure, for various temperatures, as has been done for air at atmospheric pressure (fig. 22, from E. C. C. Baly). This curve shows that the vapour is richer than the liquid in the more volatile constituent *A*. If the liquid is allowed to evaporate, it becomes progressively richer in *B*, and the vapour pressure falls, following the curve *b* (fig. 21) until the residue of liquid is pure *B*; or, at constant pressure the boiling point rises. Thus the constituents of a gas mixture can be separated by liquefying it, and allowing the liquid to evaporate. At certain temperatures, the pressure-concentration curve has a maximum as in *a* (fig. 21), or a minimum as in *c*. In such cases the enrichment of the liquid proceeds only until the maximum or minimum is reached, after which it continues to boil at constant pressure, and the vapour has the same composition as the liquid. Therefore the fractional distillation process succeeds only over that range of temperatures where the curves have the form *b*.

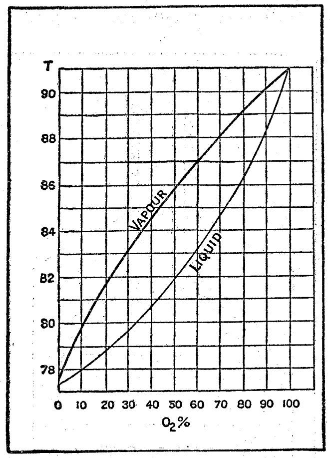
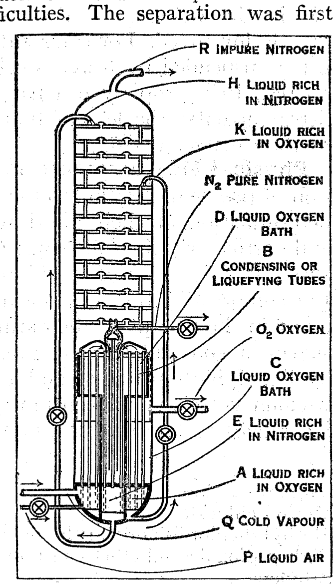


FIG. 22.—DIAGRAM SHOWING RELATIONSHIP BETWEEN TEMPERATURE AND COMPOSITION OF LIQUID AIR

Oxygen from Liquid Air.—The most remarkable result of investigations at very low temperatures has been the development of the process for the separation of oxygen from air. The boiling point of oxygen is —183.0°, while that of nitrogen is —195.8° C, so that unless the liquids form constant boiling mixtures, which is not the case, separation of the gases by liquefaction and subsequent rectification of the liquid presents no difficulties. The separation was first effected successfully by Linde on a technical scale in 1901. He adopted a method long in use by chemists for the separation of volatile liquids by distillation. Liquid air was allowed to trickle down a vertical cylinder, filled with glass balls, into a chamber at the bottom in which it was partially evaporated by cooled compressed air, passing through a coil immersed in it. The vapour passed upward, meeting the descending stream of liquid, which washed out the oxygen, so that the gas leaving the top of the cylinder was mainly nitrogen, with only 7% of oxygen, while liquid containing 96 to 98% of oxygen collected at the bottom. This liquid was drawn off and evaporated, and in this way 70% of the oxygen of the air could be separated with an impurity content of only 2% to 4%. Small oxygen plants of this simple type are in general use, but they are inefficient, as about one third of the oxygen is lost. Much more efficient separation is effected in plants operated on a principle first introduced by Claude in which the gas is fractionated in two stages, the first operated at about four atmospheres, and the second at atmospheric pressure. The working of the system is illustrated by the diagram of the separator (fig. 23). This is incorporated into a unit with an air liquefier of the Claude-Heylandt type, the separated oxygen and nitrogen being used in the return flow through the heat exchangers, in place of the expanded air in a simple liquefier. Sixty to 70% of the high-pressure air passes through the expansion engine, where it expands to 4 atmospheres, with external work. The remainder is partially liquefied by means of the usual heat exchanger and expansion valve. Both the liquid air from



BY COURTESY OF THE BRITISH OXYGEN CO., LTD.

FIG. 23.—THE CLAUDE SYSTEM OF MANUFACTURING OXYGEN BY LIQUEFYING AIR

Tables of Constants

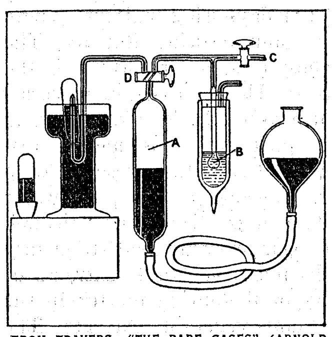
	Boiling point (°C)	Critical point (°C)	Critical pressure (atmos.)	Critical volume (cu. cm./gm.)	Melting point (°C)	Latent heat of vaporization at boiling point (gm. cal./gm.)
Hydrogen, H_2	−252.78	−239.9	12.8	32.3	−259.18	108
Oxygen, O_2	−182.97	−118.8	49.7	2.33	−218.4	50.9
Nitrogen, N_2	−195.81	−147.1	33.5	3.215	−209.85	47.6
Chlorine, Cl_2	− 33.7	144.0	76.1	1.745	−101.6	..
Helium, He	−268.93	−267.9	2.26	14.43	none	5.5
Neon, Ne	−246.09	−228.7	25.9	2.07	−248.7	..
Argon, A	−185.7	−122.4	48.0	1.88	−189.2	37.6
Krypton, Kr	−152.9	− 62.6	54.2	1.28	−157	..
Xenon, X	−107.1	16.6	58.2	0.866	−112	..
Methane, CH_4	−161.5	− 82.5	45.7	6.17	−184	138
Ethylene, C_2H_4	−103.9	9.7	50.9	4.5	−169.4	..
Acetylene, C_2H_2	− 83.6	35.9	61.6	4.33	sublimes	..
Carbon monoxide, CO	−190	−139	35	3.22	−207	50.4
Carbon dioxide, CO_2	− 78.5	31.1	73.0	2.17	sublimes	..
Ammonia, NH_3	− 33.35	132.4	111.5	4.26	− 77.7	327.1
Methyl chloride, CH_3Cl	− 24.22	143.1	65.8	2.7	− 97.7	102.3
Methyl dichlordifluoride, CCl_2F_2	− 29.8	111.5	39.6	..	−158	39.9
Hydrogen chloride, HCl	− 83.7	51.4	81.6	2.4	−112	98.7
Sulphur dioxide, SO_2	− 10.0	157.2	77.7	1.92	− 72.7	94.9

the liquefier and the cold expanded air from the expansion engine enter the chamber *A* at the bottom of the separator, through pipes *P* and *Q*. Here, since we have, at the first moment of condensation, a relatively small quantity of liquid in contact with a large quantity of vapour, a condition of equilibrium exists corresponding to that at the moment when air begins to liquefy, when we have a vapour phase containing rather less than 21% of oxygen, which is in equilibrium with a liquid containing rather less than 47% of oxygen. The air which is not liquefied passes upward through the vertical tubes *B* which traverse the chambers *C* and *D* which, as we shall see later, contain nearly pure liquid oxygen at about —183° C, and at nearly atmospheric pressure. The air, under nearly four atmospheres pressure, partially liquefies in contact with the walls of these tubes, and the liquid running back down the tubes, washes the oxygen out of the ascending stream of air, the liquid collecting in *A* having an average concentration of 40% oxygen. The gas, now poor in oxygen, passes from the top of the outer nest of tubes, down an inner set of tubes where most of it is condensed, its oxygen content being about 4%, and runs into the inner chamber *E*. The greater the quantity of the oxygen-nitrogen mixture which is condensed in *A*, the lower will be its oxygen content, and the richer in nitrogen will be the liquid which passes into *E*. Claude describes this part of the process as antecedent liquefaction and separation by backward flow. The essential feature is condensation at a pressure above atmospheric, and use of the heat of condensation to evaporate the liquid formed in the subsequent atmospheric pressure cycle. The liquids condensed in *A* and *E* are raised to the top of the fractionating column, which consists of a series of perforated trays. The nitrogen-rich liquid from *E*, throttled to 1 atmosphere pressure, enters the top of the column at *H*, at a temperature a little above the boiling point of nitrogen. As it trickles down, nitrogen is evaporated and oxygen is condensed from the rising stream of vapour, so that the liquid becomes progressively richer in oxygen. The oxygen-rich liquid from *A* joins the stream at *K*, where the composition in the column is the same as that of the added liquid. The liquid which finally reaches the bottom of the column is 99% oxygen, the impurity being largely argon. This collects in *C*, where it is used to aid in the condensation of the 4 atmosphere cycle. Finally the evaporated oxygen passes through the heat exchangers to a gas holder. The nitrogen gas from the top of the column is impure; provision is made to collect nearly pure nitrogen from an extra set of tubes connected to the liquid nitrogen chamber *E*. Oxygen plants of this type can produce 4,000 cu.ft. of oxygen per hour at an expenditure of about 180 B.H.P.

Linde has designed a separator similar in many respects to that of Claude, but using a liquefier of the Linde type. These separators are designed to deliver oxygen gas; modifications which deliver liquid oxygen, and use only the nitrogen fraction to cool the liquefier, are also in common use.

Oxygen in Industry.—Large quantities of oxygen gas are consumed in industry, and much of this is produced by one or other of the liquid air processes. The largest use is in conjunction with acetylene or hydrogen for cutting steel plate, and for welding steel and other metals. Plants for the production of oxygen have been established in almost all centres where there is a concentration of heavy industry. The gas is usually compressed into steel cylinders for transport, but these are heavy, and the return of empty cylinders creates a problem. In many large centres, oxygen is now transported in the liquid form, in tank trucks. A large bulk of the liquid can be kept without serious evaporation loss without vacuum insulation, and it is necessary only to cover the tanks well with insulating material. The liquid oxygen is first transferred to an evaporator, where heat is supplied to it, and the evaporated gas is pumped into the consumers' tanks.

In aeroplane flights above 10,000 ft. altitude it is necessary to add oxygen to the rarefied air breathed by the crew and passengers in order to maintain consciousness, or even life. During World War II this use added greatly to the demand for oxygen produced from liquid air, as this process yields gas uncontaminated with noxious impurities. Limited quantities are also used in hospitals, and, mixed with helium, for deep-sea diving. For use in aircraft, the gas is usually carried in cylinders, and is delivered to the crew through face masks, with valves to regulate the flow according to altitude. The cylinders are heavy, and a useful saving in weight can be effected by carrying liquid oxygen. Liquid oxygen systems for aircraft, consisting of vacuum containers and evaporators, have been developed on an experimental basis, but had not come into general use by 1945.



FROM TRAVERS, "THE RARE GASES" (ARNOLD & CO.)

FIG. 24.—APPARATUS USED BY RAMSAY AND TRAVERS FOR LIQUEFYING AND SEPARATING THE RARE GASES BY DISTILLATION

Charcoal impregnated with liquid oxygen is an explosive, and is used to a limited extent in mining operations. The type of charcoal used absorbs about three times its weight of liquid oxygen, approximately the correct amount to ensure complete combustion. The heat developed in the explosion is 1,940 large calories per kg., which is greater than that of blasting gelatine, but the combustion is slower. Where charcoal and liquid oxygen can be used, it has the advantage of comparative safety, since there are no noxious fumes and there is no risk in transport, before the charcoal and oxygen are combined.

The Rare Gases from Liquid Air.—The extraction of argon and neon from air has become a matter of commercial importance. Argon is used for filling the larger sizes of incandescent electric lamps; neon is used in gas discharge tubes, mainly for display purposes, on account of the brilliant red discharge which it produces. Argon boils at —185.7° C, a little below the boiling point of oxygen, and it tends to concentrate in the liquid on the lower trays of an air fractionating column. In some oxygen columns, a portion of the liquid is drawn off at this point, and passed through another column to extract the argon. Neon, which boils at —246° C, is the most volatile of the constituents of air (except for minute and variable amounts of helium), and is left as a gas when all the more plentiful constituents are condensed.

The principal source of helium is natural gas, which always contains small amounts, the proportion in some wells being as high as 3%. The commercial demand is much less than the available supply, and it is extracted only from the richest wells, principally from certain fields in Texas. To extract the helium, the natural gas, consisting mainly of methane and nitrogen with less volatile constituents, is liquefied by cooling to the temperature of liquid nitrogen. The gas left is mainly helium, which can be purified chemically, or by further cooling to the temperature of liquid hydrogen.

The rarer constituents of the atmosphere, krypton and xenon, are not of great commercial importance, but the investigations of Ramsay and Travers which led to the discovery of these gases are another interesting example of the application of low temperatures. By evaporating liquid air they first obtained a residue which consisted mainly of oxygen. The oxygen was removed, leaving argon, with some previously unknown, heavier gas as an impurity. This was introduced into the reservoir *A* of the apparatus shown in fig. 24. This communicated through a stopcock with a bulb *B* immersed in liquid air boiling under reduced pressure. The bulb *B* was exhausted, and then the stopcock *D* was opened, and the impure argon from *A* forced into the bulb *B*, where it liquefied. The liquid was evaporated in small quantities, six fractions of successively higher boiling point being collected. The least volatile portion remained in *B* as a liquid residue. The first two samples were discarded, and the remainder were retreated one by one. After several treatments the most volatile sample was nearly pure argon. The central samples, and final liquid residue were evidently new gases, to which the names krypton and xenon were given. These were also prepared in a nearly pure state by further treatment. A large quantity of the nitrogen fraction from liquid air was treated in the same way, and finally yielded a gas which could not be condensed with liquid air. This gas was named neon, and was purified by condensing the remaining nitrogen and argon with liquid hydrogen.

The melting point of ice on the absolute scale = 273.16° Abs. (International Congress on Refrigeration, 1936). Lowest temperature attained 0.0034° Abs. (De Haas, 1935). (*See* also HEAT; THERMODYNAMICS.)

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LIQUEURS, the general term applied to perfumed or flavoured potable spirits, sweetened by the addition of sugar. The term "liqueur" is also used for certain wines and unsweetened spirits of very superior quality, or remarkable for their bouquet, such as tokay or fine old brandy or whisky.

The basis of all the "liqueurs," proper consists of (*a*) relatively strong alcohol or spirit, which must be as pure and neutral as possible; (*b*) sugar or syrup; and (*c*) flavouring matters. There are three distinct main methods of manufacturing liqueurs. The first, by which liqueurs of the highest class are prepared, is the "distillation" or "alcoholate" process. This consists in macerating various aromatic substances such as seeds, leaves, roots and barks of plants, etc., with strong spirit and subsequently distilling the infusion so obtained, generally in the presence of a whole or a part of the solid matter. The mixture of spirit, water and flavouring matters which distils over is termed the "alcoholate." To this is added a solution of sugar or syrup, and frequently colouring matter in the shape of harmless vegetable extracts or burnt sugar, and a further quantity of flavouring matter in the shape of essential oils or clear spirituous vegetable extracts. The second method of making liqueurs is that known as the "essence" process. It is employed, as a rule, for cheap and inferior articles; the process resolving itself into the addition of various essential oils, either natural or artificially prepared, and of spirituous extracts to strong spirit, filtering and adding the saccharine matter to the clear filtrate. The third method of manufacturing liqueurs is the "infusion" process, in which alcohol and sugar are added to various fresh fruit juices. Liqueurs prepared by this method are frequently called "cordials."

The French, who excel in the preparation of liqueurs, grade their products, according to their sweetness and alcoholic strength, into *crêmes, huiles* or *baumes,* which have a thick, oily consistency; and *eaux, extraits* or *élixirs,* which, being less sweetened, are relatively limpid. Liqueurs are also classed, according to their commercial quality and composition, as *ordinaires, demifines, fines* and *sur-fines.* Certain liqueurs, containing only a single flavouring ingredient, or having a prevailing flavour of a particular substance, are named after that body, for instance, *crême de vanille, anisette, kümmel, crême de menthe,* etc. On the other hand, many well-known liqueurs are compounded of very numerous aromatic principles. The nature and quantities of the flavouring agents employed in the preparation of liqueurs of this kind are kept strictly secret, but numerous "recipes" are given in works dealing with this subject. Among the substances frequently used as flavouring agents are aniseed, coriander, fennel, wormwood, gentian, sassafras, amber, hyssop, mint, thyme, angelica, citron, lemon and orange peel, peppermint, cinnamon, cloves, iris, caraway, tea, coffee and so on.

The alcoholic strength of liqueurs ranges from close on 80% of alcohol by volume in some kinds of absinthe, to 27% in anisette. The liqueur industry is a very considerable one in France. Among other well-known trade liqueurs may be mentioned maraschino, which takes its name from a variety of cherry—the marasca—grown in Dalmatia, the centre of the trade being at Zara; kümmel, the flavour of which is largely due to caraway seeds; allasch, which is a rich variety of kümmel; and cherry and other "fruit" brandies and whiskies, the latter being perhaps more properly termed cordials. (*See* also BENEDICTINE, D. O. M.; CHARTREUSE; CREME DE MENTHE; KÜMMEL.)

See Duplais, *La Fabrication des liqueurs;* and Rocques, *Les Eaux-de-vie et liqueurs.*

LIQUID AIR. A pale blue, paramagnetic liquid having a density nearly equal to water. It is chiefly a mixture of liquid oxygen (boiling point—183.0° C) and liquid nitrogen (boiling point—195.8° C). If the liquid is allowed to evaporate the mixture loses nitrogen and becomes much richer in oxygen. Louis Cailletet, in Dec. 1877, succeeded for the first time in liquefying air. Liquid air is prepared in large quantities in connection with the isolation of oxygen from the air. It is an article of commerce and finds many useful applications in the laboratory. (*See* LIQUEFACTION OF GASES.)

LIQUIDAMBAR, LIQUID AMBER or **SWEET GUM,** a product of *Liquidambar styraciflua* (family Hamamelidaceae), a tree native to the United States, Mexico and Central America. The earliest record of the tree appears to be in a Spanish work by F. Hernandez, published in 1651, in which he describes it as a large tree producing a fragrant gum resembling liquid amber, whence the name (*Nov. Plant.,* etc., p. 56). In Ray's *Historia Plantarum* (1686) it is called *Styrax liquida.* It was introduced into Europe in 1681 by John Banister, the missionary collector sent out by Bishop Compton, who planted it in the palace gardens at Fulham. The gum resin yielded by this tree has no special medicinal virtues, being inferior in therapeutic properties to many others of its class. It has long been used in France as a perfume for gloves, etc. It is mainly produced in Mexico. (*See* SWEET GUM.)

LIQUIDATION. A British joint stock company, being a purely artificial body created by law, can only be brought to an end by legal process. This legal process is called *liquidating,* or winding-up, the company.

A company may be wound up (1) *Voluntarily,* by the passing of a special or extraordinary resolution that it be wound up, and the appointment of a person to act as liquidator. The liquidator so appointed has to convene a meeting of creditors, and the creditors may, if they think fit, pass a resolution deputing some named person to apply to the court to appoint another person to act as liquidator, either with or in place of the existing liquidator. Ordinarily, the court would act upon such a request in cases where the company appeared to be insolvent. (2) *Under the Supervision of the Court.* This form of procedure is now practically obsolete. (3) *Compulsorily.* Here the procedure is analogous to that in *bankruptcy.* The official receiver takes charge of the company's affairs in the first instance, and it is the duty of the directors of the company to supply him with a sworn statement of its affairs. This *statement of affairs* is submitted by the official receiver to separate meetings of the creditors and contributories (or shareholders). Each meeting has a right to nominate a liquidator, who may be the official receiver; the official receiver reports the result of the meetings to the court, and the court thereupon appoints a liquidator.

Duties of Liquidator.—Whatever form the liquidation takes, it is the duty of the liquidator (1) to realize the assets of the company to the best advantage; (2) to adjust the rights of contributories *inter se; i.e.,* to determine what calls must be made upon the partly-paid shares of the company (if any) in order to provide for the payment of its debts, and to do justice to the different classes of shareholders; (3) to investigate the causes of liquidation, and if necessary to institute proceedings against any persons who may have contributed to its failure; (4) to distribute the proceeds of the realization of the assets among those entitled to participate, having regard to the priorities provided by law; (5) to close the liquidation, and provide for the final dissolution of the company.

On the appointment of a liquidator, the directors and all the former officers of the company cease to function, and the liquidator becomes the only officer capable of acting in the name of the company and using its *common seal*. In so doing he acts as agent of the company only.

Debenture-holders are secured creditors only to the extent of any specific or general charge that they may hold upon the assets of the company. Usually, a receiver is appointed to look after their special interests; but, in the absence of a receiver, it is the duty of the liquidator to see that, subject to payment of proper costs, the proceeds of the sale of all assets charged in favour of debenture-holders are applied (subject only to the rights of preferential creditors) first in satisfaction of debenture-holders' claims.

In the absence of express provision to the contrary, every share in the company carries equal rights and responsibilities. Thus, if all the shares are not fully-paid, the rights of the respective holders cannot be adjusted until either the partly-paid shares have been fully paid up, or a sum has been returned to the holders of fully-paid shares equal to that uncalled upon the partly-paid shares. But, of course, no return can be made to shareholders until all the debts of the company have been paid. (L. R. D.)

United States.—Although both liquidation and winding-up are terms in use in the United States, the legal process is most frequently called dissolution; and the dual forms refer to voluntary and involuntary dissolution. Liquidation is often used in the narrower sense of the actual disposition of the company's assets.

In a voluntary dissolution the directors usually act as liquidating trustees. In involuntary dissolution the receiver appointed by the court will liquidate the assets. There is no formal creditors' meeting provided for although such meetings are often called and act in an advisory capacity.

In comparing involuntary dissolution with bankruptcy, it should be noted that the bankruptcy statute excludes from its operation railroad, banking and insurance companies. The United States supreme court has further held that in many circumstances a public utility company may be compelled to continue operating even though its stockholders wish to dissolve. In such a case neither bankruptcy nor liquidation would be available to a railroad company. It has, however, been held that when a railroad company is operating at a continuous loss the courts and legislatures must allow it to liquidate. (J. L. We.)

LIQUID OXYGEN EXPLOSIVES: *see* Explosives: *Liquefied Gases.*

LIQUID STATE, THE. The states of aggregation of chemical substances are classified as gas, liquid and solid. Gases and liquids are distinguished from solids by the property of fluidity. Elastic solids resist both tensile and shear deformation with stresses proportional to the strains. They are therefore capable of supporting shearing stress at equilibrium. The representative fluid, obeying the Newtonian law of viscosity, resists shear deformation only with a stress proportional to the rate of strain. Fluids are therefore incapable of supporting shearing stress and, under the action of gravity, flow to adapt their shapes to those of their containers. The mechanical distinction between fluids and solids is not sharp. Many substances, notably certain high polymeric materials, exist in states exhibiting mechanical properties intermediate between those of the elastic solid and the viscous fluid.

Each substance possesses a critical temperature above which there exists but a single fluid phase. Above the critical temperature there is no distinction between gas and liquid. At each temperature below the critical there exists a pressure, called the vapour pressure, at which two fluid phases are capable of coexistence. The more dense is designated as the liquid and the less dense as the vapour. At pressures exceeding the vapour pressure the liquid is stable. At pressures less than the vapour pressure the vapour or gas is stable.

The boiling point of a liquid under constant external pressure is the temperature at which the vapour pressure becomes equal to the external pressure. Heated at constant pressure, a liquid remains stable until its boiling point is reached, when it is transformed to vapour with the absorption of heat. The heat absorbed in the vaporization of unit mass of liquid is called the latent heat of vaporization.

In general, substances possess one or more crystalline solid modifications. Some or all of them may be capable of coexistence with the liquid phase. At a specified external pressure, the temperature at which a crystalline solid and the liquid coexist is called the melting point of the solid or the freezing point of the liquid. When a liquid is cooled to the freezing point, it is transformed into the solid with the liberation of heat. The heat liberated when unit mass of liquid is transformed into solid is called the latent heat of fusion. Noncrystalline solids, for example glassy or vitreous materials, generally do not possess definite melting points, but soften gradually to a liquid phase with increasing temperature. Noncrystalline solids are frequently unstable with respect to transformation to crystalline phases, but the rate of transformation may, as in the case of glasses, be exceedingly slow.

Substances are observed to possess triple points of specified temperature and pressure at which solid, liquid and gas may coexist. At pressures below that of the triple point the liquid is no longer stable. When the solid is heated below the triple point pressure, it sublimes to vapour without passing through an intermediate liquid phase.

Liquids in contact with their own vapours or with air possess a property called surface tension which, unless opposed by external forces, causes the interface to reduce to minimum area. Therefore, in the absence of gravity and other external forces, the stable form of a mass of liquid is spherical. Surfaces between a liquid and a solid or another immiscible liquid are also characterized by interfacial tensions, which determine whether the liquid in question will wet or spread on the other material.

As a rule, substances possess only one liquid modification. Exceptions are found in the case of helium which possesses two liquid forms and in certain substances, for example para-azoxyanisole, which possess optically anisotropic liquid crystalline phases as well as a normal liquid phase.

The Molecular Structure of Liquids.—The structure of substances on the molecular scale is determined by a balance between the ordering influence of intermolecular forces and the disordering influence of thermal motion. At low temperatures the influence of intermolecular forces predominates to give the well-ordered structural characteristics of the crystal lattice. At high temperatures the influence of thermal motion predominates to give the random and featureless structure of a gas. The structure of liquids corresponds to a degree of order intermediate between that of the crystalline solid and that of a gas.

The structure of an ideal crystal is characterized by a high degree of order and organization in the arrangement of the atoms and molecules of which it is composed. This order is described by the theory of space lattices. There exists a fundamental unit of structure composed of a small number of atoms or molecules in a definite geometrical configuration. The crystal lattice is built up as a periodic reproduction of the fundamental unit in the three directions of space. Real crystals possess various types of disorder such as mosaic structure and lattice dislocations as well as thermal disorder associated with lattice vibrations and lattice defects.

When a crystalline solid melts to the liquid, the long-range order of the crystal lattice is destroyed. However, a residue of local order persists in the liquid state. Each molecule maintains a partially ordered arrangement of its neighbours which is a blurred replica of that of the crystal lattice. This vestigial order lacks the long-range character of that of the crystal lattice and becomes imperceptible at distances greater than several molecular diameters.

The local order characteristic of the liquid state is described by the radial distribution function $g(R)$, defined as the ratio of the average local molecular density $\rho(R)$ at a distance R from an arbitrary molecule to the bulk density ρ_0 of the liquid.

$$\rho(R) = \rho_0 g(R) \qquad (1)$$

A radial distribution function everywhere equal to unity corresponds to a completely random or disordered structure. Departures of $g(R)$ from the value unity measure the local order established by a molecule in the arrangement of its neighbours. For the representative liquid, $g(R)$ is a curve which possesses a series of rapidly damped maxima and minima. The positions of the maxima roughly correspond to the first several co-ordination shells of the crystal lattice characteristic of the solid state of the material. The minima correspond to distances intermediate between co-ordination shells. The local order described by the radial distribution function lacks the sharpness of crystalline order and is appreciable only at distances of a few molecular diameters. The resemblance of liquid structure to crystalline structure is therefore limited to a domain of molecular dimensions in the vicinity of any molecule. The radial distribution function specifies only the average local density, from which significant statistical fluctuations must occur as the neighbours of a specified molecule are interchanged with other molecules in the course of thermal motion.

The experimental determination of the radial distribution function is based upon the measurement of angular distribution of intensity of X-rays scattered by the liquid, according to techniques developed by F. Zernicke and J. A. Prins and by P. Debye and H. Mencke. A beam of monochromatic X-rays is allowed to traverse a small sample of the liquid, confined in a glass capillary or in the form of a jet. The intensity of the scattered radiation is recorded as a function of scattering angle on a photographic plate, in an ionization chamber, or with a Geiger-Müller counter. An X-ray scattering photograph of a liquid resembles to a certain extent a Debye-Scherrer powder diagram of a crystalline solid. However, instead of the well-defined rings of maximum intensity of the powder diagram, a liquid gives only a few broad and diffuse rings of rapidly diminishing intensity.

From the intensity $I(\vartheta)$ of the X-rays scattered by a liquid in a direction making an angle ϑ with the incident beam, the radial distribution function may be calculated with the aid of the Fourier integral theorem. The relationship may be expressed in the following manner,

$$\begin{aligned} g(R)-1 &\approx \frac{1}{2\pi^2 R}\int_0^\infty s\,i(s)\sin(sR)ds \\ i(s) &= (I/I_e - Nf^2)/Nf^2 \\ s &= (4\pi/\lambda)\sin\theta/2 \end{aligned} \tag{2}$$

where I_e is intensity of radiation scattered by a single electron, λ the X-ray wave length, and f the form factor of the atoms of which the liquid is composed. The Fourier integral may be evaluated with the aid of an harmonic analyzer or other mechanical computing devices.

Although the X-ray scattering technique is strictly applicable only to a monatomic liquid, it may be employed in an approximate fashion to obtain worthwhile qualitative information concerning the structure of polyatomic liquids when the scattering can be principally attributed to a single type of atom or when the form factors of the several types of atoms composing the molecules are not significantly different in magnitude.

Quasi-crystalline models of local liquid structure may be used to advantage in the interpretation of the radial distribution function. While it is recognized that long-range crystalline order is absent, the local arrangement of the neighbours of each molecule is regarded as a blurred replica of the first several co-ordination shells of a single crystal lattice or of a superposition of several lattice types. The number of neighbours in each diffuse co-ordination shell is estimated as the integral of $4\pi R^2\rho_0 g(R)$ under the corresponding peak of the radial distribution function.

Quasi-crystalline analysis of the radial distribution functions of the liquid metals, for example sodium and mercury, leads to the conclusion that the local structure corresponds to a close-packed arrangement of spheres. J. D. Bernal and R. H. Fowler have employed the quasi-crystalline model with great success in interpreting the structure of liquid water. The liquid is regarded as a three-dimensional net in which each water molecule is linked to four neighbours by hydrogen bonds. By superposing co-ordination structures of the β-quartz, trydymite, and closed-packed types, a radial distribution function, yielding an X-ray scattering curve in substantial agreement with experiment, may be constructed. At low temperatures the β-quartz structure predominates, and at high temperatures the contribution of the closed-packed structure increases. Many of the anomalous properties of water, for example, the maximum density at 4° C., are accounted for by the Bernal-Fowler model.

The structure of the liquid paraffin hydrocarbons has been interpreted along similar lines by B. E. Warren. In these liquids, the structure approximates the arrangement realized in the axial close-packing of slender rods. The X-ray scattering curves of the aliphatic alcohols exhibit inner peaks not observed for the corresponding hydrocarbons. This peak may be qualitatively interpreted, if it is assumed that the alcohol molecules are linked in chains by hydrogen bonds between the hydroxyl groups, while the aliphatic radicals remain approximately close-packed as in the corresponding hydrocarbons. Similar qualitative interpretations of the structures of many organic liquids can be made.

The investigation of the relation between liquid structure and intermolecular forces involves difficult problems in statistical mechanics which have received only partial solution. The statistical mechanical theory of molecular distribution in liquids has been studied by J. E. Mayer and J. G. Kirkwood. An approximate integral equation relating the radial distribution function to the potential of intermolecular forces has been formulated by J. G. Kirkwood and solved by Kirkwood and E. Monroe for a system of rigid spherical molecules without attractive forces. The theoretical distribution function possesses the general characteristics of the experimentally determined radial distribution functions for representative liquids.

The Thermodynamic and Mechanical Properties of Liquids.—The thermodynamic properties of an homogeneous liquid in equilibrium are determined by its equation of state,

$$p = f(T, v) \tag{3}$$

which specifies the pressure p as function of the temperature T and the specific volume v, and by its specific heat as a function of temperature at a constant value of the pressure. The equation of state cannot be expressed in closed form in terms of elementary mathematical functions, but simple analytical approximations may be used for limited ranges of the variables. In general, the compressibilities and thermal expansion coefficients of liquids are not very sensitive to pressure, away from the critical state. However, the compressibility decreases slowly with increasing pressure.

Heterogeneous equilibrium between liquid and vapour or liquid and crystalline solid is described by the Clapeyron equation.

$$\frac{dp}{dT} = \frac{L}{T\Delta v} \tag{4}$$

where L is the heat absorbed and Δv is the specific volume increment in the transition. This differential equation determines the pressure p as a function of temperature T for states of coexistence of the liquid and the contiguous phase. Thus, when applied to liquid-vapour equilibrium, it determines the vapour pressure as a function of temperature.

According to statistical mechanics, the thermodynamic behaviour of a liquid is determined on the molecular scale by the forces acting between the molecules of which it is composed. The intermolecular force between a pair of molecules is one of repulsion at small distances and one of attraction at large distances. The repulsion at small distances prevents molecules from interpenetrating to an appreciable extent and gives them an effective size. The attraction at large distances is called the van der Waals force and is responsible for the general cohesive properties of matter. The potential $V(R)$ of a pair of chemically saturated spherical molecules or atoms, for example argon, situated at a distance R from each other may be approximately represented by the expression, formulated by J. E. Lennard-Jones,

$$V(R) = \frac{\lambda_1}{R^s} - \frac{\lambda_2}{R^6} \tag{5}$$

where λ_1 and λ_2 are constants and s is an exponent in the neighbourhood of 12. The first term, dominating at small intermolecular distances, gives rise to repulsion, and the second, dominating at large distances, gives rise to the van der Waals attraction.

According to J. E. Mayer, the pressure p is related to the potential of intermolecular force $V(R)$ and the radial distribution function $g(R)$ in the following manner,

$$pv = RT - \frac{2\pi N}{3}\rho_0\int_0^\infty R^3\frac{dV}{dR}g(R)dR \tag{5}$$

where V is the molar volume, N is Avogadro's number, R the gas constant, and T the absolute temperature.

The molar heat of vaporization is related to the potential of intermolecular force and the radial distribution function through the formula,

$$L = RT - 2\pi N\rho_0\int_0^\infty R^2 V(R)dR \tag{6}$$

where the symbols have the same significance as in equation (5).

The statistical mechanical theory of liquid structure has been approached from another standpoint by H. Eyring and J. Hirschfelder and by J. E. Lennard-Jones and A. F. Devonshire. In these theories the quasi-crystalline model of local liquid structure is employed to estimate the free volume accessible to each molecule, in which it is supposed to execute gas-like thermal motion. The free volume is much smaller than the total volume per molecule, since each molecule is caged by its neighbours. According to the free volume theories, the equation of state has the form,

$$p = RT\left(\frac{\partial \log v_f}{\partial v}\right)_T - \left(\frac{\partial E}{\partial v}\right)_T \tag{7}$$

where v_f is the free volume and E is the molar internal energy. The several free volume theories prescribe different models upon which to base the calculation of v_f. They have been very successful in reproducing the empirical equations of state of many liquids.

In fluid mechanics the relation between the stress tensor σ and the rate of strain $\dot{\epsilon}$ is of primary importance. For the Newtonian fluid in which the principal shearing stresses are proportional to the corresponding rates of strain, this relation is

$$\sigma = -(p + \tfrac{2}{3}\eta\nabla\cdot\boldsymbol{u})\mathbf{1} + 2\eta\dot{\epsilon} \tag{8}$$

where $\mathbf{1}$ is the unit tensor, u the fluid velocity and η the coefficient of viscosity. The stress law of equation (8) when introduced into the equation of motion leads to the Navier-Stokes equation,

$$\rho\frac{d\boldsymbol{u}}{dt} = \rho\boldsymbol{F} - \nabla p + \eta\nabla^2\boldsymbol{u} + \frac{\eta}{3}\nabla\nabla\cdot\boldsymbol{u} \tag{8}$$

where ρ is the density and $\boldsymbol{F}$ is the external force acting on unit volume of the fluid. The Navier-Stokes equation together with the equation of continuity,

$$\nabla \cdot (\rho \mathbf{u}) = -\partial \rho / \partial t \qquad (10)$$

describes the motion of viscous fluids. The study of the solutions of these equations under appropriate initial and boundary conditions constitutes the science of hydrodynamics.

The coefficient of viscosity of a liquid is related to its structure and the intermolecular forces in a complicated way. According to Eyring, it may be represented in the form,

$$\eta = \frac{a_1 h}{a_2 a_3 a^2} e^{-\Delta F \pm /RT} \qquad (11)$$

where h is Planck's constant and $\Delta F^{\pm}$ is the free energy of activation for the elementary flow process. In this equation, a_1 is the dimension of the unit of flow perpendicular to the direction of flow, a_2 and a_3 the dimensions parallel to the direction of flow, and a the distance moved by the unit of flow in the elementary process.

Electrical and Optical Properties of Liquids.—With the exception of the liquid metals, molten salts, and solutions of salts in ionizing solvents, the electrical conductivities of liquids are very small. In the liquid metals the conductivity is electronic. In molten salts and solutions of salts the conductivity is electrolytic, that is the electric current is carried by the ions of the salt. For example, in an aqueous solution of sodium chloride, the current is carried by the ions Na^+ and Cl^-.

The dielectric constants of nonpolar liquids, for example benzene, the molecules of which do not possess permanent electric dipole moments, do not differ greatly from unity and generally are in the range 1.00 to 3.00. The dielectric constants of polar liquids, for example water, the molecules of which possess orientable electric dipole moments, are generally one or two orders of magnitude larger than those of nonpolar liquids. Thus the dielectric constant of water is approximately 80 at 25° C. With the exception of liquid crystalline phases, liquids are optically isotropic. In nonpolar liquids the refractive indices for the visible spectrum do not differ greatly from the square roots of their dielectric constants measured in the radio or audio frequency spectrum. In polar liquids, the refractive indices for light in the visible spectrum are of the same magnitude as those of nonpolar liquids.

The absorption spectra of liquids in the visible and ultra-violet region of the spectrum reflect the electronic structure of their component molecules and do not differ markedly from the absorption spectra of the substances in the vapour state. However, on account of the perturbing influence of intermolecular forces, changes in frequency and intensity, as well as the broadening and blurring of the band structure of the vapor spectrum, are observed. The infra-red and Raman spectra of liquids may differ markedly from those of their vapours, because of the presence of structural frequencies characteristic of the liquid state. Such structural frequencies are analogous to the lattice vibrational frequencies which give rise to the residual ray spectrum of ionic crystals.

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LIQUORICE. The hard and semi-vitreous sticks of paste, black in colour and possessed of a sweet, somewhat astringent taste, known as liquorice paste or black sugar, are the inspissated juice of the roots of a leguminous plant, *Glycyrrhiza glabra,* the *radix glycyrrhizae* of pharmacopoeia. The plant is cultivated throughout the warmer parts of Europe, especially on the Mediterranean shores, and to some extent in Louisiana and California. The roots for use are obtained in lengths of three or four feet, varying in diameter from $\frac{1}{4}$ to 1 in., they are soft, flexible and fibrous, and internally of a bright yellow colour, with a characteristic, sweet pleasant taste. To this sweet taste of its root the plant owes its generic name *Glycyrrhiza* (the sweet-root), of which the word liquorice is a corruption. The roots contain grape-sugar, starch, resin, asparagine, malic acid and the glucoside glycyrrhizin, $C_{24}H_{36}O_9$, a yellow amorphous powder with an acid reaction and a distinctive bitter-sweet taste. On hydrolysis, glycyrrhizin yields glucose and glycyrrhetin.

Stick liquorice is made by crushing and grinding the roots to a pulp, which is boiled in water over an open fire, and the decoction separated from the solid residue of the root is evaporated till a sufficient degree of concentration is attained, after which, on cooling, it is rolled into the form of sticks or other shapes for the market. The preparation of the juice is a widely extended industry along the Mediterranean coasts; but the quality best appreciated in Great Britain is made in Calabria and sold under the names of Solazzi and Corigliano juice. Liquorice enters into the composition of many cough lozenges and other demulcent preparations; and in the form of aromatic syrups and elixirs it has a remarkable effect in masking the taste of nauseous medicines.

LIQUOR LAWS AND LIQUOR CONTROL. Laws to regulate or prohibit the manufacture, sale and transportation of beverage alcohol or intoxicating liquors are of ancient origin everywhere and are growing more numerous and complex in all countries. They are more often found and in greater variety as tax measures ostensibly for the purpose of raising revenue, but even here the dominant motive is usually the social aim to combat the evils of alcoholism and promote public health, public order and social welfare.

Another factor of growing importance since the middle of the 19th century has been the rapid urbanization, industrialization and mechanization of modern life in the leading nations of the world. There is a consequent wider recognition of the need for sobriety in safeguarding public order and physical efficiency.

There are four general methods of legislative control of the liquor traffic:

(1) *Licensing,* the oldest and most widely used method.
(2) *The No-Private-Profit Scandinavian or Company System,* which seeks to secure disinterested management by entrusting a monopoly of sale of liquor to a body of citizens who have no personal interest or profit in it.
(3) *State Monopoly,* where the state retains the wholesale or retail trade, or both, in its own hands, takes the profits as public revenue, and of course retains complete control.
(4) *Restriction or Limited Prohibition,* which is usually a system of high licence with local option or local veto.

Two important distinctions in the licence system as practised more extensively in the United Kingdom and in the United States than elsewhere should be noted. In the United Kingdom we find a single homogeneous system, gradually evolved after centuries of experience with the licensing principle, whereas in the United States before and after the era of national prohibition many different systems are coexistent due to the quasi sovereignty of the individual states. Also American law and legislative practice have never varied the traditional "common law" theory of a licence as a temporary permit, revocable for violation of the conditions upon which it was granted, and terminable at the will of the issuing authority upon the expiration of the brief term—usually one year—for which it was granted, and without vesting any property right in the expectation of renewal. Since 1904, however, a new principle of compensation, as discussed below, has been introduced into the licensing system of England.

I. THE UNITED KINGDOM

The number of public houses, including beerhouses for "on" consumption in England and Wales from 1831 to 1935 decreased in proportion to population, being 1 public house to 168 persons in 1831, 1 to 375 in 1909, 1 to 398 in 1911, 1 to 458 in 1921 and 1 to 538 in 1935 (*see* G. B. Wilson, *op. cit.,* below, p. 236), and 1 to 535 in 1937 (*cf.* Home Office: *Licensing Statistics,* 1937, Parl. Papers, Cmd. 5869, London, 1938). The decrease in the corresponding showing for Scotland is likewise continuous and much more rapid. As a whole, the United Kingdom shows a large and progressive diminution in the number of public houses to population, which has not been counterbalanced by an increase in "off" licences. The Licensing Act, 1904, which became known as the "Balfour act," provided compensation of licences withdrawn on grounds other than misconduct and destroyed the centuries-old unqualified discretion of the justices to refuse the renewal of on-licences, without compensation. This act accelerated greatly the reduction in the number of public houses, but the number of clubs, registered under the Licensing Act, 1902, has increased at a greater rate but apparently represents only 7% of the total amount spent in England and Wales in 1935 for liquors. (*See* Geo. B. Wilson, *Alcohol and the Nation,* London, 1940, p. 143.)

Change in liquor consumption, if we could measure it accurately, and did we know more about the factors affecting it, would of course be the best test of the effectiveness of laws. The two foremost authorities on scientific research in this field, Dr. G. B. Wilson in England (*Op.cit.* c.22), and Prof. E. M. Jellinek of Yale university in *Alcohol Explored* (1942, c.2), and in his study of "Alcohol Consumption Rates" (*Quar. Jour. Studies on Alcohol*, iii, no. 2, pp. 267–80), are agreed that the task is difficult, that we must proceed slowly and cautiously, but that the outlook is good for answers to age-long controversies on the use and abuse of alcohol. Wilson sums up a discussion of liquor consumption during World War I, by saying that the controlling factor over the whole period of the war "was the restriction on the amount of intoxicating liquor available for consumption." Haggard and Jellinek (*Op.cit.* p. 272) tell us that the failure of total prohibition wherever tried need not blind us to the definite effect in decreasing the immoderate use of alcohol which legal measures have had in England, Belgium, Switzerland and Norway—such measures as taxation, regulation of closing hours, licence restrictions, etc. The same authors are cited as authority for the statement (*Information Service*, xxi, no. 40, New York, Dec. 5, 1942) that per capita of "absolute alcohol" from wine, beer and spirits in Great Britain (also in Germany, the Netherlands, Norway and Sweden) tended to decrease from about 1901 to 1930 (war years 1914–18 not included), then rose sharply in 1932 but by last reports available, is "far below the lowest previous figure since the turn of the century." Effective control of the beverage liquor traffic was demonstrated as possible during World War I by Lord D'Abernon, chairman of the Central Control board, through restrictive measures with respect to sale, alcoholic content, taxation, closing hour, limitation of off-premises sales to 2½ hours per day, five days a week, etc. Much of these gains has been retained. Per capita consumption in the United Kingdom was: 1917—27 gal. beer and 6.7 gal. spirits; 1938—14.2 gal. beer and 0.21 gal. spirits, and for the population over 18 years of age, 2.89 and 1.65 respectively.

The important licensing acts since 1904 have been: (1) the Licensing (Consolidation) Act, 1910, which codified all existing licensing laws of England and Wales, repealed almost entirely the Licensing acts of 1828–1904, and remained on the statute book until 1921, though partially superseded during the years 1915–21 by orders of the Central Control board (Liquor Traffic); (2) the Temperance (Scotland) Act, 1913, which limited hours for licensed premises, increased restrictions on clubs supplying liquor, and gave local option to local government electors to vote "no license", "one-fourth reduction", or "no change"; (3) the wartime legislation, 1914–19, (a) Orders under the Defence of the Realm Act, 1914; (b) Intoxicating Liquor (Temporary Restrictions) Act, 1914; (c) Defence of the Realm (Amendment) Act, 1915, under which the Liquor Control board was created as the executive authority. The control by the board was first applied to the Lowlands of Scotland and to important shipbuilding and industrial areas in England; by the end of the war it applied to 29 areas or about three-fourths of England, Scotland and Wales. In 1916 the board tried government monopoly in certain areas, notably in the Carlisle area where this system remained as a permanent institution; (4) the Licensing Act, 1921, which abolished the Liquor Control board, and made permanent some of its regulations, and also applied them to registered clubs; the act also made statutory the state ownership of the Carlisle area, and substituted "permitted hours" for "closing hours" previously in force; (5) the Licensing (Permitted Hours) Act, 1934, which gave the justices authority to extend the hours prescribed in the 1921 act for part of the year, but still contained strict limitation of hours. This principle has been found the most effective measure to reduce drunkenness and the abuse of beverage alcohol.

A Royal Commission on Licensing appointed in 1929 had reported (1932, Parl. Papers, Cmd. 3988) in favour of retention of wartime regulations of hours; other recommendations were: the more rapid reduction of licences; more experimentation with public ownership of the liquor trade; more definite encouragement of specific education on the subject of alcohol; the creation of a National Licensing commission to supervise and assist the proposed reform measures, etc., but no steps had been taken up to 1943 by the government to deal with these recommendations.

II. THE BRITISH COMMONWEALTH OF NATIONS

Canada.—Liquor legislation is based fundamentally on the licence system and practices of the United Kingdom, and also has followed pretty closely that of the United States. While the provinces, like the states, had their own laws which varied in stringency, they usually provided for licence modified by local veto. The Canada Temperance Act, 1878 (Parl. Dom. Can. 41 Vict. c. 16, May 10), known as the Scott act, was a federal law providing for local option in any city or county on petition of one-fourth of the electors at three-year intervals. Under this act a rapid growth of dry areas in the Maritime provinces took place, and Prince Edward Island became completely dry and Nova Scotia nearly so, while in the other provinces where the Scott act was not popular, dry territory also spread rapidly under provincial statutes (*See* L. W. Moffit, "Control of the Liquor Traffic in Canada" in *Annals*, Amer. Acad. P. & S. S., v. 163, Sept. 1932).

This was the situation down to the outbreak of World War I. In the next 15 years, 1916–30, all nine provinces except Prince Edward Island, which had had prohibition for 15 years previously, adopted provincial prohibition (four in 1916, three in 1917, and Quebec, limited to spirituous liquors, in 1919), and repealed these laws (two in 1921, two in 1927, and one each in 1923, 1924, 1925 and 1930) in favour of control by direct government sale.

National prohibition, which received a majority of 13,687 in a total vote of over 500,000, in a plebiscite in 1898, never gained enough support to secure enactment by the dominion government. The constitutional controversy over the respective powers of the dominion and the provinces was settled in 1901 by decision of the privy council that the provinces had complete control of the retail trade in liquor and the dominion, of manufacture and importation. Then followed much legislation analogous to the Wilson and Webb-Kenyon acts in the United States (*q.v.* in article PROHIBITION) to protect dry territory by local option from invasion by liquor from surrounding wet areas. Without a real federal prohibition law, even with these aids to enforcement, provincial prohibition became generally recognized as unenforceable, or at least too difficult, costly and its attendant evils too serious, to warrant its continuance. Unlike the United States, Canada in abandoning total prohibition abandoned also the licence system and went over completely to state monopoly. The Canada Temperance act remained in force, up to 1943, and local option had been little modified, that is, no area that did not want them would have stores or licensed premises established within their borders. While controversies raged and opinions differed as to results, there seemed to be general acceptance of the control system, and nowhere any strong tendency to revert to prohibition, or to the old licence system.

Some advantages accruing from the monopoly of purchase and sale vested in the government, over competitive commercial distribution of beverage alcohol, are: strict limitation of advertising, reduction of inducements to buy, various devices for keeping the quantities bought and amount consumed to ordinary levels without stimulation of profit-seeking vendors and the elimination of the old bar. These results have been achieved by the control system of Canada, and the efforts of the provincial commissions and control boards, and their personnel generally have been of a high order. Yet consumption increased to such an extent that as recently as Dec. 16, 1942, Prime Minister Mackenzie King broadcast an appeal from Ottawa for greater temperance and abstinence as part of the war effort and announced that after Feb. 1, 1943, liquor advertisements would be prohibited throughout Canada for the duration.

Other British Commonwealth Countries.—These have generally followed British models and been less repressive in their policies of licensing and liquor control than Canada. In Australia the existing licence legislation in all six states makes provision for some sort of local option and machinery for the reduction of the number of licences where it seems desirable or where local option votes are in favour of reduction. Local option concerning the sale of fermented and spirituous liquors was in force in South Australia and Tasmania (*Official Year Book*, v. 33, 1940, p. 940), but in New South Wales such polls were suspended after 1913, and in Victoria, Queensland and Western Australia state-wide polls superseded the local polls. In 1928 a special state-wide referendum was taken in New South Wales on state-wide prohibition with compensation. It resulted in a majority of 500,000 against prohibition in a total vote of 1,268,119, being over 88% of the qualified voters (*Official Year Book,* no. 22, 1929, p. 1005). All the states except South Australia have a fixed maximum for licences, above which the licence boards may not go except under special conditions such as demand of increased population. The Licence Reduction boards in New South Wales and Victoria (and similar machinery in all the other states), exist for the reduction of licences where it seems desirable or local option votes so direct. Funds for compensation for licences refused renewal are derived from special taxes usually assessed on the volume of the liquor trade. Provision is made for a poll usually about once every seven years, and in some states total prohibition may be voted on when these polls are taken. Other conditions affecting the Licence Reduction boards vary in the different states, and the reductions effected in the decade 1920–30 were substantial. The per capita consumption, however, does not seem to decrease proportionately. The figures available (*Official Year Book,* 1940) give for Australia: Spirits, 0·2 imp. gal.; wine, 0·36; and beer 8·2; showing little change for each of the years since 1935. The corresponding figures for New Zealand were: 0·3, 0·2, and 8·6; for Canada 0·2, 0·3, and 6; for the United Kingdom: 0·2, 0·3, and 33·1; and for the U.S.A.: 0·9, 0·4, and 13 (according to a comparative table in the *Official Year Book,* 1940, p. 957). In New Zealand three state-wide polls were taken following 1919 on prohibition without compensation, state purchase and continuance of licence. Continuance won by small majorities in all three, though prohibition obtained a plurality in two polls. From the New Zealand 1942 *Official Year Book,* the following statistics are taken of per capita consumption in gallons, for specified years under New Zealand's controlled licence and local option policy: 1926—spirits, 0·47; wine, 0·19; beer, 9·2; 1932—0·21; 0·1; 5·8; 1938—0·28; 0·2; 10·7; and 1940—0·27; 1·9; 11·2. In the Union of South Africa since the License Act of 1928 some reduction in the number of licensed premises has taken place. The Union's *Official Year Book,* no. 22, 1941, p. 191, gives the number of retail liquor licences in 1936 as 1,978 or 1 to 875 Europeans, 15 years of age and over, and in 1940 as 2,051 or 1 to 929; and bottle store licences in 1936 as 552 or 1 to 3,161, and in 1940 as 545 or 1 to 3,498. The corresponding figures for convictions for drunkenness (Europeans) were 6,661 and 5,425. In India the movement which began in 1920 with the introduction of measures to restrict the liquor traffic, and with prohibition and local option in some of the states, seems to have continued down to the outbreak of World War II, but the number of shops licensed for the sale of liquors, etc., increased 13% in the second half of the decade 1929–39 compared with the first half (*Stat. Abstract for Brit. India,* Parl. Papers, Cmd. 6333, p. 780*ff.*, London, 1942).

III. OTHER EUROPEAN COUNTRIES

Prior to World War I, continental European countries gave little legislative attention to the liquor traffic. It was generally licensed for revenue purposes but as for control of beverage alcohol as a means of combatting the evils of alcoholism, that was left to local authorities and to ordinary police regulation. There were notable exceptions. In Russia, Sweden and Norway, Finland and Estonia, important experiments were made with various forms of liquor control and prohibition. A strong and growing temperance and total abstinence movement, in most countries wholly individualistic in character, dated from the latter part of the 19th century in the countries of northern Europe, especially in Finland, Norway, Sweden and Denmark. It was only a little less active in northern central countries like Germany, Switzerland, Belgium and Holland but was weaker in France and Slav countries; and ineffective or non-existent in southern Europe—Italy, Greece, Spain and Portugal. World War I stimulated and greatly increased liquor control, both for food and manpower conservation, but most legislative measures aimed at reducing the consumption of beverage alcohol were weakened or disappeared in the postwar years. After the outbreak of war in 1939 in spite of greater food shortages and need for conservation of alcohol and grains for war uses, there was less governmental interference with beverage alcohol except in Germany, and partially, in Switzerland and France. The individualistic temperance movement gained strength everywhere in Europe, and especially in the northern European countries.

Austria-Hungary and the Balkans.—Prior to 1914 in the Austro-Hungarian empire the liquor licence system followed closely that of Germany. In 1905 the individual temperance movement with government assistance, organized and conducted successfully the 10th International Congress Against Alcoholism with the minister of public instruction as its president. Temperance instruction in the schools was introduced, and in recent years the Hungarian government contributed to the noted Museum of Hygiene and Temperance in Budapest and, by various measures, favoured the nonalcoholic uses of fruits, including grapes, which was a movement stemming from Germany but spreading rapidly in all countries. In the Balkans the individual temperance movement was strong in places but generally less effective and governmental measures for liquor control were either nonexistent or weak and sporadic. The Koran prohibition of the use of wine influenced Moslem peoples but even in Turkey this prohibition, still strictly observed in rural areas, was abolished, and in 1923 an alcohol monopoly was created by law. The widespread use of dried fruits and of unfermented grape juice beverages both in Turkey and elsewhere in Bulgaria and other Balkan countries, exercised greater restriction. Statistics show over half of the grape crop in Turkey is used for dried grapes, about one-third for nonalcoholic beverages, one-sixth consumed as fresh grapes, and less than 2% for alcoholic wine. In Yugoslavia Dr. Stampar as director of social hygiene at the ministry of public health directed an educational campaign against alcohol and enlisted the co-operation of provincial and local hygiene offices, and of the minister of public instruction. But when he recommended state action by legislation there were no results other than minor restrictions, Sunday closing, etc., on liquor establishments. Total abstinence for a time made good progress in connection with the youth movement in recent years. In Bulgaria legislative measures against abuse of alcohol were numerous and probably more effective than elsewhere in the Balkans. Schools were active in temperance instruction which was compulsory and the ministry of public instruction organized a temperance day every year in the schools. All licensed places where alcoholic beverages were sold were required by law to close on Sundays, legal holidays and many church holy days, also they were obliged to sell grape juice or other non-alcoholic beverages which were said to be quite popular in such places. Local option polls were held and women participated though they did not have the suffrage in other matters. In Rumania educational efforts were weaker and the few restrictions the law attempted to put on the number of liquor establishments were feebly enforced. Here too, as elsewhere in the Balkans, new forces were at work, especially among the youth movements which would bring, with peace and greater economic stability, greater control of the liquor traffic, and reduction in the consumption of alcohol.

Belgium, Denmark and Holland.—After severe wartime restrictions, Belgium in 1918 prohibited the manufacture and sale of spirits, wines with more than 15% alcoholic content, and other beverages (including beer with more than 8%), except necessary alcohol for medicinal, scientific and industrial uses. The next year two measures were enacted by the parliament, one increasing the tax on alcoholic beverages, and prohibiting the consumption of spirits in all places accessible to the public, and authorizing the legal sale of alcoholic beverages only in the minimum quantity of two litres for consumption off the premises; the second was a tax measure for licensed premises providing for increased taxes on alcohol, and repression of illicit distillation, but leaving the trade in fermented liquors of small alcoholic content free. Licensing conditions and restrictions, following the French system, were usually left to local authorities. The number of licensed houses in proportion to population, and the per capita consumption, were still among the highest in Europe, and prohibitive and restrictive measures, chiefly tax measures, were directed against absinthe and spirituous liquors. Available statistics of consumption for the five years ending in 1936 (*Belg. Ann. Stat.* v. 60, 1938) show no significant changes in this period: beer, 15·7 in 1932 and 14·5 in 1936 (100,000 hectolitres), with fluctuations a little higher in 1934 than in 1933 and again in 1936 compared with 1935; beverage alcohol in 1,000 litres, 97 in each of the four years to 1936, and wines, 12·9 in 1933 to 13·9 in 1936.

Denmark had a comprehensive licensing law in force in 1913 with "off" and "on" provisions for sale of spirits, wines and beers (with more than 2·25% of alcohol). An important licensing act of 1925 fixed the maximum number of licences at the number in existence Jan. 1, 1924, with local option as to new licences and permitting local authorities to restrict their issue to a public utility company on the Gothenburg principle. A government handbook entitled *Denmark* (Royal Danish Ministry for Foreign Affairs and the Danish Stat. Dept., 1939, Copenhagen) says that the per capita consumption of pure alcohol prior to 1914 was 6¾ litres of 100%, annually, and in 1938 it was 2½ litres. This publication also states that temperance legislation is "mainly limited to regulations regarding the number of places where alcoholic beverages may be consumed, and to trading in spirits." Efforts at total prohibition generally failed. Alcohol is heavily taxed. A government adviser on temperance was appointed in 1933. There are many temperance societies all over the country with upwards of 118,000 members pledged to abstain from spirituous liquors. The state, however, made little use of legislative powers in combatting alcoholism, but was active in the educational field, both directly through the schools and the public health agencies and in collaboration with the temperance societies. In this connection it may be noted that Iceland, so long associated with Denmark, adopted national prohibition in 1908 by a small majority of the 8,000 votes cast, abandoned it by a referendum vote with 4,000 majority against out of 26,000 votes cast Nov. 13, 1933, and the sale of liquor was legalized in 1935. This was largely due to pressure from other countries, notably Spain, against restrictions on importations of their wines and liquors, and partly, as in Finland, to the difficulty in controlling smuggling.

Holland long had a strong temperance movement under able leadership in Protestant, Catholic and neutral groups, finally united in a loose federation in the national commission against alcoholism in 1909. The fundamental licensing law of 1881 also provided for the limitation of the number of licensed premises to a fixed proportion of the total population, varying according to the size of the town or district. A revision of this law in 1904 gave the communal authorities the right to request the government every five years to reduce the number of public houses or refuse any new licence. The long struggle, nearly 30 years, for local option was finally lost in 1932 when the Dutch parliament voted on an amended licensing measure adopted without the local option feature which at one time had received the signatures of nearly one-tenth of the entire population to a petition in its favour presented to Queen Wilhelmina. No country justified its greater faith in education than in legislation, by more ingenious means and greater perseverance in educational efforts.

France and Switzerland.—Under the basic licensing act of 1880 France moderately restricted places with "on" licences but left their regulation largely to local authorities. The number of public houses increased to 1 to every 81 persons in 1900, and was reported to be 1 to 80 in 1938, a proportion only exceeded by Belgium. The Local Government Act, 1884, empowered municipal authorities to fix the usual conditions, hours of closing, etc., attached to licences. Taxation of the trade, then light, was greatly increased. Manufacture and sale of absinthe was prohibited by the act of March 16, 1915, but the act was weakly enforced and there were many equally deleterious substitutes. The whole tax and regulatory policy as far as there was one, was directed against spirits and to protect the wine industry. Even the consumption of spirituous liquors greatly increased. The per capita consumption of distilled liquor in France in the period 1928–32, the latest for which reliable statistics are available, was 5·52 litres, five times that of Denmark, four times that of Great Britain, more than twice that of Norway or Holland, and 25% higher than Sweden. An investigation by the Academy of Medicine in 1925 showed that the consumption of beverage alcohol had doubled in the period 1918–25. For the period 1928–32 per capita wine consumption was 167 litres per annum and beer 33·7 litres. The total amounted to 20·6 litres of absolute alcohol, a higher annual per capita than that of any other country in the world. Home distillers were said to number 1,500,000, and enjoy a tax exemption on 10 litres of pure alcohol for personal use. Voluntary temperance movements were not lacking, and the Blue Cross in Protestant circles, the Golden Cross in Catholic, the Good Templars' order and other similar bodies kept up an educational campaign against alcoholism, with little government aid but strengthened by the relatively new movement here as elsewhere in Europe for the wider nonalcoholic use of fruits and the increased market for fresh and dried grapes.

In Switzerland the federal government maintained a state monopoly of distilled liquor, extended by referendum on April 6, 1930, to control home distillers (peasants) of fruit alcohol. After 1935 the monopoly took action to promote the nonalcoholic use of fruits, the manufacture of unfermented cider, the taking over of peasants' stills and provision for use of fruit waste for cattle feed, etc. Under a referendum, July 5, 1908, absinthe was prohibited but the enforcement of this prohibition was not too rigid. The cantons regulate retail liquor trade, and determine the number and conditions of licensing. An inquiry in 1931–38 showed 1 licence to 172 inhabitants, and in Italian cantons as high as 1 to 67, and little restriction of fermented beverages and excessively large numbers of licensed places, including grocery stores, for "off" sale of distilled spirits. In 1929 a referendum to give the cantons power to prohibit the manufacture and sale of distilled liquor was rejected by a 2 to 1 vote, with nearly 700,000 votes cast. The Blue Cross and other voluntary temperance movements were active, likewise experiments like the "cafés chocolats" and temperance hotels made steady but slow progress. They retarded but did not halt the increasing per capita consumption of alcohol.

Finland and Estonia.—The early Russian prohibition of vodka, and wartime prohibition, applied to both countries. Estonia repealed wartime prohibition in 1920 for liquor control similar to the "Bratt" system in Sweden. The communal electors from 1927–34 had local option to prevent the opening of liquor shops which resulted in much dry territory, and the Temperance Federation conducts a vigorous educational campaign. Increasing consumption of alcoholic beverages, especially in rural districts, had aroused the government to the need for greater licence restrictions and revival of local option. Finland had long been a leader in vigorous and intelligent experiments in liquor control. For details of the prohibition experience, 1919–32, *see* J. H. Wuorinen's *Prohibition Experiment in Finland* (1931) and his article in *Annals,* Am. Ac. P. & S. S. (Sept. 1932). The parallelism of the 13 years of national prohibition in Finland and the U.S.A. is striking. The act of Jan. 30, 1932, repealed prohibition in Finland and set up a state-owned and directed alcohol company which supervised the manufacture. sale and import of intoxicating beverages. The company was charged with the duty of stamping out "the illegal trade in intoxicants, and will reduce the use of alcoholic beverages to the smallest possible minimum, as well as prevent drunkenness and its harmful consequences." It established liquor shops in cities and towns, fixed hours and closing conditions on Sundays, holidays and at other times so that the shops were actually open less than half the year, and fixed prices for hotels, restaurants, railway cars, steamers, etc., where liquor, beers or wines might be dispensed usually only with meals. The company paid taxes and customs duties, the same as other concerns, and the profits for the first two years went to meet general government expenses, then 35% for temperance work, suppression of illegal liquor trade, and for the national old-age insurance fund; 35% to other public uses, and the balance, 30%, was divided among localities where no liquor was sold. It is said that rum running was practically stamped out by the end of June 1934. The company might declare a dividend not to exceed 7% before profits were distributed as indicated above, and did so for the second year of operation, 1932–33, when the profits were said to have amounted to $1,500,000. The government held 98% of the stock. Home manufacture of malt beverages and wines was permitted. Municipal and communal councils by a two-thirds vote may prohibit sale, manufacture and importation of beverage alcohol within their jurisdiction.

Germany and Italy.—Germany long had a licence system graded to be more restrictive on spirituous liquors, but chiefly intended for revenue purposes only. The wartime restrictions during World War I, which were severe and both general and local, were intended for conservation of food and alcohol for war uses. Administration of licence conditions and variations of the same were left to local authorities. In 1923 the reichstag prohibited the sale of absinthe, and adopted a local option measure requiring a two-thirds vote in any district for no licence. Two years later the reichstag defeated by a vote of 200 to 168 a measure for stricter regulation of licensed premises, and again in 1927 rejected a wider local option bill. Steady growth of the voluntary temperance movement, owing its leadership largely to the Good Templars' order, continued from the beginning of the century down to the advent of Hitler in 1933, since which time the Empire Community to Combat Alcoholism (Reichsfachgemeinschaft zur Bekaempfung des Alkoholismus) federated the temperance societies and eliminated the Jewish members and other, to them, undesirable features. It had other methods than the usual legislative ways of enforcing its policies. In addition to its educational campaign, the empire office against the abuse of alcohol and tobacco, the new name for a further consolidation since July 12, 1939, under the public health department of the old empire community with other organizations dealing with the treatment of inebriates, profited by legislation such as the sterilization law which could be applied to persons suffering from severe alcoholism, and the law providing for the internment of habitual alcoholic delinquents. Blood tests for drunken drivers in traffic accidents, and the absolute prohibition of liquor advertisements recommending alcoholic beverages for young people, were other legislative measures used, but to the sport motive and the able direction of efforts to promote the nonalcoholic use of fruits, the consumption of nonalcoholic beverages (especially unfermented cider) must be attributed credit for whatever progress was made. The acid test of consumption of alcoholic beverages showed little change in the per capita consumption of beer or spirits in 1937–38 compared with that of 1928–29. A per capita of 63.7 for beer, and 1.21 litres of 100% alcohol was very little lower than it was for the previous decade, and quite a bit higher than for several of the intervening years. In Italy the consumption statistics for 1933–36, latest available, show the annual per capita for beer, 1 litre, and for spirits, 0.36 litre, in both cases about one-third of that in 1919–22; wine about the same at 100 litres and total absolute alcohol 1.62 litres less. In 1913 the manufacture and importation of absinthe was prohibited and a licence system introduced limiting licences to 1 to 1,000 population (previously 500) and with greater restrictions on hours, etc. In the postwar period, 1919 to the outbreak of World War II, the Italian government actively co-operated with the temperance movement, and on its own account, did much to promote nonalcoholic use of fruits and the consumption of nonfermented beverages, and recreational facilities for the use of spare time for children and adults. Also "grape day" introduced by Mussolini in 1930 in Milan spread generally and met with some success in diverting the huge grape industry to other uses than wine production.

Russia and Poland.—For Russia liquor control was for a half century, and continued to be, wholly an economic problem. A pioneer in nation-wide prohibition by imperial ukase as a war measure in 1914, Russia gave up one-fourth of the revenue needed to support its national budget. It got in return some social gains in temporary rise in the standard of living of the peasants which appealed to the communists who came into power in 1917, but also an economic dislocation from the illicit manufacture of samogon, and the home distillation of vodka. In 1924 the sale of vodka was again permitted but with restrictions and control exercised through the state alcohol monopoly. In 1929 the council of people's commissars adopted decrees providing for a more thorough regulation of the liquor traffic, prohibition of the sale of vodka, wine and beer on holidays and pay days; included also were the prohibition of the use of alcoholic drinks in window displays, and certain encouragement for nonalcoholic beverages, and the right of municipal and district councils to close any store or restaurant selling wine, beer or vodka. The latter provision was a sort of local option right but it was exercised autocratically from Moscow where the liquor control policy rested on the conviction that drunkenness is the inevitable result of bad living conditions and oppression, that education and regulation may be necessary but only the elimination of the social conditions responsible for the use of alcohol will achieve permanent results (*Cf.* Joseph Barnes: "Liquor Regulation in Russia," in *Annals*, Am. Ac. P. & S. S., Sept. 1932). Poland long had an alcoholism section at its ministry of social affairs but the voluntary temperance movement while ably led was never numerically strong. Its excellent licensing system, dating back to acts of parliament in 1920–21, was highly restrictive and made provision for provincial and local option on no licence which seems to have been voted in many rural areas but poorly enforced.

Sweden and Norway.—The important revision of the basic liquor control law of 1917 enacted by the riksdag, June 18, 1937, (no. 436), after the report of its revising commission which was appointed in 1928 and reported in 1934, went into effect Oct. 1, 1938. The changes are too numerous for even a brief résumé here but on the whole they strengthen, simplify and unify the control (*Cf.* Bengtsson, *op. cit.*, p. 143ff., for excellent comparative summary). The social purpose that "all sale of intoxicating liquors shall be so organized that it is attended by a minimum of harm" is restated and so emphasized in the 1937 law as to give the administrative authorities added powers to shape policies of sales agencies. The communal veto (a sort of local option exercised by the people's representatives, not by direct popular vote) for off-premises trade was abolished but was retained for the bar and retail store trade. Provision was made to reduce the number of system companies, 121 in number in 1937, so that there should be none where there was none in 1937 and in no city or town of less than 5,000 inhabitants. Within a year the number had already been cut to 41. Stricter measures were provided for safeguarding public profits; also a profit quota system for the transferred licences under which many hotels and restaurants were operated. The principle of profit limitation was strictly applied to wholesaling and manufacturing of spirituous liquors, and even to retailing and on-premises sale of Pilsner beer. From 1919 to 1936 the number of control book holders, or spirits permit holders, increased steadily. In 1936 the number was 1,350,000 or 21.6% of the population, and included 150,000 women. One-fifth of them could purchase the maximum quota of 4 litres of spirituous liquors, but the average allotment was only 2.15 litres, 80% of which was actually consumed. The companies were given larger discretionary powers to fix and limit within the legal maximum the purchase rights of private owners of control books. The per capita consumption of alcoholic beverages in 1936 of spirits of 50% was 4.4 litres; wine 0.9; beer (2.25–2.75 max. per cent of alcohol by volume), 22.0; and this showed little change since 1920, but a small steady increase year by year after 1933. Bengtsson says (*Op. cit.*, p. 153): "Sweden, compared with the prewar period (*i.e.*, 1914), has not reduced its alcohol consumption to any greater degree than many other European countries, and perhaps not to the same extent as some of those countries. When the question of the reduction of the most serious and conspicuous social effects of alcohol is considered, however, Sweden occupies a prominent place among the nations."

In Norway prior to the adoption of national prohibition in 1916 the "Samlags" or company system similar to that in Sweden had long been in existence, but with local option to prohibit retail sale of spirits from 1904–16. Two-thirds of the country districts and about half the towns were "dry." In 1919 a popular vote of 5 to 3 in about 800,000 voting decided in favour of maintenance of national prohibition but this was reversed by a similar vote in 1926 when 5 to 4 in a total of 950,000 were against prohibition which was abolished by law, April 5, 1927. Local option, however, was retained and made stricter. Only towns with over 4,000 may vote every six years to permit or prohibit sale of alcoholic beverages. At the last poll held in 1934, out of 67 towns, 21 voted "no sale," 11 beer only, 18 beer and wine, and only 17 authorized sale of spirits. The German invasion prevented the next poll due in 1940 from being held. The government made provision for treatment of inebriates, co-operated through established machinery with the temperance societies, and actively participated in educational work to combat alcoholism. The statistics of per capita consumption for the period 1928–32, were for spirits, 2.12 litres, wine 1.06, beer 17.04, making a total of absolute alcohol of 2.11 which was reduced in 1936 to 1.95 litres.

IV. THE UNITED STATES

The thousands of statutes, state and federal, and local ordinances without number, in the United States prior to and through the era of national prohibition, constitute in themselves the most extensive and illuminating experiment in liquor legislation and social control of the liquor traffic in all history. They are the background of what has taken place since repeal of national prohibition in 1933. (*See* PROHIBITION.)

The post-repeal era began with Executive Order 6474, Dec. 4, 1933, congress not being in session at the time, pursuant to Title I of the National Industrial Recovery act. The order set up the Federal Alcohol Control administration to administer the codes of fair practices for the liquor industry. The codes sought (1) to protect the consumer from false labelling and advertising; (2) to prevent unfair practices such as commercial bribery, control of retail outlets, gifts and prizes to trade or consumer buyers, etc.; (3) to prevent shipments into dry territory in violation of state laws; (4) to prevent sales of distilled spirits in bulk containers; (5) limitation of production and importation to quantity sufficient to meet consumer demands; (6) price control. This lasted until the FACA ceased to function, May 27, 1935, when the NIRA was declared unconstitutional by the supreme court in the Schechter case (295 U.S. 495) but congress continued the same general policy by the Federal Alcohol Administration act in Aug. 1935 (49 Stat. 977, 1935, 27 U.S.C. par. 201ff.) which established the Federal Alcohol administration as a new division in the treasury department. Congress, however, eliminated from the new act the former code provisions with reference to price control, limitation of production and allocation of importations, but it continued and strengthened the basic permit conditioned not only upon observance of fair practices as formerly in the case of the codes but also upon the observance of all federal laws relating to liquor. Thus the FAA has authority to determine who may engage in the liquor business as an importer, distiller, rectifier or wholesaler. Brewers are not included. It enforces the act and regulations thereunder, not only by invoking the penalties imposed for violations but also by revoking or suspending permits for cause after the holder has been notified and given a hearing. The act was amended by the Liquor Administration act of June 26, 1936 (27 U.S.C., Supl. 1940, 201ff.), which abolished the office of administrator and made the FAA an independent agency governed by a three-man board appointed by the president, by and with the advice of the senate; but by Executive Order, April 2, 1940, it was restored to its previous status of a division in the treasury department. The basic permit, considered so essential to the regulation of the character of the industry, the protection of the revenue, and the enforcement of the 21st amendment with its new prohibition of the invasion of the rights of "dry" territory, was upheld by the U.S. court of appeals in the *Arrow* case (109 F., 2d, 397, C.C.A. 7th, 1940) but whether the basic permit, if applied to wholly intrastate transactions, is valid, had not up to 1943 been decided. For full details of federal control as exercised by the alcohol tax unit in charge of a deputy commissioner of internal revenue in the treasury department, since the consolidation of the FAA with this unit in July 1940, *see* John E. O'Neill, "Federal Activity in Alcohol Beverage Control" (*Law and Contemp. Probs.*, Duke University Law School, vol. vii, no. 4, 1940, pp. 570–99).

One of the chief reasons for the breakdown of national prohibition was the unwillingness on the part of the states, and their failure to co-operate with the federal government in its enforcement. Repeal of national prohibition put the problem of liquor control largely back in the hands of the states. Outside of the three states (Kansas, Mississippi and Oklahoma) which in 1943 continued to have state-wide prohibition, all of the 45 others fall under one of two methods of liquor control—monopoly control (17) or licensing control (28). As state-wide or state-administered systems either method is a departure for most of the states. South Carolina in preprohibition days did have a state dispensary, and other southern states made some use of county stores, but elsewhere and where licence prevailed both the licensing and policing of the liquor trade was chiefly a local government matter. In 1943, while the business of manufacturing, distributing, transporting and selling alcoholic beverages was in private hands in the 28 states under licence control, the state exercised control, through licence, in 4 exclusively, in 2 sharing it with the counties, in 6 sharing with the municipalities, and in 15 sharing with counties and municipalities, while in only 1 (Louisiana) the parishes and municipalities rather than the state administered control. In the 17 monopoly states all but one operated retail establishments. Wyoming alone had a monopoly of the wholesale business and left retail business in private hands, but the state, counties and municipalities shared the licensing power. Three others shared that power with the municipalities, and one other, North Carolina, shared it with the counties. In the other 12 states of this group there was exclusive state administration of the control system except in 2 (Alabama and Michigan) where local approval was necessary before the state might issue on-sale licences. Thirty-six states retained some form of local option but 3 of them had no dry areas in July 1942, and 5 more, less than 1%, while North Carolina had 72.7% of its population living in dry areas by local option, and in only 14 states was more than 10% of the population living in dry areas.

The chief aim of state control seems to be to so distribute administrative duties and responsibilities between the state and its local subdivisions, and the state and local police, as to prevent the return of the saloon. Thus three of the licence states prohibit the on-premises sale of spirits, and nine of the monopoly states prohibit such sales by the drink. In general there is a separation of "package" from "on-premises" sale, and the latter is further limited to bona fide restaurants and hotels.

The methods and devices employed in state control to protect the revenue, eliminate the saloon, the bootlegger, and illegal production of alcoholic beverage liquor, to restrict output, unfair trade practices, promotional efforts (undesirable advertising, gifts, prizes, etc., to stimulate demand), and to regulate prices are too numerous to mention here. (Cf. *State Liquor Legislation*, prepared by Marketing Laws Survey, sponsored by U.S. Department of Commerce, WPA, Wash., D.C., 1941, pp. 910; "Alcoholic Beverage Control," in *Law and Contemporary Problems*, vol. 7, no. 4, pp. 600–708, Duke Univ. Law School, 1940.) The public revenue derived from the new liquor legislation was estimated in 1940 to be about $1,500,000,000, 68.5% of which came from federal taxes and import duties. The state governments received 28.8%, and the local governments 2.7%. The per capita return in the 17 monopoly states was about a dollar higher than it was in 27 licence states, though it fluctuated from 0.41 (North Carolina) to 4.79 (Montana) in the monopoly states, and from 0.86 (Arkansas) to 3.28 (New York) in the licence states. Results measured in terms of consumption of alcoholic beverages are a better gauge of the effectiveness of liquor control. Unfortunately the statistics of consumption were in 1943 too incomplete and unreliable for the years since repeal to give a satisfactory basis for judgment even for the prewar years. So many other factors besides liquor laws and their administration such as general economic conditions, price and purchasing power fluctuations, that valid comparison with preprohibition figures are not as significant as they may seem. Culver and Thomas (*State Liquor Administration—A Statutory Analysis*, Univ. of Cal., Berkeley, 1940) estimate that the per capita consumption of distilled spirits and beer in 1938 in the United States was lower than in any year from 1900 to 1917, also that the per capita consumption of distilled spirits in 1938, based on reports from 44 wet states was 1.038 gal.; wine 0.554 gal., based on 40 states; and beer (36 states) 13.81. Later reports of the Distilled Spirits institute, Washington, D.C., give the per capita apparent consumption of distilled spirits for 45 states and the District of Columbia in 1941 as 1.16 gal., and 1942, 1.33. The figures for the separate states show an increase in 44 states and the District of Columbia, varying from 0.1% to 53.5%, and a decrease in only one state of 4.6%. Both sources cited give the gross and per capita figures for the licence and monopoly states separately, but to quote Culver and Thomas (p. 7 *op. cit.* above) "without much more detailed study of other factors affecting consumption no positive statement can be made concerning the relationship of the type of control system to the consumption of alcoholic beverages." Finally it seems from information supplied by Distilled Spirits institute, that the percentage of population in the U.S. under state and local-option prohibition Oct. 1938 was 17.8, and Nov. 1942 was 18.3. (For list of states, both years, and per cent of area "dry" in each, see *Repeal Review*, vol. 7, no. 4, Dec. 1942, p. 23, Repeal Associates, Wash., D.C.)

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LIRA. The Italian name (Lat. *libra*, pound) for a silver coin, the Italian unit of value in the Latin Monetary union, originally corresponding to the French, Swiss and Belgian franc (*q.v.*), and the drachma of Greece, etc. The name is sometimes used of the Turkish pound, *medjidie*. (*See* Italy and Currency.)

LIRI or **GARIGLIANO,** a river of central Italy (anc. *Liris*), which rises at Cappadocia, 7 mi. west of Avezzano, and traverses a beautiful valley between lofty mountains, followed by the railway from Avezzano to Roccasecca. At Isola del Liri are two fine waterfalls. Below Ceprano, the ancient Fregellae, after it has issued from the mountains, the Liri is joined by the Sacco (anc. *Trerus*) formed by the union of several torrents between Palestrina and Segni, and the Melfa from the mountains northeast of Atina, and runs through a broader valley. It then turns through the mountains southwest of the Via Latina and falls into the sea just below Minturno, after a course of 104 mi.

LIROCONITE, a rare mineral consisting of hydrous basic copper and aluminum arsenate, with the probable formula $Cu_9Al_4(OH)_{15}(AsO_4)_5 \cdot 20H_2O$. It crystallizes in the monoclinic system, forming flattened octahedra almost lenticular in shape. Characteristic is the bright sky-blue colour, though sometimes, possibly owing to differences in chemical composition, it is verdigris-green. The colour of the streak or powder is rather paler; hence the name liroconite, from the Gr., λειρός, pale, and κονία, powder. The hardness is $2\frac{1}{2}$, and the specific gravity 2·95. The mineral was found at the beginning of the 19th century in the copper mines near Gwennap in Cornwall, where it was associated with other copper arsenates in the upper, oxidized portions of the lodes.

LISBON (*Lisboa*), the capital of Portugal; on the right bank of the river Tagus, near its entrance into the Atlantic ocean, in 38° 32′ 24″ N. and 9° 11′ 10″ W. Pop. (1930) 594,390; (1940) 709,179. Lisbon, westernmost of European capitals, is built on terraces up the sides of a range of low hills. It fronts the Tagus, and the view from the river of its white houses, and its numerous parks and gardens, is comparable in beauty with the approach to Naples or Constantinople by sea. The lower reaches of the estuary form a channel (Entrada do Tejo) about 2 mi. wide and 8 mi. long, which is partially closed at its mouth by a bar of silt, while the Rada de Lisboa is a tidal lake formed by the broadening of the estuary in its upper part to fill a basin 11 mi. long with an average breadth of nearly 7 mi. Lisbon extends for more than 5 mi. along the shores of both channel and lake, and for more than 3 mi. inland. Its suburbs, which generally terminate in a belt of vineyards, parks or gardens, interspersed with villas and farms, stretch in some cases beyond the inner line of defence 25 m. long, supplementary to the forts and other military works at the mouth of the Tagus, on the heights of Cintra and Alverca, and at Caxias, Sacavem, Monsanto and Ameixoeira. The climate of Lisbon is mild and equable, though somewhat oppressive in summer. Extreme cold is so rare that in the twenty years 1856–1876 snow fell only thrice. The mean annual temperature is 60·1° F, the mean for winter 50·9°, the average rainfall 29·45 in. The water supply is conveyed to the city by two vast aqueducts. The older of these is the Aqueducto das Aguas Livres, which was built in the first half of the 18th century and starts from a point near Bellas, 15 m. W.N.W. It is conveyed across the Alcantara valley through a magnificent viaduct of thirty-five arches, exceeding 200 ft. in height. At the Lisbon end of the aqueduct is the Mãe de Agua (*i.e.,* "Mother of Water"), containing a huge stone hall in the midst of which is the reservoir. The Alviella aqueduct, opened in 1880, brings water from Alviella near Pernes, 70 m. N.N.E.

The four municipal districts (*bairros*) into which Lisbon is divided are the *Alfama,* or old town, in the east; the *Cidade Baixa,* or lower town, which extends inland from the naval arsenal and custom house; the *Bairro Alto,* comprising all the high ground west of the Cidade Baixa; and the *Alcantara,* or westernmost district, named after the small river Alcantara, which flows down into the Tagus. Other names commonly used, though unofficial, are "Lisboa Oriental" as an alternative for Alfama; "Lisboa Occidental" for the slopes which lead from the Cidade Baixa to the Bairro Alto; "Buenos Ayres" (originally so named from the number of its South American residents) for the Bairro Alto southwest of the Estrella Gardens and east of the Necessidades Park; "Campo de Ourique" and "Rato" for the suburbs respectively north-west and north-east of Buenos Ayres.

The Alfama represents Roman and Moorish Lisbon; many of its narrow, steep and winding alleys retain the mediaeval aspect which all other parts of the city have lost; and almost rival the slums of Oporto in picturesque squalor. The most conspicuous feature of the Alfama is the rocky hill surmounted by the Castello de São Jorge, a Moorish citadel which has been converted into a fort and barracks. The Sé Patriarcal, a cathedral founded in 1150 by Alphonso I. was wrecked by an earthquake in 1344 and rebuilt in 1380, but the earthquake of 1755 shattered the dome; the roof and belfry were subsequently burned, and after the work of restoration was completed the choir and façade were the only parts of the 14th-century Gothic church unspoiled. In one of the side chapels is the tomb of St. Vincent (d. 304), patron saint of Lisbon; a pair of ravens kept within the cathedral precincts are popularly believed to be the same birds which, according to the legend, miraculously guided the saint's vessel to the city. The armorial bearings of Lisbon, representing a ship and two ravens, commemorate the legend. Other noteworthy buildings in the Alfama are the 12th-century church of São Vicente de Fóra, originally, as its name implies, "outside" the city; the 13th-century chapel of Nossa Senhora do Monte and the 16th-century church of Nossa Senhora da Graça, which contains a reputed wonder-working statue of Christ and the tomb of Afonso de Albuquerque (1453–1515).

Modern Lisbon.—West of the Alfama the city dates chiefly from the period after the great earthquake. Its lofty houses, arranged in long straight streets, its gardens and open spaces, a few of its public buildings, and almost all its numerous statues and fountains, will bear comparison with those of any European capital. The centre of social and commercial activity is the district which comprises the Praça do Commercio, Rua Augusta, Rocío, and Avenida da Liberdade. The Praça do Commercio, or Terreiro do Paço, is a spacious square, one side of which faces the river, while the other three sides are occupied by the arcaded buildings of the custom house, post office and ministries. In the midst is a bronze equestrian statue of Joseph I., by J. M. de Castro, which was erected in 1775 and gives point to the name of "Black Horse Square" commonly applied to the Praça by the British. A triumphal arch on the north side leads to Rua Augusta, originally intended to be the cloth-merchants' street; for the plan upon which Lisbon was rebuilt after 1755 involved the restriction of each industry to a specified area. This plan succeeded in the neighbouring Rua Aurea and Rua da Prata, still, as their names indicate, famous for goldsmiths' and silversmiths' shops. Rua Augusta terminates on the north in the Rocío or Praça de Dom Pedro Quarto, a square paved with mosaic of a curious undulatory pattern (Rolling Motion Square) and containing two bronze fountains, a lofty pillar surmounted by a statue of Pedro IV., and the royal national theatre (Theatro de Dona Maria Segunda), erected on the site which the Inquisition buildings occupied from 1520 to 1836. The narrow Rua do Principe, leading past the central railway station, a handsome Mauresque building, connects the Rocío with the Avenida da Liberdade, one of the finest avenues in Europe. The central part of the Avenida, a favourite open-air resort of Lisbon society, is used for riding and driving; on each side of it are paved double avenues of trees, with flower-beds, statues, ponds, fountains, etc., and between these and the broad pavements are two roadways for trams and heavy traffic. Thus the Avenida has the appearance of three parallel streets, separated by avenues of trees instead of houses. Its width exceeds 300 ft It owes its name to an obelisk 98 ft. high, erected in 1882 at its southern end, to commemorate the liberation of Portugal from Spanish rule (Dec., 1640). North and north-east of the Avenida are the Avenida Park, the Edward VII. Park (so named in memory of a visit paid to Lisbon by the king of England in 1903), Campo Grande, with its finely wooded walks, and Campo Pequeno, with the bull-ring. Other noteworthy public gardens are the Passeio da Estrella, commanding magnificent views of the city and river, the Largo do Principe Real, planted with bananas and other tropical trees, the Tapada das Necessidades, originally the park of one of the royal residences, and the Botanical Gardens of the polytechnic school, with a fine avenue of palms and collections of tropical and subtropical flora hardly surpassed in Europe. There are large Portuguese cemeteries east and west of Lisbon, and an English cemetery, known also as *Os Cyprestes* from the number of its cypresses. This was laid out in 1717 at the cost of the British and Dutch residents and contains the graves of Henry Fielding (1707–1754), the novelist, and Dr. Philip Doddridge (1702–1751), the Nonconformist divine.

Lisbon is the seat of an archbishop who since 1716 has borne *ex officio* the honorary title of patriarch. The Estrella church, with its white marble dome and twin towers, is visible for many miles above the city. The late Renaissance church of São Roque contains two beautiful chapels dating from the 18th century, one of which is inlaid with painted tiles, while the other was constructed in Rome of coloured marbles, and consecrated by the pope before being shipped to Lisbon. Its mosaics and lapis lazuli pillars are exceptionally fine. The 14th-century Gothic Igreja do Carmo was shattered by the great earthquake. Only the apse, pillared aisles and outer walls remain standing, and the interior has been converted into an archaeological museum. The church of Nossa Senhora da Conceição has a magnificent Manueline façade.

The Palacio das Cortes, in which both Houses of Parliament sit, is a 16th-century Benedictine convent, used for its present purpose since 1834. It contains the national archives, better known as the Torre do Tombo collection, because in 1375 the archives were first stored in a tower of that name. The royal palace, or Paço das Necessidades, west of Buenos Ayres, is a vast 18th-century mansion occupying the site of a chapel dedicated to Nossa Senhora das Necessidades.

Suburbs and Environs.—In the extreme west of Lisbon, beyond the Alcantara valley, are Belem (*i.e.,* "Bethlehem"), beside the Tagus, and Ajuda, on the heights above. The Paço de Belem, built in 1700 for the counts of Aveiro, became the chief royal palace under John V. (1706–1750). The Torre de Belem, on the foreshore, is a small tower of beautiful design, built in 1520 for the protection of shipping. The finest ecclesiastical building in Portugal except the monasteries of Alcobaça and Batalha also fronts the river. It is the Convento dos Jeronymos, a Hieronymite convent and church, founded in 1499 to commemorate the discovery of the sea-route to India by Vasco da Gama. It was built of white limestone by João de Castilho (d. 1581), perhaps the greatest of Manueline architects. Parts of the building have been restored, but the cloisters and the beautiful central gateway remain unspoiled. The interior contains many royal tombs, including that of Catherine of Braganza (d. 1705), the wife of Charles II. of England. The supposed remains of Camoens and Vasco da Gama were interred here in 1880. In 1834, when the convent was secularized, its buildings were assigned to the Casa Pia, an orphanage founded by Maria I. Since 1903 they have contained the archaeological collections of the Portuguese Ethnological Museum. The royal Ajuda palace, begun (1816–1826) by John VI. but left unfinished, derives its name from the chapel of N. S. de Ajuda ("Our Lady of Aid"). In the coach-house there is an unsurpassed collection of state coaches, the cars upon which figures of saints are borne in procession, sedan chairs, old cabriolets and other curious vehicles.

The more important towns, Setubal, Cintra, Torres Vedras and Mafra, are described in separate articles. Sines, a small seaport on Cape Sines, was the birthplace of Vasco da Gama. On the left bank of the Tagus, opposite Lisbon, are the small towns of Almada, Barreiro, Aldeia Gallega and Seixal, and the hamlet of Trafaria, inhabited by fishermen. The beautiful strip of coast west of Oeiras and south of Cape Roca is often called the "Portuguese Riviera." Its fine climate, mineral springs and sea-bathing attract visitors at all seasons to the picturesque fortified bay of Cascaes, or to Estoril, Mont' Estoril and São João do Estoril, consisting chiefly of villas, hotels and gardens. Remarkable progress has been made of recent years at Mont' Estoril, where the thermal springs now have magnificent buildings, with a casino and new hotel; the railway to Lisbon has been electrified. The Boca do Inferno ("Mouth of Hell") is a cavity in the rocks at Cascaes resembling the Bufador at Peñiscola. The villages of Carcavellos, Bucellas, Lumiar and Collares produce excellent wines; at Carcavellos is the receiving station for cables, with a large British staff, and a club and grounds where, as at the new Sports Club nearer Lisbon, social and athletic meetings are held by the British colony. Alhandra, on the right bank of the Tagus, above Lisbon, was the birthplace of Albuquerque; fighting bulls for the Lisbon arena are bred in the adjacent pastures.

Population and Communications.—Lisbon has various railway stations—for the lines to Cintra, northern and central Portugal, Madrid via Valencia de Alcántara; and for southern Portugal and Andalusia. In 1902 the railways north and south of the Tagus were connected near Lisbon by a bridge. In the previous year an extensive system of electric tramways replaced the old-fashioned cable cars and mule trams. Electric and hydraulic lifts are used where the streets are too steep for trams. Lisbon is lighted by both electricity and gas; it has an admirable telephone service, and is connected by the Carcavellos cable-station with Cornwall (England), Brazil, Vigo in Galicia, Gibraltar, the Azores and Madeira. There are extensive quays with hydraulic cranes, graving docks and warehouses on both banks of the river, and Lisbon has long been one of the principal ports of debarcation for passengers from Brazil and of embarcation for emigrants to South America. The fisheries have always been important, and in no European fishmarket is the produce more varied.

The population of Lisbon, 187,404[1] in 1878, rose to 301,206 in 1890, 594,390 in 1930 and 709,179 in 1940. It includes a large foreign colony, composed chiefly of Spaniards, British, Germans, French, Brazilians and immigrants from the Portuguese colonies, among whom are many half-castes. The majority of the Spaniards are domestic servants and labourers from Galicia, whose industry and easily gained knowledge of the kindred Portuguese language enables them to earn a better livelihood here than in their own homes. The British, German and French communities control a large share of the foreign trade. The Brazilians and colonial immigrants are often merchants and landowners who come to the mother-country to spend their fortunes in a congenial social environment.

The street life of the city is full of interest. The bare-footed fishwives (*varinas,* women of Ovar) bearing flat trays of fish on their heads; the Galician water-carriers, with their casks; the bakers, bending beneath a hundredweight of bread slung in a huge basket from their shoulders; the countrymen, with their sombreros, sashes and hardwood quarter-staves, give colour and animation to their surroundings; while the bagpipes played by peasants from the north, the whistles of the knife-grinders, and the distinctive calls of the vendors of fruit, lottery tickets, or oil and vinegar, contribute a babel of sound. For church festivals and holidays the country-folk come to town, the women riding on pillions behind the men, adorned in shawls, aprons and handkerchiefs of scarlet or other vivid hues, and wearing the strings of coins and ornaments of exquisite gold and silver filigree which represent their savings or dowries.

History.—The name Lisbon is a modification of the ancient name *Olisipo,* also written *Ulyssippo* under the influence of a mythical story of a city founded by Odysseus (Ulysses) in Iberia, which, however, according to Strabo, was placed by ancient tradition rather in the mountains of Turdetania (the extreme south of Spain). Under the Romans Olisipo became a *municipium* with the epithet of *Felicitas Julia,* but was inferior in importance to the less ancient *Emerita Augusta* (Mérida). From 407 to 585 it was occupied by Alaric, and thenceforward by the Visigoths until 711, when it was taken by the Moors. Under the Moors the town bore in Arabic the name of *Al Oshbūna* or *Lashbūna.* It was the first point of Muslim Spain attacked by the Normans in 844. When Alphonso I. of Portugal took advantage of the decline and fall of the Almoravid dynasty to incorporate the provinces of Estremadura and Alemtejo in his new kingdom, Lisbon yielded only after a siege of several months (Oct. 21, 1147), in which Alphonso was aided by English and Flemish crusaders on their way to Syria. In 1184 the city was again attacked, unsuccessfully, by the Muslims under the powerful caliph Abu Yakub. In the reign of Ferdinand I., the greater part of the town was burned by the Castilians (1373), and in 1384 they again besieged Lisbon. It became the seat of an archbishop in 1390; the seat of government in 1422. During the 16th century it gained much in wealth and splendour from the establishment of a Portuguese empire in India and Africa. From 1580 to 1640 Lisbon was a provincial town under Spanish rule, and it was from this port that the Spanish Armada sailed in 1588.

For many centuries the city had suffered from earthquakes, and on Nov. 1, 1755, the greater part of it was reduced almost in an instant to a heap of ruins. A tidal wave at the same time broke over the quays and wrecked the shipping in the Tagus; fire broke out to complete the work of destruction; between 10,000 and 20,000 persons lost their lives; and the value of the property destroyed was about £20,000,000. The shock was felt from Scotland to Asia Minor. Careful investigation by Daniel Sharpe, an English geologist, has delimited the area in and near Lisbon to which its full force was confined. Lisbon is built in a geological basin of Tertiary formation, the upper portion of which is loose sand and gravel destitute of organic remains, while below these are the so-called Almada beds of yellow sand, calcareous sandstone and blue clay rich in organic remains. The Tertiary deposits, which altogether cover an area of more than 2,000 sq.m., are separated near Lisbon from rocks of the Secondary epoch by a great sheet of basalt. The uppermost of these Secondary rocks is the hippurite limestone. It was found that buildings on the blue clay were destroyed and those on the Tertiary deposits seriously injured, while those on the hippurite limestone and basalt were undamaged.

The French invasion of Portugal in 1807 caused the removal of the court to Brazil, and the subsequent Peninsular war, loss of Brazil through rebellion, and a period of internal warfare and contest for the throne resulted in a decadence of Lisbon from which it recovered slowly. The city suffered damage during revolutions in 1910, 1915, 1917, 1919 and 1927. After 1939 Lisbon assumed a peculiar importance as one of the last accessible loop-

[1]This figure represents the population of a smaller area than that of modern Lisbon, for the civic boundaries were extended by a decree dated Dec. 23, 1886.

holes of escape from Western Europe. A great number of refugees congregated there, with Portuguese emigration records showing that some 200,000 had passed through her ports in the period Nov. 1939–Aug. 1941. (*See* PORTUGAL: *History*.)

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LISBURN, a market town, urban district and cathedral city of Co. Antrim, Northern Ireland, on the Lagan, 8 mi. S.S.W. of Belfast by rail. Pop. (1937) 13,042. Area, 1.8 sq.mi. In 1627 it was granted by Charles I to Viscount Conway, who built the castle, and introduced English and Welsh settlers. In 1641 the town was set on fire by insurgents. The troops of Cromwell gained a victory near there in 1648, and the castle surrendered in 1650. Christ church (1622) is the cathedral church of the united Protestant dioceses of Down and Connor and Dromore, and has a monument to Jeremy Taylor, bishop of Down and Connor. The staple manufactures are flax spinning, the manufacture of linen and thread and the weaving of damasks and muslins, originally introduced by Huguenots. There is considerable agricultural trade. The ruins of Castle Robin, 2 mi. N. of the town, on a summit of the White mountains, date from the time of Queen Elizabeth. At Drumbo, $3\frac{1}{2}$ mi. E. of Lisburn, is the Giant's Ring, with a dolmen in the centre. Here are also remains of a round tower. The N. Ireland transmitter of the British Broadcasting company is at Blaris, 2 mi. from Lisburn.

LISIEUX, a town of north-western France, capital of an arrondissement in the department of Calvados, 30 mi. E. of Caen by rail. Pop. (1936) 16,032. In the time of Caesar, Lisieux, under the name of *Noviomagus*, was the capital of the Lexovii. Though destroyed by the barbarians, by the 6th century it had become one of the most important towns of Neustria. Its bishopric, suppressed in 1802, dated from that period. In 877 it was pillaged by the Normans; and in 911 was included in the duchy of Normandy by the treaty of St. Clair-sur-Epte. Civil authority was exercised by the bishop as count of the town. In 1136 Geoffrey Plantagenet laid siege to Lisieux, which had taken the side of Stephen of Blois, but before it fell in 1141 both it and the neighbourhood had been reduced to famine. In 1152 the marriage of Henry II. of England to Eleanor of Guienne, which added so largely to his dominions, was celebrated in the cathedral. Thomas à Becket took refuge there, and some vestments used by him are shown in the hospital chapel. Taken by Philip Augustus and reunited to France in 1203, the town was a frequent subject of dispute between the contending parties during the Hundred Years' War, the religious wars, and those of the League.

Lisieux is in the valley of the Touques at its confluence with the Orbiquet. Towers of the 16th century, old fortifications, and streets of houses of the 14th, 15th and 16th centuries, are features. The church of St. Peter, formerly a cathedral, the oldest Gothic church in Normandy is contemporary with the cathedrals of Canterbury and Sens. Begun in the latter half of the 12th it was completed in the 13th and 16th centuries. There is a lantern-tower over the crossing and two towers surmount the west façade. The church of St. Jacques (late 15th century) contains Renaissance glass, some stalls and old frescoes, and a curious picture on wood, restored in 1681. The old episcopal palace is used for civil purposes and contains a beautiful hall (the salle dorée). Lisieux is the seat of a sub-prefect, and has tribunals of first instance and of commerce, a chamber of arts and manufactures, and a board of trade arbitrators. Its manufactures of woollens are important, and bleaching, wool and flax-spinning, tanning, brewing, timber-sawing, metal-founding, and the manufacture of machinery, hosiery and boots and shoes are carried on; there is trade in grain, cattle, cheese and fruit.

LISKEARD, a market town and municipal borough of Cornwall, England, 18 mi. W.N.W. of Plymouth by rail. Pop. (est. 1938) 4,120. Liskeard was at the time of the Domesday Survey an important manor. Richard, king of the Romans, built the manor house or castle and resided there occasionally. In 1240 he constituted Liskeard a free borough and its burgesses freemen with all the liberties enjoyed by the burgesses of Launceston and Helston. In 1266 he granted fairs at the Feasts of the Assumption and St. Matthew. His son in 1275 granted to the burgesses for a yearly rent of £18 the borough in fee farm with its mills, tolls, fines and pleas, pleas of the crown excepted. Liskeard was made a coinage town for tin in 1304. Queen Elizabeth's charter of 1586, was surrendered to Charles II in 1680 and a new one granted by his brother under which the corporation became a self-elected body, and the parliamentary franchise became vested in the corporation and freemen. Sir Edward Coke was returned for this borough in 1620, and Edward Gibbon the historian in 1774. In 1832 Liskeard was deprived of one of its members and in 1885 it became merged in the county. Liskeard manufactures woollen goods, and there are small iron foundries. The public library contains the Leonard Courtney collection of rare Cornish books. Area of borough, 4.2 sq.mi.

LISLE, ALICE (*c.* 1614–1685), commonly known as Lady Alice Lisle, was born about 1614, and married John Lisle (d. 1664), a member of Cromwell's House of Lords. On July 20, 1685, a fortnight after the battle of Sedgemoor, the old lady consented to shelter John Hickes, a well-known Nonconformist minister, at her residence, Moyles court, near Ringwood. Hickes, who was a fugitive from Monmouth's army, brought with him Richard Nelthorpe, also a partisan of Monmouth, and under sentence of outlawry. The two men passed the night at Moyles court, and on the following morning were arrested, and their hostess, who had denied their presence in the house, was charged with harbouring traitors. Her case was tried by Judge Jeffreys at the opening of the "Bloody Assizes" at Winchester. She pleaded that she had no knowledge that Hickes's offence was anything more serious than illegal preaching, that she had known nothing previously of Nelthorpe (whose name was not included in the indictment, but was, nevertheless, mentioned to strengthen the case for the Crown), and that she had no sympathy with the rebellion. The jury reluctantly found her guilty, and, the law recognizing no distinction between principals and accessories in treason, she was sentenced to be burned. James II. allowed beheading to be substituted for burning. Lady Lisle was executed in Winchester market-place on Sept. 2, 1685. One of the first acts of parliament of William and Mary reversed the attainder on the ground that the prosecution was irregular and the verdict injuriously extorted by "the menaces and violences and other illegal practices" of Jeffreys.

See Howell, *State Trials;* H. B. Irving, *Life of Judge Jeffreys;* Stephen, *History of the Criminal Law of England.*

LISMORE, an island in the entrance to Loch Linnhe, Argyllshire, Scotland, 5 mi. N.W. of Oban, $9\frac{1}{2}$ mi. long and $1\frac{3}{4}$ mi. broad. Pop. (1931) 280. It divides the lower end of the loch into two channels, the Lynn of Morvern on the west and the Lynn of Lorne on the east. The name is derived from the Gaelic *lios mòr*, "great garden," from the fertility of the soil. Several ruined castles stand on the coast, and the highest point is 500 ft. Oats, potatoes and lime are exported. Steamers call at Achnacroish, and there is a ferry to Port Appin. A Columban monastery was founded in Lismore by St. Moluag about 592. About 1200 the see of Argyll was separated from Dunkeld by Bishop John, "the Englishman," and Lismore soon afterwards became the seat of the bishop of Argyll. The small cathedral has been restored, and is used as the parish church. The Rev. John Macaulay, grandfather of Lord Macaulay, and the Rev. Donald M'Nicol (1735–1802), who took up the defense of the Highlands against Dr. Johnson, were ministers of Lismore.

LISMORE, a town in the northeast of New South Wales, Australia, situated on the Richmond river (*q.v.*), 65 mi. from its mouth at Ballina and 22 mi. from the same town by road. Coal occurs in the neighbourhood and the timber reserves were formerly largely exploited. Lismore is the centre of the chief dairy district of the state (av. ann. temps.: 76°–57.6° F; av. ann. rainfall: 34.5 in.), with butter factories which export to the

United Kingdom. The growing of sugar cane, after a decline, has recovered ground.

The town is well built, lies on the main North Coast railway (Sydney and Brisbane), has local branch lines (Ballina, etc.); also connections by motor coach with the northern highlands (Tenterfield, etc.), and, by river steamer, with Ballina and the sea (coastal trade). Pop. (1933), 11,762.

LISMORE, a market town and seat of a diocese in Co. Waterford, Eire, 43 mi. W.S.W. of Waterford by rail. Pop. (1936) 1,194. It is situated on a hill rising steeply from the Blackwater.

The original name of Lismore was Maghsciath. A monastery founded here by St. Carthagh in 633 became celebrated as a seat of learning. The bishopric, said to have originated with this foundation, was united to that of Waterford in 1363. In the 9th and beginning of the 10th centuries the town was repeatedly plundered by the Danes, and in 978 the town and abbey were burned by the men of Ossory. Henry II. received in Lismore castle the allegiance of the archbishops and bishops of Ireland. In 1581 the manor was granted to Sir Walter Raleigh. It was incorporated as a municipal borough in the time of Charles I. In 1800 it ceased to exercise its municipal functions.

The baronial castle, erected by John in 1185, was the residence of the bishops till the 14th century. It was besieged in 1641 and 1643, and in 1645 it was partly destroyed by fire. On the summit of the height is the cathedral of St. Carthagh; portions are probably of the 12th and 13th centuries, but the bulk of the building is of the 17th century, and considerable additions were made in the 19th. There is some river trade and the town is the centre of a salmon fishery district.

LISSA (Serbo-Croatian *Vis;* Lat. *Issa*), an island in the Adriatic sea belonging to Yugoslavia and occupied by Italy in World War II. Lissa lies 31 mi. S. by W. of Spalato, and is the outermost island of the Dalmatian Archipelago. Its greatest length is 10½ mi.; its greatest breadth 4½ mi. In shape it is long, as are most of the islands on this longitudinal coastline. The central plain is fertile. Its culminating point is Mount Hum (1,942 ft.), on the southwest. Lissa, the capital, contains the palace of the old Venetian counts Gariboldi, the former residence of the English governor, the monastery of the Minorites and at a little distance to the west the ruins of the ancient city of Issa.

Lissa is said to have been settled by people from Lesbos, the Issa of the Aegean. The Parians, assisted by Dionysius the Elder of Syracuse, introduced a colony in the 4th century B.C. During the First Punic War (265–241 B.C.) the Issaeans with their beaked ships helped the Roman Duilius; and the great republic, having defended their island against the attacks of Agron of Illyria and his queen Teuta, again found them serviceable allies in the war with Philip of Macedon (*c.* 215–211). As early as 996 the Venetians ruled the island, and, though they retired for a time before the Ragusans, their power was effectually established in 1278. Velo Selo, then the chief settlement, was destroyed by Ferdinand of Naples in 1483 and by the Turks in 1571. The present city arose shortly afterwards. During the Napoleonic wars, the French held Lissa until 1811, and during this period the island prospered greatly, its population increasing from 4,000 to 12,000 between 1808 and 1811. In the latter year the French squadron was defeated by the British (*see* below). In 1812 the British established an administrative system, under native officials, in Lissa and the adjoining islands of Curzola and Lagosta. All three were ceded to Austria in 1815. The islanders gain their livelihood by viticulture, for which Issa was once famous, by sardine fishing and by the distillation of rosemary oil. Pop. about 10,100. After World War I Lissa passed to Yugoslavia.

Battles of Lissa.—Two naval actions have been fought in modern times near this island. The first took place on the 13th of March 1811, and was fought between a Franco-Venetian squadron, under the command of an officer named Dubourdieu (of whom little or nothing else is known), and Captain (afterwards Sir) William Hoste with a small British force. The Franco-Venetian squadron (Venice was then part of the dominions of the emperor Napoleon) consisted of six frigates, of which four were of forty guns, and of five corvettes or small craft. The British squadron was composed of three frigates, the "Amphion," 32 (Captain William Hoste), the "Cerberus" (Captain Henry Whitby) and the "Active," 38 (Captain James A. Gordon). With them was the "Volage," 22 (Captain Phipps Hornby). The action has a peculiar interest because the French captain imitated the method of attack employed by Nelson at Trafalgar. He came down from windward in two lines parallel to one another, and at an angle to the British squadron. Captain Hoste was not compelled to lie still as the allies did at Trafalgar. He stood on, and as the two French lines had to overtake him as he slipped away at an angle to their course, one of them got in the way of the other. Captain Hoste materially forwarded the success of his manoeuvre by leading the foremost French ship, the "Favorite," 40, on to a reef, which was known to himself, but not to the enemy. Both squadrons then turned, and the Franco-Venetians falling into great confusion were defeated in spite of the gallant fighting of the individual ships. Two prizes were taken and Dubourdieu was killed.

The second naval battle of Lissa was fought between the Austrian and Italian navies on the 20th of July 1866. The island, then in possession of the Austrians, was attacked by an Italian squadron from Ancona of 12 ironclads and 22 wooden vessels. One of the ironclads was damaged in a bombardment of the forts, and two were detached on other service, when an Austrian squadron of 7 ironclads, one unarmoured warship the "Kaiser" and a number of small craft which had left Fasano under the command of Admiral Tegethoff came to interrupt their operations. The Italian admiral Persano arranged his ships in a single long line ahead, which allowing for the necessary space between them meant that the Italian formation stretched for more than 2 m. Just before the action began Admiral Persano shifted his flag from the "Re d'Italia," the fourth ship in order from the van, to the ram "Affondatore," the fifth. This made it necessary for the "Affondatore" and the ships astern to shorten speed, and, as the leading vessels stood on, a gap was created in the Italian line. Admiral Tegethoff, who was on the port bow of the Italians, attacked with his squadron in three divisions formed in obtuse angles. The Italians opened a very rapid and ill-directed fire at a distance of 1,000 yds. The Austrians did not reply till they were at a distance of 300 yds. Under Tegethoff's vigorous leadership, and aided by the disorder in the Italian line, the Austrians brought on a brief, but to the Italians destructive, mêlée. They broke through an interval between the third and fourth Italian ships. The unarmed Austrian ships headed to attack the unarmed Italians in the rear. At this point an incident occurred to which an exaggerated importance was given. The Italian ironclad "Re di Portogallo" of 5,600 tons, in the rear of the line, stood out to cover the unarmoured squadron by ramming the Austrians. She was herself rammed by the wooden "Kaiser" (5,000 tons), but received little injury, while the Austrian was much injured. The "Kaiser" and the wooden vessels then made for the protection of fort San Giorgio on Lissa unpursued. In the centre, where the action was hottest, the Austrian flagship "Ferdinand Max" of 5,200 tons rammed and sank the "Re d'Italia." The Italian "Palestro" of 2,000 tons was fired by a shell and blew up. By midday the Italians were in retreat, and Tegethoff anchored at San Giorgio. His squadron had suffered very little from the wild fire of the Italians. The battle of July 20 was the first fought at sea by modern ironclad steam fleets, and therefore, attracted a great deal of attention. The sinking of the "Re d'Italia" and the ramming of the "Portogallo" by the "Kaiser" gave an immense impulse to the then popular theory that the ram would be a leading, if not the principal, weapon in modern sea warfare. This calculation has not been borne out by more recent experience, and indeed was not justified by the battle itself, in which the attempts to ram were many and the successes very few. The "Re d'Italia" was struck only because she was suddenly and most injudiciously backed, so that she had no way on when charged by the "Ferdinand Max."

For the first battle of Lissa *see* James's *Naval History,* vol. v. (1837). A clear account of the second battle will be found in Sir S

Eardley-Wilmot's *Development of Navies* (London, 1892); *see* also H. W. Wilson's *Ironclads in Action* (London, 1896). (D. H.)

LISSA: *see* LESZNO.

LIST, FRIEDRICH (1789–1846), German economist, was born at Reutlingen, Württemberg, on Aug. 6, 1789. Unwilling to follow the occupation of his father, who was a tanner, he became a clerk in the public service, and by 1816 had risen to the post of ministerial under-secretary. In 1817 he was appointed professor of administration and politics at the university of Tübingen, but the fall of the ministry in 1819 compelled him to resign. As a deputy to the Württemberg chamber, he was active in advocating administrative reforms. He was eventually expelled from the chamber and in April 1822 sentenced to ten months' imprisonment from which he was released on promising to emigrate to America, where he lived from 1825 to 1832. Successful both as a journalist and as a speculator in coal and railways, he was employed on a mission to Paris and in 1832 became United States consul at Leipzig.

He strongly advocated the extension of the railway system in Germany, and the establishment of the *Zollverein* was due largely to his enthusiasm and ardour. Ill health and financial difficulties darkened his later days, and on Nov. 30, 1846, he died by his own hand.

List holds historically one of the highest places in economic thought as applied to practical objects. His principal work is entitled *Das Nationale System der Politischen Ökonomie* (1841). Though his practical conclusions were different from those of Adam Müller (1779–1829), he was largely influenced both by him and Alexander Hamilton. It was particularly against the cosmopolitan principle in the modern economical system that he protested, and against the absolute doctrine of free trade, which was in harmony with that principle. He gave prominence to the national idea, and insisted on the special requirements of each nation according to its circumstances and degree of development.

He refused to Smith's system the title of the industrial, which he thought more appropriate to the mercantile system, and designated the former as "the exchange-value system." He denied the parallelism asserted by Smith between the economic conduct proper to an individual and to a nation, and held that the immediate private interest of the separate members of the community would not lead to the highest good of the whole. He maintained that national unity, which is the result of past development, is necessary to the individual whose interests should be subordinated to the preservation of this unity. The nation having a continuous life, its true wealth must consist—and this is List's fundamental doctrine—not in the quantity of exchange-values which it possesses, but in the full and many-sided development of its productive powers. Its economic education should be more important than the immediate production of values, and it might be right that one generation should sacrifice its gain and enjoyment to secure the strength and skill of the future. In the sound and normal condition of a nation which has attained economic maturity, the three productive powers of agriculture, manufactures and commerce should be alike developed. But the two latter factors are superior in importance, as exercising a more effective and fruitful influence on the whole culture of the nation, as well as on its independence. But for the growth of the higher forms of industry, only those countries of the temperate zones are adapted, while the torrid regions have a natural monopoly in the production of certain raw materials; and thus between these two groups a division of labour spontaneously takes place.

List then goes on to explain his theory of the stages of economic development through which the nations of the temperate zone naturally pass, in advancing to their normal economic state. These are (1) pastoral life, (2) agriculture, (3) agriculture united with manufactures; while in the final stage agriculture, manufactures and commerce are combined. The economic task of the state is to bring into existence through legislative and administrative action the conditions required for the progress of the nation through these stages. Out of this view arises List's scheme of industrial politics. Every nation should begin by fostering its agriculture by free trade and when it is economically so far advanced that it can manufacture for itself, a system of protection should be employed to allow the home industries to develop themselves fully. When the national industries have grown sufficiently strong, the highest stage of progress has been reached; free trade should again become the rule, and the nation be incorporated with the universal industrial union. What a nation loses for a time in exchange values during the protective period she gains in the long run in productive power. The practical conclusion which List drew for Germany was that she needed for her economic progress an extended and conveniently bounded territory reaching to the seacoast both on north and south, and a vigorous expansion of manufactures and commerce, and that the way to the latter lay through protective legislation with a customs union comprising all German lands, and a German marine with a Navigation act. List ably represented the tendencies and demands of his time in his own country; his work had the effect of fixing the attention, not merely of the speculative and official classes, but of practical men generally, on questions of political economy; and his ideas were undoubtedly the economic foundation of modern Germany, as applied by the practical genius of Bismarck.

See biographies of List by Goldschmidt (Berlin, 1878), Jentsch (Berlin, 1901) and Hoeltrel (1910); M. E. Hirst, *Life of Friedrich List* (London, 1909) contains a bibliography and a reprint of List's *Outlines of American Political Economy* (1827). *See* also the article by Eheberg in *Handwörterbuch der Staatswissenschaften* vol. vi. (4th ed., 1925).

LISTA Y ARAGON, ALBERTO (1775–1848), Spanish poet, critic and mathematician, was born in Triana, a suburb of Seville Oct. 15, 1775. As a youth he showed unusual mathematical talent, and at the age of twenty he was made professor of mathematics in a nautical college in Seville. He distinguished himself as a poet and critic and was appointed to the chair of rhetoric and poetry in the university of Seville in 1807.

During the French invasion he was exiled in France, where he remained for four years. Among his many published works were, *Lectures on the Dramatic Literature of Spain,* and a *Treatise on Pure and Mixed Mathematics,* which was long considered a standard work. He died on Oct. 15, 1848.

LISTED SECURITIES, securities which have been examined, approved and listed, or admitted for trading, on one of the stock exchanges. Before a security can be listed on an exchange the issuing company must be investigated by a committee of the exchange and must meet many requirements. Each exchange has its own requirements for listing but those of the New York Stock exchange, although more rigid than others, may be taken as representative. The "Committee on Stock List" examines and acts upon the applications for listing but its findings may be reviewed by the governing committee of the exchange. The reason for the investigation of securities and the listing of only those desired is to place upon the exchange only sound securities concerning which there is available sufficient information to permit intelligent analysis and trading. Securities of new and untried corporations are not accepted, and in order to have its securities accepted for listing a company must have operated long enough to establish a satisfactory character and an earning capacity. Corporations with listed securities must publish their balance sheets, statements of earnings, announcements of directors' meetings, and notices of closing and opening of books. It is also required that the listed issues be large and widely held. The fact that a security is listed on an exchange must not, however, be taken as a guarantee of any kind. It does not give assurance that market prices will not decline, that stock will pay dividends, that bonds will pay interest, or be paid at maturity. (J. H. B.)

LISTER, JOSEPH LISTER, 1ST BARON (1827–1912), English surgeon and founder of antiseptic surgery, was born at Upton, Essex, on April 5, 1827. His father, Joseph Jackson Lister, F.R.S., became eminent in optical science by perfecting the achromatic lens and improving the compound microscope. Joseph Lister was educated at the Quaker schools at Hitchin and at Tottenham, and then at University college, London. He received his M.B. and F.R.C.S. in 1852, having been trained under the two noted physiologists, Wharton Jones and William Sharpey. In the autumn of 1853, Lister went to Edinburgh with an introduction from Sharpey to Syme (*q.v.*) whose house surgeon he became. In 1856 he married Syme's daughter, and soon afterwards was made assistant surgeon to the Royal infirmary, where he gave his first course of lectures on surgery. In the following year he produced his classic paper on "The Early Stages of Inflammation," an investigation in which his interests had already been roused by his contact with gangrene and pyaemia in University college hospital, London. About the same time, he began work on the coagulation of blood, a subject related to the early stages of inflammation. In his Croonian lecture to the Royal Society in 1863 on this topic, he concluded that the real cause of coagulation of the blood is "the influence exerted upon it by ordinary matter, the contact of which for a very brief period effects a change in the blood, inducing a mutual reaction between its solid and fluid constituents, in which the corpuscles impart to the liquor sanguinis a disposition to coagulate."

On his appointment to the chair of surgery at Glasgow in 1860, Lister at first busied himself with his articles on amputation and on anaesthetics for Holmes' *System of Surgery.* He then resumed his researches on inflammation, his suspicion that decomposition of the blood in the wound was the main cause of suppuration taking on a new meaning after his attention was drawn in 1865 to the work of Pasteur by his colleague, Dr. Thomas Anderson. Pasteur (*q.v.*) had shown that putrefaction, like other fermentations, was due to microbes growing in the putrescible substance and coming from the air. Lister at once saw that if putrefaction was caused neither by the spontaneous generation of germs nor by the oxygen in the air—two predominating theories of his day—there was some chance of preventing it. But how were the organisms in the air to be destroyed before they entered the wound? Of three possibilities, filtration, heat and chemical agents, he selected the last for experiment.

The first experiment was made in 1865 upon a compound fracture, the agent used being carbolic acid. It was applied to the wound undiluted, so as to form with the blood a dense crust, the surface of which was painted daily with the acid until all danger had passed. The results, after a first failure, were so satisfactory that Lister wrote his paper, "On a New Method of treating Compound Fracture, Abscess, etc.," for the *Lancet* between March and July 1867, and at the British Association in Dublin, in the same year, spoke of the value of his methods. However, the caustic property of undiluted carbolic acid, though insignificant in comparison with the evils to be avoided in compound fracture, made it unsuited for general surgery. It was necessary to mitigate its action by blending it with some inert substance, and the endeavour to find this substance which would provide perfect antiseptic efficiency with the least possible irritation of the tissues formed the subject of experiments continued for many years. Lister found the lac plaster to be most satisfactory. It was a mixture of crystallized carbolic acid and shellac which, when spread on calico and painted with a solution of gutta-percha in benzine, passed through the gutta-percha without adhering to the skin so firmly as to prevent drainage.

Lister now turned his attention to the arrest of haemorrhage in aseptic wounds. It had long been the practice to employ silk or flax for tying arteries, long ends being left to provide escape of the pus together with the portion of the arterial coats included in the knot. Lister hoped that if, by antiseptic means, the thread were deprived of microbes, it would no longer cause suppuration, but might be left with short cut ends to become embedded permanently among the tissues of the wound, which thus would be allowed to heal by first intention. In Dec. 1867 a trial of carbolized silk ligature was so successful that he applied it in a case of femoral aneurysm in a woman. Here again the results were satisfactory. But a year later, the patient having died from other causes, the necropsy showed remnants of the silk incompletely absorbed, with appearances which seemed to indicate that they had been acting as causes of disturbance. Thus he began to seek for a material susceptible of more speedy absorption. He experimented upon the carotid artery of a calf with carbolized catgut, a substance prepared from the small intestine of a sheep. Here again success warranted its use for human subjects, but the difficulty of ensuring its right preparation led him to adopt ultimately a sulphochromic catgut.

In 1869 Lister succeeded his father-in-law, Syme, in the chair of clinical surgery of Edinburgh. There his chief accomplishments were his researches in bacteriology, his substitution of the dressings of absorbent gauze for the non-absorbing lac plaster and his attempt to provide an atmosphere free from microbes by means of a spray of a 1–20 watery solution of carbolic acid. The efficacy of this famous spray, which was used all over the continent, was questioned by Bruns of Tübingen in his paper, *Fort mit dem Spray* of 1880, and Lister himself was beginning to be dubious about the harmfulness of atmospheric dust. At the London Congress in 1881, he narrated experiments which proved both that the serum of the blood is unfavourable for the development of the bacteria swarming in the air and that the cells of an organizing blood-clot have a remarkable power of disposing of microbes and of limiting their advance. Finally, in 1887, Lister abandoned the spray, having come to the conclusion that the air might be disregarded in operations. The spray had served the purpose of maintaining a pure condition of the *entourage* of the operation, and Lister now had to emphasize the necessity for redoubled vigilance on the part of the surgeon and his assistants when his "unconscious caretaker," as he called it, was disregarded.

The relation of Ignaz Semmelweiss, the Hungarian physician, to Lister is of historical importance. Long after Lister's first publication on the antiseptic system (1867) Semmelweiss was unknown or ignored. The French academy pronounced against his opinions as did the highest pathological authority in Germany. In the early 70s Lister's method was in full operation in Hungary as elsewhere, yet none of the surgeons of Budapest ever mentioned Semmelweiss, not even when they gave a great banquet to Lister in 1883. It was after this occasion that Dr. Duka, a Hungarian physician practising in London, wrote a biography of Semmelweiss, which he sent to Lister. Thenceforth Lister regarded Semmelweiss as in some measure his forerunner, though the Hungarian was not aware of the microbic origin of septic poisons, nor were his methods suitable for surgical work.

In 1877 Lister accepted the chair of surgery at King's college, London, which he held for 15 years. While there, the publication of Koch's book on the etiology of traumatic infectious diseases led him to experiment with various mercurial preparations, until he finally adopted a double cyanide of mercury and zinc. In 1896 he retired from practice, but not from scientific study. From 1895 to 1900 he was president of the Royal Society, and in 1896 president of the British Association. In 1883 he was created a baronet, and in 1897 was raised to the peerage as Baron Lister of Lyme Regis. Among the Coronation honours in 1902, he was nominated an original member of the new Order of Merit. He died at Walmer, Kent, on Feb. 10, 1912. The best monument to Lister is the Lister Institute of Preventive Medicine, London—of which he was one of the founders at its inception as the British Institute of Preventive Medicine in 1891. It was modelled on the Pasteur institute in Paris. On the continent he was even more renowned, the German surgeons, especially Thiersch and Volkmann, being the first to adopt his ligature technique and his aseptic treatment, which had banished for ever the prevalent surgical pests—pyaemia, septicaemia, erysipelas and hospital gangrene. Among Lister's contributions to general surgery, Godlee (*see* below) mentions his new amputation through the condyles of the femur, his new operation for excision of the wrist joint and for carcinoma of the breast, his improved surgery of the bladder and urethra and his introduction of such instruments as the aortic tourniquet, the wire needle, the ear hook, the sinus forceps, the urethral bougies and the forceps for extracting stones from the prostatic urethra.

See Lister's *Collected Papers,* 2 vols. (Oxford, 1909); R. J. Godlee, *Lord Lister* (Oxford, 1924); W. Cheyne, *Lister and his Achievement* (1925); and A. Turner, *Joseph, Baron Lister,* centenary vol. (Edinburgh, 1927).

LISTER, JOSEPH JACKSON (1786–1869), English scientist and father of Joseph Lister, was born in London, Jan. 11, 1786. He had only a few years of formal schooling, but even after he no longer attended classes he was diligent in educating himself. He became a wine merchant by trade, taking over his father's shop, but his interest lay in lenses even as a child, and in 1824 he began the work on the compound microscope which was to be his chief contribution to science. In 1830, in a paper, "On the Improvement of Compound Microscopes," which he read before the Royal society, he made public the results of six years' work on the microscope. During that time he had discovered the principle of aplanatic foci, which enabled him to outline to W. Tulley, a noted optician, the methods for constructing a powerful achromatic microscope which would transmit images with almost no distortion. It was excessive distortion of the image which had previously prevented the microscope from taking its proper place in scientific research.

In addition to his work with the microscope, Lister made important studies on mammalian blood and invented the photographer's tripod. He died in Upton, Essex, Oct. 24, 1869.

LISTER, MARTIN (*c.* 1638–1712), English naturalist and physician, was born at Radclive, near Buckingham. He was educated at St. John's college, Cambridge, graduating in 1658–59. He was elected a fellow in 1660 and became F.R.S. in 1671. He practised medicine at York until 1683, when he removed to London. In 1684 he received the degree of M.D. at Oxford and in 1687 became F.R.C.P. He contributed numerous articles on natural history, medicine and antiquities to the *Philosophical Transactions*. His principal works were *Historiae animalium Angliae tres tractatus* (1678); *Historiae Conchyliorum* (1685–92); and *Conchyliorum Bivalvium* (1696).

As a conchologist he was held in high esteem, but while he recognized the similarity of fossil mollusca to living forms, he regarded them as inorganic imitations produced in the rocks. In 1683 he communicated to the Royal society (*Phil. Trans.*, 1684), *An ingenious proposal for a new sort of maps of countries; together with tables of sands and clays, such as are chiefly found in the north parts of England*. In this essay he suggested the preparation of a soil or mineral map of the country, and thereby is credited with being the first to realize the importance of a geological survey. He died at Epsom, Feb. 2, 1712.

LISTER, THOMAS HENRY (1800–1842), English author, was educated at Cambridge university. He held several minor government positions until 1836, when he was made the first registrar-general of births, deaths and marriages of England and Wales, the office having just been created. His best-known literary work was his novel *Granby* (1826), which was well thought of in the early 19th century. He was also the author of six other novels, *Herbert Lacy, Romance of Real Life, Flirtation, Yes and No, Arlington* and *Hulse House;* a play, *Epicharis;* and a biography, *The Life and Administration of Edward, First Earl of Clarendon, with Original Correspondence and Authentic Papers never before published*. He died June 5, 1842, at Knightsbridge.

LISTON, JOHN (*c.* 1776–1846), English actor, was born in Soho, London. He attended school in Soho and for a time taught school but soon turned to the stage, making his public debut at Weymouth as Lord Duberley in *The Heir-at-law*. At first he played serious roles, some of them in support of Mrs. Siddons, but he was badly fitted for them and was far from successful. After he joined Stephen Kemble, however, he began to play low comedy parts and it was in them that he gained his reputation, especially in the representation of old men and country boys. An introduction to Charles Kemble led to his appearance at the Haymarket in 1805 as Sheepface in *The Village Lawyer*, and his association with this theatre continued almost uninterruptedly until 1830. He also performed during his lifetime at Covent Garden, Drury Lane and the Olympic theatre, retiring from the stage in 1837.

Liston played numerous Shakespearean comedy parts, but his best role is almost universally considered to be the part of Paul Pry in John Poole's play of that name. During his last years Liston's mind failed, and he died in London, March 22, 1846. There is some disagreement as to whether he was a real comedian or merely a buffoon, but he was indisputably the most successful comic actor of his day.

LISTON, ROBERT (1794–1847), Scottish surgeon, was born at Ecclesmachan, Linlithgow, Scotland, Oct. 28, 1794. His elementary education was given him by his father, after which he studied at the University of Edinburgh, starting medical work in 1810 under the noted anatomist, John Barclay. Beginning in 1815, he held a number of positions in hospitals, taught anatomy for a time in Edinburgh and in 1827, after some difficulty caused by his tactless methods of criticizing the policies of the Royal infirmary in Edinburgh, was made one of the surgeons to the infirmary.

In 1834 he left Edinburgh for London, becoming shortly after his arrival professor of clinical surgery in University college, University of London, and a surgeon of the North London hospital. He was placed on the council of the Royal College of Surgeons in 1840 and six years later was chosen one of its examiners. He died in London, Dec. 7, 1847.

Liston was an exceptionally skilful surgeon and was famous for the speed and proficiency with which he performed difficult operations never before attempted. He was the inventor of many operative procedures which later became standard surgical technique, and he is particularly noted for the thigh splint which bears his name. In addition to articles in medical journals, he was the author of *Principles of Surgery* (1831–32) and *Practical Surgery* (1837).

LISU (LISAW, YAWYIN), a tribe inhabiting the Salween valley in northern Burma, believed to have migrated southward from the Tibeto-Chinese borders, and still in a migratory condition. They belong to the group called *protomorphus* by Haddon, otherwise described as having Caucasian affinities. They are divided into clans with names suggesting totemism, *e.g.*, fish-, bee-, hemp-people. Some customs suggest Indonesian affinities, viz., spirit- and ancestor-worship; burial in the fields; use of bark or leather cuirasses. They keep hunting dogs, use cross-bows with poisoned arrows and cultivate maize and buckwheat. Houses are built on the ground. The men wear short hair or pigtail, the women two plaits or horns over the ears.

See Litton, *Report on Upper Salween* (Rangoon, 1906); Enriquez, *A Burmese Arcady* (1923). (J. H. H.)

LISZT, FRANZ (1811–1886), Hungarian pianist and composer, was born on Oct. 22, 1811, at Raiding, Hungary. His appeal to musicians was made in a threefold capacity, and we have, therefore, to deal with Liszt, the unrivalled pianoforte virtuoso (1830–48); Liszt, the conductor of the "music of the future," at Weimar, the teacher of Taussig, Bülow and a host of lesser pianists, the eloquent writer on music and musicians, the champion of Berlioz and Wagner (1848–61); and Liszt the prolific composer, who for some 35 years continued to put forth pianoforte pieces, songs, symphonic orchestral pieces, cantatas, masses, psalms and oratorios (1847–82). As virtuoso he held his own for the entire period during which he chose to appear in public; but the militant conductor and prophet of Wagner had a hard time of it; and the composer's place is still in dispute.

Liszt's father, a clerk to the agent of the Esterhazy estates and an amateur musician of some attainment, was Hungarian by birth and ancestry, his mother an Austrian-German. The boy's gifts attracted the attention of certain Hungarian magnates, who furnished 600 gulden annually for some years to enable him to study music at Vienna and Paris. At Vienna he had lessons in pianoforte, playing from Karl Czerny of "Velocity" fame, and from Salieri in harmony and analysis of scores. In his 11th year he began to play in public there, and Beethoven came to his second concert in April 1823. During the three years following he played in Paris, the French provinces and Switzerland, and paid three visits to England. In Paris he had composition lessons from Paër, and a six months' course of lessons in counterpoint from Reicha. In the autumn of 1825 the handsome and fascinating *enfant gâté* of the salons and ateliers—"La Neuvième Merveille du monde"—had the luck to get an operetta (*Don Sancho*) performed three times at the Académie Royale. The score was accidentally destroyed by fire, but a set of studies *à la* Czerny and Cramer, belonging to 1826 and published at Marseille as 12 Études, op. i, is extant and shows remarkable precocity. After the death of his father in 1828 young Liszt gave pianoforte lessons in Paris, got through a good deal of miscellaneous reading and felt the influence of the religious, literary and political aspirations of the time. He attended the meetings of the Saint-Simonists, lent an ear to the romantic mysticism of Père Enfantin and later to the teaching of Abbé Lamennais. He also played Beethoven and Weber in public—a very courageous thing in those days.

The appearance of the violinist Paganini in Paris, 1831, marks the starting point of the supreme eminence Liszt ultimately attained as a virtuoso. Paganini's marvellous technique inspired him to practise as no pianist had ever practised before. He tried to find equivalents for Paganini's effects, transcribed his violin caprices for the piano and perfected his own technique. After Paganini he received a fresh impulse from the playing and the compositions of Chopin, who arrived in 1831, and yet another impulse of equal force from a performance of Berlioz's *Symphonie Fantastique, épisode de la vie d'un artiste,* in 1832. Liszt transcribed this work, and its influence ultimately led him to the composition of his "Poèmes symphoniques" and other examples of orchestral program music.

From 1833 to 1848—when, with characteristic indifference to material considerations, he gave up playing in public—he was the prince of pianists. Five years (1835–40) were spent in Switzerland and Italy, in semi-retirement in the company of the comtesse d'Agoult (*q.v.*), by whom he had three children, one of them afterward Frau Cosima Wagner. These years were devoted to further study and were interrupted only by occasional appearances at Geneva, Milan, Florence and Rome and by annual visits to Paris, when a famous contest with Thalberg took place in 1837. The enthusiasm aroused by Liszt's playing and his personality—the two are inseparable—reached a climax at Vienna and Budapest in 1839–40, when he received a patent of nobility from the emperor of Austria and a sword of honour from the magnates of Hungary in the name of the nation. During the eight years following he was heard at all the principal European centres. He gained much money and gave large sums in charity. His munificence with regard to the Beethoven statue at Bonn made a great stir. The monument was completed at his expense and unveiled at a musical festival conducted by Spohr and himself in 1845.

In 1848 he settled at Weimar with Princess Sayn-Wittgenstein (d. 1887), and remained there till 1861. During this period he acted as conductor at court concerts and on special occasions at the theatre, gave lessons to a number of pianists, wrote articles of permanent value on certain works of Berlioz and the early operas of Wagner and produced those orchestral and choral pieces upon which his reputation as a composer mainly depends. His efforts on behalf of Wagner, then an exile in Switzerland, culminated in the first performance of *Lohengrin* on Aug. 28, 1850. Among other works produced during this period for the first time or revived with a view to the furtherance of musical art were Wagner's *Tannhäuser, Der fliegende Holländer, Das Liebesmahl der Apostel,* and *Eine Faust Overtüre,* Berlioz's *Benvenuto Cellini,* the *Symphonie Fantastique, Harold en Italie, Roméo et Juliette, La Damnation de Faust,* and *L'Enfance du Christ*—the last two conducted by the composer—Schumann's *Genoveva, Paradise and the Peri,* the music to *Manfred* and to *Faust,* Weber's *Euryanthe,* Schubert's *Alfonso und Estrella,* Raff's *König Alfred,* Cornelius' *Der Barbier von Baghdad* and many more.

It was Liszt's habit to recommend to the public such works as he produced not merely by performing them as admirably as possible but also by explanatory articles or essays, such as his two masterpieces of sympathetic criticism, the essays *Lohengrin et Tannhäuser à Weimar* and *Harold en Italie,* which articles found many readers and proved very effective. They are now included together with articles on Schumann and Schubert, Chopin and others in his *Gesammelte Schriften* (6 vol., Leipzig).

The compositions belonging to the period of his residence at Weimar comprise two pianoforte concertos, in E flat and in A, the *Todtentanz,* the *Concerto pathétique* for two pianos, the solo sonata *An Robert Schumann,* sundry *Études,* 15 *Rhapsodies Hongroises,* 12 orchestral *Poèmes symphoniques, Eine Faust Symphonie,* and *Eine Symphonie zu Dante's "Divina Commedia,"* the 13th Psalm for tenor solo, chorus and orchestra, the choruses to Herder's dramatic scenes "Prometheus," and the Missa solennis known as the *Graner Fest Messe.*

Liszt retired to Rome in 1861 and joined the Franciscan order in 1865. The Princess Wittgenstein, it has been said, was determined to marry him, and since neither he nor her family wished their connection to take this form, Cardinal Hohenlohe quietly had him ordained. From 1869 onward he—now the Abbé Liszt—divided his time between Rome and Weimar, where, during the summer months, he received pupils—gratis as formerly—and from 1876 up to his death at Bayreuth on July 31, 1886, he also taught for several months every year at the Hungarian Conservatoire of Budapest.

Liszt's pianoforte technique was based on the teaching of Czerny, who brought up his pupil on Mozart, a little Bach and Beethoven, a good deal of Clementi and Hummel, and a good deal of his (Czerny's) own work. Classicism in the shape of solid, respectable Hummel on the one hand, and Karl Czerny, a trifle flippant, perhaps, and inclined to appeal to the gallery, on the other, these gave the musical parentage of young Liszt. Then appears the Parisian Incroyable and grand seigneur—"Monsieur Lits," as the Parisians called him. Later, we find him imitating Paganini and Chopin, and at the same time making a really passionate and deep study of Beethoven, Weber, Schubert, Berlioz. Thus gradually was formed the master of style—whose command of the instrument was supreme and who played like an inspired poet.

Liszt's strange musical nature was long in maturing its fruits. At the pianoforte his achievements culminated in the two books of studies, twice rewritten, and finally published in 1852 as *Études d'exécution transcendante,* the *Études de concert* and the *Paganini Studies;* the two concertos and the *Todtentanz,* the sonata in B Minor, the Hungarian Rhapsodies and the fine transcriptions of Beethoven's symphonies (the 9th for two pianofortes as well as solo), and of Berlioz's *Symphonie Fantastique,* and the symphony *Harold en Italie.* In his orchestral pieces Liszt was the great apostle of program music (*q.v.*), and in that capacity may be said to have established his most conspicuous claim, apart from his achievements as a pianist, to a place in musical history.

Of his own orchestral works the *Dante* and *Faust* symphonies are generally considered the best. The subject of the *Dante symphony* (1847–55) was particularly well-suited to Liszt's temperament and offered good chances for the display of his peculiar powers as a master of instrumental effect. In the *Faust symphony* (1854–57) the moods of Goethe's characters—Faust, Gretchen and Mephistopheles—are depicted in three instrumental movements, with a chorus of male voices supplying a kind of comment, by way of close. The method of presentation in both symphonies is by means of representative themes (*Leitmotif*), and their combination and interaction. Incidents of the poem or play are illustrated or alluded to as may be convenient, and the exigencies of musical form are not unfrequently disregarded for the sake of special effects. Of the 12 Poèmes symphoniques, *Orphée* is perhaps the most consistent from a purely musical point of view and is exquisitely scored, while *Les Préludes, Tasso* and *Mazeppa* contain many happy pages.

In the choral numbers of the five masses, and in the oratorios *Die Heilige Elisabeth* and *Christus,* there are also fine movements, even if those works as a whole can never be regarded as commensurate with the high aims and genuine religious fervour which went to their making. More truly inspired than most of these larger works are some of Liszt's songs.

Speaking generally of Liszt it may be said that the man was greater than his music. Distinguished by the rarest magnanimity of nature and generosity of soul, he laboured even more energetically to advance the cause of others than his own; most conspicuously of all, of course, in the case of Wagner, and if only for his labours in this regard, and as a fearless champion of all that was noblest in the art, alike ancient and modern, he deserves ever to be held in lasting honour and remembrance.

Bibliography.—Liszt's writings, *Gesammelte Schriften,* were col-

lected by Lina Ramann (6 vols., Leipzig, 1880–83). His correspondence appeared in 9 vol., 1894–1904, edit. by La Mara, and various additional volumes were published later, including *Briefwechsel zwischen Wagner und Liszt,* edit. E. Kloss (2 vol., 3rd ed., 1910). For biographical material *see* L. Ramann, *Franz Liszt als Künstler und Mensch* (3 vol., 1880–94; Eng. trans. by E. Cowdray, 2 vol., 1882); Cosima Wagner, *Franz Liszt* (1912); B. Schrader, *Franz Liszt* (1914); J. Kapp, *Franz Liszt* (1909, 1926); R. Wetz, *Franz Liszt* (1925); A. Hahm, *Franz Liszt, Symphonische Dichtungen erläutert* (1920).

LISZT, FRANZ VON (1851–1919), German jurist, cousin of the composer, Franz Liszt, was born in Vienna on March 2, 1851. He qualified in 1875 as a teacher of criminal law at Graz in Austria, was a professor at Giessen (1879), Marburg (1882), Halle (1889), and in Berlin in 1899. In 1912 he became a member of the Fortschrittliche Volkspartei (Progressive People's party) in the Reichstag.

Liszt's life work was the scientific foundation and reform of the criminal law of which the basic principles are contained in his treatise *Der Zweckgedanke im Strafrecht* (1882). It opposes the principle of regarding punishment as a reprisal and sets up the claim of systematic prevention of a special nature. In the fight against the law-breaker, Liszt, together with the Dutchman Van Hamel and the Belgian Prins, founded the *Internationale Kriminalistische Vereinigung* (International Criminalist Union) in 1889, in which all reforms which became the basis of modern criminal law were initiated.

Liszt's claims in favour of conditional sentence and pardon as well as postponement of punishment later passed into practice. At Marburg he created the Criminalist seminary, at which later in Halle and especially in Berlin students from all lands met. Liszt was also a leading authority on international law. He died at Seeheim on June 22, 1919.

His chief works are *Meineid und falsches Zeugnis* (1876); *Lehrbuch des deutschen Strafrechts* (1881, 21st ed. 1919); *Lehrbuch des Völkerrechts* (1898, 11th ed., 1918); *Strafrechtsfälle zum akademischen Gebrauch* (13th ed. 1922); *Strafrechtliche Aufsätze und Vorträge* (1905). *See* also *Abhandlungen des Kriminalistischen Seminars* (1889, etc.); *Mitteilungen der Internationalen Kriminalistischen Vereinigung* (1890, etc.).

LITANY, a word used by Eusebius and Chrysostom, commonly in the plural, in a general sense, to denote a prayer or prayers of any sort, whether public or private. It is similarly employed in the law of Arcadius (*Cod. Theod.* xvi tit. 5, leg. 30). But some trace of a more technical meaning is found in the epistle (*Ep.* 63) of Basil to the church of Neocaesarea, in which he argues, against those who were objecting to certain innovations, that neither were "litanies" used in the time of Gregory Thaumaturgus. The nature of the recently introduced litanies, which must be assumed to have been practised at Neocaesarea in Basil's day, can only be conjectured. Probably they had many points in common with the *rogationes,* which, according to Sidonius Apollinaris, had been coming into occasional use in France about the beginning of the 5th century, especially when rain or fine weather was desired, and, so far as the three fast days before Ascension were concerned, were first fixed, for one particular district at least, by Mamertus, or Mamercus, of Vienne in A.D. 477. It is assumed that they were penitential and intercessory prayers offered by the community while going about in procession, fasting and clothed in sackcloth.

In the following century the manner of making litanies was to some extent regulated for the entire eastern empire by one of the *Novels* of Justinian, which forbade their celebration without the presence of the bishops and clergy, and ordered that the crosses which were carried in procession should not be deposited elsewhere than in churches, nor be carried by any but duly appointed persons. The first synod of Orleans (A.D. 511) enjoins for all Gaul that the "litanies" before Ascension be celebrated for three days. On these days all menials are to be exempt from work, so that everyone may be free to attend divine service. The diet is to be the same as in Quadragesima; clerks not observing these rogations are to be punished by the bishop. In A.D. 517 the synod of Gerunda provided for two sets of "litanies," the first of which were to be observed with fasting for three days, from Thursday to Saturday in the week after Pentecost; the second for three days from November 1. The second council of Vaison (529), consisting of 12 bishops, ordered the *Kyrie eleison,* first introduced at this time from the eastern Church, to be sung at matins, mass and vespers.

A synod of Paris (573) ordered litanies to be held for three days at the beginning of Lent, and the fifth synod of Toledo (636) appointed litanies to be observed throughout the kingdom for three days from December 14. The first mention of the word litany in connection with the Roman Church goes back to the pontificate of Pelagius I (555–560) but implies it was at that time already old. In 590 Gregory I, moved by the pestilence which had followed an inundation, ordered a "litania septiformis," sometimes called *litania major,* that is to say, a sevenfold procession of clergy, laity, monks, virgins, matrons, widows, poor and children. It must not be confused with the *litania septena* used in church on Easter Even. He is said also to have appointed the processions or litanies of April 25 (St. Mark's day), which seem to have come in the place of the ceremonies of the old Robigalia. In 747 the synod of Cloveshoe ordered the litanies or rogations to be gone about on April 25 "after the manner of the Roman Church," and on the three days before Ascension "after the manner of our ancestors." The latter are still known in the English Church as rogation days. Games, horseracing and junketings were forbidden; and in the litanies the name of Augustine was to be inserted after that of Gregory. The reforming synod of Mainz in 813 ordered the major litany to be observed by all for three days, barefoot and clothed in sackcloth and ashes. The sick only were exempted.

As regards the form of words prescribed for use in these "litanies" or "supplications," documentary evidence is defective. Sometimes it would appear that the "procession" or "litany" did nothing else but chant *Kyrie eleison* without variation. There is no reason to doubt that from an early period the special written litanies of the various churches all showed the common features which are now regarded as essential to a litany, in as far as they consisted of (1) invocations, (2) deprecations, (3) intercessions and (4) supplications. In details, however, they must have varied immensely. The offices of the Roman Catholic Church recognize two litanies, the "Litaniae majores" and the "Litaniae breves," which differ from one another chiefly in the fullness with which details are entered upon in each of the four parts. It is said that in the time of Charlemagne the angels Orihel, Raguhel and Tobihel were invoked, but the names were removed by Pope Zacharias as really belonging to demons. In some mediaeval litanies there were special invocations of S. Fides, S. Spes and S. Charitas.

The litanies, as given in the breviary, are at present appointed to be recited on bended knee, along with the penitential psalms, in all the six week-days of Lent when ordinary service is held. Without the psalms they are said on the feast of Saint Mark and on the three rogation days. A litany is chanted in procession before mass on Holy Saturday. The "litany" or "general supplication" of the Church of England, which is appointed "to be sung or said after morning prayer upon Sundays, Wednesdays and Fridays, and at other times when it shall be commanded by the ordinary," closely follows the "Litaniae majores" of the breviary, the invocations of saints being of course omitted. A similar German litany will be found in the works of Luther. In the Roman Catholic Church there are a number of special litanies peculiar to particular localities or orders, such as the "Litanies of Mary" or the "Litanies of the Sacred Name of Jesus."

There was originally a close connection between the litany and the liturgy (*q.v.*). The ninefold *Kyrie eleison* at the beginning of the Roman mass is a relic of a longer litany of which a specimen may still be seen in the Stowe missal. In the Ambrosian liturgy, the threefold *Kyrie eleison* or Lesser litany occurs thrice, after the *Gloria in excelsis,* after the gospel and at the end of the mass. On the first five Sundays in Lent a missal litany is placed before the *Oratio super populum* and, on the same five Sundays, in the Mozarabic rite before the epistle. In Eastern liturgies, litanies are a prominent feature, as in the case of the deacon's litany at the beginning of the *Missa fidelium* in the Clementine liturgy and immediately before the *Ana-*

phora in the Greek liturgy of St. James.

LITCHFIELD, a town of Connecticut, U.S.A., with a borough of the same name, 28 mi. W. of Hartford and served by the New York, New Haven and Hartford railroad; the county seat of Litchfield county. The population of the town was 4,029 in 1940; of the borough, 1,234.

Litchfield is a region of beautiful scenery, including Mt. Prospect and Lake Bantam (1,001 ac.). The town is a summer resort. Dairying is the principal occupation.

The lands included in the township of Litchfield (originally called Bantam) were bought from the Indians in 1715–16 for £15, the Indians reserving a certain part for hunting. The township was incorporated in 1719, was named Litchfield, after Lichfield in England, and was settled by immigrants from Hartford, Windsor, Wethersfield, Farmington and Lebanon, all within the state of Connecticut, in 1720–21. In 1751 it became the county seat of Litchfield county, and at the same time the borough of Litchfield, which was incorporated in 1879, was laid out. From 1776–80, two depots for military stores and a workshop for the Continental army were maintained there. The leaden statue of George III, erected in Bowling Green in New York city in 1770 and torn down by the citizens on July 9, 1776, was cut up and taken to Litchfield, where, in the house of Oliver Wolcott, it was melted into bullets for the American army by Wolcott's daughter and his sister. Aaron Burr, whose only sister married Tapping Reeve (1744–1823), lived in Litchfield with Reeve in 1774–75. In 1784 Reeve established here the Litchfield law school, the first institution of its kind in America. In 1798 he associated with himself James Gould (1770–1838), who after Reeve's retirement in 1820 continued the work with the assistance of Jabez W. Huntington (1788–1847) until 1833. The school was never incorporated, it had no buildings and the lectures were delivered in the law offices of its instructors, but among its 1,000 or more students were many who afterward became famous, including John C. Calhoun; Levi Woodbury, twice United States senator from New Hampshire, secretary of the navy, secretary of the treasury and a justice of the United States supreme court; John Y. Mason; John M. Clayton; and Henry Baldwin, a justice of the United States supreme court.

In 1792 Mrs. Sarah Pierce made one of the first efforts toward the higher education of women in the United States by opening in Litchfield her Female seminary, which had an influential career of about 40 years and numbered among its alumnae Harriet Beecher Stowe, Mrs. Marshall O. Roberts, Mrs. Cyrus W. Field and Mrs. Hugh McCulloch.

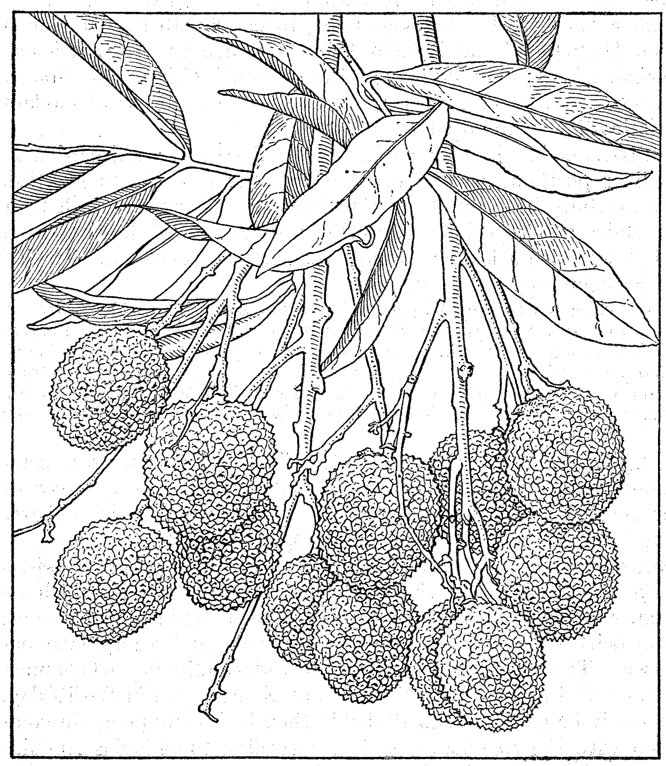
Litchfield was the birthplace of Ethan Allen; of Henry Ward Beecher; of Harriet Beecher Stowe, whose novel *Poganuc People* presents a picture of social conditions in Litchfield during her girlhood; of Oliver Wolcott, Jr.; of John Pierpont, the poet, preacher and lecturer; and of Charles Loring Brace, the philanthropist. It was also the home, during his last years, of Oliver Wolcott; of Colonel Benjamin Tallmadge, an officer on the American side in the War of Independence and later a federalist member of congress; and of Lyman Beecher, who was pastor of the First Congregational church of Litchfield from 1810–26.

LITCHFIELD, a city of Montgomery county, Ill., U.S.A., 52 mi. N.E. of St. Louis, on federal highway 66, and served by the Big Four, the Burlington, the Illinois Central, the Wabash and the Litchfield and Madison railways. The population was 6,612 in 1930; 7,048 in 1940. It is in an agricultural and coal-mining region, and has varied manufactures. Litchfield was incorporated as a town in 1856, as a city in 1859.

LITCHI or LYCHEE, the fruit of *Litchi chinensis,* a tree of the family Sapindaceae, considered indigenous to southern China and adjacent regions, where it has been cultivated for at least 2,000 yrs. The common name is variously written—*litchi, lichee, lychee, leechee, lichi* and so on. According to Yule and Burnell (*Hobson-Jobson*) the pronunciation in northern China is *leechee,* while in the southern part of that country it is *ly-chee.* The latter is generally preferred in the United States.

This is the favourite fruit of southern China. Neither the orange nor the peach is held to equal it. While living in exile at Canton, the poet Su Tung-po declared that litchis would reconcile one to eternal banishment; and Chang Chow-ling, a statesman of the 8th century A.D., composed a poem in which he praised the litchi as the most luscious of all fruits. The first published work devoted exclusively to fruit culture was one on litchi varieties, written by a Chinese scholar in A.D. 1056. In Kwangtung province alone the annual litchi crop is said to be 20,000,000 to 30,000,000 lb. worth $1,000,000 to $1,500,000.

Though introduced into India and several other parts of Asia at an early date, its establishment in the American tropics and subtropics was tardy, because of the fact that the seeds rapidly lose their viability and that the transportation of living plants from one part of the world to another was difficult until modern times. It is said to have been planted in Jamaica about 1775, but did not spread in that island. While the tree may have been grown in Florida as early as 1886, it was not until 1916 that the first fruits were produced in that state. Numerous introductions were made by the U. S. dept. of agriculture between 1900 and



BUREAU OF PLANT INDUSTRY, U.S. DEPARTMENT OF AGRICULTURE

FRUIT OF LITCHI (LITCHI CHINENSIS), ⅔ SIZE

1920, several of which—notably the Brewster variety—proved successful in Florida. A few small commercial plantings were made. In California an occasional tree has borne fruit, but in general it does not appear that conditions are suitable. Numerous trees have fruited in Cuba, in Central America, in Brazil and in other parts of tropical America. Many have been grown successfully in the Hawaiian Islands.

The litchi is subtropical rather than strictly tropical in its requirements, needing a moderate amount of winter chilling to fruit abundantly. At the same time, it tolerates less frost than the orange. The tree is handsome, reaching a height of 35 or 40 ft., with a broad round-topped crown of glossy green foliage, particularly striking when covered with clusters of fruits individually resembling large strawberries. The leaves are compound, with two to four pairs of elliptic-oblong to lanceolate leaflets 2 to 3 in. in length. The flowers, which are small and unattractive, are borne in terminal panicles sometimes a foot long. The fruit is oval to ovate, 1½ in. in diameter in the better varieties, with a brittle rough outer covering, red in colour, enclosing white translucent flesh and a single seed—large in the common forms but small and shrivelled in the better ones. The flavour of fresh litchis resembles that of Bigarreau cherries or Muscat grapes. Dried litchis, commonly called "litchi nuts," are frequently seen in Chinese shops in the United States; they somewhat resemble raisins surrounded by thin shells, and are vastly inferior to the fresh fruit though they have a flavour all their own.

While litchis are easily grown from fresh seed, superior varieties (of which there are a number, including No Mai, Haak Ip and several from northern India) must be propagated vegetatively. Air-layering is the method usually employed. Under greenhouse conditions they can also be grown from tip cuttings. Although the best soil for litchis is perhaps a rich alluvial loam, trees have done well in Florida on sandy loams. Planting distances vary from 20 to 30 ft. and the trees require little pruning. They usually come into bearing at five to eight years of age and are long lived: an early Chinese account mentions one which was cut down when it was 800 yrs. old. (W. Po.)

LITERARY, HISTORICAL AND ARCHAEOLOGICAL SOCIETIES. Owing to the great number of such societies, it is manifestly impossible to include all in this brief list. Only those of paramount importance and of more than purely national appeal will be found here.

Great Britain and Ireland: *The British Academy* (1901, incorp. 1902, under title *British Academy for the Promotion of Historical, Philosophical, and Philological Studies*), *Proceedings; The Royal Society of Literature of the United Kingdom* (1823, incorporated in 1825), *Transactions* (1829–39; 1843, etc.); and the *Royal Asiatic Society of Great Britain and Ireland* have their headquarters in London, as well as the following literary societies, all of which issue publications: *East India Asso.* (1866); *The Irish Literary Soc.; Japan Society; Library Assoc.* (1877); *Malone Soc.* (1906); *Oriental Translation Fund Soc.* (1828); *Pali Text Soc.* (1882); *Philological Soc.* (1842); *Soc. for the Promotion of Hellenic Studies* (1879); *Viking Soc. for Northern Research* (1908, org. 1892 as the *Viking Club*); *Wyclif Soc.* (1882). The *Manchester Literary Club, Trans. and Papers* (1847, etc.), and the *Manx Soc.* (1858) at Douglas, may also be mentioned. In Glasgow are the *Ballad Club* (1876), and the *Scottish Soc. of Literature and Art* (1886), and in Dublin the *National Literary Soc. of Ireland* (1892).

The oldest and most important society in England dealing with history and archaeology is the *Society of Antiquaries of London*, which is said to have been founded by Archbishop Parker in 1572. The meetings were not publicly recommenced until 1707; the present body was incorporated in 1751. It publishes *Vetusta Monumenta* (1747), *Archaeologia* (1770), and *Journal* (quart.). The *Royal Archaeological Institute of Great Britain and Ireland* (1843), *Archaeological Journal* (1844); *British Archaeological Association* (1843), *Journal* (1843); *Royal Numismatic Society* (1836), *Numismatic Chronicle* (1836); *Royal Historical Society* (1868), *Transactions* and the works of the *Camden Society* (1878); and *Institute of Historical Research* (1921), *Bulletin*, belong to London, as well as the following societies, all of which issue publications: *Bibliographical Soc.* (1892); *British School at Athens* (1886); *British School at Rome* (projected 1899; opened 1901, incorp. 1912); *British Record Soc., Ltd.* (1888) amalgamated 1890 with *The Index Library* (1878, incorp. 1893); *Canterbury and York Catholic Record* (1904); *Egypt Exploration Soc.* (1883); *Genealog. and Biogr., Cymmrodorion* (1751–1773), revived in 1820; *Soc. of Dilettanti* (1734); *Folklore Soc.* (1878); *Harleian Soc.* (1869, incorp. 1902); *Huguenot Soc.* (1885); *London and Middlesex Archaeol. Soc.* (1855); *London Topogr. Soc.* (1899); *New Palaeographical Soc.* (1903); *Palestine Exploration Fund* (1869); *Parish Registers Soc.* (1896); *Soc. for Prot. Anc. Buildings* (1877). Outside London are the *Roy. Soc. of Antiquaries of Ireland* (1890), founded as the *Kilkenny Arch. Soc.* (1849), changed to *Roy. Hist. and Arch. Assn.*, 1869; the *Soc. of Antiquaries of Scotland* (1780) at Edinburgh; and the *Irish Archaeol. and Celtic Soc.* (Incorp. 1912) at Dublin.

Canada: Halifax, *Nova Scotia Hist. Soc.* (1878), *Coll.* Montreal, *Société historique* (1857), *Mém.* (1859); *Antiquarian and Numismatic Soc.* (1872), *Journ.* (1872). Ottawa, *Roy. Soc. of Canada* (1883), *Proceed. and Trans.* Quebec, *Lit. and Hist. Soc.* (1824), *Trans.* (1829). Toronto, *Ontario Hist. Soc.* (1888), *Papers and Records* (1899), and the *Royal Canadian Institute* (1914) (1849, as the *Canadian Inst.*), *Trans.*

United States: The central antiquarian body is at Washington: *Archaeological Institute of America* (founded, Boston, 1879, incorp. 1906). It has 44 affiliated societies, maintains 6 schools of archaeology and publishes the *Amer. Journ.* (1897), *Art and Archaeology* (1914), and *Bulletin* (1910). Other important societies are the *American Antiquarian Society*, Worcester, Mass. (1812), *Proceed.* (1843); *American Hist. Assoc.*, Wash., D. C. (1884), *Annual Report* (1884) and *Amer. Hist. Rev.* (1895); *Carnegie Institution of Washington* (1902), *Publications* (1903); *Essex Institute*, Salem, Mass. (1848), *Proceed.* (1846), *Bulletin* (1869), *Hist. Coll.*, (1859); *Amer. Numismatic Soc.*, New York City (1858, revived 1864 under title *Amer. Numis. and Archaeolog. Soc.*, changed to present name, 1907), *Numismatic Notes and Monographs* (1920); *Amer. Oriental Soc.*, Boston (1842), *Journ.* (1842); *Amer. Library Assoc.*, Chicago (1876), *Catalogues, Bulletin, Papers and Proceed.* There are also the various state and local societies including *Mass. Hist. Soc.*, Boston (1791), *Proceed.* (1857) and *Coll.* (1792); *New England Hist. Geneal. Soc.*, Boston (1844), *N.E. Hist. and Geneal. Reg.* (1847); *New York Hist. Soc.*, New York City (1804), *Coll.* (1811); *Maryland Hist. Soc.*, Baltimore (1844), *Md. Hist. Mag.* (1906) and *Archives of Maryland* (1883); *Ohio State Archaeol. and Hist. Soc.*, Columbus (1885), *Ohio Archeol. and Hist. Soc. Quart.* (1887); *Wisconsin Archaeol. Soc.*, Madison (1899), *Wis. Archaeologist* (1901); *State Hist. Soc. of Wis.*, Madison (1849, reorg., 1853), *Wis. Mag. of Hist.* (1917); *Wis. Hist. Coll.* (1855) and *Proceed.* (1887).

Belgium: Antwerp, *Acad. roy. d'Archéol. de Belgique* (1842), *Annales* (1843). Arlon, *Inst. Archéol. de la prov. de Luxembourg* (1847), *Annales.* Bruges, *Soc. pour l'Hist. et les Antiq. de la Flandre* (1839), *Publ.* Brussels, *Soc. de l'Hist. de Belgique* (1858), *Publ.; Soc. Roy de Numism.* (1841), *Revue; Soc. des Bibliophiles Belges, Mons.* (1737), *Publ.; Soc. Roy d'Archéol.* (1887, as *Soc. d'Archéol. de Bruxelles*, title changed 1912), *Annales* (1887); *Inst. Int. de Bibliogr.* (1895), *Répertoire.* Ghent, *Soc. Roy. des Beaux-Arts et de la Litt.* (1808), *Annales* (1844); *Willems Fond* (1851); *Maatschappij de Vlaamsche Bibliophilen* (1839); *Soc. d'Hist. et d'Archéol.* (1893, as *Cercle Hist. et Archéol.*), *Bull.* Liége, *Inst. Archéol.* (1850), *Bull.* (1852). Louvain, *Soc. Litt.* (1839), *Mem.* and *Publ.* Namur, *Soc. Archéol. de Namur* (1845). Tournai, *Soc. Hist. et Archéol.* (1846, as *Soc. Hist. et Litt.*, title changed 1859), *Annales* (1896), superseded *Mém.* (1853–95) and *Bull.* (1849).

Bulgaria: Sofia, *Bulg. Acad.* (1910) (1869, as *Bulg. Lit. Soc.*), *Period.* (1870); *Bulg. Archaeol. Inst.* (1920), *Bull.*

China: Hongkong, *Roy. Asiatic Soc., Trans.* (1848–55). Shanghai, *Roy. Asiatic Soc., Journ.* (1858).

Denmark: Copenhagen, *Dansk Hist. Forening* (1839), *Historisk Tidsskrift; Island. Lit. Selskab* (1780); *K. Danske Selskab* (1745), *Magazin; K. Nordiske Oldskrift Selskab* (1825, reorg. 1865), *Aarböger* (1866–85), *Raekke* (1866), *Kjobenhavn* (1866).

Estonia: Narva, *Archaeol. Soc.;* Tartu, *Selts Kirjanduse Letts* (1907).

Finland: Helsingfors, *Finska Litt. Sällskapet* (1831), *Toimituksia* (1842); *Finnish Archaeol. Soc.* (1870), *Tidskrift* (1874); *Finnish Hist. Soc.* (1875), *Arkisto* (1876); *Finnish Lit. Soc.* (1831), *Suomi; Lang., Hist. and Archaeol. Soc. of Finno-Ugrians* (1883); *Swedish Lit. Soc. in Finland* (1885).

France: *The Congrès Archéologique de la France* first met in 1834. Bordeaux, *Soc. Archéol.* (1873). Paris, *Soc. Nat. des Antiq. de Fr.* (1804, projected; org. 1805 as *Académie celtique;* reorg. 1813 as *Soc. des. Antiq. de Fr.;* 1814, designated *Soc. Roy.*, but suppressed after 1848; 1852 reorg.) *Mém.* (1805); *Soc. de l'Hist. de Fr.* (1833), *Annuaire* (1837); *Soc. de l'École Nat. des Chartes* (1839), *Documents* (1873); *Soc. Asiatique* (1822), *Journ. Asiat.* (1822); *Soc. de l'Hist. du Prot. Fr.* (1853), *Bull.; Soc. de Linguistique de Paris* (1863); *Soc. française de Numism. et d'Archéol.* (1866); *Soc. Bibliogr.* (1868), *Polybiblion; Soc. Philol.* (1867), *Actes* (1869–1907); *Soc. des Études Hist.* (1833), *Revue* (1834); *Soc. d'Hist. Moderne* (1901), *Bull.; Soc. d'Hist.*

Contemp. (1890), *Publ.* (1892); *Soc. d'Hist. Diplomatique* (1876); *Soc. des Bibliophiles Fr.* (1820); *Soc. des Anciens Textes Fr.* (1875), *Bull.*

GERMANY AND AUSTRIA: Berlin, *Ver. f. Gesch. d. Mark. Brandenb.* (1836), *Forschungen* (1841); *Ver. f. d. Gesch. Berlins* (1865), *Mittheil.* (1884), *Schriften* (1866–1902); *Hist. Ges.* (1872), *Mittheil.* (1873); *Archäol. Ges.* (1841), *Sitzungsber, Archäol. Zeitung; Numism. Ges.* (1843), *Jahresber.* (1845), *Herold* (1869); *Phil. Ges.* (1843), *Der Gedanke* (1861); *Ges. f. d. Philol.* (1877), *Jahresber.* (1879); *D. Bibliogr. Ges.* (1902), *Ztschr.* (1903, etc.); *Ver D. Bibliothekare* (1900), *Jahrbuch* (1902); *D. Orient-Ges.* (1898), *Mittheil.* Cologne, *Hist. Ver.* (1834). Leipzig, *D. Ges. z. Erforschung vaterl. Spr. u. Alterth.* (1697, reorg. in 1824), *Jahresber.* (1825), *Mittheil.* (1845); *Fürstlich Jablonowski's Ges.* (1768), *Acta* (1772); *Börsenver. d. D. Buchhändler* (1825), *Börsenblatt* (1834); *Hist. Theol. Ges.* (1814). Vienna, *K. k. Orient. Akad.; K. k. Heraldische Ges. "Adler"* (1870), *Jahrbücher* (1874); *Ver für Österr. Volkskunde* (1894), *Ztschr.*

GREECE: Athens, *Soc. Archéol.; Amer. School Class. Studies* (1882); *École Franç. d' Athènes* (1846); *British School at Athens* (1886); *'Αρχαιολογική 'Εταιρεία* (*Arch. Soc.*) (1837), *'Εφημερίς*; *Hist. and Ethnol. Soc.* (1883); *Literary Soc. Parnassos* (1865); *Soc. for Cretan Studies* (1924).

HOLLAND: Leyden, *Acad. Lugduno-Batava; Maatschappij der Nederlandsche Letterkunde* (1766), *Tijdschrift.* Luxembourg, *Inst. Archéol.* (1846, reorg. in 1862), *Annales.* Utrecht, *Hist. Genootschap* (1845).

ICELAND: Reykjavik, *Islenzka fornleifarfelag* (1880); *Hid islenzka Bókmentafelag* (1816), *Skirnir* (1827–1925).

INDIA: Bombay, *Literary Soc. of Bombay* (1804, as *Roy. Asiatic Soc.* Branch, title changed 1923), *Journ.* (1841), *Trans.* (1819–1923). Calcutta, *Asiatic Soc. of Bengal* (1784, as *Asiatick Soc.*, title changed 1851), *Asiatick Researches* (1788–1839), *Journ.* (1832–1910), *Journ.* and *Proceed.* (1905), *Mém.* (1905), *Bibliotheca Indica* (1849); *Indian Research Soc.* (1907), *Trans.* Colombo, *Roy. Asiatic Soc., Journ.* (1845). Singapore, *Roy. Asiatic Soc., Publ.* (1895–6). These Roy. Asiatic Societies are local branches of the R. A. S. of Great Britain and Ireland.

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LITERATURE, a general term which, in default of precise definition, may stand for the best expression of the best thought reduced to writing. Its various forms are the result of race peculiarities, or of diverse individual temperaments, or of political circumstances securing the predominance of one social class which is thus enabled to propagate its ideas and sentiments. In early stages of society, the classes which first attain a distinct literary utterance are priests who compile the chronicles of tribal religious development, or rhapsodes who celebrate the prowess of tribal chiefs. As man feels before he reasons, so poetry generally precedes prose. It embodies more poignantly the sentiment of unsophisticated man. Prose of any permanent value would first show itself in the form of oratory. The development of abstract reasoning would tend to deprive prose of its superfluous ornament and to provide a simpler and more accurate instrument.

CLASSICAL LITERATURE

A survey of this subject, of the preservation or loss of ancient literature, and of the history of classical scholarship will be found under CLASSICS. The history of classical scholarship is further dealt with under the various biographies such as BENTLEY, RICHARD; PORSON, RICHARD; SCALIGER. The method of scholarship is extensively dealt with under TEXTUAL CRITICISM. The two great branches of the subject are handled *in extenso* under GREEK LITERATURE and LATIN LITERATURE. These articles are supplemented by articles on the various schools of writers: ALEXANDRIAN SCHOOL, ANNALISTS, GEOPONICI (*see* also HELLENISM), and on the chief anonymous or pseudonymous works: ANTHOLOGY, CONSTITUTION OF ATHENS, PERVIGILIUM VENERIS, PRIAPEIA and others. All classical writers of any importance have also their own biographies: AESCHYLUS; ARISTOPHANES; BOETHIUS; ANICIUS MANLIUS SEVERINUS, etc., including scientific writers such as EUCLID or PAPPUS OF ALEXANDRIA; but a general guide to the treatment of ancient scientific and artistic knowledge must be sought under the summary articles—ART; MATHEMATICS, FOUNDATIONS OF; MATHEMATICS, HISTORY OF; MEDICINE; MUSIC; etc. The chief legendary figures used as material by classical writers are dealt with separately under such heads as ACHILLES, ARGONAUTS, OEDIPUS, THESEUS. Classical prosody is dealt with under headings such as HEXAMETER; IAMBIC; SAPPHIC METRE; a study of Latin prose rhythm will be found under CICERO, of Greek under ISAEUS and DEMOSTHENES, etc.

Mediaeval and Modern.—The various literatures of the world are surveyed, so far as is possible, on national lines—English, French, American, German, Portuguese, Czecho-Slovakian and so forth. The history of Afrikaans Literature will be found under the heading SOUTH AFRICAN LITERATURE, and under SWISS LITERATURE will be found the literatures written by Swiss authors in German, French and other languages. Then the general surveys are supplemented by long detailed studies of the chief authors—SHAKESPEARE, WILLIAM; DANTE, ALIGHIERI; CERVANTES SAAVEDRA, MIGUEL DE; etc. For the various literary forms—Novel, Drama, Sonnet, Essay, Biography, etc.—*see* the articles under these headings. The chief characters in mediaeval legend are described in their various transformations in such articles as FAUST, TRISTAN, GAWAIN, etc. Journalism is covered in several articles such as NEWSPAPERS and PERIODICAL, and almost everything relating to the history of books is touched on in such articles as BOOKS, BOOK-COLLECTING, BIBLIOGRAPHY, LIBRARIES, INDEX.

Modern developments in literature will be found treated in supplementary articles on BIOGRAPHY; NOVEL; POETRY, as well as in such an article as FREE VERSE.

LITERNUM, an ancient town of Campania, Italy, on the low sandy coast between Cumae and the mouth of the Volturnus. It was probably once dependent on Cumae. It is mainly famous as the residence of the elder Scipio, who withdrew from Rome and died here. His tomb and villa are described by Seneca. The lagoons behind made it unhealthy, though the construction of the Via Domitiana through it must have made it a posting station. Villa Literno, some 7 mi. north-east from its site, is an important junction on the new direct line from Rome, the line for Pozzuoli and the Mergellina station at Naples diverging here.

LITHGOW, WILLIAM (1582–?1650), Scottish traveller and writer, was born and educated in Lanark. He was caught in a love-adventure, mutilated of his ears by the brothers of the lady (hence the sobriquet "Cut-lugged Willie"), and forced to leave Scotland. For 19 years he travelled, mostly on foot, through Europe, the Levant, Egypt and northern Africa, covering, according to his estimate, over 36,000 miles. The story of his adventures may be drawn from *The Totall Discourse of the Rare Adventures* . . . (1614; fuller edition, 1632, etc.). He is the author of a *Present Surveigh of London* (1643). Of his poems "Scotland's Welcome to King Charles, 1633" has considerable antiquarian interest.

The best account of Lithgow and his works is by F. Hindes Groome in the *Dict. Nat. Biog.*

LITHGOW, a town of New South Wales, Australia, lying on the central tableland (altitude 3,000 ft.), 96 mi. by rail N.W. of Sydney. It stands in the heart of the "Western" coal field which possesses steam as well as coking coal. The state coal mine is situated near Lithgow. Large supplies of good iron ore are available at Tallawang (100 mi. N.W.), Carcoar (80 mi. S.W.) and Cadia (100 mi. S.W.). Limestone is quarried 25 mi. away and manganese ore is available at Grenfell (156 mi. W.). It is thus a thriving industrial town (pop. 1933, 13,444). The Hoskins Iron and Steel Co. had large works (blast furnaces with capacity 150,000 tons per ann.; output [1925] 95,500 tons pig iron [£525,000]); these have been moved to Port Kembla on the coast south of Sydney. The Commonwealth Small Arms factory, fire-brick and pipe works, tweed and sawmills, etc., make Lithgow one of the chief industrial centres of Australia. Near by is the famous zigzag railway, an engineering marvel now superseded by tunnels.

LITHIUM, a metallic element belonging to the group of alkali metals and occurring on the earth only in combination, having been first recognised as a separate element by Arfvedson in 1817, symbol Li, atomic number 3, atomic weight 6·94 (two isotopes 6 and 7). It is widely distributed, although in small proportions, in the mineral, vegetable and animal kingdoms. It is found in several characteristic minerals, *e.g.*, lepidolite or lithia mica and in petalite. The ash of many plants contains an appreciable amount of lithium chloride (tobacco ash about 0·44%), and lithium compounds are present in every organ of the human body and especially the lungs. The term "lithia water" recalls the reputation possessed by lithium salts such as the carbonate or citrate for assisting in the elimination of uric acid in gout and in rheumatoid affections, but the potency of lithium compounds in this respect is much exaggerated since the tolerated dose of lithium does not increase the solubility of uric acid in the blood serum. Accordingly, lithium salts have been largely superseded in medicine by organic diuretics such as urotropine (hexamine).

Silicates containing lithium, when heated with calcium oxide, carbonate or sulphate, yield the corresponding soluble lithium compounds which can be extracted with water. The extract, freed from heavy metals, contains lithium and other alkali metals; these are converted into carbonates, and lithium carbonate, being only sparingly soluble, is deposited and separated. The carbonate is converted into lithium bromide and chloride; a mixture of the former salt with 12% of the latter melts at 520° C and is used in the electrolytic production of metallic lithium. The metal has been isolated by electrolysis of a solution of lithium chloride in pyridine, and also by heating lithium hydroxide with magnesium.

Lithium is a silvery white metal tarnishing in moist air. It is harder than the other alkali metals but softer than lead, which it resembles in ductility. Its melting point is variously given 179° to 186° C. It is the lightest of those elements which are solid at the ordinary temperature and it has the highest specific heat, 0·9408, of any solid element. Its spectrum is characterised by a bright red line (6,708 Å.U.) and a fainter orange one (6,104 Å.U.). Lithium decomposes water at the ordinary temperature, liberating hydrogen and forming a caustic solution of lithium hydroxide (lithia). Lithium burns in air or oxygen to the white oxide, Li_2O, and when heated in nitrogen it furnishes the nitride, Li_3N.

Lithium hydride, LiH, produced by direct combination of the metal with hydrogen at bright red heat, is a white, crystalline opalescent mass melting at 680° C; it undergoes electrolytic decomposition, liberating lithium at the cathode and hydrogen at the anode. Lithium fluoride, LiF, is sparingly soluble, but the chloride, LiCl, is soluble in water and also in many organic solvents such as the alcohols, acetone and pyridine. Lithium hydroxide, LiOH, produced by adding water to the oxide, is a white crystalline mass resembling caustic soda or potash but less hygroscopic; it dissolves readily in water and absorbs carbon dioxide to form lithium carbonate, Li_2CO_3. Lithium acetylacetone, $LiC_5H_7O_2$, obtained in colourless needles by the action of acetylacetone on aqueous lithium hydroxide, is soluble in water or alcohol. Lithium phosphate, Li_3PO_4, is very sparingly soluble in water and less so in alkaline solutions, and is sometimes employed in the estimation of lithium; for this purpose the fluoride is also used and the solubility of lithium chloride in amyl alcohol serves to separate lithium from the other alkali metals. Lithium fluoride and fluophosphate are used in ceramics in the production of enamels. The lithium salts employed in medicine are the benzoate, bromide, carbonate, citrate, hippurate, iodide, salicylate, sulphate and hydrogen tartrate. *Lithii citras effervescens* is a mixture of citric acid, lithium citrate and sodium bicarbonate. Since in large or concentrated doses lithium salts cause unpleasant symptoms, they should be freely diluted.

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(G. T. M.)

LITHOGRAPHY is both an art and a method of printing. Lithograph is from the Greek: Litho—stone; Graph—to write or draw—and means "writing on stone," or "drawing on stone." Actually, it embraces the use of stone and of materials other than stone both for art and for commercial printing purposes. As an art it has long been used by some of the most eminent artists—at times by many, at times by very few. As a method of printing it has been employed in a gradually increasing volume.

Lithography—A Form of Art consists of drawing with a greasy substance—both crayon and ink are used—on a special type of stone or metal (aluminium or zinc) or on a special kind of paper to be transferred subsequently to stone or metal. It is the most direct of all the graphic arts because the artist sees the exact value of each line or dot as he draws it, following which his drawing can be reproduced so accurately that it may truly be said to have been multiplied. Lithographic crayon yields broader tones than the etching needle; it makes and retains finer lines than can be obtained in wood block. Moreover, lithographic inks produce as fine lines and dots in pen and stipple drawings as are produced by any other means. All of these print exceptionally well. Lithography as an art has always played some part in lithography as a method of printing and at one time was more important than commercial reproduction.

Now the part played by "art" in lithography is relatively small although many artists are again turning to it as a versatile medium of expression.

Lithography—A Method of Commercial Printing is one of the three basic commercial graphic arts processes—the others being relief or letterpress and intaglio or gravure. Relief, letterpress or typographic printing is the art of printing from movable type, engravings, electrotypes, etc., the impression points or surfaces being raised or in relief. Intaglio or gravure is the reverse of relief printing in that the printing is done from depressions or recesses which have been etched or engraved into the surface of the plate or cylinder. Lithography is a chemical process of printing from a plane surface—the printing portions of the surface being neither raised as in relief printing nor depressed as in gravure or intaglio. The lithographic process is dependent upon the natural repulsion between grease and water; moisture prevents the greasy printing ink from adhering to the stone or plate except where it is covered by design. At present few stones are used for either drawing or printing.

About 1820 it was discovered that zinc possessed most of the essential qualities of lithographic stone. Later on, aluminium came into use. For lithographic printing these metals are today used almost exclusively.

LITHOGRAPHY AS AN ART: THE PROCESS

Drawing Materials.—The best medium on which to draw is Kelheim stone, that on which Senefelder was by chance working when he discovered the art. Three grades of lithographic stone are used: blue (hard), grey (medium), and yellow (soft). The blue is used for engraving, the grey for very fine work, and the yellow for relatively coarse work.

Lithographic stones are grained by rubbing two together with a sifted layer of flint or carborundum between; the resulting grain, consisting of innumerable, minute depressions, can be varied by changing the quality of the graining material (flint, carborundum, sand, etc.). Necessary erasures on such a fine surface are best effected by means of a small piece of lithographic stone rotated with sand and water; defects may be picked out with a needle; a knife may be used to scratch out, but if the grain is removed the part shows scratchy if drawn on again. After being reground and washed thoroughly with clean water the stone is then ready to receive a new drawing.

Zinc and aluminium plates for the artist's use are bought already grained. The disadvantages of using a plate are that its surface easily becomes greasy, corrections are hard to make and its colour may at first confuse values for the artist. In drawings made direct on either a stone or plate a greasy composition known as "tusche" can be applied for solid black lines or large black areas.

Despite its excellence as a drawing surface, the inconvenience connected with carrying the lithographic stone about has caused it to be chiefly used as a receiving surface for drawings transferred from paper. Not only can paper be easily carried in the artist's portfolio, but, since a drawing made on paper has to be transferred to another surface before it can be printed, it appears as it will when printed and does not have to be made in reverse like those made direct on a zinc or aluminium plate or on stone. Good lithographic paper, made by hand in Germany, France, Scotland, and Austria, has a specially prepared chalk surface that is very good to draw on, permits scraping out with a knife and transfers well.

In the United States artists usually employ a fine quality of tracing paper. When making a drawing on paper that is to be transferred to a stone or plate it is not necessary to develop the design with lithographic crayon. A Conté sanguine pencil can be used for the preliminary design over which lithographic crayon is passed later; also charcoal or a lead pencil can be used, since neither these nor the Conté contain grease enough to interfere with transference. The Conté marks, however, being red, can be easily distinguished from those of the black lithographic crayon, while the black marks of charcoal or lead pencil are likely to confuse the artist.

Changes in a drawing on paper can be made by painting out with Chinese white, which, if applied smoothly, can be drawn over; or they can be made on the stone or plate after transference. Since transferring has a tendency to intensify, the drawing should be kept slightly lighter than it is to appear in the finished print.

Lithographic crayon is a composition of soap, wax, oil, and lamp-black. A No. 0 crayon is very soft, No. 1 soft, No. 2 medium, No. 3 hard, No. 4 very hard, and No. 5 copal. In warm weather a No. 3 or No. 4 crayon should be used; in cold weather any may be used but it is advisable never to use a No. 5.

Great care must be taken to keep the drawing surface absolutely clean, free from dust, crumbs, etc. In all cases, the artist must be careful not to touch the surface of the stone, plate or paper with his hand; perspiration, which contains grease, will reproduce in smudges, marring the finished print. A piece of paper or light felt should be kept between the drawing surface and the artist's hand and arm.

Transferring.—Generally, drawings transferred from paper soon after being finished yield the best results, but drawings protected by a film of gum may be preserved indefinitely. Some printers prefer to transfer to a zinc or aluminium plate rather than to stone, believing that the plate reproduces fine tints better. Transferring a drawing on paper to either involves the same method, but a stronger acid solution is used for stone. The drawing is first placed in a "damp book," which consists of damp blotters with a rubber cover. If the paper tends to wrinkle it is stretched with thumb-tacks. It is left between the blotters from 20 to 60 minutes, until the printer believes it ready to transfer, then dropped on the stone or plate, already on the press, and left in the position in which it lands; to move it is to smudge. It is then covered with "backing"—a sheet of clean paper and a sheet of compressed fibre-board whose upper surface is greased to further the passage of the scraper over it. In running the stone or plate through the press care should be taken that the scraper runs entirely across the drawing but not to the edge of the stone or plate, which the scraper slipping off under pressure would damage. To facilitate this a margin of at least one inch should be allowed for every stone or plate; and this holds whether the drawing is made direct on these surfaces or is transferred to them. The bed of the press is slid forward, normal pressure is applied, the bed is turned through the press, the pressure is released and the bed is returned to its original position.

If special transfer paper has been used it should be soaked off; ordinary tracing paper should be pulled off without dampening. The plate or stone is then fanned dry and allowed to stand for about 30 minutes.

The Etch.—What has happened in transferring the drawing to the stone or plate is that some of the greasy lithographic crayon has been forced off the paper onto the plate or stone. If the craftsman is satisfied with the transfer he gives it what is known as an "etch," *i.e.*, a solution of, for a stone, gum arabic and nitric acid, or, for a zinc plate, gum arabic, chromic acid and phosphoric acid, or, for an aluminium plate, gum arabic and phosphoric acid, flowed over the surface with a brush or a piece of absorbent cotton. The gum arabic desensitizes the surface not drawn on, decreasing its affinity for grease; the acid eats away any invisible particles of grease that may be on the surface, but when in the correct solution (*see* formulas appended), does not affect the drawing itself, which is protected by the wax in the lithographic crayon. If the craftsman thinks the transfer poor, he coats the surface of the stone or plate with pure gum arabic, washes it off with water, inks it up until the drawing appears, dusts the inked drawing with rosin, then gives it an "etch."

After the "etch" has dried on the stone the surface is washed with clean water, sponged with a pure solution of gum arabic, rubbed down as smooth as possible with a clean rag and fanned dry. In the case of a plate, the acid solution is washed off without being allowed to dry.

Next the greasy material constituting the image (drawing) is washed off with turpentine, leaving the drawing invisible, apparently destroyed; but it is preserved, of course, in the grease still remaining on the stone or plate. A little asphaltum is rubbed in and fanned dry. The stone or plate is then dampened again with water so that when the ink, which contains grease, is applied it will take only on the grease and be repelled by all parts of the surface not drawn on. It is then dampened with a sponge and inked up with a roller.

It is advisable, finally, to dust the stone or plate with rosin dust, to clean it up, polishing out all dirt, and to repeat the process, after which it is ready for printing.

Drawings made direct on a stone or plate are given an "etch," and then prepared for printing in the manner indicated above. Lithographic engraving, or intaglio printing, is done with a needle on stone desensitized by a solution of gum arabic and nitric acid. Such engravings are inked with a dauber that pushes the ink into the engraved lines; otherwise they are treated like a lithograph drawn direct on stone.

Printing.—Lithographic ink is made from the best dry colour and linseed oil (or synthetic material). It is generally sold stiff so that the craftsman can soften it with varnish to the consistency demanded by his working conditions and the results that he wants. It is available in various colours, but, no matter what colour or combination of colours is wanted in the print, all drawings are made in black, one stone being prepared for each colour desired. The ink is applied by means of a roller made of wood covered with grain leather; during the operation, difficult because the ink must be applied evenly until judged strong enough, the stone or the plate rests on the bed of the press in order that an impression can be made at once.

Sliding pressure is used in printing a lithograph. The scraper, which is made of box or apple wood sharpened to a blunt edge and covered with well greased leather, is set by a screw. Hand-made paper is generally used for lithographic prints, the best grades of which come from Italy, Sweden, France, and Japan; machine-made paper, however, gives good results in practice. The paper is generally moistened to enable it to print very fine tints in full value. It is then placed on top of the plate or stone as it rests in the centre of the press bed, and is covered with backing. Pressure is applied and, the same precautions being taken as in transferring, the stone is cranked through the press; the pressure is released and the bed of the press is returned to its original position.

The first prints pulled have a tendency to be light; the proper strength of the image is built up gradually. If, after a few prints have been pulled, the image has a tendency to grow too dark it is advisable to repeat the "etching" process; if the stone is in colour, before being given an "etch" it is washed with turpentine, rolled up with black ink and dusted with rosin.

As many prints as are wanted can be had, but, when the stone or the plate is taken from the press, it should be rolled up with ink, gummed down with gum arabic and rubbed down very smoothly with a clean rag in order to keep the image intact.

Formulas.—The proportions of gum arabic and acid used in the solution known as the "etch" vary with the quality of the stone or plate, the type and age of the drawing, and the temperature of the room. Only the following approximate proportions can be given: For a stone, one half glass of gum arabic to one teaspoonful of nitric acid. For a zinc plate, one half glass of gum arabic to one teaspoonful of chromic acid to from 12 to 15 drops of phosphoric acid. For an aluminium plate, one half glass of gum arabic to from 15 to 20 drops of phosphoric acid. (*See* also ETCHING.) (G. C. MI.; MA. S.)

LITHOGRAPHY AS AN ART: HISTORY

The history of lithography as a form of art leaves no chance for ingenious theory and learned speculation. Art authorities may argue over the origin of etching and wood-engraving, but the inventor of lithography, Alois Senefelder (1771–1834), himself gave the facts of his invention in *A Complete Course of Lithography—Der Steindruck* (1818)—a book which is half autobiographical, half technical, and wholly absorbing. He was a Bavarian actor and dramatist. Not over successful, he endeavoured to be his own printer and publisher as well and, to that end, experimented with metal plates and Solenhofen stone, acids and inks. According to his often-quoted story, his mother asked him, one day when he was at work, to write her week's washing list and, paper not being handy, he wrote it with his greasy ink on a smooth stone upon which he practised writing in reverse.

Later, instead of cleaning off the writing, he was curious to see what would happen if he etched the stone and pulled a proof. What happened was his discovery of relief engraving on stone (1796). But only after "thousands of experiments" did he make the further, the all-important discovery (1798) that without etching the writing or design in relief, he could prepare the stone so as to get a print from the surface. This is lithography-chemical surface printing.

Germany.—Senefelder did not start out to benefit the artist, nor did the business men who took him up and launched his invention. The first patents were mostly for printing music and calico. However, artists and their patrons quickly saw the possibilities of lithography as an art. In Germany, royalty patronized Senefelder; Baron Aretin went into partnership with him (1806). Less came of royal condescension than of the first work of note issued by the Senefelder-Aretin Press (1808): the reproduction of Dürer's Missal of Maximilian from the copy in the Munich Royal Library, the drawings made by N. Strixner. German artists grew enthusiastic, got to work on stone, less often as original lithographers than as faithful copyists. The Old Masters, Strixner, Piloty, Mitterer, Hanfstängl were the most accomplished. Their reproductions were extraordinary, but no artist of genius or talent can make himself a mere machine, the Old Masters necessarily lost something in their interpretation, and, eventually, photography did away with the artist as copyist.

England.—Already, in 1801, Senefelder had taken out patents in England, where he was personally overshadowed by Philip André and Hullmandel, who seemed inclined to appropriate all the credit, and the profit too. Fortunately he was recognized by the Royal Society of Arts as the inventor, a gold medal was bestowed upon him, and artistic lithography—"Polyautography" the English then called it—was encouraged. The interest of artists was roused, and an album of *Specimens of Polyautography* was published by André in 1803, with Benjamin West, Stothard, Barry, Fuseli among the contributors. For some years, however, little was heard of the new invention. Now and then an experiment was made by artists, notably by Blake and Bewick. But Géricault had made his lithographs in London and Bonington his in France before lithography acquired the least popularity, before royal and titled amateurs, Queen Victoria and Count d'Orsay of the number, began to amuse themselves with it, before albums of "Views" of architecture and landscape were "on the town." Artists like Prout and Harding went to France to work for Baron Taylor's colossal, never-finished *Voyages Pittoresques* which no doubt stimulated the British fancy for such publications as Wilkie's *Tour in the East,* Lewis's *Sketches in Spain and the Orient,* Roberts' *Holy Land.* As a rule, for these English publications, the artists simply supplied sketches from their sketch books which professional lithographers reproduced on stone and printed. Under such conditions it is small wonder that lithography languished as an art, that the artist who practised it for pure love of the medium was the exception. Cattermole's lithotints remain, the few by Cotman, and John Linnell Jr.'s copies, especially one of Mulready's *The Sonnet* which the most skilled German never surpassed. By 1850 lithography in England was really a *Finished Chapter of Illustrative Art,* as it was later described by William Simpson, whose *India* was the last of the big travel books.

France.—Lithography as an art met with the most immediate response in France. There also it received early official recognition and honours, was patronized by amateurs, was for a time the mode in modish drawing-rooms—a fashionable plaything. But in France this period was short. General Baron Lejeune's famous *Cossack* inaugurated the fashion, and was also, no doubt, the first inspiration of the cheaply got up, cheaply priced albums of military subjects that did so much to popularize the Napoleonic legend. Good printers multiplied rapidly—Engelmann, Lasteyrie, Delpech, Gihaut, Motte, Lemercier. The Vernets, Charlet and Raffet were quick to see in Napoleon and his armies a motive for their lithographs. Charlet contributed not only to the subject but to the art, experimenting tirelessly, getting amazing effects out of *la manière noire*—"mezzotint applied to stone." Raffet on a few inches of paper could make a romance of war, turn it into beauty, in such prints as *Le Réveil* and *Ils grognaient mais le suivaient toujours.* Other artists used lithography for portraits, none more notably than Achille Devéria, above all in his renderings of R. J. Lemercier, founder of the great printing house, and of Alexandre Dumas, *Père.* Painters were attracted by the medium and the variety of its resources. There were few who did not give it at least a trial. Géricault went further than a mere trial, his boxers and horses were among the best known prints of those years and, later, the most sought after by collectors. Delacroix mastered the method triumphantly in his *Lion de l'Atlas* and *Tigre Royal,* less strikingly in his illustrations for *Faust* and *Hamlet*. Isabey's triumph was in his little towns for Baron Taylor, his shipping and harbours for himself. But the list is endless—the prints published sometimes separately, sometimes in magazines and papers. Much of the best work came out in *L'Artiste,* the most successful of the magazines, or in Philipon's two papers, *La Caricature* and *Le Charivari* with Daumier and Gavarni for regular contributors. From the beginning French lithographers had devoted themselves to caricature and fashion plates, records of social life and political satire with as much zest as to war, portraits and "picturesque views," but Daumier and Gavarni excelled them all.

Other countries lagged far behind Germany, England and France in the first half of the last century. Spain gave us Goya, the brilliant, the romantic, the grim; Manet, with paint or canvas, did not get more life and colour out of the bull-ring than Goya with greasy chalk on stone. The rest of Europe was practically barren. In America lithography was entirely commercial, with nothing to show that Americans appreciated it as an art save for a stray print by Lafarge or William Morris Hunt and the *Campaign Sketches* of Winslow Homer, made during the Civil War and remembered now because of his fame as a painter. By the middle of the century, the first great period of the art of lithography was everywhere at an end.

Decline of the Art.—Already in 1840, etchings were competing with lithographs in *L'Artiste* and Beraldi was announcing the decline of lithography. In 1864 Burty declared the art *en pleine décadence*. Both were right. The reasons are not far to seek. The swing of the pendulum for one, lithographs had been almost too popular. French lithographers, warned to be serious like the Germans, began to copy pictures which they did, though with distinction, at the sacrifice of original design. Photography became a serious rival in all countries, bringing its disastrous gift of cheapness. Photographic processes replaced lithography, as well as wood-engraving, for the illustration of magazines and papers. In the '60s photo-lithographs were finding their way into Baron Taylor's monumental work. The commercial lithographer soon preferred the camera to the artist. The horrors of chromo-lithography demoralized the public.

A mystery was made of the actual printing. Artists, not allowed near the press—and few had presses of their own—were kept in an outer room waiting for proofs. The earlier transfer papers were abominable. Dealers fought shy of lithographs and collectors hesitated to follow where dealers feared to lead. Under the new conditions the art threatened to disappear.

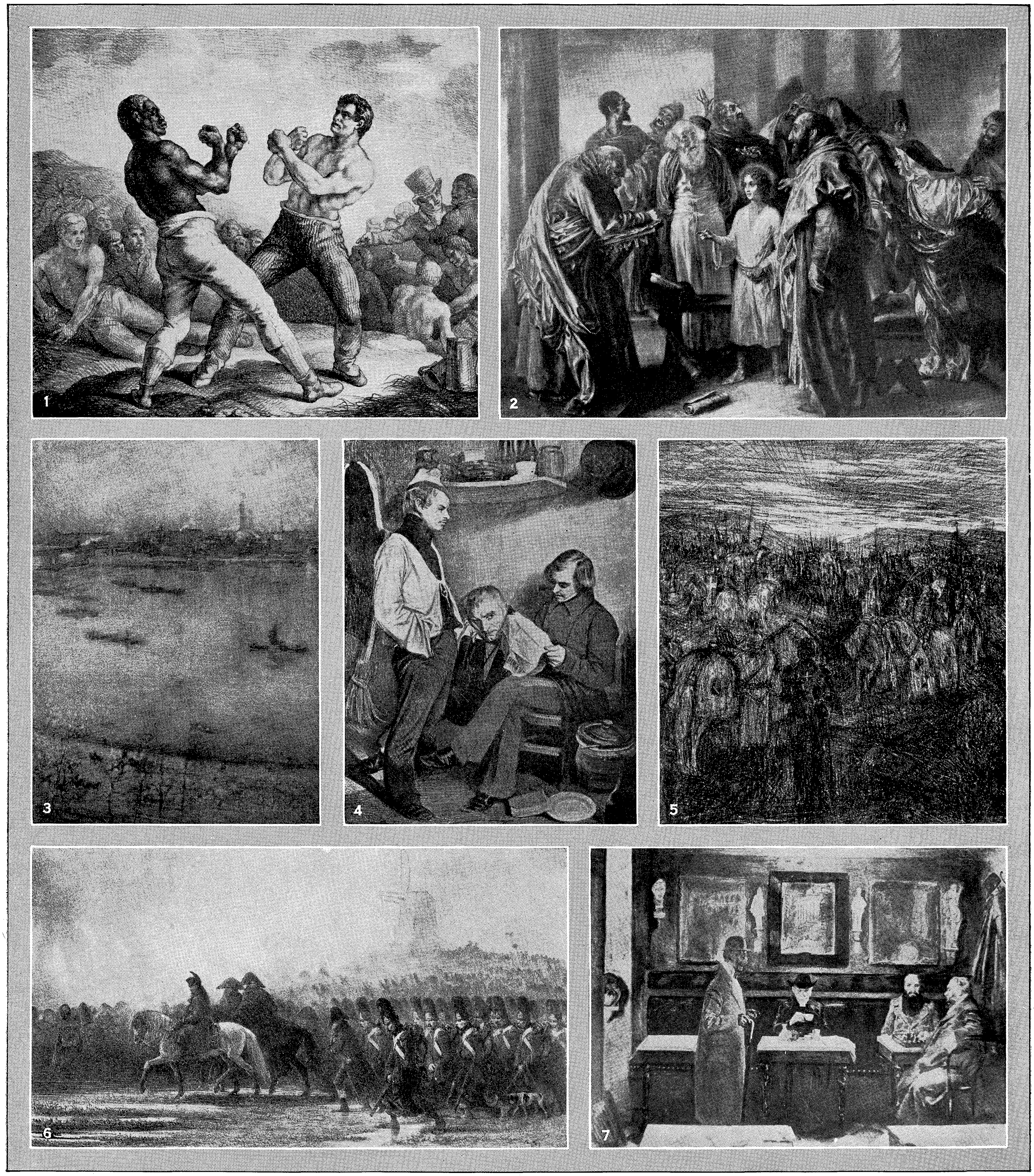
Later Revival.—But an art with such possibilities for the artist could not altogether die. Adolf Menzel, trained in a Berlin printing shop, was the chief link between the first great period and the revival. In the '40s and '50s, those dark decades for lithography, he was doing his *Uniforms of the Army of Frederick the Great,* issuing his *Sketches on Stone* in a portfolio, bringing out occasional prints, none more famous than his *Christ in the Temple*. His lithographs are marvels of technical knowledge and accomplished drawing, an inexhaustible mine for the intelligent student. In France, the new generation was discovering lithography for itself through the work of the French masters. In the '60s Manet experimented, also Bracquemond, Legros, Fantin-Latour, who began his well-known series with Wagner as inspiration. In London in the '70s the printer Thomas Way interested Whistler, who, enchanted with so autographic a medium, produced little masterpieces that made a talk in the studios. Several appeared in *Piccadilly, The Albemarle, The Whirlwind,* publications which his contributions could not save from an early death. And so, little by little, lithography as an art came into its own again, especially in France where a retrospective exhibition of lithographs was held at the École des Beaux Arts in 1891. Beraldi now talked of the revival in the air and the French, ever leading in such movements, prepared for a more important, more complete exhibition to celebrate the centenary of Senefelder's invention.

The '90s were the years when the Champ-de-Mars *Salon* opened its doors wide to the new school of lithographers, and the black-and-white section was a place to linger in—the years when Toulouse-Lautrec, Steinlen, Odilon Redon, Valloton, Ibels, Anquetin were at work, and Chéret made the walls of Paris gay with his posters. Painters returned to the stone—Besnard, Blanche, Gandara, Puvis de Chavannes and Carrière who never did anything finer in any medium than his portrait of Paul Verlaine. Lithographs again appeared in papers and magazines, again were issued in series, gave the chief interest to such collections as *L'Estampe Originale,* for which Toulouse-Lautrec made the memorable poster in colour. The excitement reached its climax with the wonderful Centenary Exhibition at the Champ-de-Mars, opening in 1895, three years in advance of the actual date as if France could not wait to pay its tribute to Senefelder.

In England only a few shared Whistler's enthusiasm. C. H. Shannon set up his own press, lithographed much the same subjects he painted, with much the same delicacy and grace. Joseph Pennell used lithography for the illustration of Macmillan's new edition of *The Alhambra* and the *Devon and Cornwall* volume in the *Highways and Byways* series. He had no press, the printing was done at Way's where mystery prevailed, and the pale grey prints gave no idea of his powerful Panama and War Work lithographs that were to come later. William Rothenstein published portfolios of portraits. Charles Conder's lithographs, in their subjects, seem like his fans, but even vaguer in design, more elusive in charm. William Strang, like Rothenstein, turned to portraiture—grave serious studies. A few more artists could be named but, in all, so few that when Great Britain was asked to contribute to the Champ-de-Mars Exhibition, Alfred Gilbert, the sculptor who had begun his career in a lithographer's office, and Charles Goulding, the lithographic printer, scattered transfer paper, chalks and washes wholesale among Royal Academicians and prominent outsiders before any sort of contemporary representation could be made. England held a retrospective exhibition at the Victoria and Albert Museum three years later, 1898, the correct date, with not much more to show in the British Section than the collections sent to the Champ-de-Mars.

Düsseldorf chose the same year for its Centenary Exhibition as Paris (1895–96), and German and Austrian artists played their part in the revival. Hans Thoma and Max Liebermann, Greiner, Unger and Fischer, one woman of power and distinction, Kathe Kollwitz, had revived the traditions of the great days in Germany. A few lithographs were published during its short life by the magazine *Pan* and excellent work has been done at the Pan Printing Press in Berlin. *Jugend* opened its pages to the men of the younger generation, reproducing their lithographs. And a number of other magazines and papers have, with more or less success, looked to lithography for their principal attraction. Belgium has contributed to the chronicles of lithography, and Félicien Rops, Henri de Groux, Emil Claus, Fernand Knopf are among the masters. In Holland, Bauer, Von Hoytema, Van Toroop, Van s'Gravesande, Jacob Maris, Veth, are names to be remembered. In New York the Grolier Club arranged an exhibition in 1896 which probably was an influence in awakening American artists, so long lukewarm. Arthur B. Davies, experimenting in colour, Albert Sterner, George Bellows, Charles Locke, a much younger man, are the most prominent of the too small group of artists who have as yet practised the art in America. J. McLure Hamilton also is an American, but his work has been done mostly in England. Factors in arousing this new interest were the improvement of transfer paper, the use of aluminium plates, the growing tendency of the artist to print his lithographs himself on his own press.

Since 1900 lithography has been more alive and active in England than elsewhere. Public interest dwindled after the Victoria and Albert Museum Exhibition but not the interest of artists. Certain magazines even in the '90s opened their pages to lithographers, whose work may be found in *The Pageant, The Savoy, The Studio, The Magazine of Art, The Art Journal.* But 1907–08



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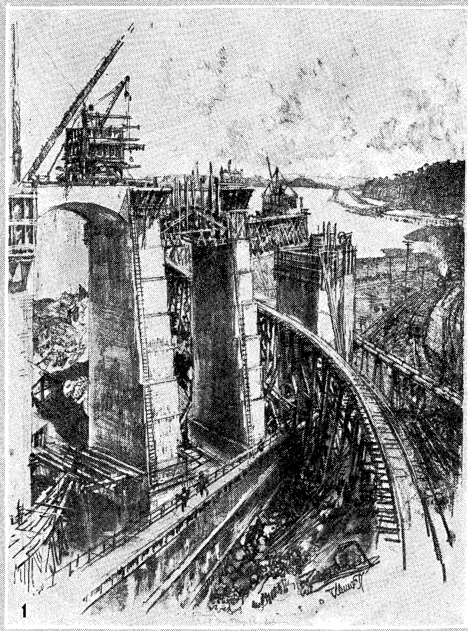
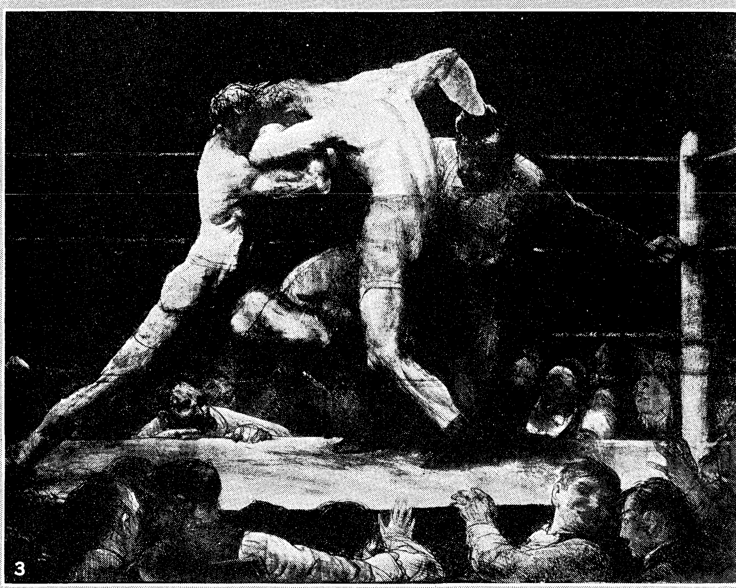
LITHOGRAPHS OF THE 19TH AND 20TH CENTURIES

1. "The Boxers," printed between 1817 and 1821, by Théodore (Jean Louis André) Géricault (1791–1823), French
2. "Christ as a Child in the Temple," 1852, by Adolf von Menzel (1815–1905), German
3. "The Thames," by James A. McNeill Whistler (1834–1903), American
4. "Souvenir de Sainte-Pélagie," by Honoré Daumier (1808–79), French
5. "Il se composa une armée," by Marius A. J. Bauer (1864–1932), Dutch. This is one of a series of illustrations for *La Légende de Saint Julien l'Hospitalier*, by Flaubert
6. "Ils grognaient, et le suivaient toujours," 1836, by Denis Auguste Marie Raffet (1804–60), French
7. "Rome, the Café Greco," 1913, by John Copley (1875–   ), English

LITHOGRAPHY

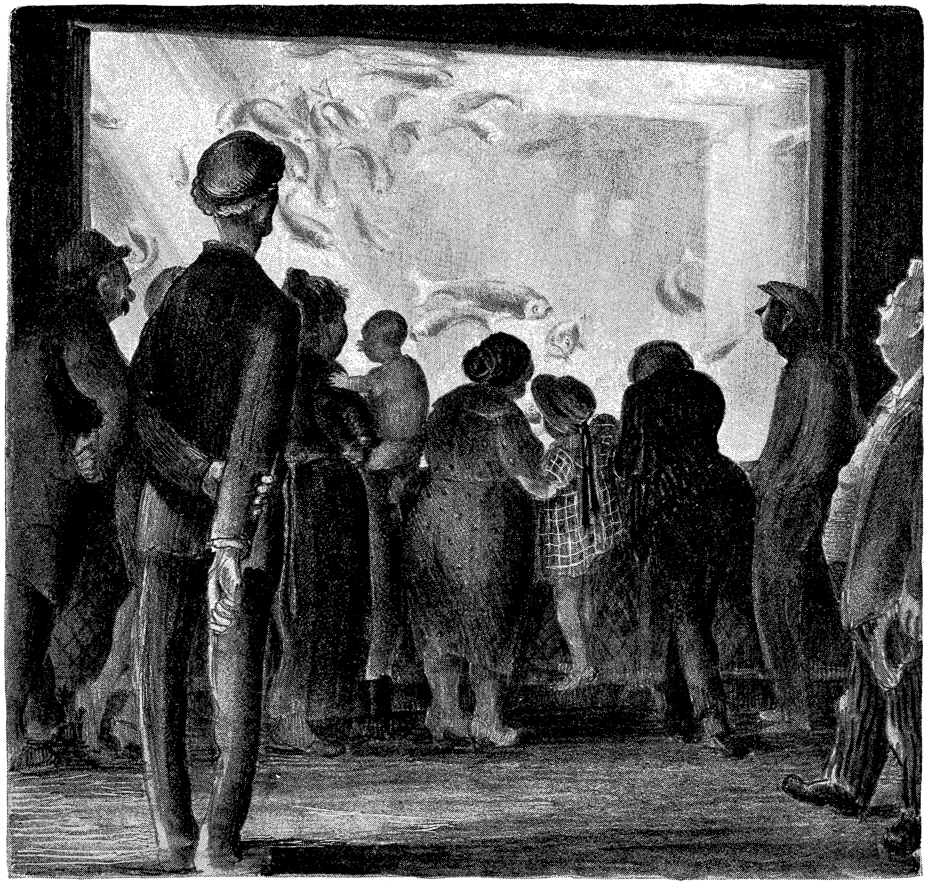




BY COURTESY OF (1) MRS. JOSEPH PENNELL, (2) THE U.S. NAVY RECRUITING BUREAU, (3) EMMA S. BELLOWS, (4) THE TWENTY-ONE GALLERY, LONDON

AMERICAN AND ENGLISH LITHOGRAPHY, 20TH CENTURY

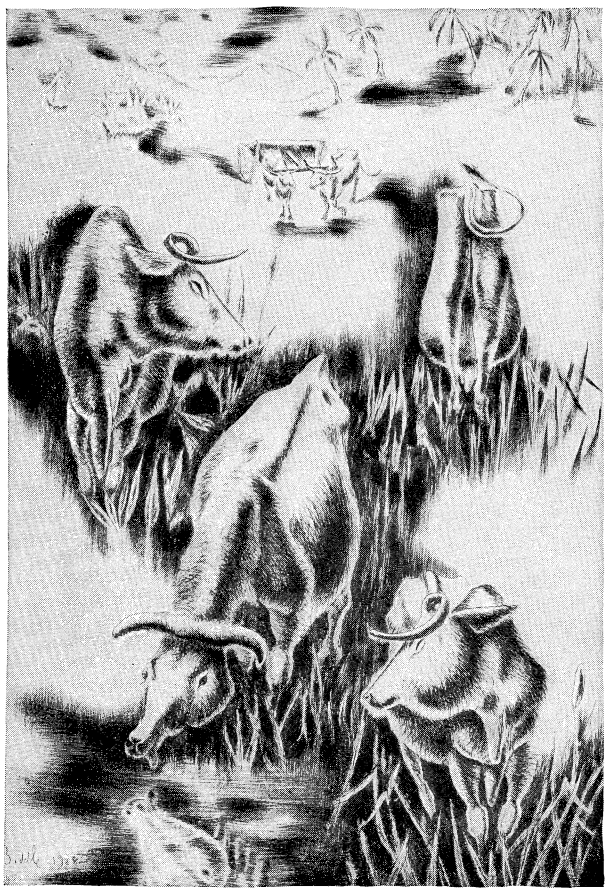
1. "Approaches to Gatun Lock, Panama Canal," by Joseph Pennell (1857–1926), American
2. War Poster by Frank Brangwyn (1867–), English
3. "A Stag at Sharkey's," 1917, by George W. Bellows (1882–1925), American
4. "Hooley's Arches," *c.* 1912, by G. Spencer Pryse (1882–), English

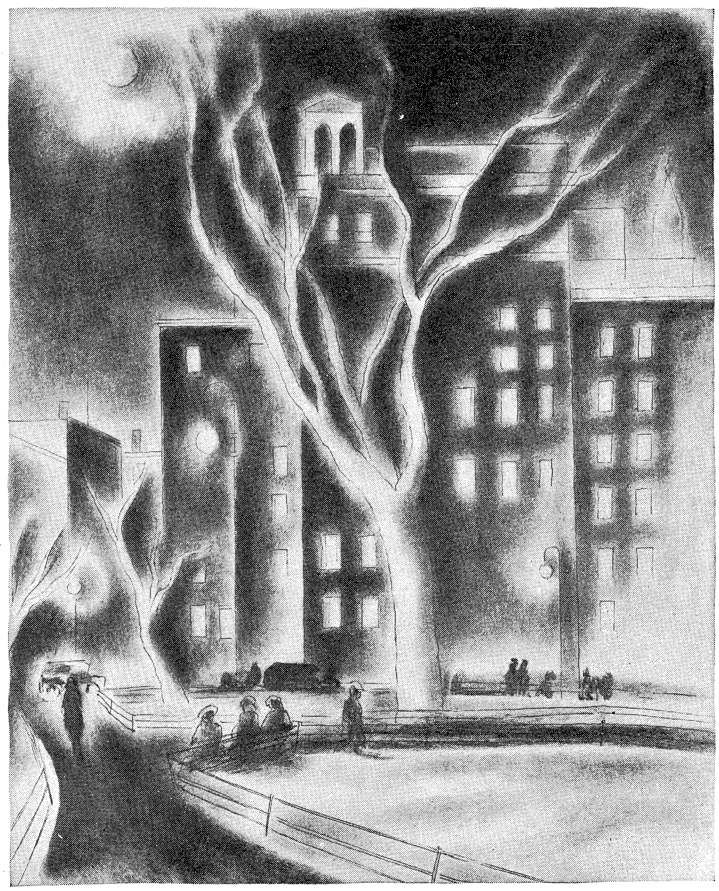


TWO LITHOGRAPHS

1. "Goldfish" by Mabel Dwight, an interesting genre subject taken from the aquarium and showing dark figures silhouetted against a light motif
2. "The Crypt" by Mabel Dwight, showing a suggestive use of black shadows which are cast against a light wall and give relief to the figures

LITHOGRAPHY





THREE MODERN AMERICAN LITHOGRAPHS

1. "Entrance to a Village" by Ernest Fiene. The massing of dark foliage and the angular light areas makes an effective design
2. "Cows" (drypoint on stone) by George Biddle. Strong in design and original in technique
3. "Washington Square" by Ernest Fiene, in which a sense of light is produced by leaving areas exposed, and an impression of mistiness by blurring thin edges

brought the boldest venture of all, *The Neolith,* a quarterly which lithographed text and illustrations alike. It ran for only four numbers. But almost immediately three men associated with it, A. S. Hartrick, F. Ernest Jackson, J. Kerr Lawson, to whose number Joseph Pennell, who had been living in England for years, was promptly added, established the Senefelder Press, which was soon abandoned, and organized the still prosperous Senefelder Club with Pennell as president. The first exhibition was given in the early winter of 1909 and since then annual exhibitions have been held in London and many others throughout Europe and America. Most of the distinguished lithographers of the day became members: J. McLure Hamilton, C. H. Shannon, John Copley its first secretary, E. J. Sullivan, Ethel Gabain, Spencer Pryse, Frank Brangwyn, the second president. The club already in the first quarter of the century did much to restore lithography to its rightful place among the graphic arts, and upon it the future of the art, in a large measure, now rests.

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LITHOGRAPHY: A METHOD OF COMMERCIAL PRINTING

Lithographic printing—variously referred to by such terms as planography, photo-lithography, offset lithography, photo-offset, offset, offset printing, and others—has forged ahead as a leading commercial graphic arts process. Both because of the versatility of the process itself and because of important new adaptations coupled with basic technological advances, its useful field has steadily widened.

Paper, whether it be of smooth or rough finish, paperboard, cloth, leather, metal—even wood—are all successfully lithographed today. Moreover, through the use of decalcomania, a form of lithographic transfer, referred to below, name plates, brand identifications, and a multitude of colourful decorations may be easily applied in instances where direct printing would be impossible and hand painting would be prohibitive in cost.

The earliest known example of lithography produced in the United States was an illustration for the *Analectic Magazine* published in Philadelphia about 1819. The use of the process spread rapidly to Boston and New York. In the early days the lithographic impressions were taken from the original stone on which the design had been drawn by the artist. All designs were drawn backwards so that when the impression was pulled from the stone it became a normal print. Lithographs were printed only in black, on a hand press. All early coloured lithographs were hand-coloured, a slow, expensive procedure and very uncertain as to results.

The important steps in the development of lithography as a method of commercial printing can be described as follows:

Taking a single impression of a subject from a stone on a hand press was a slow process and necessarily limited the output to the speed of an operator. A real advancement was the discovery that transfer impressions could be taken from the original stone on paper coated with cornstarch and gelatine. These were fastened face up on a large sheet of paper in correct position for printing and the sheet of transfers was then placed face down on a large stone and under pressure the impressions were transferred to the stone. Upon removal of the paper the large stone carried several ink impressions instead of one and the printer could now deal with these multiple impressions as a unit. This development increased the market for certain types of labels and small subjects.

The next important development was the introduction of the power press about 1865. Following the first successful experiment, presses increased in size and speed. There was a constantly increasing demand for larger stones, finally reaching the size of approximately 44x64 inches. The speed of the flat-bed or stone press was limited by its reciprocating motion to approximately 600 sheets per hour.

Next came successful experiments with zinc plates, which made possible the development of the rotary press. Whereas lithographic stones were very heavy and could be handled only in a flat-bed press, the thin, light-weight zinc plate could be strapped around a cylinder. The speed of the rotary press was about 1,100 impressions per hour. This doubling of the output of the press substantially reduced the cost and materially increased the market for lithography. Rotary presses were later built to print, from one feeding, two to five colours which further reduced the cost of manufacturing. A special type of high-speed web rotary press was built about 1895 which printed six colours on one side and one colour on the other side of a roll of paper.

The development of the offset press dates back to about 1875, though the press did not come into extensive use until the early part of the 20th century. The earliest use of the rotary offset press was in tin printing. Later on, more or less by accident, it was discovered that a fine offset impression could be taken on paper and, following the usual experimental stage, the lithographic process called "offset" came rapidly into general use.

The stone press has one cylinder which carries the paper as it comes in contact with the stone, the paper and the stone travelling at exactly the same speed. The single-colour, direct-rotary press has twin cylinders, one carrying the plate and the second carrying the paper, both cylinders rotating at the same speed. Thus, the flatbed and direct-rotary presses are examples of direct printing. The offset press has a third or rubber-blanket cylinder. The printing image is first transferred from the plate to the rubber blanket and thence to the paper which travels around the impression cylinder. Modern offset presses deliver in excess of 4,000 impressions an hour on fine-register, colour work.

Offset presses are built in a variety of sizes from 12x17in. to 50x72in. and print from one to four colours from a single feeding. Also, web offset printing—single and multi-colour—is being rapidly developed.

The above outline has touched principally on the development of presses, but quite as important, if not more so, has been the development of technique in making originals and press plates. In the earlier period, all work was drawn or engraved by the artist on stone. Later on, originals were also drawn or otherwise laid down on zinc and aluminium plates. Discovery and development of the process of hand transfer made possible the simultaneous printing of multiple prints. Then came the development of photo-lithography.

While originally all lithographing was done in black only, experiments in printing colours in perfect register were carried to a successful conclusion, and thus was made possible the faithful reproduction of works of art and other subjects. The procedure in making the original drawing for reproduction in colours was quite simple, a separate stone or plate being required for each colour. To insure perfect register, cross marks were placed in the top, bottom, and side margins of each plate. These register marks served to prevent an overlapping of the colours or a misfitting of the lines as the successive colours were printed.

Photography was invented by Daguerre and Niepce about 1840. Experiments were carried on (about 1851) in Paris on sensitized stone and excellent prints resulted. Continual experimentation in the making of lithographic originals by photography resulted in the development of several photographic processes to be used in colour lithography. These had limited use even in the latter part of the 19th century. One of these, the submarine process, is still employed to some extent.

With the development of colour-separation methods in connection with colour filters, the use of the camera for making both originals and press plates increased rapidly until today much the larger volume of colour lithography is known as "process," meaning photographic. Consequently, work which formerly required from eight to ten colours is now done in four or, at most, six. The speed of the camera, and its elimination of many formerly required steps, has expedited preparation of original plates. Letterheads, bank checks, stock certificates, and other items of commercial stationery which were formerly produced from engravings with an etching needle on stone are now produced photographically from pen and ink sketches with no loss of fine detail.

There has been substantial progress in the making of longer-lived and better printing plates. Original drawings on metal are used as press plates only when the subject approximates the full sheet size of the press. Outdoor posters, which are made up of ten or more large sheets, are an example of work that is printed from the original drawings. In general, however, there are three types of press plates in common use—(1) the hand-transfer plate which is made by pulling impressions from the original plate on specially prepared paper for transfer under pressure to the full-size press plate; (2) the albumin plate, and (3) the deep-etch plate. The latter two are photo-mechanical plates. Albumin plates, being less expensive, are generally used for less exacting short runs; deep-etch plates are generally used for the more exacting jobs, particularly those calling for a wide range of tone values, a large number of impressions and a brilliance in appearance. The product from the deep-etch plate is equal in quality to the best turned out by any other method of printing.

A machine, known as a photo-composer, is often used to prepare photo-mechanical press plates on which the same design is duplicated several times. This precision machine is designed to carry a plate up to 56x72 inches. The photographic plate of the subject to be printed is placed in a movable frame which is then manipulated up and down and across the plate according to a predetermined layout leaving impressions in the multiple positions as required. This machine is capable of such precision that successive plates for the same job can be brought into perfect colour register. Another machine, known as the vacuum frame, is also used for making plates for one-colour, photo-lithographic work and for multi-colour work which does not require close register.

Tin Printing, which was introduced about 1875, is the application of the lithographic process to the decoration of metal plate. A substantial percentage of can-label work formerly done by the paper lithographer has in recent years gone to the tin lithographer. Many of the metal containers one sees, some simply and others elaborately decorated, are the product of tin printing.

The method employed is similar to that already described for paper lithography. The press plates are similarly prepared—largely photo-mechanically—and are run on an offset press. Sheets of prepared tin instead of paper are fed into the press and are then oven dried at high temperature, this procedure being repeated for each additional colour required.

Decalcomania is a lithographic process with certain definite variations. The word "decalcomania" is coined from a Greek root meaning literally "decal"—off the paper; "mania"—craze. In other words, a craze for taking or transferring a picture off a paper background onto another surface. The process originated about 1860 in France but other European nations, particularly Germany, were quick to develop it.

One of the distinguishing variations is the fact that decalcomania, unlike ordinary lithography, is printed on a very absorbent, starch- or dextrine-coated paper. This coating material must afford both a smooth printing surface and one that will prevent the inks, lacquers, or varnishes from penetrating into the paper stock. It must also act as an adhesive where the design is printed face up.

Decalcomania is reproduced from lithographic stone, zinc, copper, and, in more recent years, even by a silk or copper screen method. There are three basic types of decalcomania thus produced—"face-up," "face-down," and a combination of the two carrying copy on both sides of the decalcomania.

In the face-up decalcomania numerous white base-coats are first printed, oftentimes eight or ten whites being applied, until a heavy enough body of ink has been deposited on the decalcomania paper to insure a sturdy support for the actual design. It is necessary to dry thoroughly each white impression before applying the succeeding one. After the base-coats have been applied the other colours follow in order.

In the case of a face-down decalcomania the reverse procedure is followed. All of the tints are successively applied and then followed by the other colours shown in the design after which the backings or base-coats are run. This type of transfer requires unusual skill and experience since it is reverse printing. The artist must know beyond any question how each of the following colours will affect the design.

In printing the combination face-down and face-up design, where copy appears on both sides of the decalcomania, all of the operations involved in both face-down and face-up decalcomanias are performed, the face-up design being printed on top of the face-down design. It will be readily understood that to insure correct register in lithographing decalcomanias full control of press-room temperature and humidity is essential.

Decalcomania is used extensively—in the lettering and decorating of commercial trucks and cars, on railway rolling stock and aeroplanes, as vehicle licences affixed to windshields, as interior decorations on the walls of homes, as revenue or tax stamps on certain commodities, as name-plates or decorative designs on all types of manufactured articles, and as window signs for dealer identification. It is successfully applied to wood, metals, rubber, glass, cloth, and plastics.

Originally merely a plaything or novelty, decalcomania is today an accessory in one form or another to almost every important industry. Recent refinements and improvements indicate still greater usefulness for this highly specialized type of lithography.

Recent Developments.—The lithographic industry, as indicated above, has grown appreciably in the last decade or two. This growth must be attributed to improved techniques, equipment, and materials. Offset presses are more accurate, more adaptable and much faster. Offset rubber blankets last much longer than formerly and give far less trouble to the operator. Photographic procedures have advanced rapidly. The paper negatives, now widely used, were unheard of a few years ago. The use of photographic dry plates, instead of the traditional wet plates, is now the rule rather than the exception. Especially significant is the further development of dry plates which have enabled lithographers to develop the dot etching method successfully. Paper and ink manufacturers have kept pace. Speedier presses required faster-drying inks and papers that would meet more exacting demands.

Established in 1924 through the efforts of the Lithographers National Association Incorporated, the trade association for the lithographers of the United States, the Lithographic Technical Foundation has been an important contributor to this forward movement for the two-fold purpose of basic research and education. Outstanding among its efforts to effect improvements and economies in practice are the "deep-etch" method of making press plates, the improvement and standardization of the albumin method of plate making, the development of a substitute for turpentine which is far less harmful to the worker's hands, the development of the paper hygroscope to ascertain the moisture content of a pile of paper, the register rule to compare the dimensions of the image on the plate in colour work and the print of the same on the sheet, and the inkometer for measuring the tackiness of ink.

The task of passing on to the plants the results of technical research—in other words, of putting them to practical use—is one of the responsibilities of the education department of the Foundation. To this end it has developed and offered a variety of educational courses for meeting the varied needs of all types of employees. *Research Bulletins,* issued from time to time, cover new technological developments of interest to lithographers. (*See* COLLOTYPE; COLOUR PRINTING; PHOTO-ENGRAVING.)

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LITHOPONE, a white pigment consisting of a mixture of barium sulphate ($BaSO_4$) and zinc sulphide (ZnS), manufactured in large quantities and used as a substitute for white lead. The essential steps in its preparation are: finely ground barytes (barium sulphate) is calcined at a white heat with coal, coke or charcoal. The BaS thus produced is dissolved from the mass with water and treated by either of two methods: (*a*) a weak solution of $ZnSO_4$ (free from iron) is added in slight excess and the precipitate of $BaSO_4$ and ZnS thus formed is well washed and dried. The crude dry lithopone is calcined at a low red heat, dropped into cold water where it is finely ground and then pressed and dried; (*b*) the BaS is treated with a solution of $ZnCl_2$, producing ZnS and $BaCl_2$. A solution of $ZnSO_4$ is added, precipitating $BaSO_4$. By the fresh addition of BaS solution, the $ZnCl_2$ formed in the latter reaction can be used to precipitate more ZnS. Lithopone is non-poisonous and its cost is only about half that of white lead or zinc oxide. Unlike these latter, lithopone is not discoloured by the H_2S and other sulphurous gases usually present in the atmosphere of all large cities. Unless carefully prepared, due to the presence of impurities, lithopone rapidly darkens in the presence of sunlight. (F. J. G. DU.)

LITHOSPHERE, the solid crust of the earth (Gr. *λίθος*, a stone, and *σφαῖρα*, a sphere). The surface soil, a fluctuating layer of loose earthy material which may extend down for a few hundreds of feet, lies upon a mass of hard rock several miles thick but of varied character and composed mainly of sandstones, mudstones, limestones and various igneous and metamorphic rocks. These two layers form the lithosphere which is constantly affected by the tectonic movements of the solid nucleus below it. Volcanic activity is manifested, mountains are folded, levels change and fresh surfaces are exposed to the cycle of erosion; but through all the changes the lithosphere retains those characteristics which differentiate it from the other spheres of the earth.

LITHUANIA (LIETUVA), a Baltic republic of the soviet union and, for 22 years following the war of 1914–18, an independent state. The people speak the oldest surviving Indo-European language, closely resembling ancient Sanskrit, which, with that of the Letts, comprises the modern remnants of the Aestian or Balt group of languages. In the days of its greatest imperial power the grand duchy of Lithuania stretched from the Baltic to the Black sea and was the last stronghold in Europe against Christianity. Following the union with Poland and the conversion of Lithuania in 1385, Polish influence and language dominated the people for more than 400 years. In 1795 most of ethnic Lithuania was annexed by imperial Russia. Taking advantage of the unstable conditions in eastern Europe following the Russian Revolution, the Lithuanians proclaimed their independence in 1918 and were able to maintain it until June 1940, when soviet troops took over the country. The German army occupied Lithuania 1941–44.

Geography.—Lithuania extends from 53° 53′ to 56° 26′ north and from 21° 3′ to 26° 50′ east. In 1939, after Vilnius (*q.v.*) (Vilna, Wilno) and surrounding territory was ceded to Lithuania, and following the seizure of Klaipeda (Memel [*q.v.*]) by Germany, the area of the republic was 22,958 sq.mi. It is bounded by Latvia on the north, White Russia on the south and east, and the Baltic sea and East Prussia on the west. The country is overlaid with glacial deposits, in some places 400 ft. thick. The typical bottom moraine, with erratics from Finland, extends over most of it, and glacial furrows, striae and elongated troughs run northwest and southeast, as do the eskers. Sand dunes extend along the shores of the Baltic. At one time the region was heavily forested, but in the period previous to the outbreak of war in 1939 only 17% was forested, while 49% was arable, 25% meadows and pastures, 8% turf pits, marshes and swamps, and 1% rivers and lakes. Nearly 2,000 lakes dot the landscape. Lithuania consists chiefly of a low plain watered by the Nemunas (Niemen) and its tributaries. This river system has cut deep valleys in the Baltic hills, which extend roughly from Daugavpils to Kaunas, and empties into Kurisches Haff. In the north numerous streams drain into the Muša river, an affluent of the Aa (Lielupe). The average altitude of Lithuania is 490 ft., with the highest hills being Alsenai (1,112 ft.) and Jakaucizna (961 ft.) in the long-disputed Vilnius area, and Taurapilis (823 ft.).

The climate varies from maritime along the coast to modified continental in the interior. Centrally located Kaunas has an average temperature of 44° F. (Jan., 23.3° F.; July, 65.3° F.), with an average precipitation of 24 in. Four months of the year are usually below freezing and 160 days are rainy, with half of these in late summer. Winds in the summer are predominantly from the N.W., while in the winter they move in from the S.W.

Except for small areas of alluvial soil, principally near the major rivers, most of Lithuania's farmland is low in organic material. The impermeable subsoil and the excess of precipitation over evaporation encourage mould and soil deterioration. Peat bogs have developed in some marshy clay regions, notably in Kobrin and Slanimas, and there are shifting sands in the Pruzenai and Vilkaviškis districts.

Flora and Fauna.—The proportion of Lithuania left in forests is only about half what it was in 1880. The most important trees are fir (40%), pine (28%), aspen (13%), but birch, alder and oak are of some consequence. The great forests are found in the south and east, in the districts of Mariampole and Vilkaviškis.

More than 226 kinds of birds, 35 kinds of wild animals, 12 kinds of amphibians and 7 kinds of reptiles are native. Especially common are rabbits, foxes, wolves, badgers, squirrels, deer, wild hogs and otters. World War I brought about a change in the Lithuanian fauna, with elk, beavers, grouse and black stork becoming almost extinct. More than 40 species of fish can be enumerated in the fresh waters, while Kurisches Haff is rich in brill, trout, whiting, smelt, sole and herring.

Natural Resources.—Although the natural resources have not yet been thoroughly prospected, geologists believe there are no commercial metals, oil or coal. Underdeveloped peat fields, chalk for cement and lime, clay for ceramics, some amber near the East Prussian frontier, and small quantities of quartz have been produced in commercial quantities. There are sulphur springs at Birstonas and brine baths at Druskinikai which contain radium.

Population.—Soviet Lithuania in 1941, including ceded Vilnius districts but excluding Klaipeda, had an estimated population of 2,879,070 and a density of 125.4 per sq.mi. Both the birth rate, 24.8 in 1934, and the death rate, 14.6, showed declining trends. Under 1937 territorial conditions the people were about 81% Lithuanian, 7% Jewish, 4% German, 3% Poles, 2% Russian, White Russian, and 3% Tartars, Letts and others. Acquisition of Vilnius considerably increased the Jewish element. About 80% was Roman Catholic and 5.5% Lutheran; 76.8% lived on isolated farms, and only 15.8% in communities of 2,000 or larger.

Capital and largest city was Vilnius, pop. (est. 1941) 210,000. Other important centres were Kaunas 120,000; Gardinas (Grodno) 51,000; Šiauliai 27,000; and Panevežys 25,000.

Emigration.—During the era of independence the rate of emigration fell to about half its pre-1914 level, averaging 5 per 1,000. It is estimated that a third of the Lithuanians had moved abroad in the 50 years preceding World War I, primarily because of the famines of 1850 and 1867, the insurrections of 1863 and 1905, and the 1874 military service law.

Until the United States applied restrictive legislation in 1924, the bulk of the Lithuanian migration was to American coal mining districts and industrial cities, but by 1930, 80% of the emigrants were settling in Brazil and Argentina, with growing numbers moving to South Africa and Palestine. In 1930 more than a quarter of the emigrants were Jewish.

Although only 193,606 registered as Lithuanians in the 1930 U.S. census, nationalist sources place the figure as high as 750,000. Their rate of naturalization was then 25.6%, and their rate of illiteracy, 24.5%. In addition to a number of Lithuanian cultural and religious movements, many schools have been established, including Marianopolis college and high school in Thompson, Conn. Approximately 80,000 Lithuanians have settled in the United Kingdom, especially in the mining districts of Scotland.

HISTORY

Archaeologists have found evidence that in Neolithic times (3000–1500 B.C.) people closely resembling present-day Lithuanians were living near the shores of the Baltic sea and had reached a relatively high state of culture. But other scholars, studying the close linguistic tie between Lithuanian and Sanskrit as well as the ancient folklore, believe the Lithuanians migrated to their present home about the time of Christ, presumably from the upper reaches of the Dnieper river. Earliest historical records are found in Tacitus, Roman historian of the 1st century A.D., and

Ptolemy, Greek geographer in the following century.

Formation of the Empire.—As early as the 5th century a shadowy theocratic federation was formed among some of the pagan Lithuanian tribes, but not until after 1230, when the Teutonic Knights moved into East Prussia, did the almost isolated tribes band together. Under their leader, Mindaugas (Mindove, Mendog), an effective military organization was built, and in 1251 he and his family were baptized. Two years later he was crowned the first and only king in Lithuanian history by the authority of Pope Innocent IV. But before Mindaugas' death in 1263, during a campaign against the Knights, he had repudiated Christianity and had even sacrificed his prisoners to his ancient gods.

Gediminas (Gedymin [*q.v.*], Gedimin), 1316–1339, was the first great empire builder. In 1321 he took Kiev; in 1323 he founded Vilnius; in 1325 he married his daughter to the prince of Poland. He wrote to Pope John XXII offering to accept Christianity by agreement with him, but the Knights and the Poles objected because they were seeking political as well as spiritual domination. Gediminas introduced western civilization into the grand duchy, granted local autonomy, and made White Russian the official language. Ablest of the dynasty was Algirdas (Olgerd, Olgierd [*q.v.*]), 1345–1377, who ruled with his brother Keitutas (Keijstut). Though at constant war with the Knights, he succeeded in spreading the Lithuanian empire from Vitebsk on the Dvina, Mogilev on the Dnieper, Bryansk on the Desna and the coast of the Black sea from the Dnieper to the Dniester. Before he became a Christian and died as a monk, Algirdas had ruled over 350,000 sq.mi. His son, Jagela (Jagellon, Jagello, Jagiello), succeeded him, and after making a deal with the Knights, killed Keitutas.

Union with Poland, 1385–1795.—The Polish barons and prelates were largely responsible for the Union of Krevo (Krewo) of Aug. 15, 1385, which created an essentially dynastic union between their country and the grand duchy of Lithuania. The Polish queen, Jadwiga (Hedwig), reluctantly married Jagela; Lithuania established the Roman Catholic church; and Jagela was crowned Wladyslaw V (or Ladislas II) of Poland. In Lithuania, Vytautas (Witold, Witowt), son of Keitutas, escaped from Jagela's prison, rallied the nobles, and in 1392 was elected Lithuanian grand duke. His armies fought enemies on all sides, but they achieved their greatest success on July 15, 1410, at Grünewald near Tannenberg, when with Polish, Russian, Czech and Tartar allies, they decisively and finally crushed the German Knights. A crown for Vytautas from Emperor Sigismund was being held up by the Poles when he died in 1430.

The Lithuanian-Polish union was confirmed by the pacts of Vilnius in 1401 and 1434, of Horodlo in 1413, of Gardinas in 1501 and 1512, and Lublin in 1569. This last union also ceded large sections of Lithuania to Poland, doubling its size. From 1501 onward the Lithuanians and Poles were ruled by one sovereign, and from 1569 had a common legislature. The Lithuanians, though sometimes anxious to break away, sank into a state of dependence. Polish language was used by all but the lower classes. Polish laws and customs were adopted. The kings, in order to secure succession, bargained away their rights and eventually became mere puppets for the national assembly (*Sejm and Rada*), which itself was impotent because of the *liberum veto*. Subsequently the dual state was involved in a common downfall, and in the third partition of 1795 ethnic Lithuania fell to Russia except for Suvalkai, which went to Prussia.

Russian Rule and the Renaissance, 1795–1918.—Under Tsar Paul I considerable autonomy was granted to the ceded territories, but Alexander I revoked most of these privileges. When Polonized Lithuanian nobility took part in the Polish rebellion of 1830, Nicholas I retaliated with a ruthless policy of Russification. Russian was made the official language, Polish was proscribed. All monasteries were closed, the number of schools was cut from 394 to 94, even the name "Lithuania" was lost in the new "Northwest Territory." The policy was further extended after the great rebellion of 1863. Muraviev, the governor-general, made religion the test of nationality. He exiled 9,000 of the revolutionists, imported Russians to fill government offices, closed the Roman Catholic schools, and forbade the use of the Lithuanian language in any printed form.

The only real Lithuanian intelligentsia was an extremely small group of *émigrés* and some of the lower clergy. *Aušra* (Dawn), a nationalist paper established in 1883 by Dr. Jonas Basanavičius and printed in Lithuanian, was smuggled in from Tilsit, East Prussia. *Varpas* (Bell), inaugurated six years later, was active until the 1905 revolution. At the turn of the century arose the Social Democrat movement, which was centred almost exclusively in the towns among the White Russians and Jews. The Lithuanians, increasingly conscious of their nationality, joined the 1905 revolution. The Ukase of Oct. 22 granted them free speech, free assembly and right to call a congress at Vilnius. Two months later when this congress met under Basanavičius, it demanded autonomy for Lithuania, the restoration of ethnic frontiers and of the historical capital of Vilnius, and the use of the Lithuanian language in the schools. As the tsardom regained strength, this movement collapsed, though it had at least succeeded in removing the ban on the use of Lithuanian. Subsequently even the electoral franchise for the duma was unfavourable to the Lithuanian nationalists. Russian progressives who favoured autonomy for Poland did not contemplate it for Lithuania.

Era of Independence, 1918–1939.—The German armies which occupied Lithuania in Sept. 1915 remained for more than three years. Requisitioning and destruction were heavy. The use of Lithuanian was severely restricted. Even during the early months of occupation a secret nationalist committee of five was formed, composed of A. Smetona, J. Savlys, Stankevičius, S. Kairys and P. Klimas. German officials, with virtual annexation to Germany as a condition, finally agreed to permit a Lithuanian conference to meet in 1917. This group elected a 20-person national council (*Taryba*) under the leadership of Antanas Smetona, which proclaimed Lithuanian independence, Feb. 16, 1918. The same proclamation agreed to "special relations" with Germany in return for recognition. The crown of Lithuania was subsequently offered to Wilhelm von Urach, a Württemberg duke supposedly related to Mindaugas, but the offer was withdrawn in November. The provisional constitution, adopted in Oct. 1918, vested supreme power in a three-man presidium, which included A. Smetona, who became provisional president in April 1919. Professor Augustinas Voldemaras formed the first cabinet on Nov. 11, 1918.

The newly formed Lithuanian army drove out the Bermondt-Avalov "free corps," but the Poles and Bolsheviks continued to battle through southern and eastern Lithuania. With boundaries still unsettled, the Constitutional assembly met May 15, 1920. Of the 112 delegates, 59 were Christian Democrats, 29 Populists, 14 Social Democrats, 6 Jewish, 3 Polish and 1 German. July 12, 1920 the treaty of Moscow was signed with the Russians recognizing Lithuanian claims to a large portion of Vilnius and Gardinas districts and granting indemnities to Lithuania. On Oct. 7 the Lithuanian-Polish boundary seemed settled when the treaty of Suvalkai was signed, using approximately the Curzon line and granting Vilnius to Lithuania. But two days later the supposedly freebooting army of Gen. Lucian Zeligowski occupied the Vilnius district and set up an independent government, and necessitated the moving of the Lithuanian capital to Kaunas. Subsequent evidence seems to show that this expedition moved under orders from Polish chief-of-state Pilsudski. The council of the League immediately took steps to settle this dispute, but after a futile series of proposed solutions had been offered and after Vilnius had officially been incorporated into Poland in March 1922, the conference of ambassadors on March 15, 1923 accepted the *coup de main*. Full diplomatic and commercial relations were not reestablished between Poland and Lithuania until 1938.

Imitating the Poles, the Lithuanians in Jan. 1923 moved an army in civilian clothes into Klaipeda, which was under a temporary inter-Allied control, and on Jan. 15 formally took over the district. The conference of ambassadors agreed to the union within a month and on May 8, 1924, in Paris, signed a convention setting up Klaipeda as an autonomous unit under Lithuanian sovereignty. Although the German population was slightly greater than the Lithuanian, access to the non-German hinterland almost doubled the trade of Klaipeda. Germany granted Lithuania *de jure* recognition March 23, 1918; soviet Russia on July 12, 1920. France and England did not follow suit until Dec. 1921. The United States delayed until July 25, 1922. Lithuania became a member of the League of Nations on Sept. 22, 1921.

Following a cabinet shift in May 1926, bringing to power a coalition of Socialists, Populists and the national minorities, soviet friendship began to grow. When the Lithuanian-Russian Security pact was signed Sept. 28, the British responded with a temporary financial blockade. By means of a *coup d'etat* on Dec. 17 the Smetona-Voldemaras group took over the government with but 20% of the *Seimas* supporting them (Nationalist and clerical parties). Opposition parties were eliminated and civil liberties curtailed. The constitution of Aug. 1922 was rewritten for the new situation and promulgated on May 15, 1928.

On Jan. 29, 1928, G. Stresemann and A. Voldemaras signed a German-Lithuanian protocol agreeing to conciliate or arbitrate all difficulties between the two countries. In Feb. 1929 Lithuania joined Latvia, Estonia and Poland in signing the Litvinov protocol in Moscow. A long contemplated Baltic pact was completed Sept. 13, 1934 between Estonia, Latvia and Lithuania.

In Sept. 1929 discontent broke out in the dictatorship and Smetona expelled Voldemaras and suppressed his fascist "Iron Wolf" organization. Voldemaras' attempt to return to power in 1934 was effectively thwarted. A third constitution of May 1938 further increased the power of the president.

Poland, taking advantage of the confusion created by German seizure of Austria in 1938 and the shooting of a Polish soldier who had wandered across the frontier, sent an ultimatum to Lithuania demanding establishment of normal relations and the acceptance of the Vilnius cession to Poland. On March 17 the Lithuanian government agreed to accept the terms. A year later, March 22, 1939, after a similar ultimatum incident, Germany seized Klaipeda, the centre through which passed annually three-quarters of Lithuania's exports and two-thirds of her imports. Five days later a new cabinet, composed of the leaders of the banned opposition parties, formed a ministry under General Jonas Černius, formally announcing U.S.S.R. friendship, but with Smetona riding out the change as president.

In the Vortex of World War II, 1939–1944.—After the loss of Klaipeda events moved with devastating rapidity for Lithuania. World War II brought German and Russian armies into Poland in Sept. 1939, and intensified the whole Baltic situation. On Oct. 10 Lithuania signed a pact granting the U.S.S.R. garrison privileges in the country and gaining in return the city and district of Vilnius. In November, however, all Lithuanians were forced to leave Klaipeda. Precarious independence was maintained until June 1940, when Premier Antanas Merkys went to Moscow "to conduct negotiations," and was joined by Juozas Urbsys, foreign minister. On July 14, after opposition had been quieted by protective arrests, the people voted for inclusion in the soviet union; on Aug. 3, Lithuania was admitted formally as the 14th soviet republic. Some 82,000 additional people in the Vilnius district were added to the new republic. President Smetona fled and some 12,000 Jews and war refugees set out for New Guinea via Japan. Reports indicated that during the following year thousands were deported to the east as sovietization continued. Great Britain and the United States refused to recognize the new regime, froze Lithuanian assets, and allowed the old legations in London and Washington to remain.

On June 23, 1941, the day after the German attack on Russia, the Lithuanians staged a revolution and declared independence. The German army reached Kaunas, June 24, but the peoples' hopes in a Germanic liberation were soon dashed. The minister to Berlin, Col. K. Škirpa, was elected prime minister, but he was kept in custody by the nazis. Hence, Juozas Ambrazevičius became chief minister. On July 17, 1941, Hitler announced creation of the "Ostland," including the three Baltic states and White Russia; Heinrich Lohse was named reichscommissar, and Adrian von Renteln became commissioner-general for Lithuania. The position of the provisional government was by this time utterly untenable and it resigned on Aug. 5. On Aug. 10 a national ceremony was held at the tomb of the Unknown Soldier, and thereafter the nazis were left in complete control. The reichscommissar promised "order . . . construction and civilization . . . a supervised economy," but reconstruction was obviously slow. A few Dutch and Danes were colonized, but the sovietized lands were retained by the state, and on March 17, 1943, Lohse proclaimed that individuals could regain land only if they participated in the "war against bolshevism." Universities were closed, and the nazi library "revision" took 27,000 volumes out of two Kaunas libraries, 23,000 from the university library and 40,000 from the Academy of Sciences in Vilnius. In 1943 some 100,000 Lithuanian labourers were reported to be in Germany; demands for troops caused thousands of men and boys to flee to the woods and become guerrillas. The general Russian offensive swept into the country by the summer of 1944 and by mid-October all of Lithuania was retaken. Some Lithuanians welcomed their "communist brothers"; others fled with their "nazi" comrades. Lithuania itself had been devastated in the fighting and much of its Jewish population was said to have been slaughtered. The country was re-established as a soviet republic.

Education.—Until the marriage of Grand Duke Zigmantas (Sigismund I, 1506–48) with the Italian princess, Bona Sforza, brought merchants, artisans and humanist scholars to Lithuania, there was no organized education. The later rivalry between the Protestants and the Catholics brought a rush of school building and the entrance of the Jesuit order. The Vilnius academy (est. 1578) became the centre of the cultural life. Following the rebellion of 1831 all the Catholic schools were closed, leaving only three large Orthodox Russian seminaries open. Not until after the revolution of 1905 was teaching of the Lithuanian language permitted. By 1914 there were more schools in the Baltic area than in any other section of Russia.

Compulsory education was not introduced in the independent republic until 1930, largely because of the lack of trained Lithuanian-speaking teachers. By 1939 Lithuania had 2,335 primary schools, 27 secondary schools, 56 gymnasiums, 5 teachers' training colleges, 21 special advanced training schools and 126 special craft schools. Approximately 250 of the primary schools were established for the benefit of minority groups. Agricultural education was a part of the usual curriculum. University of Vytautas the Great, which was moved from Vilnius and re-established in Kaunas in 1922, had 292 professors and lecturers in 1938 and 3,141 students. There was also an Academy of Agriculture in Dotnuva, Veterinary academy in Kaunas, Institute of Commerce in Klaipeda, Conservatory of Music in Kaunas, School of Arts in Kaunas and Institute of Education in Klaipeda. In 1940 several faculties from the university in Kaunas returned to Vilnius. Illiteracy in 1939 was only 15% of those over 10 years of age, about half the average of 1910–14.

Defense.—The army of independent Lithuania was established during the closing months of 1918 to drive out Bolshevik, German and Polish troops. During the following year an officers' school was established and compulsory military service for all able-bodied men over 21 years of age was instituted. Eighteen months became the usual period of service. Officers were recruited from the military academy (2- or 3-year course), and it was the custom to send 10 to 15 young officers to French, Belgian and Czechoslovakian military schools. The budget effectives numbered about 25,000, including 1,500 officers. The regular army was supplemented by a powerful voluntary riflemen's association (*Šauliai*), organized by districts, with about 55,000 men. The 380-ton former German minesweeper, "Prezidentas Smetona," was the only vessel in the Lithuanian navy and was acquired in 1928 primarily to suppress smuggling.

ECONOMICS AND FINANCE

When independence in 1918 cut off Lithuanian trade with Russia, a fortunate new market was found in Germany. Economic relations between these two countries remained thriving until after 1933 and the magnification of the so-called Memel Question, when increasingly the trade shifted to Great Britain.

Imports and Exports.—Although Lithuania has almost al-

Import and Export of Merchandise

	Value in millions of litai					
	1934	1935	1936	1937	1938	1939
Import	139	129	156	213	224	169
Export	147	152	190	208	233	203
Balance	+8	+23	+34	−5	+9	+34

ways maintained a favourable balance of trade, the total volume of trade showed little tendency to grow. In the face of economic warfare, the government as early as 1932 introduced an import licensing system; in 1935 it was forced to manage the export of currency in order to maintain gold currency coverage; and eventually it virtually monopolized foreign trade through three government-dominated agencies: Maistās, Pienocentras and Lietukis.

The principal items of export by value were butter, live pigs, flax and tow, eggs, poultry, beef, timber, cheese, skins and hides, and wood pulp. The chief imports were cotton and wool cloth and yarn, coal, fertilizers, iron, machinery, liquid fuels, cement, chemicals, sugar and salt.

Distribution of Trade

	Percentage of total trade											
	1923		1926		1929		1932		1935		1938	
	Exp.	Imp.	Exp.	Imp.	Exp.	Imp.	Exp.	Imp.	Exp.	Imp.	Exp.	Imp.
Germany	43.3	80.9	45.8	53.6	59.4	49.3	39.1	40.3	3.6	11.4	26.8	24.5
Great Britain	26.9	5.3	24.6	8.0	17.4	8.5	41.4	10.8	45.6	37.2	39.4	30.9
U.S.S.R.	—	—	.1	.1	—	4.3	3.5	6.1	8.6	10.6	5.7	6.7

Currency and Banking.—The litas, the monetary unit of Lithuania, equalled 100 centas, contained 0.150463 grams of fine gold, and was related to the U.S. dollar (10 litai to a dollar). After dollar devaluation in 1933 the exchange rate was 6 to 1. The soviet government in 1940 substituted the ruble for the litas.

The Bank of Lithuania, established in 1922 as a mixed corporation to serve as a bank of issue, had assets in 1940 of 318,695,503 litai with 175,783,750 litai of notes in circulation. In addition, 8 other banks in Lithuania proper (excluding Vilnius) and 14 mutual credit societies had an aggregate capital of 75,000,000 litai. Co-operative credit societies, especially prevalent among the Jewish population, accounted for an additional 13,000,000 litai capitalization. Under soviet occupation all savings accounts of more than 1,000 litai were confiscated.

Government finance was conservative. The national debt in 1939 was 134,000,000 litai or only 47 litai per capita. The budget, though growing, was traditionally balanced, and in 1939 had a surplus of more than 5,000,000 litai over expenses of 356,000,000 litai. Yield from government and mixed enterprises was a prominent source of revenue. Communications, education and agriculture accounted for three-quarters of the state expenses.

Agriculture and Land Legislation.—Mediocre waterlogged soil and insufficient capital for its development were handicaps to Lithuanian agriculture, but the extensive government program of education, communications and indirect subsidy did much to improve conditions. In tsarist times nearly 40% of the land was held in large estates, but soon after independence the provisional government instituted reforms, which were followed by the Fundamental Agrarian Law of 1922. This confiscated with compensation the portion of estates greater than 197.7 ac. (with a few exceptions); all land seized by the Russian government after 1863; and all commercially-sized forests, peat bogs and mineral claims. The farm land was distributed to landless farm labourers and small landholders, with the head of each family receiving no more than 49.4 ac. By 1936 only 3% of the land remained in estates larger than 197.7 ac. and but 10.6% was operated by nonowners; 45,000 new farms had been established. Under soviet rule all land was nationalized and the former owners were made managers, and each farm was limited to 74 ac. Collectivization was encouraged and most of the farms greater than 197.7 ac. were directly controlled through commissars. The Germans restored the right of ownership but not the confiscated land.

Lithuania is best suited for stock raising. In spite of losses averaging 40% of all the livestock during World War I, the losses were more than made up by 1925. Export of livestock and dairy products climbed from 26.1% of the total value of exports in 1924 to 61.4% in 1939. Butter production expanded tenfold. Pigs became more numerous (1,117,180 in 1938) while cattle were falling off (1,103,550). Scientific animal husbandry and breeding progressed slowly. Sheep, horses, geese and poultry were also important.

Cereal, leguminous and root crops are grown successfully, although the grain is only of fair quality and often must be artificially dried. Winter rye and oats are the most popular crops and occupy about one-third of the arable land. Because of primitive cultivation methods, nearly 15% of the land lies fallow each year. Foreign market demands greatly encouraged wheat production and made Lithuania the third most important flax exporting country in Europe. Co-operatives have been the backbone of agricultural life and stem from the 18th century. By 1939, 401 dealt with credit, 275 with consumer goods, 224 manufacturing, 2 insurance and 430 miscellaneous. The Central Union of Agricultural Co-operatives (Lietukis, est. 1923) united more than 100 local societies and 20,000 members. Through it most of the grain, flax and leguminous crops were exported; and fertilizer, salt, liquid fuel and agricultural machinery imported. In 1926 the dairying societies withdrew, forming the Central Union of Dairy Co-operatives (Pienocentras), which handled almost all milk, butter and eggs for export. In 1926 Lietukis secured 45% of the capital stock of Maistas, in which the government also had a large interest, a company slaughtering and exporting nearly all Lithuanian livestock. The soviets made these organizations government agencies with monopoly rights in their special fields.

Industry.—Including Klaipeda, where half the industry was located, only 6.43% of the Lithuanian working population was engaged in industry and handicraft. Food processing exceeded all others in value (223,400,000 litai), but woodworking, textiles, clothing and metal industries were of some importance. In the period of independence labour unions were superseded by a government-sponsored workers' organization. Disputes were settled by a commission of three; one from this organization, one from government and one from the chamber of commerce. Strikes were uncommon. Government factory inspectors checked on conditions and wages, and supervised the compulsory health insurance program. The average wage for unskilled workers in Kaunas (1934) was 5.3 litai per day.

Communications and Transportation.—In 1920 Lithuania had only one-fifth the railroads and one-twentieth the highways of neighbouring East Prussia. Total railroad mileage in 1937, 1,085 mi., was only about 100 mi. greater than for 1923. Government operation had shown considerable profit. Through use of farmer aid, the highway system was expanded to 20,426 mi., but only 8 mi. were macadamized and 1,193 gravelled. The 417 mi. of navigable waterways, principally the Nemunas and Neris, carried considerable trade. The merchant marine was negligible. In 1938 there were 26,591 telephones, 2 broadcasting stations and 53,667 radios.

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(F. D. S.)

LITHUANIAN AND LETTISH LITERATURE. The literary history of the Lithuanians and Letts dates from the Reformation and comprises three clearly defined periods. (1) Up to 1700, when the chief printed books were of a liturgical character. (2) During the 18th century, when a vigorous educational movement began, dictionaries, grammars and other instructive works were compiled, and written poems began to take the place of songs preserved by oral tradition. (3) When the revival of national feeling at the beginning of the 19th century resulted in the establishment of newspapers and the collection and publication of the national folk-poetry. In both literatures, works of a religious character predominate, and both are rich in popular ballads (*dainos*), folk-tales and fables.

The first book printed in Lithuanian was a translation by Mažvydis of Luther's shorter Catechism (Königsberg, 1547); other translations of devotional or liturgical works followed, and by 1701 59 Lithuanian books had appeared, the most noteworthy being those of the preacher J. Bretkun (1535–1602). The spread of Calvinism led to the publication, in 1701, of a Lithuanian New Testament. The first dictionary was printed in 1749. But perhaps the most remarkable work of the second period was *The Four Seasons,* a pastoral poem in hexameters by Christian Donalitius (1714–80), which was edited by Nesselmann (Königsberg, 1869) with a German translation and notes. In the 19th century various collections of fables and folk-tales were published, and an epic, the *Anykščiu Šilelis* ("The Grove of Anykščiai"), was written by Bishop Baranauskas-Baronas. A very famous name is that of Dr. Vincas Kudirka, who wrote both the words and music of the Lithuanian national anthem. He died in 1899. But it was in journalism that the chief original work of the third period was done. F. Kelch (1801–77) founded the first Lithuanian newspaper, a Protestant religious monthly published at Königsberg; and between 1834 and 1895 no fewer than 34 Lithuanian periodicals were published in the United States alone.

Among the more prominent later writers was Jonas Mačiulis (1862–1932), better known as Maironis, popularly styled the "Poet Prophet of the Lithuanian Renaissance," distinguished alike for his dramatic, epic and lyrical poetry. His best-known lyrics are "Voices of Spring," "Young Lithuania" and "Our Sufferings." W. St. Vidunas, born in Lithuania Minor in 1868, is another deeply revered scholar, philosopher, poet and dramatist. Jurgis Baltrušaitis has won fame both as a Lithuanian and a Russian lyric poet of the very first rank. Of the younger men one of the most talented and original is V. Krevé-Mickevičius, who deals with essentially national themes in both prose and poetry. His greatest work in this connection is the historical drama "Skirgaila." Several women also have achieved well-deserved distinction in Lithuanian literature, notably Marija Pečkauskaité (1878–), who writes under the pen-name of the "Witch of Šatrija"; Sophie Ciurlioniené, the realist playwright, and the late Sofija Pšibilauskiené (pen-name, "The Owl of Lazdynai").

Of late western influence has made itself felt, but the inspiration, themes and methods of expression are for the most part fundamentally Lithuanian.

Luther's Catechism (Königsberg, 1586) was the first book printed in Lettic, as in the sister speech. In the 17th century various translations of psalms, hymns and other religious works were published, the majority being Calvinistic in tone. The educational movement of the 18th century was inaugurated by G. F. Stender (1714–96), author of a Lettic dictionary and grammar, of poems, tales and of a *Book of Wisdom* which treats of elementary science and history. Much educational work was subsequently done by the Lettic Literary Society, which publishes a magazine (*Magazin,* Mitau, from 1827), and by the "Young Letts," who published various periodicals and translations of foreign classics, and endeavoured to free their language and thought from German influences. Somewhat similar tasks were undertaken by the "Young Lithuanians," whose first magazine the *Auszra* ("Dawn") was founded in 1883. The famous name of the late Dr. Jonas Basanavičius is closely associated with this publication. From 1890 onwards the literature of both peoples was marked by an ever-increasing nationalism; among the names most prominent during this period may be mentioned those of the dramatist Steperman and the poet Martin Lap, both of whom wrote in Lettic.

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LITHUANIAN LANGUAGE. The Lithuanian language belongs, with Lettish and the extinct Old-Prussian language, to the Baltic branch of the Indo-European family. It has preserved until the present day the phonetic system of the hypothetical Indo-European parent-speech with such fidelity as to play a very important rôle in the study of the past history of the other Indo-European languages. It is written in the Latin alphabet, but without *f, h, q, w, x* (*f* and *h* occur in words borrowed from other languages), and with the addition of the following: *č* (=*ch* in *church*), *ē* or *ė* (=*ay* in *pay*), *ū* (=*oo* in *moon*), *š* (=*sh* in *shoot*), *ž* (=*j* in French *jour*). The approximate values of the remaining vowel-letters are: *a* as in English *father, e* as in *bet, where, i* as in *bit, o* as in *go, u* as in *put, y* as *ee* in *seen:* of the remaining consonant-letters, *p, t, k, b, d, g* and *v* are pronounced as in English (*g* always hard as in *get*); *c* is pronounced *ts; s* as in *so; z* as in *zero; j* as *y* in *yet.*

The relation between the phonetic system of the parent Indo-European speech, as reconstructed from Latin, Greek, Sanskrit and the other Indo-European languages (including Lithuanian) and that of Lithuanian is outlined in the following table:—

I.–E.	a	e	o	i	u	ā	ē	ō	ī	ū	p	t	b	d	bh	dh
Lith.	a	e	a	i	u	o	ē	uo	y	ū	p	t	b	d	b	d.

I.–E.	k	ĝ	ĝh	k^w	g^w	g^wh	r	l	m	n	y	w	s
Lith.	š	ž	ž	k	g	g	r	l	m	n	j	v	s

Examples (the words quoted in brackets from cognate languages have in many cases preserved the Indo-European sounds unchanged): *ašis* "axle" (Lat. *axis*), *esti* "is" (Greek *esti*), *avis* "sheep" (Lat. *ovis*), *šuns* "of a dog" (Gr. *kunos,* Sanskrit *śunas*), *moteri* (acc. sg.) "woman" (Gr. [Doric] *mātera*), *mēnesi* (acc. sg.) "month" (Lat. *mēnsem*), *duoti* "to give" (Lat. *dōnum*), *vytis* "willow twig" (Lat. *vitis* "vine"), *pūti* "to rot" (Lat. *pūs* "pus"), *bulis* "buttock" (Skt. *bulis*), *danti* (acc. sg.) "tooth" (Gr. *odonta*), *bijotis* "to fear" (Skt. *bhayate* "he fears"), *dūmai* (pl.) "smoke" (Skt. *dhūmas*), *paršas* "pig" (Lat. *porcus*), *žirnis* "pea" (Lat. *grānum,* Skt. *jīrṇas* "pounded," Engl. *corn*), *vežu* "convey in a cart" (Lat. *veho*), *katras* "which" (Skt. *kataras,* Greek *poteros*), *gija* "thread" (Skt. *jiyā* "bow-string," Gr. *biós* "bow"), *ginklas* "weapon," *genēti* "to prune" (Skt. *hanti*=Hittite *kuenzi,* "he kills" [also "he strikes"], plur. Skt. *ghnanti*=Hittite *kunanẓi* "they kill" [or "strike"]).

Each word has one stressed syllable, the position of which is not determined by any simple general rule, but may be different even in different inflections of the same word. The stressed syllable may be long or short: if long it will have either the acute accent or the circumflex, if short the grave accent. The accents are not written by the Lithuanians; they were not recorded on a great scale until the Lithuanian Kuršaitis (Friedrich Kurschat) marked all the words in his grammar (1876), dictionary (1868–74, 1883) and New Testament edition with the three signs (´), (˜) and (`). The distinctions of which these three marks are the written signs are not in all cases easily audible by a foreigner, but their reality is proved by the absence of any serious contradiction between the testimony of Kuršaitis and that of other native observers. The available data were analysed by the Russian Philip Fortunatov (died 1914) and the Swiss Ferdinand de Saussure (died 1913), who elucidated the principles governing the movement of the accent and also showed, *inter alia,* that certain accentual distinctions in Lithuanian correspond exactly to certain distinctions of a non-accentual nature in some other Indo-European languages (especially Greek and Sanskrit), and that these non-accentual distinctions existed in the Indo-European parent-language.

The inflectional system is of the same type as in Latin, Greek and Sanskrit. The Noun and Adjective have six cases (Nom., Accus., Gen., Dat., Instrumental and Locative). Some stems have also a Vocative. The Dual survives, but the Neuter has been given up (except in certain fossilized relics). A "definite" form of the Adjective is formed by tacking on to it the pronominal stem *ja–*, both being declined, *e.g., geras* "good," gen. *gero, geras–is* "the good man," gen. *gero–jo.* In the Verb there has been a sweeping simplification of the complicated Indo-European system. Given the Pres. Indic., the Preterite Indic., and the Infinitive, all the other parts of a verb can be formed according to simple rules. The types of Present are often archaic; the Future is closely related to the Greek Future (Lith. *duosiu* "I will give" = Gr. *dōseō*), and the Indo-European Participles have survived with little change.

In the vocabulary the native element predominates, but there are also loan-words from Germanic and Slavonic. Some Germanic loans seem to be ancient, *e.g., šarvas* "armour" from Gothic *sarwa* "weapon," *midus* "mead" from the unattested Gothic *midu, kvietys* "wheat," *kliepas* "loaf" from Old Norse *hveiti, hleifr.* The precise source of *kunigas* "priest" (*cf.* primitive Germanic *kuningaz* "king") and *pinigai* "money" (*cf.* Old Norse *penningr,* etc.) is uncertain. Some Germanic words have passed into Slavonic and thence into Lithuanian, *e.g.,* Gothic *biuda-,* Slavonic *bl'udo,* Lithuanian *bliūdas* "dish." The older Lithuanian texts contain numerous loan-words (both Germanic and Slavonic) which have not been given currency in the modern literary language.

Large numbers of Lithuanian (or rather Baltic) words were borrowed by Finnish (or rather by the Finnish-Mordvinian-Tcheremissian speech-community) about the beginning of the Christian era. Some recent writers date these borrowings earlier still, from 1000–500 B.C., but this is doubtful.

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(R. McK.)

LITHUANIANS and **LETTS,** two kindred peoples of Indo-European origin, now constituting independent republics, on the shores of the Baltic Sea, and in the basins of the Niemen and the Duna. The two races number about 4,250,000, of whom 2,000,000 are Letts. Ptolemy mentions (iii. 5) two clans, the Galindae and Sudeni, who probably belonged to the western subdivision of this group, the Borussians. In the 10th century the Lithuanians under the name of Litva, with two other branches of the same stem—the Borussians and the Letts—occupied the south-eastern coast of the Baltic Sea, a tract bounded by Finnish tribes in the north, and by Slavs elsewhere.

In this forested, marshy country the Lithuanians maintained their national character notwithstanding the vicissitudes of their history. Their chief priest, *Krive-Kriveyto* (the judge of the judges), under whom were seventeen classes of priests and elders, worshipped in the forests; the Waidelots brought their offerings to the divinities at the foot of oaks; even now, the veneration of great oaks is a widely spread custom in the villages of the Lithuanians, and even of the Letts.

By the 10th century the Lithuanians were divided into three main branches:—the *Borussians* or *Prussians;* the *Letts* (who call themselves *Latvis,* the name given to them in Russian chronicles, *Letygola,* being an abbreviation of *Latvin-galas,* "the confines of Lithuania"); and the *Lithuanians,* or rather *Lituanians, Litva* or *Letuvininkaï*—subdivided into Lithuanians proper, and *Zhmud* (*Zmudz, Samogitians* or *Zemailey*), the "Lowlanders." To this group belong the *Yatvyags,* or *Yadzvings,* a warlike, black-haired people who inhabited the forests at the upper tributaries of the Niemen and Bug. Nestor's chronicle distinguishes also the *Zhemgala,* later known as *Semigallia,* who in the 10th century inhabited the left bank of the Duna. Several authors consider also as Lithuanians the *Kors* of Russian chronicles, or *Cours* of Western authors, who inhabited the peninsula of Courland, and the *Golad,* a clan settled on the banks of the Porotva, tributary of the Moskva river, which seems to have been thrown far from the main stem during its migration to the north. The *Krivichi,* who inhabited what was the government of Smolensk, may belong to the same stem. These peoples are subdivided into numerous independent clans and villages, separated from one another by forests and marshes. The Lithuanians are well built, with elongated faces and fine features, very fair hair, blue eyes and delicate skin. Their chief occupation is agriculture, especially apiculture and cattle breeding. The Letts of Courland are mainly Lutherans. Some are Roman Catholics, others belong to the Greek Church. All Lithuanians have maintained much of their heathen practices and creed; the names of pagan divinities, numerous in the former mythology, are continually mentioned in songs, and in common speech. *See* LATVIA; LITHUANIA.

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LITMUS, a colouring matter which occurs in commerce in the form of small blue tablets, which, however, consist mostly, not of the pigment proper, but of calcium carbonate and sulphate and other matter devoid of tinctorial value. Litmus is extensively employed by chemists as an indicator (*q.v.*) for the detection of free acids and free alkalis. An aqueous infusion of litmus, when exactly neutralized by an acid, exhibits a violet colour, which by the least trace of free acid is changed to red, while free alkali turns it to blue. It is manufactured in Holland from certain kinds of lichens (species of *Roccella* and *Lecanora*). The colouring matter results from the action of air and ammonia on orcin during the preparation of litmus from the lichen.

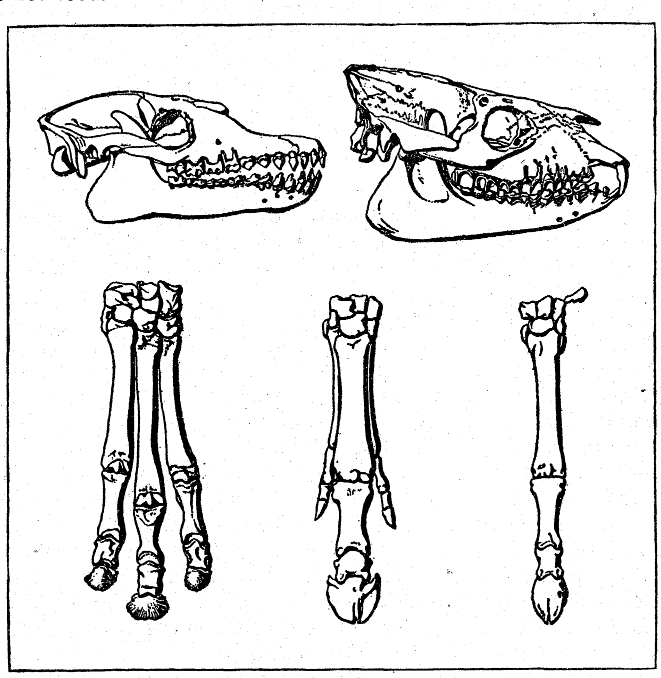
LITOMĚRICE or LEITMERITZ, a town and episcopal see in northern Bohemia girdled by forested hills, on the high right bank of the Elbe, opposite the entry of the Eger. At the limit of steamer navigation on the Elbe, it is the terminus of the Bohemian–Saxon steamship service. Situated in the midst of a very fertile country, the "Bohemian Paradise," which produces large quantities of cereals, fruit, hops and wine, its great weekly corn and cattle markets bind town and country. In addition it has an important brewing industry and a thriving transit trade. By reason of its situation the town has suffered during frontier struggles and during the Thirty Years' War lost most of its Czech population who, as Protestants, left the town and forfeited their property to German immigrants. The population is strongly German. Pop. (1930) 18,509. In 1938 the town came under German rule.

LITOPTERNA, an extinct order of hoofed mammals, confined to South America where, with the Notoungulata or Toxodontia (*q.v.*) they were the typical and abundant hoofed herbivores during the long period when the continent was isolated from all others. They arose from the most primitive ungulates, the

Condylarthra (*see* PHENACODUS), and they retained many unprogressive characters, for instance in the brain and teeth, although some of them became peculiarly specialized in other respects. Even in the Paleocene, the Litopterns were already separated into two families, Proterotheriidae and Macraucheniidae, each of which thereafter had a long history and included highly varied species and genera.

In the earliest Proterotheres, such as *Wainka* in the Paleocene and *Polymorphis* in the Eocene, the teeth were very primitive and barely distinguishable from those of Condylarths. In later forms the teeth remain relatively unprogressive, but some Miocene genera show a remarkable specialization of the feet. Originally five-toed, as in all primitive mammals, in the Miocene these animals had become three-toed or one-toed. Even in the three-toed forms such as *Diadiaphorus,* the weight rested mainly on the large middle hoof and in one genus, *Thoatherium,* the other hoofs were completely lacking. The foot of *Thoatherium* thus closely resembles that of the one-toed modern horse. The vestiges of the other toes are even more reduced than in the horse, and *Thoatherium* is the most completely one-toed of all known mammals. It is also noteworthy that it reached this condition in the Miocene, when all the horses still had three toes. The whole appearance of the animal was quite horselike. Since it is completely certain that the ancestry of *Thoatherium* was very different from that of the horse, this is a remarkably good example of the principle of evolutionary convergence: animals of different ancestry can come to resemble each other closely if their habits are similar.

The specialization of *Thoatherium* did not save it from extinction, and the last surviving Proterotheres, in the Pliocene, were three-toed.



FROM W. B. SCOTT, "REPORTS ON THE PRINCETON EXPEDITIONS TO PATAGONIA"

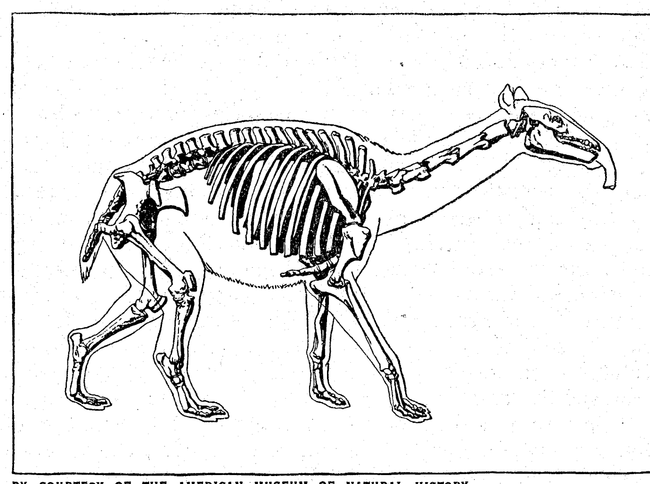
SKULLS AND FEET OF LITOPTERNA FROM THE MIOCENE OF PATAGONIA

Above, skulls of Theosodon and Diadiaphorus; below, forefeet of Theosodon, Diadiaphorus and Thoatherium

In the other family of Litopterns the toes were early reduced to three and remained so, the weight being evenly distributed with little tendency to concentrate on the middle toe. The teeth were in a closed series, with gradual progression from the simple incisors to the complex molars. The molars became high-crowned, with an intricate pattern of crests and valleys in the latest forms. The skull at first had much the same primitive, Condylarth-like structure as in the early Proterotheres. Its progressive modification can be followed in a series of genera that give an example of structural evolution almost as striking as that provided by the fossil horses, although less familiar to nonspecialists. The best-known genera of this series are *Cramauchenia,* Oligocene, *Theosodon,* earlier Miocene, *Scalibrinitherium,* late Miocene and *Macrauchenia,* Pleistocene.

The most obvious change in the skull is the progressive shortening of the nasal bones, accompanied by the development of an inflated, flexible, proboscislike snout.

Macrauchenia, the last member of this group, was as large as a camel. Its long neck and legs and short body and tail must have made it look much like a camel when alive, although its snout and the three toes on each foot, rather than two as in the camel, were striking differences. This is one of the best-known



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

SKELETON WITH BODY OUTLINE OF THE MACRAUCHENIA, THE LAST SURVIVOR OF THE LITOPTERNA

and first-discovered of South American fossil animals. The first remains, about half of a skeleton, were found in Patagonia by Charles Darwin during his voyage on the Beagle and were named and described by Richard Owen in 1840. Numerous other specimens, including the complete skeleton, have since been found in the Pampean deposits of Argentina.

Of all the hosts of Litopterns, only *Macrauchenia* survived into the Pleistocene and it, too, then became extinct, perhaps from its inability to compete with the more intelligent camels and other herbivores that then invaded South America from the north.

See W. B. Scott, *A History of Land Mammals in the Western Hemisphere,* revised ed. (1937). (G. G. SI.)

LITOTES, a rhetorical figure in which emphasis is secured for a statement by turning it into a denial of the contrary, *e.g.,* "a citizen of no mean city," *i.e.,* a citizen of a famous city, or "A. is not a man to be neglected."

LITTLE ENTENTE. The Little Entente was a political organization, created after World War I, which bound together three Central European states, Czechoslovakia, Yugoslavia and Rumania, for purposes of their common interest.

Origins under the Dual Monarchy.—Those nations had in the past been throttled by the Germanizing, Magyarizing system of the old Austria-Hungary; one of the objects of the Little Entente was to defend the freedom they won after the war against all attempts to restore the former regime. The Little Entente had its roots in a series of political acts and declarations dating back to the days of the old monarchy. In the Austrian half of the Habsburg empire the representatives of the small nations in the parliament at Vienna joined in opposition to the centralizing system which opposed the non-German peoples.

In the Hungarian half the oppressed Slovaks, Serbs, Croats and Rumanians met in 1848 and made a protest against Magyar imperialism; they did so again in 1895 at Budapest; and in 1905 ten non-Magyar deputies of the Budapest parliament formed a club for a like purpose.

During World War I, when the Austro-Hungarian peoples revolted and helped the Western Entente to break the system of militarist imperialism, a common aim again produced common action. In April 1918 a congress of the oppressed Austro-Hungarian peoples was held at Rome, and in the autumn of that year the Central European Democratic Union was formed in America. A year earlier a great meeting of representatives of the Austro-

Hungarian nations had taken place at Kiev in Russia and had established a special committee to fight against German and Austro-Hungarian imperialism. A prominent place was taken in all these actions by the Czechoslovaks, Yugoslavs and Rumanians, supported by Poles, by the Italians of "Italia irridenta" and finally by Ukrainians. The co-operation of the first three nations was particularly close, and toward the end of the war they undertook diplomatic action in common. The Little Entente was formed soon after the peace treaties had been signed, when attempts began to be made by various elements of the prewar regime to bring about a restoration of the Habsburg dynasty.

The Formation of the Little Entente.—The Czechoslovaks, Yugoslavs and Rumanians knew that a return of the Habsburgs would mean the restoration of the German-Magyar absolutism and the destruction of the freedom won by the political revolution of 1918. The Habsburg intrigues were chiefly engineered in Hungary, where the new regime in central Europe was last to be recognized and where intense propaganda was conducted for the recapture of the Slovak, Serbo-Croat and Rumanian territory. The Habsburg menace led to corresponding defensive measures on the part of the threatened States. The Czechoslovak foreign minister travelled on Aug. 13, 1920 to Belgrade where, on the following day, a defense treaty, of which the broad outlines had already been negotiated, was concluded between the kingdom of the Serbs, Croats and Slovenes and the Czechoslovak republic, binding both states, in case of an unprovoked attack by Hungary on either of them, to provide mutual aid the one to the other, and to refrain from making any alliance with a third Power without the consent of both. At Bucharest, whither the Czechoslovak foreign minister proceeded from Belgrade, the basis was negotiated on Aug. 19 for an analogous entente. On Sept. 19, 1920, Rumania informed both those states that it recognized a similar obligation, though it concluded special treaties to that effect with Czechoslovakia on April 23, 1921, and with Yugoslavia on June 7 of that year. The opportuneness of that defensive alliance was proved in April and in Oct. 1921, when two attempts were made to restore the Habsburgs in the person of the former Emperor Charles. Those attempts failed only because they met with the combined armed resistance of Czechoslovakia, Yugoslavia and Rumania.

The European Side of the Entente.—The states which had formed the Little Entente, independently of the European Great Powers, were aware that mere defense measures would not suffice for the maintenance of the new regime if the states concerned were themselves lacking in creative forces, or failed to attain the greatest possible degree of political and economic solidarity and an atmosphere of mutual trust and fruitful co-operation throughout the whole area of Central Europe. The ultimate and wider aim of the Little Entente was therefore to educate central Europe as to the advantages of universal peace and European consolidation. The progress made in the realization of this policy was best seen in the political and economic spheres. The main political object was to persuade all the central European states to work in peaceful co-operation with the new states, and much success was soon achieved. Starting from the treaty of Rapallo between Yugoslavia and Italy and the agreements worked out on the occasion of the visit of the Czechoslovak foreign minister to Rome in Jan. 1921, that policy bore fruit in the Czechoslovak-Austrian agreement of Dec. 16, 1921, which bound both states to abandon hostile propaganda and to settle all disputes by peaceful arbitration. The same principles were the basis of the Czechoslovak-Polish treaty of Nov. 6, 1921, which, although not ratified, created better relations between the two states, and, being followed by the Polish-Rumanian political treaty, materially improved the relations of Poland with the Little Entente.

In the measures taken to save Austria from financial ruin Czechoslovakia had a large share, and did not hesitate to make sacrifices in the interests of mutual confidence. A like policy was followed by the Little Entente towards Hungary, despite the fact that it had been the nationalist elements of Hungary and their Habsburg sympathies that had brought the defensive alliance of the Little Entente into existence. The latter knew from the beginning that correct and, as far as possible, friendly relations between it and Hungary were essential to the complete pacification and consolidation of central Europe. The states forming the Little Entente showed the best of good will in this respect, as was proved by the frequently repeated attempts of Czechoslovakia to negotiate with the Hungarian government, from as early a date as 1921. If those attempts were unsuccessful, it was because Hungary sought by an adventurous policy to avoid an understanding with its neighbours. Under the pressure of economic difficulties, and later on under the influence of the peaceful tendencies of European politics, especially of Locarno, Hungary indeed made several attempts at a central European orientation and even concluded commercial treaties with its neighbours, but there was no immediate and permanent change, though this change would have been nowhere more welcomed than in the countries of the Little Entente, whose only wish was that the change be permanent so that a new Hungary, consolidated both economically and politically, might co-operate in the reconstruction of central Europe.

Economic Policy.—The economic policy of the Little Entente started from the conviction that in central Europe it was necessary not only to overcome the harmful results of the depreciated currency, the obstacles to trade connections and the disturbances in the industrial world, but also to make up for the consequence of the disintegration of the old monarchy, which had constituted a kind of economic whole. The basis of its economic policy, therefore, was the minimizing of these results by the earliest possible establishment of commercial relations with each other and with the rest of the world. The political negotiations were therefore always combined with economic negotiations, which were the basis of a series of commercial treaties, at first between the states of the Little Entente and then with all the neighbouring countries. Questions of common interest to all the states springing from the former Austria-Hungary were discussed with good results at special conferences; *e.g.,* those at Rome and Portorose in 1921, and, later, the special conferences dealing with passport, transport and other problems. The results of this economic co-operation were not of course equally satisfactory in each of the states concerned, nor were they enough in themselves to restore healthy conditions to those states whose economic, financial and currency difficulties left them with no alternative to calling in international financial help.

Expansion of the System.—The increased activity and the determined policy of the states forming the Little Entente outgrew the limits of the simple defense treaties which constituted the original basis. On Aug. 31, 1922, that formal basis was considerably enlarged by the conclusion of a new treaty, in the second article of which both Czechoslovakia and Yugoslavia recognized the treaties concluded by Czechoslovakia with Rumania, Austria and Poland on the one hand, and by Yugoslavia with Rumania and Italy on the other. In the third article both parties agreed to put their economic, financial and transport relations on a firm basis by co-operation; and finally in a further article they undertook to support one another in their international, political and diplomatic relations and to take common measures if their common interests should be threatened.

The principles incorporated in that treaty revealed both the spirit underlying the Little Entente and the basis of its future activity. Emphasis was laid on the importance of economic co-operation and of solidarity in international affairs; the periodical renewal and extension of the existing system of commercial treaties, together with the ever-increasing moral weight of the Little Entente in the councils of Europe, proved that the statesmen of the Little Entente had a firm grasp of both political and economic realities. At international conferences, such as those of the League of Nations, the representatives of the Little Entente regularly spoke as one man, and therefore contributed to a considerable simplification of international relations; their behaviour was particularly noteworthy in that it was not only of a united but of a constructively peaceful character. Essentially the Little Entente was to continue to promote the pacification and the consolidation of central Europe.

The Development of the Little Entente.—In the years which followed its foundation, the Little Entente grew in stature and underwent an interesting development. Dr. Eduard Beneš, the Czechoslovak foreign minister, explained in an address on Feb. 6, 1924 that the members had shown an example of close co-operation. They had preserved central European peace and acted as a moderating influence and brought about a degree of consolidation within the Danubian region. Nevertheless, there were serious problems, even in that period of calm, though the only common bond formally uniting the members of the Little Entente had to do with Hungary. The major problem of Czechoslovakia, however, seemed likely to be Germany, while Italy might constitute Yugoslavia's principal concern, and Russia that of Rumania. Centrifugal, rather than centripetal forces might determine the future of the member states.

The Connections with France.—While French statesmanship had nothing to do with the origins of the Little Entente, and was even opposed to its organization in the beginning, the group had become so well solidified by 1924 that on Jan. 25, 1924, France made an alliance, later implemented by a military pact, with Czechoslovakia. The pact provided for mutual consultation on problems endangering the postwar settlement, and stipulated common action against Habsburg restoration, any attempt against Austrian independence, and any German aggression. In 1926 France signed a similar alliance with Rumania and in 1927 one with Yugoslavia, though these were never genuinely implemented. Together with the French alliance with Belgium in the west and with Poland in the east, the French-Little Entente connection made up the essence of the French postwar system of alliances.

The Consolidation of the Little Entente.—The next several years witnessed a striking consolidation of the Little Entente, which was playing a considerable role in European politics, as Dr. Beneš' part in the drafting of the Geneva protocol of 1924 bore ample testimony. Nevertheless the member states, together with Poland, were disappointed by the failure of the Locarno conference to offer genuinely effective guarantees of their own frontiers on the east of Germany.

The constitutional and organic structure of the Little Entente, which had been built on the foundations of the bilateral treaties of 1920 and 1921, was modified somewhat by an agreement of Czechoslovakia, Rumania and Yugoslavia on May 21, 1929, which provided that renewal of the treaties of alliance should become automatic at the end of each five-year period. Moreover, at the same time, the three states signed the Tripartite treaty for the peaceful settlement of all their differences in accordance with the model treaty of arbitration and conciliation which the League of Nations had adopted in 1928.

A new period of development appeared to have begun in the history of the Little Entente when the era of crisis, beginning with the great world depression, came in the years 1929 and 1930. Despite grave difficulties in industry, commerce and agriculture throughout central and southeastern Europe, optimism seemed to prevail within the circles of the Little Entente, and in the years of crisis which followed, members of the Little Entente took a significant part in the councils of Europe. Men like Dr. Beneš and M. Nicolae Titulescu made their voices felt, especially within the circles of the League of Nations.

While fascist Italy had been an enemy of the Little Entente from the beginning, the advent of Adolf Hitler to power in Germany on Jan. 30, 1933 was an immediate challenge to the whole postwar structure in central Europe. Barely more than two weeks later, on Feb. 16, 1933, Czechoslovakia, Rumania and Yugoslavia proceeded definitely to strengthen the bonds of union and federation against the new and growing menace. Under the able leadership of Eduard Beneš, Nicolae Titulescu and Bogoljub Jevtich, as well as King Alexander of Yugoslavia, the natural evolution toward closer unity was hastened, and a veritable, if short-lived, diplomatic federation was constituted.

The new pact provided for the creation of a permanent council of the states of the Little Entente, composed of the three foreign ministers or their delegates, which was to be the directing organ of the common policy of the Little Entente. The permanent council was to meet at least three times a year. Article VI significantly provided:

> Every political treaty of each state of the Little Entente, every unilateral act changing the present political situation of one of the states of the Little Entente in regard to a third state, as well as any economic agreement implying important political consequences, will thenceforth require the unanimous consent of the council of the Little Entente. Existing political treaties of each state of the Little Entente with third states will be progressively unified as soon as possible.

For the promotion of the economic co-ordination of the three states an economic council was established. The economic council was to meet three times a year, later two. In the interval between meetings, the secretariats were to direct the economic collaboration on the basis of the resolutions adopted by the economic council.

Finally, the Little Entente then established a permanent secretariat, one section of which was to function at Geneva, Switz., the seat of the League of Nations.

As if to lay down the basic principles which were to govern the new organic union of the Little Entente, article X declared:

> The common policy of the permanent council must be inspired by the general principles contained in all the great international acts of the postwar era, such as the covenant of the League of Nations, the pact of Paris, the General Act of Arbitration, the eventual conventions on disarmament and the pacts of Locarno. Moreover, nothing in the present pact can be contrary to the principles and dispositions of the covenant of the League of Nations.

With greater strength and unity the Little Entente seemed on the threshold of much constructive activity. Under Dr. Beneš and Dr. Titulescu, especially, the Little Entente took a lead in urging the application of effective sanctions against Japan in the years 1931 to 1933. Together with Poland, which was equally threatened, the members of the Little Entente successfully protested against the Four-Power pact of March 1933, signed in July by fascist Italy, nazi Germany, Great Britain and France, which would have set up a four-power directory, as outlined by Mussolini, in substitution for the processes of the League of Nations, for the revision of treaties without consultation with and possibly against the interests of the smaller states of Europe. The members of the Little Entente were represented at the London Economic conference in June and July 1933, and on July 4 they signed a nonaggression agreement with the soviet union, represented by Maxim M. Litvinov. The next year Czechoslovakia and Rumania, though not Yugoslavia, entered into diplomatic relations with the government at Moscow. Feb. 9, 1934 witnessed an extension of the principles of regional security embodied in the Little Entente when Yugoslavia and Rumania joined with Turkey and Greece to form the Balkan Entente. Increasing menace on the part of national socialist Germany finally brought about a Czechoslovak-soviet union alliance on May 16, 1935, following the similar French-soviet alliance two weeks earlier.

The Economic Little Entente.—Meanwhile, from its first meeting in Jan. 1934 at Prague, the economic council of the Little Entente, through its resolutions, attempted to lay the foundations for closer economic collaboration among Czechoslovakia, Rumania and Yugoslavia. In view of the similarity in the agrarian structure of Rumania and Yugoslavia and of the fact that Czechoslovakia had a well-balanced agricultural and industrial economy, it was acknowledged that progress could only be made somewhat slowly. Nevertheless, the economic council gradually developed a program calling for closer co-operation among the three countries in the air, river and railway systems, the establishment of a postal union, unification of the customs and commercial codes and abolition of the passport visa. Moreover the council called for collaboration on the part of the banks of issue, agricultural educational institutions, industries and the statistical departments of the governments of the three member states. As the political structure of the Little Entente was to prepare the way for the political organization of the Danubian area, so the economic council of the Little Entente was to attempt to lay the economic foundations of that region, including both Austria and Hungary, though without much success in the case of the latter country.

The Decline of the Little Entente.—By the year 1935, however, at the very time when the Little Entente seemed to be consolidating its structure, its decline was already evident. Europe was in full crisis and had been since the beginning of the Japanese aggression against China in Sept. 1931. On Oct. 9, 1934, King Alexander of Yugoslavia was assassinated, and with him died Jean Louis Barthou, the foreign minister of France. While Yugoslavia did not disintegrate, as Mussolini apparently had anticipated, Prince Paul, the new prince regent of the country, was a weaker character and Dr. Milan Stoyadinovich, who dominated the country as premier from 1935 to 1939, pursued a policy of rapprochement toward Italy, Bulgaria and Germany—a policy which struck at the vitals of both the Little Entente and the Balkan Entente. Moreover the weakness of France, its vacillating foreign policy and the division between France and Great Britain with respect to Italy and Germany, were devastating blows to the unity of the Little Entente.

While there was surprising unity within the ranks of the Little Entente throughout the Ethiopian crisis of 1935–36 and the early phases of the war in Spain, there was distinct evidence of difficulty at the Bratislava conference of the council of the Little Entente in Sept. 1936 when Yugoslavia seemed determined to follow its own path, and the council virtually acknowledged the right of member states to pursue an independent course. Dr. Kamil Krofta, who had become the Czechoslovak foreign minister when Dr. Beneš succeeded to the presidency of the republic, in an important address to the commission on foreign affairs of the Czechoslovak parliament on March 2, 1937, noted the centrifugal forces tearing at the heart of the Little Entente:

> Of late the Little Entente has been brought face to face with a changed situation in Europe caused by the development of the Abyssinian question and the forceful character of Germany's policy. These conditions concern both the individual Little Entente states and the Little Entente as an entity. Yugoslavia has been compelled to occupy herself with the new distribution of power in the Mediterranean sea, Czechoslovakia with the intensive change in the policy of her neighbor on the north, while Rumania is affected by the relations of Europe to the soviet union.

While formal unity remained in the Little Entente, belated French attempts under the government of Leon Blum and of Czechoslovakia to consolidate the Little Entente and generalize the obligations of member states against all aggressions failed—as similar attempts had failed in the effort to attain collective security in western Europe.

The Little Entente was then in its last stages. With the seizure of Austria by Germany in March 1938, Germany was brought to the borders of Yugoslavia and Czechoslovakia was almost surrounded. On Sept. 30, 1938, as a result of the so-called Munich "agreement," Germany was permitted to annex the Sudeten regions of Czechoslovakia. The last conference of the council of the Little Entente, meanwhile, had been held at Sinaia, Rum., on Aug. 21, 1938, when an attempt was made to conciliate Hungary by an offer of equality in armaments in return for the promise of a peaceful policy on the part of that country. When the test finally came in the period of the Munich crisis, despite the reluctance of the Stoyadinovich government in Yugoslavia, both Yugoslavia and Rumania, in accordance with the terms of their alliance with Czechoslovakia, warned Hungary not to attack the republic. But the attitude of Great Britain and France being what it was, there was little question of the outcome. The Munich accord destroyed the Little Entente by destroying the keystone of the system—the republic of Czechoslovakia.

Conclusion.—The Little Entente, composed of Czechoslovakia, Yugoslavia and Rumania, and organized for the purpose of the mutual defense of these nations and their other common interests, had its imperfections. The common ties which bound the three members, involving only an attempt on the part of Hungary forcibly to revise the treaty of Trianon or an attempt to restore the Habsburg monarchy in the Danubian region, did not provide for an attack by Germany against Czechoslovakia, an Italian aggression against Yugoslavia, or a Russian move against Rumania. More universal obligations were a necessity for a viable regional organization, though the point of wisdom at the time of the origin of the Little Entente seemed to lie in the rigid limitation of common obligations to specifically common interests. The formation of the economic council of the Little Entente came too late to lay the necessary foundations for a genuine economic organization of the Danubian area. Despite attempts to extend the principles of the Little Entente to other nations in the Danubian area, especially Austria and Hungary, it was impossible to extend the membership or collaboration, particularly in the case of Hungary, which refused co-operation as long as its political claims against Czechoslovakia, Yugoslavia and Rumania were not met.

It is well to note, however, that the faults of the Little Entente were essentially those of Europe as a whole, on a somewhat smaller stage. Though the organization of the Little Entente failed to meet the problems of central Europe in the sense indicated and ultimately succumbed before the forces which triumphed at Munich in Sept. 1938, the work accomplished and the foundations laid in the period from 1920 to 1938 may yet prove their worth when the time comes once more to attempt a more rational and genuinely viable reorganization of Danubian Europe on the basis of the free association of the peoples of that region. (E. Be.; H. N. H.)

LITTLE FALLS, a city of Minnesota, U.S.A., 97 mi. N.W. of Minneapolis, on the Mississippi river; the county seat of Morrison county. It is served by the Northern Pacific railway. The population was 6,047 in 1940. The city has a hydro-electric power plant, creameries, flour mills and other manufacturing industries, and there are granite quarries near by. It was settled about 1850 and chartered as a city in 1889.

Here was buried the Chippewa chief, Hole-in-the-Day (*c.* 1827–68), who is credited with having prevented the Chippewas from joining the Sioux in their uprising of 1862, but later his body was removed by relatives. Little Falls was the childhood home of Charles A. Lindbergh.

LITTLE FALLS, a city of Essex county, New Jersey, U.S.A., about 10 mi. N.N.E. of Newark, served by the Erie railroad. The population by the federal census of 1940 was 5,561. The city takes its name from adjoining falls of the Passaic river. In 1940 Little Falls had about 30 industries, including one of the largest laundries of the world, with some 800 employees and more than 250,000 customers. There, in May 1937, the United Laundry Workers Union, supported by the Congress of Industrial Organizations, staged a strike which attracted national notice. The township later passed a special ordinance to curb the activities of the union.

Little Falls was settled by eight Passaic farmers who purchased a large tract of land from the Indian inhabitants of the vicinity in 1711.

LITTLE FALLS, a city of Herkimer county, New York, on the Mohawk river, 21 mi. E.S.E. of Utica. It is served by the New York Central lines. The population was 11,105 in 1930; in 1940 it was 10,163. The city takes its name from the cascade rapids of the Mohawk at this point (a total fall of 45 ft. in less than a mile), which furnish abundant water power. Its manufactures include knit goods, leather, bicycles, felt shoes, sectional bookcases, paper, knitting machines, hammers, rennet and junket preparations, milking machines and dairy products. The aggregate output in 1937 was valued at $12,404,558. The surrounding country is engaged largely in dairying. Little Falls was settled by Germans in 1782, and had a gristmill which served most of the Mohawk valley.

It was destroyed almost immediately by Indians and Tories, rebuilt in 1790, incorporated as a village in 1811, and chartered as a city in 1895.

LITTLEFIELD, WALTER (1867–), U.S. author and journalist, was born at Boston March 17, 1867. After studying at Harvard university he taught in Boston for two years, then joined the editorial staff of the *New York World.* He was with the *New York Tribune* for a short time, and then was employed by the *New York Times,* in the foreign news department. During the Dreyfus case in France, Littlefield was first to identify Lt. Col. du Paty de Clam as author of an article which told the circumstances of Dreyfus' arrest and revealed the secret evidence admitted at the first trial.

He wrote several works about the affair, including *The Story of the Dreyfus Case* (1936). Littlefield in 1932 became foreign editor emeritus of the *New York Times*.

LITTLEHALES, GEORGE WASHINGTON (1860–1943), U.S. hydrographer, was born in Schuylkill county, Pa. Oct. 14, 1860. He was graduated from the U.S. naval academy in 1883 and then studied at Columbian (later George Washington) university, Washington, D.C. He was hydrographic engineer of the U.S. Hydrographic office from 1900 until his retirement in 1932, and professor of nautical science at George Washington university from 1913 to 1927. From 1919 to 1922 he was chairman of the American Geophysical union's section of physical oceanography, and from 1921 to 1932 vice-president of the section of oceanography of the International Union of Geodesy and Geophysics.

He was the author of numerous works on navigation, hydrography and related subjects.

The results of his research were published in more than 100 papers. He also published some 3,000 navigational charts used throughout the world, and edited the mathematical tables used by U.S. seamen. Littlehales died Aug. 12, 1943.

LITTLEHAMPTON, a seaport, watering place and urban district in Sussex, England, at the mouth of the Arun, 62 mi. S.W. from London by the S.R. Pop. (1938) 11,340. Area, 4.5 sq.mi. The harbour is easily accessible in all weathers, and has a small trade.

Imports include wood, coal, slate, granite, cement, manure and cereals and exports are hoops, timber, etc.

LITTLE MASTERS: *see* LINE ENGRAVING.

LITTLE ROCK, the capital and largest city of Arkansas, U.S.A., and the county seat of Pulaski county; on the south bank of the Arkansas river, near the centre of the state. It is the intersection point for federal highways 65, 67, 167 and 70; is served by the Missouri Pacific, the Rock Island, and the St. Louis Southwestern railways; and has an airport of 701 ac., 2 mi. from the centre of the city.

The population was 65,142 in 1920 (26·8% Negro), 81,679 in 1930; and 88,039 in 1940 by the federal census. The aggregate population of the urban unit, including North Little Rock, across the river, and other suburbs, or the metropolitan area, was 126,724 in 1940.

Little Rock lies at the edge of the gulf coastal plain, at an altitude of 250 to 400 ft., with the foothills of the Ozarks rising to the west. Its area is 17·5 sq. miles. Besides three railway bridges, there are two beautiful highway bridges of concrete across the Arkansas, memorials to the men of the army and of the navy who died in World War I. The state capitol, of Arkansas marble (built in 1912), has a fine site in a park of 12 ac. Fair park, located in a beautiful grove of trees, includes the municipal zoo, the municipal golf course, Traveler's field for Southern league baseball games and other amusement features. Many of the state institutions are in Little Rock, including the deaf-mute institute, the school for the blind, the library, the hospital for nervous diseases and the Confederate home. The medical school of the state university is there, and among the other educational institutions are Little Rock junior college, Philander Smith college (for Negroes), the Arkansas Law school and St. John's theological seminary (Roman Catholic).

The city is the see of Roman Catholic and Protestant Episcopal bishops, and there are numerous charitable institutions under private auspices. The philanthropic agencies are financed jointly through a community chest.

There is a branch of the federal reserve bank there, a U.S. land office, a U.S. district court, and a U.S. Veterans' bureau and U.S. Veterans' hospital facility. The airport is the headquarters of the 154th observation squadron of the Arkansas national guard, and is also used for commercial purposes. Camp Joseph T. Robinson, 5 mi. N of the city, is the training area for more than 25,000 soldiers.

The fertile agricultural region surrounding Little Rock produces large crops of cotton, corn, alfalfa, potatoes, small grains, fruits and vegetables. Within a short distance are vast stands of high-grade timber and deposits of coal (including a smokeless semi-anthracite), oil and natural gas, marble, clay, flint and many other mineral resources.

The bauxite mines just outside the city produce 90% of the country's total output. At Remmel dam, 60 mi. southwest of Little Rock, is the first unit of the great hydro-electric development on the Ouachita river. There are over 300 industrial plants in Greater Little Rock (including large railroad shops across the river), and the annual value of the manufactured products in 1940 was estimated at $30,000,000.

Chief among them are cotton-seed and lumber products. Little Rock has a large trade in cotton, lumber and agricultural products. The wholesale houses do an annual business of $75,000,000, and annual retail sales aggregate $45,000,000. Bank clearings in 1940 were $406,425,913. The assessed valuation of property was $42,617,225.

In 1722 Sieur Bernard de la Harpe, exploring the Arkansas river, gave the names of La Petite Roche and La Grande Roche (or *Le Rocher Français*) to two conspicuous rocky formations on the banks of the stream, one of which (the "little rock") is now the abutment of a railway bridge. The big rock, 2 mi. upstream on the north bank, once the site of a U.S. army post, is the location of U.S. Veterans' facility. Near the smaller rock was a settlement of Quapaw Indians, which De la Harpe made his trading post.

In 1812 William Lewis, a hunter and trapper, built his home here. In 1819, when Arkansas was made a territory, preparations were made to move the seat of government to Little Rock from Arkansas Post (founded in 1686 by Henri de Tonti near the mouth of the river), and in 1821 the town was surveyed. It was incorporated as a town in 1831 and chartered as a city in 1836. Construction of the first state house (now the War Memorial building) was begun in 1833. The leading daily newspaper, the *Arkansas Gazette,* established at Arkansas Post in 1819 and soon moved to the new capital, was one of the first papers published west of the Mississippi. At the outbreak of the Civil War, Little Rock was enthusiastically antiunion. The U.S. arsenal was seized by the state authorities in Feb. 1861. In Sept. 1863, Federal forces captured the city, and it remained under Federal control for the rest of the war.

The decades of most rapid growth in the city's history are 1860–70, when the population increased from 3,727 to 12,380, and 1880–90, when it almost doubled.

LITTLE THEATRE MOVEMENT. In its beginnings, the history of community drama is the history of the drama in general. That history is dealt with in another place (*see* DRAMA). Here it is only necessary to recall that the origins of theatre art are bound up with the ritual of the tribe, and that the tribal rite offers the purest type of community drama which it is possible to conceive.

Throughout the great period of Greek classical drama the method and atmosphere of stage production were more nearly allied to those of community drama as we know it today than to the modern professional theatre. The same may be said of the drama in mediaeval times. For in both periods stage production was not primarily the work of a definite class of professional stage workers or managers. It was undertaken by a whole community as represented by the City state (in Greece) or by the church or the trade guilds (in mediaeval Europe).

THE MOVEMENT IN EUROPE

While the Renaissance was changing the whole intellectual and artistic world of Europe, we find the religious guild plays beginning to decline; a new professional theatre was being born, but at the same time there came a new impetus of community drama from the universities and schools. In England, some of the first Elizabethan dramatic literature was written for academic performances. Classical Latin plays were translated or adapted for English use, and one Nicholas Udal, headmaster of Eton college, wrote one of our first English comedies, *Ralph Roister Doister.* While the modern schoolboy might find it somewhat lengthy and involved, it is, nevertheless, full of healthy humour, interesting as one of the first examples of the modern school play. How far the earlier guild drama had degenerated at this time may be seen from the skit on the amateur play of "rude mechanicals" which Shakespeare gives us in *A Midsummer Night's Dream*. Bottom, the weaver, and his associates were obviously drawn from life, and their crude art might be paralleled by some of the less developed types of village drama which are to be seen at this day.

The Puritan movement was a severe setback to the English theatre as a whole, and at the Restoration the drama developed mainly on professional lines. On the Continent, however, amateur playing had continued to flourish, *e.g.*, the famous Passion Play at Oberammergau, first performed in 1633, and, with only one period of suppression, continued ever since. "Private Theatricals," however, were not unknown in England throughout the 18th century. In the 19th century, Charles Dickens was an enthusiastic amateur, and there came into existence a somewhat debased form of amateur drama conducted mainly as a fashionable social exercise under the cover, often, of some charitable object. In 1855, however, an important event occurred; the foundation of the Cambridge University Amateur Dramatic Club by Sir Francis Burnand, and some years later, Oxford followed suit. From that time a new interest in amateur drama became prevalent which was to culminate in the modern Little Theatre movement. These tendencies were by no means confined to England. In Russia, Stanislavsky's Moscow Art Theatre, in Paris the theatres of Antoine and Copeau, in Ireland the Abbey Theatre, Dublin, were instances of stage work initiated outside the professional theatre and destined to influence the whole conception of the theatre's aim and method. At the end of the World War the new spirit in the theatre was so well established that drama at once occupied an important place in all schemes for social and cultural reconstruction.

In Soviet Russia, community or proletarian drama was officially encouraged. One of the first acts of the revolutionary Government was, indeed, to turn the whole Russian theatre into a community theatre. Every professional playhouse was declared national property, and the work of every theatre company was placed under Government control, and supported by Government finance. The Government also encouraged the production of revolutionary drama written, acted and produced by the workers themselves. But, according to Bakshy, there is no sign that this amateur movement is destined at any time to take the place of the professional theatre.

In Germany, though the Government has not concerned itself specifically with the theatre, there have been various attempts on the part of labour and socialist organizations to gain control of professional playhouses. In some cases, *e.g.*, in Berlin, this object has been achieved, and a similar tendency is observable in Austria. France, Spain and the Scandinavian countries have felt the influence of the community movement rather less, although the traveller in France may be faced unexpectedly with the dramatic activities of a university. At Poitiers, for example, the students have built up an artistic section called *Le Studio*, which, besides helping other local societies, has produced monthly a new play of literary value. As for Italy, *Fascismo* does what it can to encourage drama in Italian schools and factories under the aegis of the *Opera Nazionale Dopolavoro*.

Great Britain.—The remarkable growth of community drama in post-war England is shown by the success of the British Drama League. The league was founded in 1919, and affiliated one small village group at Chaldon in Surrey. Ten years later there were 1,500 societies on the register of the league, the large majority being play-producing societies engaged in the study or practice of community drama. Many of these are humble village groups, attached, as likely as not, to the Federation of Women's Institutes, but there are many bands of village players working on their own, and some have actually won fame far and away beyond their own countryside. Such are the Grasmere players in the Lake district, the Hardy players of Dorchester and the Stoneland players of Sussex. The last named, in a picturesque and ancient farmyard, produce Greek plays in the English versions of Gilbert Murray. Village acting also is specially the concern of the Village Drama Society, while the company of the Arts League of Service founded just after the war, has brought to many a remote hamlet, plays and interludes of high artistic standard, thus setting an example of what can be done on a simple stage and with few material resources.

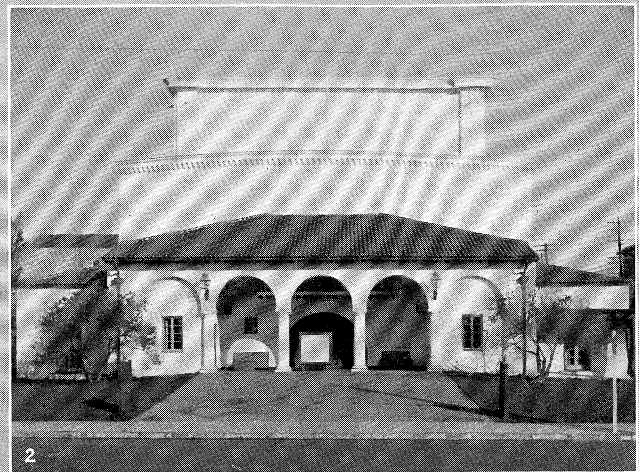
Urban community drama is, in the nature of things, likely to attain a higher degree of elaboration and permanence than is possible in the country. The Everyman Theatre, founded in Hampstead by Norman Macdermott in 1920, had a great influence in stimulating interest in the Little Theatre movement not only in London but in the provinces. That was a professional undertaking. But in cities like Hull, Huddersfield, Manchester, Liverpool, Stockport, Bath, Birmingham, Bristol and Norwich, there are Little Theatres more or less continuously occupied by companies of amateur players. The Unnamed Society of Manchester has found in Sladen-Smith a dramatist whose work is well-known to the Little Theatre players throughout the country, though it is worth while noting that the amateur Little Theatre movement in Great Britain has, on the whole, proved strangely barren in playwrights whose work has been utilized by the professional stage. A note of exception must be made in regard to the Abbey theatre, Dublin, which has been the means of endowing English dramatic literature with the works of J. M. Synge, W. B. Yeats, Lady Gregory and W. Sean O'Casey. Mr. John Drinkwater also is a playwright who owes much to his early work at the Birmingham Repertory Theatre.

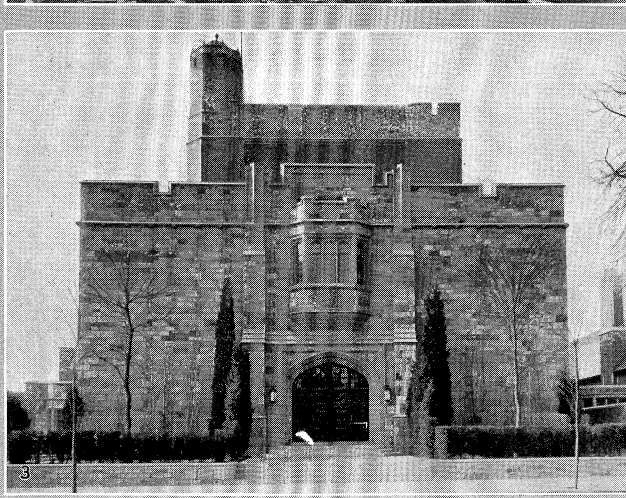
Lastly, the modern movement has not been untouched by religion. Modern mystery plays have been acted in many churches, and there are even instances where a local theatre has been hired for so long as a week at a time for the performance of a religious play or pageant, created and acted by the congregation of a simple parish church. Hofmannsthal's *Great World Theatre* has been performed in a church at Leeds, and the movement may be said to have culminated in the production of an original nativity play by John Masefield in the nave of Canterbury cathedral. The costumes for this play were designed by Charles Ricketts, and the music composed by Gustav Holst.

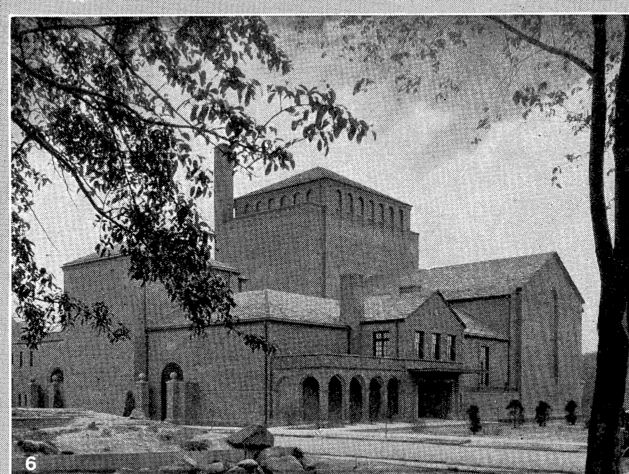
COMMON PROBLEMS

Reaction from Materialism.—Deep impulses in national psychology must have been at work to account for so striking a revival in so many countries in Europe. The simplest explanation would seem to be that the materialism rampant in life during the World War, and in thought during the period immediately succeeding it, has brought about a natural reaction which seeks to revive faith in the reality of the human spirit by the objective manifestation of it through the medium of drama. This impulse has been unable to find satisfactory or sufficient outlet through the passive witnessing of professional stage plays. Men and women have desired to come to closer grips with the fundamentals of dramatic art.

Take an average town or city; some social workers may have established a dramatic class in connection with a working men's club. This work becomes known to two or three keen students of the drama, and they determine to establish a little theatre, either in the centre of the town or in a convenient suburb. A meeting is called, a committee formed, and important people in the district give their sympathy, and even a few subscriptions are received. The new society rents a hall, and a programme of half-a-dozen plays is chosen, these to be spread over a season of three or four months, each production to last, say, a week, giving an interval of two or three weeks between each new play. The plays themselves will be chosen by a special committee, which will draw up a list of 20 or more plays, from which the producer will make his own choice, with due regard to the character of the players and the money available. All this may seem easy enough in print, but it is not so easy in practice. With little or no experience to guide it, the society will be at once confronted with countless problems. In the first place, the hall or room will almost certainly have to be specially adapted for stage performances. Even if there be electric light, a special stage equipment must be installed. Footlights are useful but not necessary, provided that flood lights





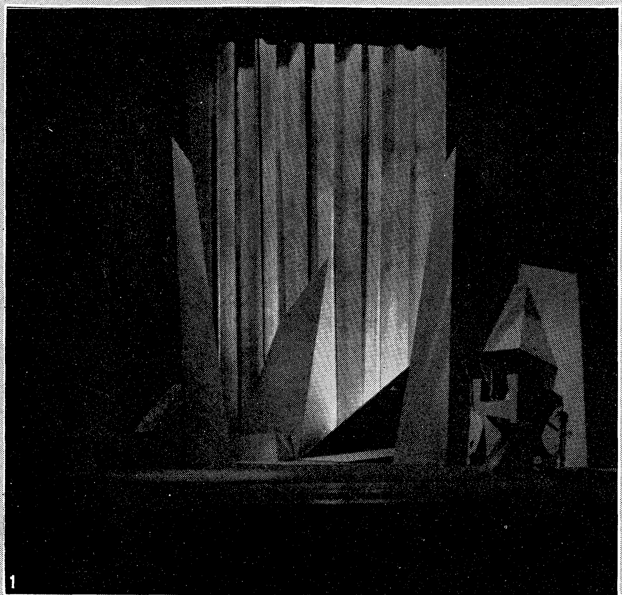
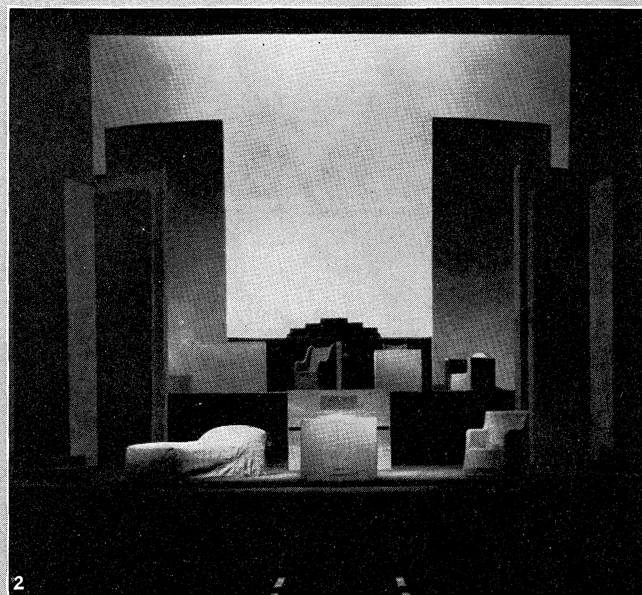
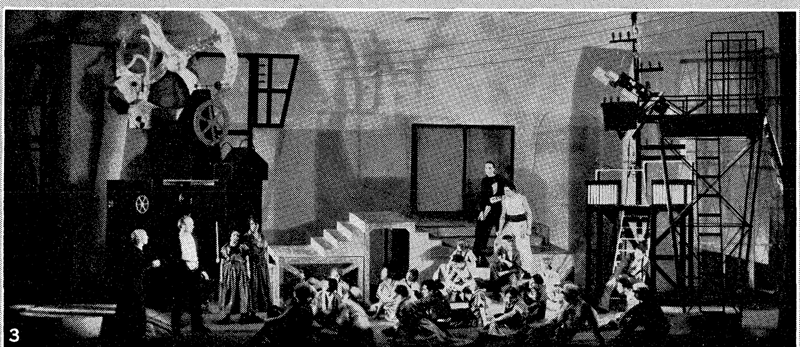


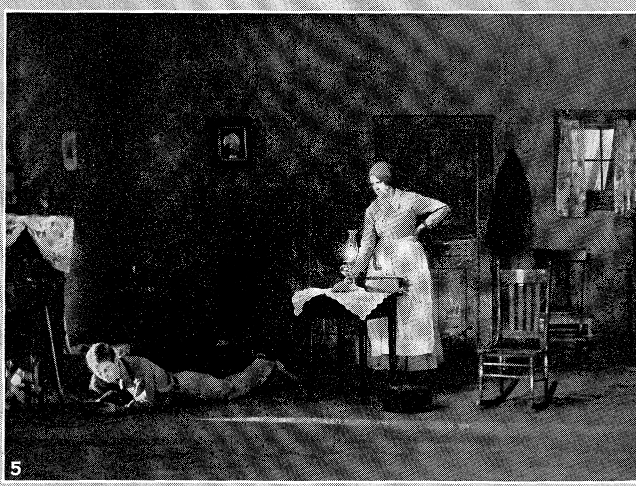
PHOTOGRAPHS, (4) A. E. ARNOLD, (6) SIGURD FISCHER

LITTLE THEATRES IN THE UNITED STATES

1. The Provincetown Playhouse, New York city, founded in 1916; one of the earliest art theatres in the United States. In 1918 the Provincetown group moved into this building, first a carriage-house, then a bottling plant, and last an experimental theatre for playwrights
2. The Lobero Theatre, Santa Barbara, Calif.; a community theatre with every modern equipment, built by the citizens and financed by them
3. The Yale University Theatre, New Haven, Conn., 1926; a modern college theatre and workshop combined, founded by Prof. George Pierce Baker. The tower-like structure in the background is the stage building, containing modern equipment and lighting plant
4. The Pasadena Community Playhouse, Pasadena, Calif.; a playhouse built and financed by the citizens of Pasadena in 1925
5. The Little Theatre, Dallas, Texas, opened April 9th, 1928. This little art theatre became nationally famous for its unusual productions under Oliver Hinsdell's direction
6. The Cleveland Playhouse, Cleveland, Ohio, 1927; a model art theatre. Deriving from amateur beginnings, it has advanced to professional stature in building, direction, productions and repertory. Architect, Philip Lindsay Small

LITTLE THEATRE MOVEMENT




BY COURTESY OF (3) THE GOODMAN MEMORIAL THEATRE; PHOTOGRAPH, (4) WAYNE ALBEE, MCBRIDE STUDIO

PRODUCTIONS BY LITTLE THEATRES IN THE UNITED STATES

1. "The Sunken Bell," Act III., by Gerhart Hauptmann, produced at the Cleveland Playhouse. Design by Frederic McConnell, director. From a photograph by Clifford Norton
2. Permanent setting for "The Great God Brown," by Eugene O'Neill, produced at the Cleveland Playhouse. Frederic McConnell, director. Design by K. Elmo Lowe, from a photograph by Clifford Norton
3. Scene from "Gas," by Georg Kaiser, the first play with a constructivist setting to be given in America. It was produced at the Kenneth Goodman Memorial Theatre, Chicago, under the direction of Thomas Wood Stevens. Produced by Marion Gering, with settings by Louis Lozowick
4. "Caste," by Tom Robertson, produced by The Cornish Players, Seattle, Washington, Nov. 1927, under the direction of Mr. and Mrs. Burton W. James. Settings designed by Floragnes Smith
5. "Clay," a tragedy of a Farm Boy, by David Ried Hoggin, a Carolina Folk-Play, produced by the Carolina Playmakers, University of North Carolina. Director Frederick H. Koch
6. "The Life of Man," by Leonid Andreiev, produced at the Carnegie Institute of Technology, Pittsburgh. Staged by Theodore Viehman; settings designed by Lee Mitchel, and executed under his direction

can be installed; these, in the form of lamps placed in five or six empty biscuit tins, with the necessary coloured gelatine screens, can be secured at a cost of £3 or £4. But ingenuity must be shown in their fixture. They must be movable, and easily suspended out of sight of the audience and just behind the proscenium arch. If scenery is impossible, it may be decided to play entirely to curtains. And then it must be discovered if the hall is so constructed as to qualify for a licence for the performance of stage plays. When all these difficulties have been surmounted, care must be taken to fulfil the conditions of stage copyright with regard to the plays produced.

The most interesting problem which confronts the Little Theatre movement is its relation to the professional and commercial theatre. In England both the Stage Guild (the representative body of the professional actors) and the Touring Managers' Association have taken official cognizance of the amateur movement; relations between the professional and the amateur have continued to be friendly. Unemployment in the theatre is a pressing and often a tragic condition, but it would be difficult to maintain that the smaller amateur groups attract a sufficient audience to make them in any real sense competitive with professional theatres. The few really important amateur theatres, some of them combining professional and amateur players, which tend to develop into full-time professional undertakings, thereby become at once new centres for professional employment.

Exactly the same tendency is seen in other countries wherever an amateur undertaking has found itself under the control of an amateur producer whose gifts and opportunities have been such as to draw him to professionalize the undertaking. The most famous instance of this is undoubtedly to be found in the genesis of the Moscow Art theatre, which began as a small enterprise of amateur theatricals in a country house near Moscow. The history of this movement is written in full by Constantin Stanislavski in *My Life in Art,* a book which should be in the hands of every student of community drama.

Endowment.—The municipally endowed theatre, as the logical extension of the community theatre idea, has been widely canvassed in England. On the continent of Europe, where public taste is usually considered to have reached a higher and more widespread level than elsewhere, State or municipal endowment has for long been a normal feature of the theatrical system. In France or Germany it is freely admitted that the more noble manifestations of stage art are seldom paying propositions, and that private enterprise cannot be expected to make impossible and continual sacrifices for the general good. The result is that few of the continental nations are without their national and municipal theatres. In many towns in central Europe the municipal theatre is the only reputable playhouse. Among English speaking peoples a great deal of the contemporary enthusiasm for community drama arises from dissatisfaction with the fare provided by the professional theatre. The amateur does his best to fill the gap, but to confine the work of the community stage within amateur limits is to narrow its scope unduly. The national theatre problem and the influence it might exercise upon the art of the professional stage will, in its solution, determine the future of the community theatre, for a national theatre is nothing more or less than the community theatre on a large scale.

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(G. Wh.)

THE UNITED STATES

For many years there have been theatres and amateur acting groups in America with features similar to those of present-day Little Theatres. Some of the early experiments made by Mary Austin in the west and south-west bore the stamp of authentic community theatre and community drama. But during the years 1906 and 1907 three groups were organized in Chicago which may safely be said to represent the beginning of the Little Theatre movement. Two of these groups were the New Theatre, directed by Victor Mapes, and the Robertson Players, under the leadership of Donald Robertson. The theatre of the trio that survived and that has had a vigorous and intensely useful life was the Hull House theatre, under the direction of Laura Dainty Pelham. In 1911 came the Wisconsin Dramatic Society, which exists under the direction of Laura Sherry. In the next year Maurice Browne started the Little Theatre of Chicago, and Mrs. Lyman Gale the Toy Theatre of Boston. In New York city organizations like the Festival Players of the Henry Street Settlement, which later became the Neighborhood Playhouse, the Provincetown Players, the Washington Square Players, which later became the Theatre Guild, form a vital part of the little theatre movement. Soon the Arts and Crafts Society of Detroit, with Sam Hume as director, founded a magazine of the theatre as a part of its activities. This journal, *Theatre Arts,* has been much enlarged in scope. It is now published in New York, and has established a means of communication between little theatres throughout the country.

The Growth of the Community Drama.—In the next 15 years little theatres sprang up like mushrooms in cities and towns all over the United States, hundreds of new organizations and scores of new playhouses being added to the record every year as the impulse toward a fuller dramatic life grew in strength and volume. The theatres ranged from rebuilt barns and bowling alleys, seating from 50 to 100 people, giving five or six single performances a year with amateur actors and makeshift scenery and lighting equipment, to theatres having the most complete modern building and equipment, including the most advanced stage mechanisms, and giving repertories of from 8 to 20 plays during a long season. The prices at these theatres range from $.50 to $2.00 or more. Most of them have some form of membership organization and subscription audience. Increasingly they are under the leadership of a professional director with the additional professional service of designer, stage carpenter, electrician and so forth, as the budget and necessity require. But the spirit still is and probably will remain always largely amateur. A great many of the ideals of the little theatre come directly from Europe, where experimental theatre organizations, variously called "Free Theatre," "Independent Theatre," "Art Theatre," "Stage Society," etc., have thriven under the leadership of distinguished men like Gordon Craig, André Antoine, Max Reinhardt, Constantin Stanislavski, Jacques Copeau, Granville-Barker and others. The American movement is distinguished from the European by its largely amateur leadership and following and its importance comes from the fact that it seems gradually to be evolving an American drama and a typically American art of the theatre. Moreover, within itself, the movement has had its ultimate source in three fairly distinct native impulses—economic, artistic, educational—and these usually have been reflected in the types of theatres they developed.

Sources of Three Main Types of Little Theatres.—For purposes of identification, these three types can be distinguished as community theatres, art theatres and college theatres or workshops, although their aims and results overlap so much that they should not be considered separately. The community theatre has come as a result of the break-up of the touring system which, controlled by an organized trade theatre in New York, for many years provided dramatic entertainment to the cities of the entire country. The high price of rents, railroading and publicity, added to a growing lack of faith in their offerings, gradually ruined the business of "the road," as it was called, closed most of the large playhouses or turned them into cinemas, and left the cities of the country largely dependent upon their own resources to supply some form of spoken drama.

The art theatre is the direct result of the desire of many young

American artists to express themselves creatively in terms of the theatre arts—play-writing, acting, directing, designing, etc.—even more alluring perhaps because a participation in them had so long been denied by Puritan tradition.

The college theatre is the most native and in many ways the most influential of the three forms. It grew out of a fusion of modern educational impulses: an appreciation of the value of the dramatic method in instruction, a desire to stimulate an understanding of the world's great dramas through a differentiation between literature intended to be read and plays intended to be acted; the need in modern psychological drama for playwrights and players with enough education to interpret life in the aspects that are more complex than mere situation; the necessity for giving students intending to work professionally in the theatre the advantage of workshop training in association with workers in the related arts, so as to enable them to save years of effort and error in a profession in which waste is disastrously expensive; and finally the desire to stimulate the theatre intelligence of the American audience, so long theatre-starved. Although any idea of such breadth and complexity is always a product of its hour rather than the invention of a single mind, the giant's share in the inception and realization of the college theatre and workshop is generally credited to George Pierce Baker, for years from 1905 professor of English at Harvard university, who started the course in playwriting known as "English 47" which, under his leadership grew to be the "47 Workshop."

College Theatres and Workshops.—The college theatre in 1928 extended from amateur dramatic groups, through the Elizabethan clubs and dramatic societies, which act as interpreters to the literary and historical courses in drama, to the drama departments and theatre workshops, many of which provided their own completely equipped playhouses. Among the courses they include are: general history of the theatre, playwriting, acting, rehearsal and performance, English pronunciation and stage speech, stagecraft, scene design, costume, the puppet theatre, stage lighting, dramatic production, etc. In many cases, and increasingly, work done in these courses is counted toward an academic degree. In some cases, as at Yale, where the department of drama is almost entirely devoted to post-graduate work, a special "certificate of proficiency" is issued. In spite of the age-old theory that the only school of the theatre is the theatre, the entire trend in America is toward a training wherever possible in one of these laboratories. Among the most complete and successful are the departments of drama at Yale university, at the Carnegie Institute of Technology at Pittsburgh, at Cornell, Vassar, Dartmouth, Wellesley, Smith, Southern California, the State universities of Iowa, Washington, California, Montana. Graduates of these institutions are in evidence all over America to-day in every branch of the little theatre, at the head of other college theatres or departments of drama, as directors, actors, designers and as successful artists in the professional theatre in New York. For example, among the men and women who have achieved success after working with Professor Baker either at the 47 Workshop or at the Yale department of drama of which he has been the head since it was founded in 1924 are Edward Sheldon, Eugene O'Neill, Sidney Howard, Philip Barry and Maurine Watkins, playwrights; Robert Edmond Jones, Lee Simonson and Donald Mitchell Oenslager, designers; Kenneth Macgowan, Theresa Helburn, Irving Pichel and Sam Hume, directors; Robert Benchley, Heywood Broun, Walter Prichard Eaton, David Carb and John Mason Brown, critics; Alexander Dean, J. A. Crafton, Esther W. Bates, Sam Eliot, Jr., and Frederick H. Koch, teachers. Each year some of these colleges add new theatres to their campuses, and the buildings are notable examples of modern theatre design and especially of stage equipment. In many important college towns these are the only theatres showing living drama today.

One special phase of dramatic work which the college workshops have developed and which offers great promise in the actual creation of an American drama and a complete American theatre is folk play-making. In the wheat fields of the Dakotas, in the sea-coast centres of the State of Washington, in the mountains of North Carolina, college groups are learning to re-create the history of their States, to interpret the character of their people, the quality and meaning of their life and labour. All the plays in these groups are written by the students on the basis of local material, to carry on a story or to establish a tradition. They are acted by student actors, and increasingly are enlarging their audiences to cover the people not only of the college town but of neighbouring towns and sometimes of neighbouring States. The Carolina Playmakers of the University of North Carolina, under the direction of Frederick Koch, have built up a large repertory of folk-plays of their own writing, a theatre company and an entire crew which travels in a large touring truck through the cities and towns of a dozen States. In North Dakota, Alfred Arvold, director of drama of the State agricultural college at Fargo, keeps the Little Country Theatre on the second floor of the administration building continually busy with productions of plays that range from Shakespeare and Ibsen to modern farce and that play to audiences of grain-growers, cattle-ranchers, miners, who come from miles around. Through the influence of Arvold's work, moreover, hardly a school-house is built in North Dakota to-day without a theatre equipment, hardly a crop is harvested without a pageant of the grain to celebrate and illuminate it, hardly an event of historical or political significance passes without its dramatic interpretation.

The Community Theatre.—The community theatre is organized to provide good entertainment for the average taste of the average family in a community, at a cost not above what the average man can afford. To be successful it must give the largest possible number of people an opportunity each to have some part in the work, not only as playwright, director, designer, actor, but as scene-painter, seamstress, electrician, business manager, play-reader, ticket taker, house manager, usher, etc., which, taken together, make the community theatre in itself a working community.

Moreover, it must be run with enough economy and economic security not to be an undue financial burden. The success of such a theatre depends on many special features. A community that is far away from the centre of theatre distribution, with an element of wealth or at least of leisure, and with a certain homogeneity, lends itself more readily to the experiment than one that is too near a metropolis, too largely industrial, too varied in its citizenship and citizen interest. The success of such a theatre depends, moreover, on certain important and rare qualities in the director, who must be at once a competent artist, a good manager and a good leader; somebody who will understand the many-sided problems of securing and spending municipal funds, who can produce good plays well, gauge the popular taste well enough to satisfy and improve it, interest his workers and create an enthusiastic and responsive audience. There are good community theatres all over America, many of them unknown outside their community and yet doing important work. Several of the best known are, as might be expected, well out of range of New York production and touring companies. In California, the Pasadena Community Theatre, under the direction of Gilmor Brown, seems to have solved most of the problems of a community theatre.

The development of community art centres in American cities and towns has given an added impetus to the growth of these theatres which—on account of the many opportunities offered by a theatre stage and auditorium—are recommended by architects and city planners as a good focus for a community art building.

The Art Theatre.—The measure of the community theatre's success is the response it gets from the community. The measure of an art theatre's success is the freedom and creative quality of its production, the contribution it makes to the growth of the individual artist and to theatre progress. The art theatre that is most apt to succeed is one that starts with a director who is at once a man of aesthetic instinct and of broad sympathy, who can use the talents of other artists creatively and gain impetus from the force of a creative failure as well as from an artistic success. Because experiment in the theatre is by its nature so expensive, because a successful artist developed by an art theatre naturally turns to professional fields of larger opportunity, as well as because good directors are scarce, there are not many art theatres in the country, except in New York, which have been permanent. There are a few worthy leaders who have achieved fine theatres, good repertories and a fair permanence of cast by steadiness of purpose. The only art theatre which has come through from amateur beginnings to professional stature in its building, its direction, its repertory and its productions, is the Cleveland playhouse, under the direction of Frederic McConnell.

What is the general trend of the little theatre movement is difficult to indicate. It is for the first time in America establishing the theatre as a force in the social life of cities large and small, it is using the dramatic impulse in education to the full, it is developing the talents of hundreds of theatre artists of various kinds, it is serving as a tributary stream to the larger stream of professional theatre life which still centres in New York. There is no end to what it can do from these beginnings.

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LITTLETON or **LYTTELTON, EDWARD,** Baron (1589–1645), son of Sir Edward Littleton (d. 1621) chief-justice of North Wales, was born at Munslow in Shropshire; he was educated at Oxford and succeeded his father as chief-justice of North Wales. In 1625 he became a member of parliament and acted in 1628 as chairman of the committee of grievances upon whose report the Petition of Right was based. In 1631 he became recorder of London, and in 1634 the king attached him to his own side by appointing him solicitor-general. In the famous case about ship-money Sir Edward argued against Hampden. In 1640 he was made chief-justice of the common pleas and in 1641 lord keeper of the great seal, being created a peer as Baron Lyttelton. In Jan. 1642 he refused to put the great seal to the proclamation for the arrest of the five members and he voted for the militia ordinance. He returned the great seal to Charles, but recovered it after joining the king at York. Littleton died at Oxford on Aug. 27, 1645; he left no sons and his barony became extinct.

LITTLETON, SIR THOMAS DE (*c.* 1407–1481), English judge and legal author, was born, it is supposed, at Frankley Manor House, Worcestershire, about 1407. He is said by Sir E. Coke to have "attended one of the universities," but there is no corroboration of this statement. He was probably a member of the Inner Temple, and lectured there on the statute of Westminster II., *De Donis Conditionalibus.* His name occurs in the Paston Letters (ed. J. Gairdner, i. 60) about 1445 as that of a well-known counsel and in 1481–42 he received a grant of the manor of Sheriff Hales, Shropshire, from a Sir William Trussel as a reward for his services as counsel. He appears to have been recorder of Coventry in 1450; he became serjeant-at-law in 1453 and was afterwards a justice of assize on the northern circuit. In 1466 he was made a judge of the common pleas, and in 1475 a knight of the Bath. He died, according to the inscription on his tomb in Worcester Cathedral, on Aug. 23, 1481. He married, about 1444, Joan, widow of Sir Philip Chetwind of Ingestrie in Staffordshire, and by her had three sons.

His *Treatise on Tenures* was probably written after he had been appointed to the bench. It is addressed to his second son Richard, who went to the bar, and whose name occurs in the year books of the reign of Henry VII. It was printed in 1481 or 1482, was one of ten earliest books published in London, and the earliest treatise on English law ever printed. There are two mss. of it written when he was alive. The book was written in law French, which was still in use for law books, though proceedings in the courts had to be in English. The essential element of English law at that time was land law, and it is of this that Littleton treats. Unlike the preceding writers on English law, Glanville, Bracton and the authors of the treatises known by the names of Britton and Fleta, Littleton borrows nothing from the sources of Roman law or the commentators. He deals exclusively with English law.

The book is written on a definite system, and is the first attempt at a scientific classification of rights over land. Littleton's method is to begin with a definition, usually clearly and briefly expressed, of the class of rights with which he is dealing. He then proceeds to illustrate the various characteristics and incidents of the class by stating particular instances, some of which refer to decisions which had actually occurred, but more commonly they are hypothetical cases put by way of illustration of his principles. He occasionally refers to reported cases. His book is thus much more than a mere digest of judicial decisions; to some extent he pursues the method which gave to Roman law its breadth and consistency of principle. In Roman law this result was attained through the practice of putting to jurisconsults hypothetical cases to be solved by them. Littleton, in like manner, is constantly stating and solving by reference to principles of law cases which may or may not have occurred in actual practice.

One may summarize the scope of the book by saying that it affords a complete view of the English land-law (that is to say, substantially, of the English law) of the middle ages, before it had become affected by the recognition of equitable rights in land. Not that Littleton was personally unaware of these, as his will shows. The first book of Coke's *Institutes* is in the form of a commentary on Littleton's *Tenures.*

Bibliography.—There are three early mss. of Littleton at Cambridge. The *editio princeps* is by Letton and Machlinia (1481–82). There were many editions in the 16th century. The first English translation is by Rastell (between 1514 and 1533). There are many commentaries, one earlier than Coke. The existing division into sections dates from the edition of West (1581).

See E. Wambaugh, *Littleton's Tenures in English* (Washington, D.C., 1903).

LITTLETON, town of Grafton county, New Hampshire, U.S.A., beautifully situated on the Ammonoosuc and the Connecticut rivers, at an altitude of 1,100 ft., 11 mi. N.W. of the Franconia notch. It is served by the Boston and Maine railroad. The population in 1930 was 4,558; in 1940, 4,571. It is a summer and winter resort and the business centre for the White mountain region. Its manufactures include whetstones, razor strops, shoes, furniture, caskets, and over 1,000,000 pairs a year of buckskin gloves and mittens. The town was at first called Apthorp, and later Chiswick. In 1874 it was incorporated under the name of Littleton, in honour of one of the first settlers.

LITTRÉ, MAXIMILIEN PAUL ÉMILE (1801–1881), French lexicographer and philosopher, was born in Paris on Feb. 1, 1801. He was educated at the Lycée Louis-le-Grand, where he had for friends Hachette and Eugène Burnouf. He then studied the English and German languages, and classical and Sanskrit literature and philology. He intended to become a doctor, and had completed his studies when his father's death (1827) made it necessary for him to begin earning money. He began to teach classics, and in 1835 became a regular contributor to the *National,* and eventually director of the paper. In 1839 appeared the first volume of his edition (completed 1862) of the works of Hippocrates, which secured his election the same year into the Académie des Inscriptions et Belles-Lettres. He also became a friend of Comte, and popularized his ideas in numerous works on the positivist philosophy.

About 1844 he started working on his great *Dictionnaire de la langue française.* In the revolution of July 1848 he took part in the repression of the extreme republican party in June 1849. His essays, contributed during this period to the *National,* were collected together and published under the title of *Conservation, révolution et positivisme* in 1852, and show a thorough acceptance of all the doctrines propounded by Comte. During the later years of Comte's life, he found himself out of sympathy with the more mystic ideas of his friend and master, but he concealed his differences of opinion, and Comte failed to perceive that his pupil had outgrown him, as he himself had outgrown his master Saint-Simon. After Comte's death in 1858 he felt free to publish his own ideas in his *Paroles de la philosophie positive* (1859), and at still greater length in his work in *Auguste Comte et la philosophie positive* (1863).

About 1863, after completing his Hippocrates and his Pliny, he set to work in earnest on his French dictionary. In the same year he was proposed for the Académie Française, but rejected, owing to the opposition of Mgr. Dupanloup, bishop of Orleans, who denounced him in his *Avertissement aux pères de famille* as the chief of the French materialists. He also at this time started with G. Wyrouboff the *Philosophie Positive*, a review which was to embody the views of modern positivists. His life was thus absorbed in literary work till the overthrow of the empire called on him to take a part in politics. He felt himself too old to undergo the privations of the siege of Paris, and retired with his family to Brittany, whence he was summoned by Gambetta to Bordeaux, to lecture on history, and thence to Versailles to take his seat in the senate to which he had been chosen by the department of the Seine. In Dec. 1871 he was elected a member of the Académie Française in spite of the renewed opposition of Dupanloup, who resigned his seat rather than receive him When he was on the point of death, his wife had him baptized, and his funeral was conducted with the rites of the Catholic Church. He died on June 2, 1881.

Littré's *Dictionary* was completed in 1873. An authoritative interpretation is given of the use of each word, based on the various meanings it had held in the past.

For his life consult C. A. Sainte-Beuve, *Notice sur M. Littré, sa vie et ses travaux* (1863); and *Nouveaux Lundis*, vol. v.; also the notice by M. Durand-Gréville in the *Nouvelle Revue* of Aug. 1881; E. Caro, *Littré et le positivisme* (1883), Pasteur, *Discours de réception* at the Academy, where he succeeded Littré, and a reply by E. Renan.

LITURGY, in the technical language of the Christian Church, the order for the celebration and administration of the Eucharist. The word (from Gr. λειτουργία, public service) has come to be used in a more general sense to denote any or all of the various prescribed forms of public worship. In this article the liturgy is treated in the stricter sense.

There are nine main families or groups of liturgies, four of them being of Eastern and five of them of Western origin and use. They are known either by the names of the apostles with whom they are traditionally connected, or by the names of the countries or cities in which they have been or are still in use.

The Syrian Rite (St. James).—The principal liturgies to be enumerated under this group are the Clementine liturgy, so called from being found in the eighth book of the Apostolic Constitutions, which claim in their title, though erroneously, to have been compiled by St. Clement, the 1st-century bishop of Rome; the Greek liturgy of St. James; the Syriac liturgy of St. James. Sixty-four more liturgies of this group have existed, the majority being still in existence. Their titles are given in F E. Brightman's *Liturgies, Eastern and Western* (1896), pp. lviii.-lxi

The Egyptian Rite (St. Mark).—This group includes the Greek liturgies of St. Mark, St. Basil and St. Gregory, and the Coptic liturgies of St. Basil, St. Gregory, St. Cyril or St. Mark; together with certain less known liturgies the titles of which are enumerated by Brightman (*op. cit.* pp. lxxiii. lxxiv.). The liturgy of the Ethiopian church ordinances and the liturgy of the Abyssinian Jacobites, known as that of the Apostles, fall under this group.

The Persian Rite (SS. Adaeus and Maris).—This Nestorian rite is represented by the liturgy which bears the names of SS. Adaeus and Maris together with two others named after Theodore of Mopsuestia and Nestorius. This group has sometimes been called "East-Syrian." The titles of three more of its now lost liturgies have been preserved, namely those of Narses, Barsumas and Diodorus of Tarsus. The liturgy of the Christians of St. Thomas, on the Malabar coast of India, formerly belonged to this group, but it was almost completely assimilated to the Roman liturgy by Portuguese Jesuits at the synod of Diamper in 1599.

The Byzantine Rite.—The Greek liturgies of St. Chrysostom, St. Basil and St. Gregory Dialogus, or The Presanctified, also extant in other languages, are the living representatives of this rite. The Greek liturgy of St. Peter is classified under this group, but it is merely the Roman canon of the Mass, etc., inserted in a Byzantine framework, and seems to have been used at one time by some Greek communities in Italy. To this group also belongs the Armenian liturgy, of which ten different forms have existed in addition to the liturgy now in general use named after St. Athanasius.

The Hispano-Gallican Rite (St. John).—This group of Latin liturgies, which once prevailed very widely in Western Europe, has been almost universally superseded by the liturgy of the Church of Rome. Where it survives, it has been more or less assimilated to the Roman pattern It prevailed once throughout Spain, France, northern Italy, Great Britain and Ireland The term "Ephesine" has been applied to this group or family of liturgies, chiefly by English liturgiologists, and the names of St. John and of Ephesus, his place of residence, have been pressed into service in support of a theory of Ephesine origin, which, however, lacks proof and may now be regarded as a discarded hypothesis. Other theories represent the Gallican to be a survival of the original Roman liturgy, or an importation into Western Europe from the East through a Milanese channel.

The Mozarabic Liturgy.—This was the national liturgy of the Spanish church till the close of the 11th century, when the Roman liturgy was forced upon it. Its use, however, lingered on, till in the 16th century Cardinal Ximenes, anxious to prevent its becoming quite obsolete, had its books restored and printed, and founded a college of priests at Toledo to perpetuate its use. It survives now only in several churches in Toledo and in a chapel at Salamanca, and even there not without certain Roman modifications of its original text and ritual.

Gallican Liturgy.—This was the ancient and national liturgy of the church in France till the commencement of the 9th century, when it was suppressed by order of Charlemagne, who directed the Roman missal to be everywhere substituted in its place. All traces of it seemed for some time to have been lost until three Gallican sacramentaries were discovered and published by Thomasius in 1680 under the titles of *Missale Gothicum, Missale Gallicum* and *Missale Francorum*, and a fourth was discovered and published by Mabillon in 1687 under the title of *Missale Gallicanum.* Fragmentary discoveries have been made since. Mone discovered fragments of eleven Gallican masses and published them at Carlsruhe in 1850. Other fragments from the library at St. Gall have been published by Bunsen (*Analecta Ante-Nicaena,* iii. 263–266), and from the Ambrosian library at Milan by Cardinal Mai (*Scriptt. Vet. Vat. Coll.* iii. 2. 247). A single page was discovered in Gonville and Caius College, Cambridge, published in *Zeitschrift für Kath. Theologie,* vi. 370.

Ambrosian Liturgy.—Considerable variety of opinion has existed among liturgical writers as to the proper classification of the "Ambrosian" or "Milanese" liturgy. If we are to accept it in its present form and to make the present position of the great intercession for quick and dead the test of its *genus,* then we must classify it as "Petrine" and consider it as a branch of the Roman family If, on the other hand, we consider the important variations from the Roman liturgy which yet exist, and the traces of still more marked variation which confront us in the older printed and ms. copies of the Ambrosian rite, we shall detect in it an original member of the Hispano-Gallican group of liturgies, which for centuries underwent a gradual but ever-increasing assimilation to Rome. We know this as a matter of history, as well as a matter of inference from changes in the text itself. Charlemagne adopted the same policy towards the Milanese as towards the Gallican church. He carried off all the Ambrosian church books which he could obtain, with the view of putting Roman books in their place, but the completion of his intentions failed, partly through the attachment of the Lombards to their own rites, partly through the intercession of a Gallican bishop named Eugenius (Mabillon, *Mus. Ital.* tom. i. Pars. ii. p. 106). It has been asserted by Joseph Vicecomes that this is an originally independent liturgy drawn up by St. Barnabas, who first preached the Gospel at Milan (*De Missae* Rit. 1 capp. xi. xii.), and this tradition is preserved in the title and proper preface for St. Barnabas Day in the Ambrosian missal (Pamelius, *Liturgicon,* i. 385, 386), but it has never been proved.

The Roman Rite (St. Peter).—There is only one liturgy to be enumerated under this group, viz. the present liturgy of the Church of Rome, which, though originally local in character and circumscribed in use, has come to be nearly co-extensive with the Roman Catholic Church, sometimes superseding earlier national liturgies, as in Gaul and Spain, sometimes incorporating more or less of the ancient ritual of a country into itself and producing from such incorporation a sub-class of distinct Uses, as in England, France and elsewhere. Even these subordinate Uses have for the most part become, or are rapidly becoming, obsolete.

The date, origin and early history of the Roman liturgy are obscure. The first Christians at Rome were a Greek-speaking community and their liturgy must have been Greek, and is possibly represented in the so-called Clementine liturgy. But the date when such a state of things ceased, when and by whom the present Latin liturgy was composed, whether it is an original composition, or, as its structure seems to imply, a survival of some intermediate form of liturgy—all these are questions which are waiting for solution.

The Roman liturgy seems to have been introduced into England in the 7th, into France in the 9th and into Spain in the 11th century, though no doubt it was known in both France and Spain to some extent before these dates. In France certain features of the service and certain points in the ritual of the ancient national liturgy became interwoven with its text and formed those many varying mediaeval Gallican Uses which are associated with the names of different French sees.

The chief distinguishing characteristics of the Roman rite are these: (*a*) the position of the great intercession for quick and dead within the canon, the commemoration of the living being placed just before and the commemoration of the departed just after the words of institution; (*b*) the absence of an "Epiklesis" or invocation of the Holy Ghost upon the elements; (*c*) the position of the *Pax* or "Kiss of Peace after the consecration" and before the communion, whereas in other liturgies it occurs at a much earlier point in the service.

LITURGIES OF THE BRITISH ISLES

Period I. The Celtic Church.—Until recently almost nothing was known of the character of the liturgical service of the Celtic church which existed in these islands before the Anglo-Saxon conquest, and continued to exist in Ireland, Scotland, Wales and Cornwall for considerable though varying periods of time after that event. But in recent times a good deal of light has been thrown on the subject, partly by the publication or republication of the few genuine works of Patrick, Columba, Columbanus, Adamnan and other Celtic saints; partly by the discovery of liturgical remains in the Scottish *Book of Deer* and in the Irish *Books of Dimma and Mulling* and the *Stowe Missal*, etc.; partly by the publication of mediaeval Irish compilations, such as the *Lebar Brecc, Liber Hymnorum, Martyrology of Oengus*, etc., which contain ecclesiastical kalendars, legends, treatises, etc., of considerable but very varying antiquity. The evidence collected from these sources is sufficient to prove that the liturgy of the Celtic church was of the Gallican type. In central England the churches, with everything belonging to them, were destroyed by the heathen invaders at the close of the 5th century; but the Celtic church in the remoter parts of England, as well as in the neighbouring kingdoms of Scotland and Ireland, retained its independence for centuries afterwards.

An examination of its few extant service-books and fragments of service-books yields the following evidence of the Gallican origin and character of the Celtic liturgy: (*a*) the presence of collects and anthems which occur in the Gallican or Mozarabic but not in the Roman liturgy; (*b*) various formulae of thanksgiving after communion; (*c*) frequent biddings or addresses to the people in the form of Gallican *Praefationes;* (*d*) the Gallican form of consecration, being a prayer called *Post-Sanctus* leading up to the words of institution; (*e*) the complicated rite of "fraction" or "the breaking of bread," as described in the Irish treatise at the end of the *Stowe Missal,* finds its only counterpart in the elaborate ceremonial of the Mozarabic church; (*f*) the presence of the Gallican ceremonial of *Pedilavium* or "Washing of feet" in the earliest Irish baptismal office. (*See* F. E. Warren, *Liturgy and Ritual of the Celtic Church,* 1881.)

Period II. The Anglo-Saxon Church.—We find ourselves here on firmer ground, and can speak with certainty as to the nature of the liturgy of the English church after the beginning of the 7th century. Information is drawn from liturgical allusions in the extant canons of numerous councils, from the voluminous writings of Bede, Alcuin and many other ecclesiastical authors of the Anglo-Saxon period, and above all from a considerable number of service-books written in England before the Norman Conquest. Three of these books are missals of more or less completeness: (1) the *Leofric Missal,* a composite 10th- to 11th-century ms. presented to the cathedral of Exeter by Leofric, the first bishop of that see (1046–1072), now in the Bodleian library at Oxford; edited by F. E. Warren (Oxford, 1883); (2) the missal of Robert of Jumièges, archbishop of Canterbury (1051–1052), written probably at Winchester and presented by Archbishop Robert to his old monastery of Jumièges in the neighbourhood of Rouen, in the public library of which it now lies; edited by H. A. Wilson (1896); (3) the *Red Book of Derby,* a ms. missal of the second half of the 11th century, now in the library of Corpus Christi College, Cambridge.

The Anglo-Saxon church owed its foundation to a Roman pontiff, and to Roman missionaries, who brought, as we are told by Bede, their native liturgical codices with them (*Hist. Eccles.* lib. ii. cap. 28). Accordingly, when we speak of an Anglo-Saxon missal, we mean a Roman missal.

Period III. Anglo-Norman Church.—The influx of numerous foreigners, especially from Normandy and Lorraine, which preceded, accompanied and followed the Conquest, and the occupation by them of the highest posts in church as well as state had a distinct effect on the liturgy of the English church. These foreign ecclesiastics brought over with them a preference for and a habit of using certain features of the Gallican liturgy and ritual, which they succeeded in incorporating into the service-books of the church of England. One of the Norman prelates, Osmund, count of Séez, earl of Dorset, chancellor of England, and bishop of Salisbury (1078–1099), is credited with having undertaken the revision of the English service-books; and the missal which we know as the *Sarum Missal,* or the *Missal according to the Use of Sarum,* practically became the liturgy of the English church. It was not only received into use in the province of Canterbury, but was largely adopted beyond those limits—in Ireland in the 12th and in various Scottish dioceses in the 12th and 13th centuries.

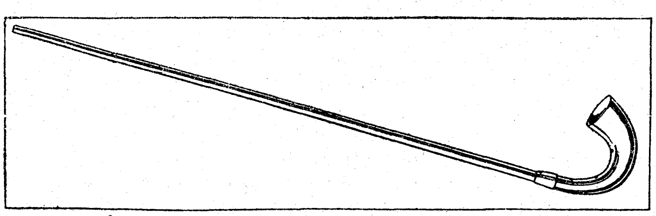
Besides the famous and far-spreading Use of Sarum, other Uses, more local and less known, grew up in various English dioceses. In virtue of a recognized diocesan independence, bishops were able to regulate or alter their ritual, and to add special masses or commemorations for use within the limits of their jurisdiction. The better known and the more distinctive of these Uses were those of York and Hereford, but we also find traces of or allusions to the Uses of Bangor, Lichfield, Lincoln, Ripon, St. Asaph, St. Paul's, Wells and Winchester. The Eucharistic service was contained in the volume called the Missal (*q.v.*), as the ordinary choir offices were contained in the volume known as the Breviary (*q.v.*).

Period IV. The Reformed Church.—The Anglican liturgy of Reformation and post-Reformation times is described under the heading of PRAYER, BOOK OF COMMON, but a brief description may be added here of the liturgies of other reformed churches. The liturgy of the Scottish Episcopal Church in nearly its present form was compiled by Scottish bishops in 1636 and imposed—or, to speak more accurately, attempted to be imposed—upon the Scottish people by the royal authority of Charles I. in 1637. The prelates chiefly concerned in it were Spottiswood, bishop of Glasgow; Maxwell, bishop of Ross; Wedderburn, bishop of Dunblane; and Forbes, bishop of Edinburgh. Their work was approved and revised by certain members of the English episcopate, especially Laud, archbishop of Canterbury; Juxon, bishop of London; and Wren, bishop of Ely. This liturgy has met with varied fortune and has passed through several editions. The present Scottish office dates from 1764. It is now used as an alternative form with the English communion office in the Scottish Episcopal Church. The general arrangement of its parts approximates more closely to that of the first book of Edward VI. than to the present Anglican Book of Common Prayer. (*See* Bishop J. Dowden, *The Annotated Scottish Communion Service*, 1884.)

American Liturgy.—The Prayer Book of "the Protestant Episcopal Church" in America was adopted by the general convention of the American church in 1789. It is substantially the same as the English Book of Common Prayer, but among important variations we may name the following: (*a*) The arrangement and wording of the order for Holy Communion rather resembles that of the Scottish than that of the English liturgy, especially in the position of the oblation and invocation immediately after the words of institution. (*b*) The Magnificat, Nunc dimittis and greater part of Benedictus were disused; but these were reinstated among the changes made in the Prayer Book in 1892. (*c*) Ten selections of Psalms are appointed for use as alternatives for the Psalms of the day. (*d*) *Gloria in excelsis* is allowed as a substitute for *Gloria Patri* at the end of the Psalms at morning and evening prayer. In addition to these there are many more both important and unimportant variations from the English Book of Common Prayer.

The Irish Prayer Book.—The Prayer Book in use in the Irish portion of the United Church of England and Ireland was the Anglican Book of Common Prayer, but after the disestablishment of the Irish church several changes were introduced into it by a synod held at Dublin in 1870. These changes included such important points as: (*a*) the excision of all lessons from the Apocrypha, (*b*) of the rubric ordering the recitation of the Athanasian Creed, (*c*) of the rubric ordering the vestments of the second year of Edward VI., (*d*) of the form of absolution in the office for the visitation of the sick, (*e*) the addition to the Catechism of a question and answer bringing out more clearly the spiritual character of the real presence.

The Presbyterian Church.—The Presbyterian churches of Scotland at present possess no liturgy properly so called. Certain general rules for the conduct of divine service are contained in the *Directory for the Public Worship of God* agreed upon by the assembly of divines at Westminster, with the assistance of commissioners from the Church of Scotland, approved and established by an act of the general assembly, and by an act of parliament, both in 1645. In 1554 John Knox had drawn up an order of liturgy closely modelled on the Genevan pattern for the use of the English congregation to which he was then ministering at Frankfort. On his return to Scotland this form of liturgy was adopted by an act of the general assembly in 1560 and became the established form of worship in the Presbyterian church until the year 1645, when the Directory of Public Worship took its place. Herein regulations are laid down for the conduct of public worship, for the reading of Scripture and for extempore prayer before and after the sermon, and in the administration of the sacrament of baptism and the Lord's Supper, for the solemnization of marriage, visitation of the sick and burial of the dead, for the observance of days of public fasting and public thanksgiving, together with a form of ordination and a directory for family worship.



LITUUS, THE CAVALRY TRUMPET OF THE ROMANS

LITUUS, the cavalry trumpet of the Romans, said by Macrobius (*Saturn.* lib. vi.) to have resembled the crooked staff borne by the Augurs. It consisted of a cylindrical tube 4ft. or 5ft. long, having a narrow bore, and shaped like the letter J.

LITVINOV, MAXIM MAXIMOVICH (1876–), Russian politician, was born at Bielostok. When 17 he entered military service as a volunteer and while in the army became interested in Marxism. When his service was completed, he became a member of the Kiev committee of the Social Democratic party. One of the members of that committee proved to be a police agent and the committee was arrested. After a year and a half in prison Litvinov with 11 companions escaped, went abroad and took an active part in the *Iskra,* the Social Democratic newspaper. Litvinov joined the Bolshevik section of the party, returned to Russia illegally in 1903, and worked there as a member of the central committee until the revolution of 1905. In that year he attended the London Congress as a delegate from the Riga Committee, and took part with Gorky in founding *Novaya Zhizn* (*The New Life*).

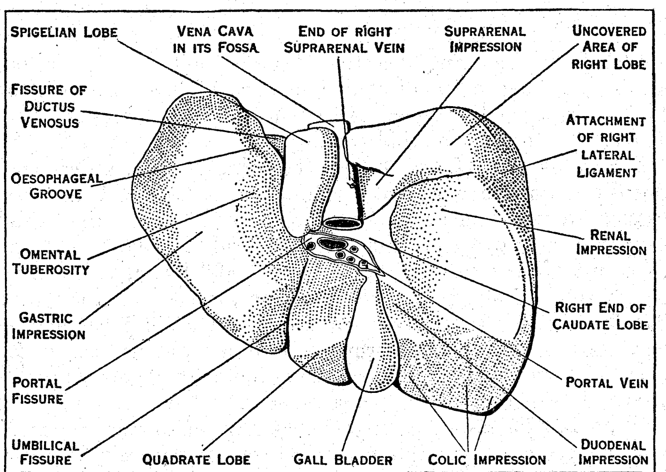
After the failure of the attempted revolution of 1905 Litvinov lived abroad, and organized the sending of weapons to the revolutionaries in the Caucasus. After the November revolution (1917) in Russia he was appointed diplomatic agent of the Soviet government in England. He was subsequently arrested as a hostage for Mr. Lockhart, for whom he was exchanged. As assistant commissar for foreign affairs he took part in the initiation of peace negotiations with Estonia, in negotiations at Copenhagen with England, in the Genoa conference and, as president of the Russian delegation, in the subsequent conference at The Hague. Litvinov continued to take a leading part in disarmament conferences, both in Moscow and Geneva. From 1930 to 1939 he was people's commissar for foreign affairs.

LIUDPRAND (LIUTPRAND, LUITPRAND) (*c.* 922–972), Italian historian and author, bishop of Cremona, came of a noble Lombard family. In 931 he entered the service of King Hugo of Italy as page; he became chancellor under Berengar, and was sent (949) on an embassy to the Byzantine court. On his return he fell into disgrace with Berengar. He then attached himself to the emperor Otto I., who made him bishop of Cremona (961). He was frequently employed in missions to the pope, and in 968 to Constantinople to demand for the younger Otto (afterwards Otto II.) the hand of Theophano, daughter of the emperor Nicephorus Phocas. His account of this embassy in the *Relatio de Legatione Constantinopolitana* (Eng. trans. in Henderson's *Select Documents of the Middle Ages,* 1896) gives a graphic and lively description of Constantinople and the Byzantine court.

Liudprand wrote (1) *Antapodoseos, seu rerum per Europam gestarum, Libri VI.,* an historical narrative, relating to the events from 887 to 949, directed against Berengar and Willa his queen; (2) *Historia Ottonis,* covering the years 960 to 964; and (3) the *Relatio de Legatione Constantinopolitana* (968–969). All are to be found in the *Monum. Germ. Hist.* of Pertz, and in the *Rer. Ital. Script.* of Muratori; there is an edition by E. Dümmler (1877), and a partial translation into German in *Geschichtsschreiber der deutschen Vorzeit* (vol. ii., 1853).

See L. M. Hartmann, *Geschichte Italiens im Mittelalter,* vol. ii. (1903).

LIVER, ANATOMY OF. The liver is a large reddish-brown gland situated in the upper and right part of the abdominal cavity. When hardened *in situ* its shape is that of a right-angled, triangular prism showing five surfaces—superior, anterior, inferior, posterior and right lateral which represents the base of the prism. It weighs about three pounds or one-fortieth of the body weight. The liver is plastic, and moulds itself to neighbouring viscera. The superior surface is in contact with the diaphragm, but has peritoneum between (*see* COELOM AND SEROUS MEMBRANES). At its posterior margin the peritoneum of the great sac is reflected on to the diaphragm to form the anterior layer of the *coronary ligament.* Near the mid line of the body, and at right angles to the last, another reflection, the *falciform ligament,* runs forward, and the line of attachment of this indicates the junction of the *right* and *left lobes* of the liver. The anterior surface is in contact with the diaphragm and the anterior abdominal wall. The attachment of the falciform ligament is continued down it. The posterior surface is more complicated (fig. 1); starting from the right and working toward the left, a large triangular area, uncovered by peritoneum and in direct contact with the diaphragm, is seen. This is bounded on the left by the inferior vena cava, which is sunk into a deep groove in the liver, and into the upper part of this the *hepatic veins* open. Just to the right of this and at the lower part of the bare area is a triangular depression for the right suprarenal body. To the left of the vena cava is the *Spigelian lobe,* which lies in front of the bodies of the tenth and



FROM CUNNINGHAM, "TEXT BOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

FIG. 1.—THE LIVER VIEWED FROM BELOW AND BEHIND
The visceral surface and posterior area of parietal surface are seen. The portal fissure has been opened to show passage of portal vein and other vessels

eleventh thoracic vertebrae, the lesser sac of peritoneum, diaphragm and thoracic aorta intervening. To the left of this is the fissure for the *ductus venosus,* and to the left of this again, the left lobe, in which a broad shallow groove for the oesophagus may usually be seen. Sometimes the left lobe stretches as far as the left abdominal wall, but more often it ends below the apex of the heart, which is $3\frac{1}{2}$in. to the left of the mid line of the body. The relations of the lower surface can only be understood if it is realized that it looks backward and to the left as well as downward (fig. 1). Again starting from the right side, two impressions are seen; the anterior one is for the hepatic flexure of the colon, and the posterior for the upper part of the right kidney. To the left of the colic impression is a smaller one for the second part of the duodenum. Next comes the *gall bladder,* a pear-shaped bag, the fundus of which is in front and below, the neck behind and above. From the neck passes the *cystic duct,* which is often twisted into the form of an S. To the left of the gall bladder is the *quadrate lobe,* which is in contact with the pylorus of the stomach. To the

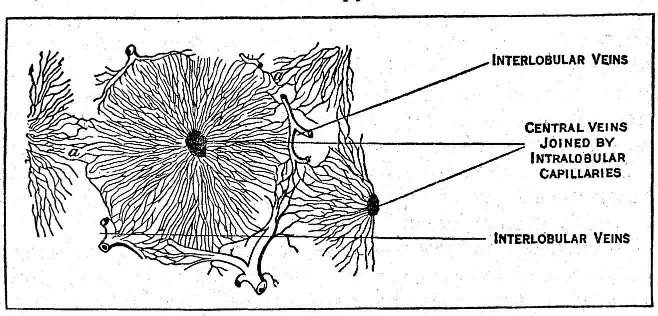


FIG. 2.—TRANSVERSE SECTION THROUGH LOBULES SHOWING VENOUS ARRANGEMENT. AT *a* THE CAPILLARIES OF ONE LOBULE ANASTOMOSE WITH THOSE OF THE ADJACENT LOBULE

left of this is the left lobe of the liver, separated from the quadrate lobe by the umbilical fissure in which lies the *round ligament* of the liver, the remains of the umbilical vein of the foetus. The under surface of the left lobe is concave for the anterior surface of the stomach (*see* ALIMENTARY CANAL), while on the other hand a convexity (*tuber omentale*) fits into the lesser curvature of that organ. The posterior boundary of the quadrate lobe is the *transverse fissure,* which is little more than an inch long and more than half an inch wide. This fissure represents the hilum of the liver, and contains the right and left hepatic ducts and the right and left branches of the hepatic artery and portal vein, together with nerves and lymphatics, the whole being enclosed in condensed subperitoneal tissue known as *Glisson's capsule.* Behind the transverse fissure the lower end of the Spigelian lobe is seen as a knob, and from the right of this a narrow bridge runs forward and to the right to join the Spigelian lobe to the right lobe and to shut off the transverse fissure from that for the vena cava. This is the *caudate lobe.* The right surface of the liver is covered with peritoneum and is in contact with the diaphragm, outside which are the pleura and lower ribs. From its lower margin the *right lateral ligament* is reflected on to the diaphragm. A similar fold passes from the tip of the left lobe as the *left lateral ligament,* and both these are the lateral margins of the coronary ligament. Sometimes, especially in women, a tongue-shaped projection downward of the right lobe is found, known as *Riedel's lobe;* it is of clinical interest as it may be mistaken for a tumour or floating kidney. The right and left *hepatic ducts,* while still in the transverse fissure, unite into a single duct which joins the cystic duct from the gall bladder at an acute angle. When these have united the duct is known as the *common bile duct,* and runs down to the second part of the duodenum (*see* ALIMENTARY CANAL).

Minute Structure of the Liver.—The liver is made up of an enormous number of conical *lobules* (fig. 3). If the portal vein is followed from the transverse fissure, it will be seen to branch and rebranch until minute twigs called *interlobular veins* (fig. 2), ramify around the lobules. From these *intralobular capillaries* run toward the centre of the lobule, forming a network among the polygonal hepatic cells. On reaching the core of the conical lobule they are collected into a central or *intralobular vein* (fig. 2) which unites with other similar ones to form a *sublobular vein* (fig. 3). These eventually reach the hepatic radicles, and so the blood is conducted into the vena cava. In man the lobules are not distinctly separated one from the other, but in some animals, *e.g.,* the pig, each has a fibrous sheath derived from Glisson's capsule (fig. 3).

Embryology.—The liver first appears as an entodermal hollow longitudinal outgrowth from the duodenum into the ventral mesentery. The upper part of this forms the future liver, and grows up into the *septum transversum* from which the central part

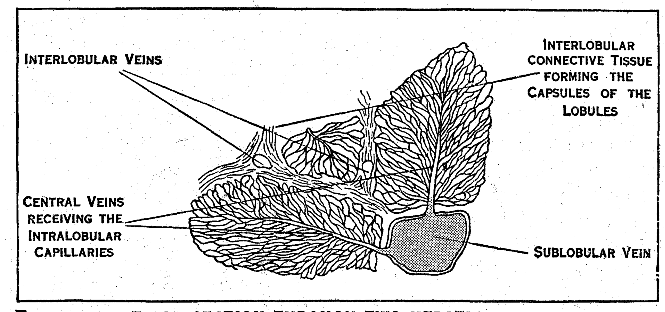


FIG. 3.—VERTICAL SECTION THROUGH TWO HEPATIC LOBULES OF A PIG

of the diaphragm is formed (*see* DIAPHRAGM). From the cephalic part of this primary diverticulum solid rods of cells called the *hepatic cylinders* grow out, and these branch repeatedly until a cellular network is formed surrounding and breaking up the umbilical and vitelline veins. The liver cells, therefore, are entodermal, but the supporting connective tissue mesodermal from the septum transversum. The lower (caudal) part of the furrow-like outgrowth remains hollow and forms the gall bladder. At first the liver is embedded in the septum transversum, but later the diaphragm and it are constricted off one from the other, and soon the liver becomes very large and fills the greater part of the abdomen. At birth it is proportionately much larger than in the adult, and forms one-eighteenth instead of one-fortieth of the body weight, the right and left lobes being nearly equal in size.

Comparative Anatomy.—In the Acrania (*Amphioxus*) the liver is probably represented by a single ventral diverticulum from the anterior end of the intestine, which has a hepatic portal circulation and secretes digestive fluid. In all the Craniata a solid liver is developed. In the adult lamprey among the Cyclostomata the liver undergoes retrogression, and the bile ducts and gall bladder disappear, though they are present in the larval form (ammocoetes). In fishes and amphibians the organ consists of right and left lobes, and a gall-bladder is present. The same description applies to the reptiles, but a curious network of cystic ducts is found in snakes and to a less extent in crocodiles. In the Varanidae (monitors) the hepatic duct is also retiform. In birds two lobes are present, but in some, *e.g.*, the pigeon, there is no gall-bladder.

In mammals Sir William Flower pointed out that a generalized type of liver exists, from which that of any mammal may be derived by suppression or fusion of lobes. The accompanying diagram of Flower (fig. 4) represents an ideal mammalian liver. It will be seen that the umbilical fissure divides the organ into right and left halves, as in the lower vertebrates, but that the ventral part of each half is divided into a central and lateral lobe. The gall-bladder when present, is always situated on the caudal surface or in the substance of the right central lobe. The Spigelian and caudate lobes belong to the right half of the liver, the latter being usually a leaf-shaped lobe attached by its stalk to the Spigelian, and having its blade flattened between the right lateral lobe and the right kidney. The vena cava is always found to the right of the Spigelian lobe and dorsal to the stalk of the caudate. In tracing the lobulation of man's liver back to this generalized type, it is evident that his quadrate lobe does not correspond to any one generalized lobe, but is merely that part of the right central which lies between the gall bladder and the umbilical fissure. From a study of human variations compared with an Anthropoid liver, such as that of the gorilla, it is fairly clear that the human liver is formed, not by a suppression of any of the lobes of the generalized type, but by a fusion of those lobes and obliteration of certain fissures. This fusion is attributed by Sir A. Keith to the effect of pressure following the assumption of the erect position. The accompanying diagram (fig. 5) shows an abnormal human liver in the anatomical department of St. Thomas's hospital which reproduces the generalized type.

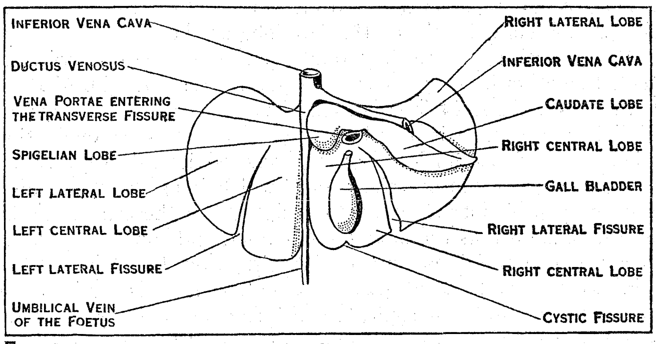


FIG. 4.—DIAGRAMMATIC PLAN OF INFERIOR SURFACE OF A MULTILOBED MAMMALIAN LIVER. THE POSTERIOR OR ATTACHED BORDER IS UPPERMOST

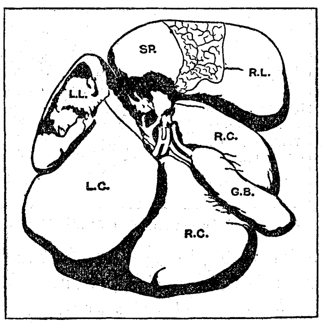


FIG. 5.—HUMAN LIVER, SHOWING A REVERSION TO THE GENERALIZED MAMMALIAN TYPE

SP, Spigelian Lobe; R.L., right lateral lobe; R.C., right central lobe; G.B., gall bladder; L.C., left central lobe; L.L., left lateral lobe

The gall-bladder is usually present in mammals, but is wanting in the odd-toed ungulates (*Perissodactyla*) and *Hyrax*. In the giraffe it may be absent or present. The Cetacea and a few rodents are also without it. In the otter the same curious network of bile ducts already recorded in the reptiles is seen. (F. G. P.)

LIVER AND GALL-BLADDER, DISEASES OF. Being somewhat friable, the human liver is often torn or ruptured by blows or kicks, and, the large blood-vessels being thus laid open, fatal haemorrhage into the belly-cavity may take place. The individual becomes increasingly collapsed, and there are pain and tenderness in the liver region. The right thing to do is to open the belly in the middle line, search for a wound in the liver, and treat it by deep sutures, or by plugging it with gauze.

Cirrhosis of the Liver.—This is a chronic fibrosis not obviously dependent upon inflammation in the majority of cases. According to the distribution of the adventitious fibrous tissue, multilobular (atrophic), uni-lobular (hypertrophic), and intercellular varieties are recognized. The commonest causes are alcohol and syphilis, but probably bacterial toxins are effective in certain cases. As the fibrous tissue undergoes the gradual contraction to which it is liable, liver cells are destroyed by pressure atrophy, thus inducing digestive disorder; bile ducts are obstructed, leading to jaundice; and the flow of blood through the liver is impeded leading to dropsy in the belly (ascites) and, secondarily, to other morbid conditions.

Inflammation of the Liver (hepatitis).—In a strict sense this disease is rare and usually septic and secondary. Thus blood passing from an inflamed appendix to the liver by the portal vein may carry pyogenic organisms and lead to a widespread and suppurative thrombosis in the liver (pyle-phlebitis), or the liver may be affected along with other parts in pyaemia or suppurative blood-poisoning. In tertiary syphilis the specific inflammation may manifest itself by the formation of a gummatous mass in the liver. Under treatment with potassium iodide the gumma may be absorbed, leaving merely a puckered scar.

Hepatic Abscess.—Apart from that form of suppuration mentioned in the last paragraph, hepatic abscess is especially common in persons from the East who have suffered from amoebic dysentery, and is usually single and large. In addition to local pain and tenderness, there is a high temperature, accompanied with shiverings or occasional rigors, the patient becoming daily more thin and miserable. Sometimes the abscess declares itself by a bulging at the surface, but if not, an incision should be made through the belly-wall over the most tender spot and a direct examination of the surface of the liver made. A bulging having been found, that part of the liver which apparently overlies the abscess should be stitched up to the sides of the opening made in the belly-wall, and should then be explored by a hollow needle. Pus being found, the abscess should be freely opened and drained. It is inadvisable to explore for a suspected abscess with a hollow needle without first opening the abdomen, as septic fluid might thus leak out and infect the general peritoneal cavity. If a hepatic abscess is injudiciously left to itself it may eventually discharge into the chest, lungs or belly, or it may establish a communication with a piece of intestine. The only safe way for an abscess to evacuate itself is on to the surface of the body.

Hydatid Cysts.—These growths are often met with in the liver, particularly in Australia. They are due to a development of the eggs of the tape-worm of the dog, which have been received into the alimentary canal with infected water or uncooked vegetables, such as watercress. The embryo of *Taenia echinococcus* finds its way from the stomach or intestine into a vein passing to the liver and, lodging there, becomes surrounded by a capsule of fibrous tissue. Inside this wall is the special covering of the embryo, which shortly becomes distended with clear hydatid fluid. The cyst should be treated like a liver-abscess, by incision through the abdominal or thoracic wall, by circumferential suturing, and by exploration and drainage.

Tumours of the Liver.—These may be innocent or malignant. The commonest innocent variety is naevus. The commonest form of malignant tumour is the result of the growth of cancerous elements from the breast along the round ligament, or brought to the liver by the veins coming from a primary focus of the stomach or large intestine. Occasionally cancer is primary in the liver. Active surgical treatment of such a tumour is out of the question. Fortunately it is, as a rule, painless.

Gall-bladder.—The gall-bladder may be ruptured by external violence and then should be removed surgically or peritonitis will be set up.

Biliary concretions, known as *gall-stones,* are apt to form in the gall-bladder. They may be composed of cholesterin or of bile pigments combined with calcium and are deposited from an organic basis such as a collection of epithelial cells or of bacilli in a slightly abnormal gall-bladder. Sometimes, in the course of a post-mortem examination a gall-bladder is found full of gall-stones, which during life had caused no inconvenience and had given rise to no suspicion of their presence. In other cases gall-stones set up inflammation (cholecystitis), which may go on to abscess. As the result of long-continued irritation the gall-bladder may become the seat of cancer.

Cholecystitis or abscess gives rise to a painful, tender swelling near the cartilage of the ninth rib of the right side. If allowed to take its course, adhesions may form around it and it may burst into the intestine or on to the surface of the abdomen, a *biliary fistula* remaining. Either condition being suspected, an incision should be made, and, its covering having been stitched to the abdominal wall, the gall-bladder should be opened and drained, or, which is still more preferable, the gall-bladder should be removed unopened.

Stones in the gall-bladder should be removed by operation, as, if left, there is a great risk of their trying to escape with the bile into the intestine and thus causing a blockage of the common bile-duct, and perhaps a fatal leakage of bile into the peritoneum through a perforating ulcer of the duct. Whether the gall-bladder should be removed along with the calculi depends upon circumstances. Other treatment than surgery is useless if not positively harmful. "Biliary colic" is the name given to the distressing symptoms associated with the passage of a stone through the narrow bile-duct. The individual is doubled up with acute pains, which, starting from the hepatic region, spread through the abdomen and radiate to the right shoulder-blade. Inasmuch as the stone is blocking the duct it gives rise to jaundice, which becomes obvious a day or two after the colic has occurred. The distress is due to spasmodic muscular contraction and comes on at intervals, each attack increasing the patient's misery. He breaks out into profuse sweats and may vomit. If the stone happily finds its way into the intestine the distress suddenly ceases. In the meanwhile, relief may be afforded by fomentations, and by morphia or chloroform, but if no prospect of the stone escaping into the intestine appears likely it must be removed surgically.

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LIVERMORE, MARY ASHTON [RICE] (1821–1905), American reformer, was born in Boston, Mass., on Dec. 19, 1821. She joined the abolitionists, and took an active part in the Washingtonian temperance movement. In 1845 she married Daniel Parker Livermore (1819–99), a Universalist clergyman. During the Civil War, as an associate member of the U.S. sanitary commission, and as an agent of its northwestern branch, she organized many aid societies, contributed to the success of the Northwestern Sanitary fair in Chicago in 1863 and visited army posts and hospitals. After the war she devoted herself to the promotion of woman suffrage and to temperance reform, founding in Chicago in 1869 *The Agitator,* which in 1870 was merged into the *Woman's Journal* (Boston), of which she was an associate editor until 1872. She served as president of the Illinois, the Massachusetts and the American woman suffrage associations. She lectured in the United States, England and Scotland, and contributed to magazines. Her writings include *The Children's Army,* temperance stories (1844); *Thirty Years Too Late,* a temperance story (1848); *A Mental Transformation* (1848); *Pen Pictures,* short stories (1863); *What Shall We Do With Our Daughters? and Other Lectures* (1883); *My Story of the War* (1888); and *The Story of My Life* (1897). With Frances E. Willard she edited *A Woman of the Century: Biographical Sketches of Leading American Women* (1893). She died at Melrose, Mass., on May 23, 1905.

LIVERPOOL, EARLS OF. Charles Jenkinson, 1st earl of Liverpool (1729–1808), English statesman, eldest son of Colonel Charles Jenkinson (d. 1750) and grandson of Sir Robert Jenkinson, Bart., of Walcot, Oxfordshire, was born at Winchester on the 16th of May 1729. The family was descended from Anthony Jenkinson (d. 1611), sea-captain, merchant and traveller, the first Englishman to penetrate into Central Asia. Charles was educated at Charterhouse school and University college, Oxford, where he graduated M.A. in 1752. In 1761 he entered parliament as member for Cockermouth and was made undersecretary of state by Lord Bute; he won the favour of George III, and when Bute retired Jenkinson became the leader of the "king's friends" in the house of commons. In 1763 George Grenville appointed him joint secretary to the treasury; in 1766, after a short retirement, he became a lord of the admiralty and then a lord of the treasury in the Grafton administration; and from 1778 until the close of Lord North's ministry in 1782 he was secretary-at-war. From 1786 to 1801 he was president of the board of trade and chancellor of the duchy of Lancaster, and he was popularly regarded as enjoying the confidence of the king to a special degree. In 1772 Jenkinson became a privy councillor and vice-treasurer of Ireland, and in 1775 he purchased the lucrative sinecure of clerk of the pells in Ireland and became master of the mint. In 1786 he was created Baron Hawkesbury, and ten years later earl of Liverpool. He died in London on the 17th of December, 1808. His best known work is *Coins of the Realm;* reprinted by the Bank of England in 1880.

His son, Robert Banks Jenkinson, 2nd earl (1770–1828), was educated at Charterhouse and at Christ Church, Oxford, where he had George Canning, afterwards his close political associate, for a contemporary. In 1790 he entered parliament as member for Appleby; he became master of the mint in 1799 and foreign secretary in Addington's administration in 1801, when he conducted the negotiations for the abortive treaty of Amiens. On the accession of Pitt to power in 1804, he obtained the home office, having in the previous year been elevated as Baron Hawkesbury to the house of lords, where he acted as leader of the government. He declined the premiership on the death of Pitt in 1806, and remained out of office until Portland became prime minister in 1807, when he again became secretary of state for home affairs. In 1808 he succeeded his father as earl of Liverpool. In the ministry of Spencer Perceval (1809–1812) he was secretary for war and the colonies. After the assassination of Perceval in May 1812 he became prime minister, and retained office till compelled in February 1827 to resign by the illness (paralysis) which terminated his life on the 4th of December 1828.

The political career of the 2nd Lord Liverpool was of a negative character so far as legislation was concerned. The energy of Castlereagh and Canning secured the success of the foreign policy of his cabinet, but in his home policy he was always retrograde. The introduction of the bill of pains and penalties against Queen Caroline greatly increased his unpopularity, originated by the severe measures of repression employed to quell the general distress, which had been created by the excessive taxation which followed the Napoleonic wars. Lord Liverpool was destitute of wide sympathies and of true political insight, and his resignation of office was followed almost immediately by the complete and permanent reversal of his domestic policy.

See *Memoirs of the Public Life and Administration of Liverpool* (1827); C. D. Yonge, *Life and Administration of the 2nd Earl of Liverpool* (1868); and references *s.v.* Londonderry, Robert Stewart; Canning, George.

The 2nd earl of Liverpool was twice married but had no children, and was succeeded by his half-brother, Charles Cecil Cope Jenkinson (1784–1851), who was lord steward, 1841–46. He left three daughters, and the earldom and barony became extinct; but in 1893 his grandson (son of his 2nd daughter and co-heiress), Cecil George Savile Foljambe (1846–1907), who had been a Liberal member of parliament from 1880 to 1892, was created Baron Hawkesbury, and in 1905 the earldom of Liverpool was revived in his person. He was lord-in-waiting to Queen Victoria 1894–95, and lord steward of King Edward VII's household from 1905 till his death in 1907, when he was succeeded by his eldest son, Arthur William de Brito Savile Foljambe (1870–1941). The 2nd earl of the 1905 creation was appointed governor of the dominion of New Zealand in 1912, and retired as governor-general (the title having been changed in 1917) in 1920.

LIVERPOOL, city; county and parliamentary borough;

seaport; Lancashire, England; 201 mi. northwest of London by rail; situated on the right bank of the estuary of the Mersey, the centre of the city being about 3 mi. from the open sea. The form of the city is that of an irregular semicircle, having the base-line formed by the docks and quays extending about 9 mi., along the northeast bank of the estuary, which varies in breadth from 1 to 2 mi. On the north the city is partly bounded by the borough of Bootle, along the shore of which the line of docks is continued. Pop. (1938) 827,400. Area 42.7 sq.mi.

The city lies on a continuous slope of varying gradient, in some districts very steep. The old borough, lying between the pool, now completely obliterated, and the river, was a conglomeration of narrow alleys, and during the 16th and 17th centuries it was several times visited by plague. When the town expanded beyond its original limits and spread up the slopes beyond the pool, conditions improved. The commercial part of the city is remarkable for the number of palatial offices built chiefly of stone, among which the banks and insurance offices stand pre-eminent. From the beginning of the 20th century, slum clearance and the improvement of sanitary arrangements and roads were vigorously carried out, though during the two World Wars work had to be curtailed. In the period 1900–18 nearly 27,500 houses were built, but between 1919 and 1931 about 30,000 were erected, 74.8% by the corporation, which in the previous period had been responsible for only 8.7%. By 1943 the corporation owned over 30,000 dwellings, etc. The principal municipal housing estate is Norris Green with 7,000 houses and a population of over 30,000. The city suffered badly in World War II; at the end of 1941 about 150,000 houses on Merseyside had been damaged.

Public Buildings.—The city is rich in buildings of architectural interest but there is practically no work in the town earlier than 18th century. The earliest important work is the Old Blue Coat hospital (built 1717) at the back of Church St., which is a Queen Anne group built round a courtyard. The town hall (opened 1754), designed by John Wood of Bath, is a rectangular stone building in the Corinthian style. It has been altered and added to and the inside remodelled since a fire in 1795. There are a large number of fine 19th-century houses in Rodney street and Abercromby square, which houses were the former residences of Liverpool merchants. Liverpool contains a fine piece of modern Graeco-Roman architecture in St. George's hall. Designed by Harvey Lonsdale Elmes and completed in 1854, it stands in the centre of the city and is surrounded by an area sufficiently extensive to exhibit its proportions. Externally the east front is faced with a fine portico of sixteen Corinthian columns, 60 ft. in height. Owing to the death of Elmes in 1847 the work was completed by Prof. C. R. Cockerell, R. A.

To the north of St. George's hall are the law courts, the Walker Art gallery, the Picton library and the museum and Technical school, which forms an impressive row of buildings. Of the public buildings, the exchange, adjoining the town hall, is worthy of note. It is built around three sides of a quadrangle and replaces an earlier structure on the same site, which had become inadequate to the needs of the city. The Customs House is an impressive building of the mid-19th century. Of modern buildings three imposing structures overlook the river at the Pier Head. These comprise the Dock Offices, the Liver buildings and the Cunard building but, although some of the buildings have distinct architectural merit, the group as a whole is very unbalanced.

Liverpool cathedral, of which the foundation stone was laid by Edward VII in 1904, will be when completed the largest Anglican church in the country. The architect, Sir Giles Gilbert Scott, planned an impressive mass of buildings in a new and romantic Gothic style, most distinctive of the architect himself. The site is an excellent one and overlooks the whole city. The building is of red sandstone, the roof of copper. The Lady chapel, full of wealth of detail and with an atrium decorated with windows commemorating noble women, was consecrated in 1910, and the choir, east transepts and chapter house in 1924. The organ, dedicated in 1926, is the largest in the country (5 manuals, 10,925 pipes). The great square tower is to be buttressed by transepts, northeast and northwest, southeast and southwest, and there is here a large "central space" for seating accommodation without trenching upon either nave or choir. Work on the "central space" and west transepts was begun in 1926. The Lady chapel is almost a separate church, and on a different level. The cathedral is oriented N. and S. The ultimate length will be 619 feet. The interior height is 116 feet. Westminster abbey is 102 ft.

The air raids of World War II took their toll of Liverpool's buildings. Of the churches, St. Michael's, Pitt St., was completely destroyed, and those of St. Nicholas, St. Catherine and St. Luke were burned out. The Derby memorial transept of the cathedral was damaged, but injury to the building as a whole was slight. Among other buildings, Blue Coat Chambers, until the outbreak of war the headquarters of the Liverpool Architectural society, was damaged; an engineering laboratory of the university received a direct hit and others were damaged, while injuries more or less serious were inflicted on the Customs House, St. George's hall, the cotton and commercial exchanges and the fine Gorce warehouses.

Railways.—There are three terminal passenger stations in Liverpool, all on the L.M.S. railway. They are:—Lime Street, Exchange and Central. The L.N.E. railway also has running powers into Central station. Connection with the Wirral is effected by the old Mersey tunnel (opened 1886), and by the new road tunnel completed in 1928. (*See* BIRKENHEAD.) The Liverpool electric overhead railway running along the line of docks from Seaforth to Dingle was opened in 1893, and in 1905 a junction was made with the L.M.S. railway by which through passenger traffic between Southport and the Dingle was established. In 1895 the Riverside station at the Prince's dock was completed, giving direct access from the landing stage to the L.M.S. system.

Water Supply.—The original supply of water was from wells in the Triassic sandstone, but in 1847 an act was passed under which extensive works were constructed and extended later at Rivington, about 25 mi. distant. The vast increase of population led to further requirements, and in 1880 another act gave power to impound the waters of the Vyrnwy, one of the affluents of the Severn. These works were completed in 1892, when one pipe line was laid. A second pipe line was opened in 1905. The catchment area was increased in 1910 by the diversion into the lake of two other rivers, the Conway and the Marchnant. Further pipe lines were completed in 1938, after which the supply area was about 118 sq.mi.

Ecclesiastical.—The see of Liverpool was created in 1880, an endowment fund of about £100,000 having been subscribed for the purpose. The parish, which was separated from Walton-on-the-Hill in 1699, contained two churches, St. Nicholas, the ancient chapel, and St. Peter's. There were two rectors, the living being held in medieties. The living is now held by a single incumbent, and a large number of the churches which have since been built have been formed into parishes by the ecclesiastical commissioners. St. Peter's was constituted the pro-cathedral, pending the erection of the cathedral. The Roman Catholics form a very numerous and powerful body in the city. Many are of Irish descent; but this district has always been a stronghold of Roman Catholicism, some of the landed gentry belonging to old Roman Catholic families. The new cathedral, designed by Sir Edwin Lutyens in the Roman style, is intended to be the largest in the world after St. Peter's, Rome. It is to be of brick, dressed with Cornish granite. The foundation stone was laid in 1933, after which the crypt, 300 ft. by 193 ft., was finished. The church will be 670 ft. long and will have the largest dome in the world.

Charities.—The earliest charitable foundation was the Blue Coat hospital, established in 1708, for orphans and fatherless children born within the borough. The original building was opened in 1718, and the hospital now maintains 200 boys and 100 girls. In 1906 the school was removed to new buildings at Wavertree. The Liverpool dispensaries (founded 1778) were among the pioneers of medical charity. The Royal infirmary now situated in Pembroke place (opened 1749), had a school of medicine attached which has become world famous and is now merged in the university. The sailors' home (opened 1850), designed to provide board, lodging and medical attendance for the seamen frequenting the port, is one of Liverpool's best-known charities. Numerous other charities, homes, clubs and institutions have arisen.

ARTS, EDUCATION AND UNIVERSITY

The free library, museum and gallery of arts, established and managed by the city council, was originated in 1850. The first library building was erected by Sir William Brown. The Derby museum, containing the collections of Edward, the 13th earl, was presented by his son. The Mayer museum of historical antiquities and art was contributed by Joseph Mayer, F.S.A. (1803–86), who presented his collections to Liverpool in 1867. The museum contains an unrivalled collection of Wedgwood and Liverpool ware. Sir Andrew Walker (1824–93) erected in 1877 the art gallery which bears his name. Large additions were made in 1884, the cost being again defrayed by Sir Andrew Walker. The valuable permanent collection of paintings includes the Roscoe collection of old masters and the bequest (1923) of James Smith of Blundellsands of 18 pictures of Watts, 4 sculptures by Rodin, many etchings and engravings by Dürer, Seymour Haden and Whistler, together with a large number of modern works, British and foreign. The annual loan exhibition held in the autumn is the most important in the provinces. The Picton circular reading room was built by the corporation and opened in 1879. Adjoining it is the Hornby library of fine art books. The Literary and Philosophical society was established in 1812. The Royal institution, established in 1817, is the centre of the literary institutions of the town. The Philharmonic society was instituted in 1840. Its new hall, replacing one that had burned, was opened in 1939.

Education.—Sunday schools were founded in 1784, as the result of a town's meeting. These were soon followed by day schools. Semi-private schools were founded by public subscription—the Royal Institution school (1819), the Liverpool institute (1825) and the Liverpool college (1840). The first has ceased to exist. The institute, a development of the Mechanics' institute, was divided into a high school and a commercial school. This school, and the Blackburne House high school for girls which was attached to it, became public secondary schools and were transferred to the corporation in 1903 and 1905 respectively. Liverpool college was formerly divided into three schools, upper, middle and lower, for different classes of the community. The middle and lower schools (Liverpool collegiate) were transferred to the corporation in 1907. Since 1902 all new secondary schools on Merseyside, apart from two Catholic schools, have been provided by the local authorities. In 1930 there were all together 20 secondary schools in Liverpool with 8,427 pupils. A cadet ship, the "Conway," for the training of boys for the mercantile marine, is moored in the Mersey. The training ship "Indefatigable," moored in the Mersey, was replaced by the H.M.S. "Phaeton," presented in 1914 to the Liverpool Sea Training homes, mainly for the sons and orphans of sailors. There are many other educational institutions, including a large technical college.

The University.—Liverpool university, as a university college, received its charter in 1881, and in 1884 was admitted as a college of the Victoria university. In the same year the medical school of the Royal infirmary became part of the University college. A supplemental charter (1900) brought the college into closer relations with the city authorities. In 1903 a charter of incorporation constituted it as the University of Liverpool. The large group of buildings is situated on Brownlow hill.

The university developed rapidly, particularly after World War I. After 1920 chairs were established in tropical diseases of Africa (1921), social science (1922), industrial chemistry—oils, fats and waxes (1923), care of animals—causation and prevention of disease—(1924), pharmacology (1930), tropical hygiene (1934), and orthopaedic surgery (1938). There are schools of tropical medicine, architecture, local history and records, social sciences and Russian studies, besides an institute of archaeology and departments of education and civic design. A tidal institute (1919) and, in connection with the department of oceanography, a sea fisheries laboratory at Port Erin are specialities. Extensive researches are carried on in the local sea fisheries in regard to fish disease and kindred subjects. The University Extension board has greatly extended its influence. With the growth of the university many new buildings and extensions were constructed, including the chemistry research building (1923), the Jane Herdman geology laboratories (1929), the veterinary hospital (1929), the social sciences building (1931), the Liverhulme building of the school of architecture (1933), an extension to the students' union (1935) and the men's hall of residence at Mossley hill (1938). A new library building was begun in 1935 and work started on further engineering laboratories just before the outbreak of World War II. A laboratory for research in tropical diseases was set up in Sierra Leone, while residential buildings, including a number of the fine merchants' houses in Abercromby square, were altered and equipped for the purposes of the various departments. There were 2,521 students in the year 1938–39.

Trade and Commerce.—In 1800 the tonnage of ships entering the port was 450,000; in 1938 it was 17,600,000. The commerce of Liverpool extends to every part of the world, but probably the intercourse with North America stands pre-eminent, there being lines of steamers to New York, Philadelphia, Boston, Baltimore, Galveston, New Orleans and the Canadian ports. Cotton is the great staple import. Meat comes next, with a large fleet of refrigerated vessels sailing from Argentina and Australia. Grain is third, though Liverpool is the greatest grain marketing centre outside the U.S., and Merseyside is the second milling centre after Minneapolis-St. Paul. The fruit trade, which comes fourth, has grown very largely on account of the post-World War I habit of eating more fruit. Other important imports are wool, sugar and timber. The port has long been a tobacco importing and re-exporting centre, and petroleum arrives in large quantities. In regard to exports, Liverpool is excellently situated. Lying so near the great manufacturing districts of Lancashire and the West Riding of Yorkshire, this port is the natural channel of transmission for their goods, although the Manchester ship canal diverts a certain proportion of the traffic. The chief exports are cotton yarns and manufactures, metal goods, machinery, vehicles (bicycles and parts, motor cars, railway engines and rolling stock) and woollen goods. Liverpool is a great centre of passenger traffic, but in this it has given way somewhat to Southampton. In general, it may be said that Liverpool's share in the trade of the United Kingdom has declined, more in share of imports than of exports and slightly more in share of trade than of total shipping. Imports measured by value increased after 1930 relative to exports, so that imports subsequently came to exceed exports.

The manufactures of Liverpool are not extensive. Unsuccessful attempts have been repeatedly made to establish cotton mills in and near the city. Engineering works, especially connected with marine navigation, have grown up on a large scale. Shipbuilding in the early part of the 19th century was active and prosperous, and although it had practically ceased, it revived somewhat after World War I. There is a considerable industry in ship-repairing, but this has shown some decline. During the latter half of the 18th century and the beginning of the 19th, pottery and china manufacture flourished in Liverpool. A large establishment, called the Herculaneum pottery, was founded in a suburb on the bank of the Mersey, but the trade long ago disappeared. Litherland, the inventor of the lever watch, was a Liverpool manufacturer, and Liverpool-made watches have always been held in high esteem. There are extensive sugar refineries and important corn mills. Sugar refining grew rapidly after World War I and the confectionery trade also developed, several large biscuit works having been built, induced by the prospect of obtaining cheap sugar directly from the Liverpool quays. Oilseed crushing is an important industry, with which is associated the manufacture of oil-cake and soap and candles. The cutting, blending and preparing of crude tobacco led to the erection of factories employing some thousands of hands, but the tobacco trade showed a substantial decline in the 15 years before World War II. Many firms are engaged in various branches of the chemical industry. Among other industries for which the city and its environs are celebrated are glass factories, bobbin works, match factories; cable, electrical and telephone engineering works; rope, sack and bag factories, cement works, and salt works. Merseyside is the most important single centre in Great Britain for sole-leather tanning. The making of compound foods for animal feeding is a new industry.

Docks.—The docks of the port of Liverpool on both sides of the Mersey are owned and managed by the Mersey Docks and Harbour board. On the Liverpool side they extend along the estuary 6½ mi., of which 1¼ mi. is in the borough of Bootle. The Garston docks, 6 mi. above Liverpool, are also within the city boundary. The Birkenhead docks have not such a frontage, but extend a long way backward. The water area of the Liverpool docks and basins is 477 ac. with a lineal quayage of nearly 29 mi. Birkenhead docks contain a water area of about 181¼ ac., with a lineal quayage of 9¾ mi. The system of enclosed docks was begun by the corporation in 1709. The Gladstone Docks, opened 1927, are among the best equipped in the world. The sill is 20 ft. below datum level and the entrance is 130 ft. wide and the area with branch docks is nearly 54 ac. A fine graving dock is part of the system. Down to 1843 the docks were confined to the Liverpool side of the Mersey. In 1843 a scheme for docks in Birkenhead was carried through, proved unsuccessful, and was acquired in 1855 by Liverpool. The Birkenhead docks were for many years only partially used, but are now an important centre for corn-milling and oil-cake making, the importation of foreign cattle and export trade to the east.

The first portion of the great landing stage, known as the Georges' stage, was constructed in 1847. This was 500 ft. long. In 1857 the Prince's stage, 1,000 ft. long, was built to the north of the Georges' stage and distant from it 500 ft. In 1874 the intervening space was filled up and the Georges' stage reconstructed, but being destroyed by fire, was reconstructed a second time. In 1896 it was extended farther north, and its length is now 2,534 ft. and its breadth 80 feet. It is supported on floating pontoons (about 200), connected with the river wall by 10 bridges, besides a floating bridge for heavy traffic 550 ft. in length and 35 ft. in width. The southern half is devoted to the traffic of the Mersey ferries, of which there are six—New Brighton, Egremont, Seacombe, Birkenhead, Rock Ferry and Eastham. The northern half is used by ocean-going steamers and their tenders. The warehouses for storing produce form a prominent feature in the commercial part of the city. In addition to general produce warehouses, grain warehouses have been constructed by the dock board at Liverpool and Birkenhead, with machinery for discharging, elevating, distributing, drying and delivering. Warehouses for the storage of tobacco and wool have also been built by the board. The Stanley tobacco warehouse is the largest of its kind in the world, the area of its fourteen floors being some 36 ac.

MUNICIPALITY AND HISTORY

Under the Municipal Reform Act of 1835, the boundaries of the original borough were extended, and there were several extensions afterward. In 1932 was added the township of Speke, where the municipal airport was established. Though opened to aircraft in 1933 it was unfinished in 1943. In 1918 the number of members of parliament was increased to eleven. The corporation of Liverpool has possessed from a very early period considerable landed property, the first grant having been made by Thomas, earl of Lancaster, in 1309. This land was originally of value only as a source of supply of turf for firing, but in modern times it has become profitable building land. A large proportion of the southern district is held in freehold by the corporation and leased to tenants for terms of seventy-five years, renewable on a fixed scale of fines. The fee farm rents and town dues originally belonging to the crown were purchased from the Molyneux family in 1672 on a long lease, and in 1777 converted into a perpetuity. With the growth of commerce these dues enormously increased, and became a cause of great complaint by the shipping interest. In 1856, by act of parliament, the town dues were transferred to the Mersey Docks and Harbour Board on payment of £1,500,000. which was applied in part to the liquidation of the bonded debt of the corporation, amounting to £1,150,000.

History.—During the 8th century colonies of Norsemen settled on both sides of the Mersey. After the Conquest the site of Liverpool formed part of the fief granted by the Conqueror to Roger de Poictou. Although Liverpool is not named in Domesday it is believed to have been one of the six berewicks, or subordinate manors, dependent on the manor of West Derby therein mentioned, and cultivated by 53 villeins, 62 bordarii or day-labourers, 3 ploughmen, 6 herdsmen, a horseman, 2 bondmen and 3 bondwomen. After various forfeitures and regrants from the crown, it was handed over by Henry II. to his falconer Warine. In a deed executed about 1191 by John, earl of Morton, afterwards King John, who was then Lord of the Honour of Lancaster, in which he confirms Henry Fitzwarine in the possession of Liverpool, the name of the town first occurs. Probably its most plausible derivation is from the Norse *Hlithar-pollr,* "the pool of the slopes." Another possible derivation is from the Prov. E. *lever,* the yellow flag or rush, O.E. *laefer,* any rush-like or sword-bladed plant. (*See* the *New English Dict., s.v.* "Levers.")

Owing to the decline of Chester as a port, due to the silting up of the river Dee, another site for a port for Ireland had to be found. Into the tidal waters of the Mersey a small stream ran, forming an open pool or sea lake at its mouth, and this was chosen as the site for the new port. The pool was admirably adapted as a harbour for vessels, being well protected, and the tide rising from 15 to 21 ft. King John repurchased the manor from Henry Fitzwarine, giving him other lands in exchange. Here he founded a borough, and by letters patent dated 1207 granted Liverpool the same status as any other free borough upon the sea and invited his subjects to take up "burgages," or allotments, in the new town, which was built along the brow of the hill on which Castle street and the Town Hall are erected. The High Cross stood near the present Town Hall, and here the main line of street was intersected by another line extending from the riverside to the Townsend bridge, which crossed the pool where the end of Dale street now is. Considerable use was made of Liverpool in the 13th century for shipping stores and reinforcements to Ireland and Wales. In 1229 a charter was granted by Henry III. confirming in detail that previously granted by his father, making Liverpool a free borough for ever, and authorizing the formation of a merchants' gild. Several charters were granted until the reign of William and Mary, whose charter was that under which the town was governed until the Municipal Reform Act of 1835. In 1880 when the diocese of Liverpool was created, the borough was transformed into a city by royal charter, in 1888 it became a county borough, and in 1892 the style and dignity of "Lord Mayor" was conferred on its chief magistrate.

The crown revenues from rents and the royal customs were leased from time to time, sometimes to the corporation, at other times to private persons. The first lease was from Henry III., in 1229, and in the same year the borough, with all its appurtenances, was bestowed with other lands on Ranulf, earl of Chester, from whom it passed to the earl of Derby, who seems to have built Liverpool castle between 1232 and 1237. The lands of his grandson, Robert de Ferrers were confiscated in 1266 when Liverpool passed into the hands of Edmund, earl of Lancaster. Liverpool again became the property of the crown, when Henry IV. inherited it from his father John of Gaunt. In 1628 Charles I. sold Liverpool to certain merchants of London, who, in 1635, reconveyed the crown rights, including the fee-farm rent of £14, 6s. 8d., to Sir Richard Molyneux, then Viscount Molyneux of Maryborough, for the sum of £450. In 1672 all these rights and interests were acquired by the corporation.

Liverpool's trade developed slowly. From £10 per annum, in the beginning of the 13th century, the crown revenues had increased towards the end of the 14th century to £38; but then they underwent a decline. The black death, about 1360, carried off a large part of the population. The Wars of the Roses in the 15th century retarded progress for at least a century, during which period the crown revenues diminished from £38 and were finally leased at £14, 6s. 8d., at which they continued until the sale by Charles I. It is, however, not safe to conclude that the reduced fee-farm rent represents an equivalent decline in prosperity; the privileges conferred by the various leases differed widely and may account for much of the apparent discrepancy.

Liverpool sent no representatives to parliament in 1264, but in 1296 the borough sent two members, and again in 1307. The next time it sent members was in 1547. In 1588 the borough was represented by Francis Bacon. During the Civil War the town was fortified and garrisoned by the parliament. It sustained three sieges, and in 1644 fell to Prince Rupert. The true rise of the commerce of Liverpool dates from the Restoration. Down to that period its population probably never exceeded about 1,000. Its trade was chiefly with Ireland, France and Spain, exporting fish and wool to the continent, and importing wines, iron and other commodities. The rise of the manufacturing industry of south Lancashire, and the opening of the American and West Indian trade, gave the first impulse to the progress which has since continued. By the end of the century the population had increased to 5,000. In 1699 the borough was constituted a parish distinct from Walton. In 1709, the small existing harbour was found insufficient to accommodate the shipping, so a wet dock was constructed with floodgates impounding the water, so as to keep the vessels floating during the recess of the tide. This dock was the first of its kind. The name of the engineer was Thomas Steers.

About now the Liverpool merchants entered on the slave trade, into which they were led by their connection with the West Indies. In 1709 a vessel of 30 tons carried 15 slaves across the Atlantic from Liverpool; in 1730, encouraged by parliament, Liverpool went heartily into the new trade. In 1751, 53 ships sailed from Liverpool for Africa, of 5,334 tons in the aggregate. The ships sailed first to the west coast of Africa, where they shipped the slaves, and thence to the West Indies, where the slaves were sold and the proceeds brought home in cargoes of sugar and rum. In 1765 the number of Liverpool slavers had increased to 86, carrying 24,200 slaves. By the end of the century five-sixths of the African trade centred in Liverpool. Just before its abolition in 1807 the number of Liverpool ships engaged in the traffic was 185, carrying 49,213 slaves in the year. Another branch of maritime enterprise which attracted the attention of the merchants of Liverpool was privateering, which, during the latter half of the 18th century, was a favourite investment. After the outbreak of the Seven Years' War with France and Spain in 1756, the commerce of Liverpool suffered severely, the French having overrun the narrow seas with privateers, and the premiums for insurance against sea risks rose to an amount almost prohibitive. The Liverpool merchants took a lesson from the enemy, and armed and sent out their ships as privateers. Some of the early expeditions proved so successful that almost the whole community rushed into privateering, with results of a very chequered character. When the War of Independence broke out in 1775, American privateers swarmed about the West Indies and, crossing the Atlantic, intercepted British commerce in the narrow seas. The Liverpool merchants again turned their attention to retaliation. Between Aug. 1778 and April 1779, 120 privateers were fitted out in Liverpool, carrying 1,986 guns and 8,745 men.

See Ramsay Muir and Edith M. Platt, *A History of Municipal Government in Liverpool* (1906); Ramsay Muir, *A History of Liverpool* (1907), *Merseyside* (Brit. Assn. Handbook, 1923); *Official Handbook* published by the Corporation; *Survey of Merseyside* (Liverpool Univ. Press, 1934); Wilfred Smith, *Distribution of Population and the Location of Industry on Merseyside* (Liverpool Univ. Press, 1942), and other publications of the social science dept. of the Univ. of Liverpool. (W. F. I.; J. I. P.; X.)

LIVERSIDGE, ARCHIBALD (1847–1927), English chemist, was born on Nov. 17, 1847 in London, and studied at the Royal School of Mines and the Royal College of Chemistry, and entered Christ's college, Cambridge. In 1867 he became instructor in chemistry at the Royal School of Naval Architecture, and three years later university demonstrator in chemistry at Cambridge. He was professor of chemistry at the University of Sydney from 1873 to 1908. In 1879 he founded the faculty of science at Sydney university, and also the school of mines (1890). Liversidge gave an impetus to technical education in Australia. He founded the Australasian Association for the Advancement of Science in 1885, acted as secretary (1888–1909) and president (1888–90). In 1902 he founded the Sydney section of the Society of Chemical Industry and served as its first chairman (1903–05). His researches were chiefly in mineralogy; he collected and analyzed meteorites. He also wrote papers on the origin of the gold nuggets in Australian alluvial deposits. His most important work is *The Minerals of New South Wales* (1888), but he was also the author of a *Report upon Technical Education and Museums* and of more than a hundred technical papers, most of which treated matters relating to chemistry and mineralogy. He died in Surrey on Sept. 26, 1927.

LIVERWORTS, the name applied to plants in the classes *Hepaticae* and *Anthocerotae* of the Bryophyta (*q.v.*); one of the commoner forms in North America is the thalloid species, *Conocephalum conicum.*

LIVERY, originally the provision of food, clothing, etc., to household servants. The word is an adaptation of the Anglo-French *livrée,* from *livrer,* to deliver, in the special sense of distributing.

In the sense of a fixed allowance of provender for horses, it survives now only in "livery-stable," *i.e.,* an establishment where horses and carriages are kept or let out for hire. From the meaning of provision of food and clothing the word is applied to a uniform worn by the retainers and servants of a household. In the 15th century in England a badge, collar or other insignia, the "livery," was worn by all those who pledged themselves to support one of the great barons in return for his promise of "maintenance," *i.e.,* of protection against enemies; thus arose the custom of "livery and maintenance," suppressed by Henry VII. The members of the London city companies (*see* Livery Companies) wore a distinctive costume or "livery," whence the term "livery companies."

In law, the term "livery" means "delivery," the legal handing of property into the possession of another; for "livery of seisin" *see* Feoffment.

LIVERY COMPANIES, the name of a class of institutions in the city of London which at one time were universal in Europe. The gild (*see* Guilds) in the 12th century "has many aspects, social, religious and economical, and it is unwise to look for any single origin for so complex an institution." The gilds assumed generally the character of corporations in the reign of Edward III. Many of them had been chartered before, but their privileges, hitherto exercised only on sufferance and by payment of their terms, were now confirmed by letters patent. Edward III himself became a member of the fraternity of Linen Armourers, or Merchant Taylors, and other distinguished persons followed his example. George VI is a freeman of the Grocers', Drapers', Fishmongers' and Merchant Taylors' companies, honorary freeman of the Needlemakers', Permanent Master of the Shipwrights', and Admiral of the Master Mariners'. From Edward III's time they are called livery companies. The charters were re-granted, generally in the original form, by successive sovereigns upon payment of a fine to the king's hanaper. In 1684, on receipt of writs *Quo warranto,* the companies surrendered their governance to the King—Charles II—who granted a charter which abolished the right of election of wardens vested by earlier charters in the liverymen of the companies, increased the number of the courts of assistants and conferred membership for life upon the persons selected for these offices. James II, just before his departure to exile, restored the ancient privileges. All proceedings were formally cancelled by Act of Parliament, 2, William and Mary session I, chapter 8. But even in cases where liverymen form an integral element in the administration of their companies' affairs, the system introduced by Charles II is followed in essentials.

The authority of the company extended to the general welfare, spiritual and temporal, of its members. In the regulation of trade they possessed extensive powers. They required every one carrying on the trade to join the company, to prevent monopoly or enhancement of prices. There was no question of a monopoly until the degeneration of the craft gilds into limited corporations of capitalists. In the regulation of trade the goldsmiths had the assay of metals, the fishmongers the oversight of fish, the vintners of the tasting of wine, etc. The companies enforced their regulations on their members by force and by fines. Many of their ordinances looked to the domestic affairs and private conduct of the members. The grocers ordain "that no man of the fraternite take his neyghbor's house y[t] is of the same fraternite, or enhaunce the rent against the will of the foresaid neyghbor." The wearing of beards was forbidden. Football was prohibited. Attempts to restrict marriage to daughters of liverymen were made and failed. Members reduced to poverty by adventures on the sea, increased price of goods, borrowing and pledging, or any other misfortune, are to be assisted "out of the common money, according to his situation, if he could not do without."

From Gild to Charitable Trust.—But the companies gradually lost their industrial character. The richer members engrossed the power and the companies tended to become hereditary and exclusive. Persons became members who had nothing to do with the craft, and the rise of great capitalists and the development of competition in trade made the regulation of industry by means of companies no longer possible. The usurpation of power on the part of the richer members encountered, still encounters, opposition. In the Goldsmiths' company in 1529 the mode of electing officers, and the system of management generally, was challenged by three members who called themselves "artificers," poor men of the craft of goldsmiths. The dispute was carried into the court of chancery and the star chamber. The artificers accused the company of changing the constitution of the society, by persons who "were but merchant goldsmiths, and had but little knowledge in the science." In 1531 the three complainants were expelled from the company, and then the dispute seems to have ended. In most cases their regulative functions have disappeared. The Fishmongers company still carries out the supervision of certain Acts with vigour and success. The Goldsmiths carry out the assay of the Pyx. Throughout the companies have been owners of property and managers of charitable trusts.

The City and the Companies.—The ordinance of Edward II. required freemen of the city to be members of one or other of the companies. By the ordinance of 49 Edw. III. (1375), the trading companies were to nominate the members of common council, and the persons so nominated alone were to attend both at common councils and at elections. An ordinance in 7 Richard II. (1383) restored the elections of common councilmen to the wards, but corporate officers and representatives in parliament were elected by a convention summoned by the lord mayor from the nominees of the companies. An act of common council in 7 Edw. IV. (1467) appointed the election of mayor, sheriffs, etc. to be in the common council, together with the masters and wardens of the companies. By 15 Edw. IV. masters and wardens were ordered to associate with themselves the honest men of their mysteries,[1] and come in their best liveries to the elections; that is to say, the franchise was restricted to the "liverymen" of the companies. At this time the corporation exercised supreme control over the companies, and the companies were still genuine associations of the traders and householders of the city. The delegation of the franchise to the liverymen was thus, in point of fact, the selection of a superior class of householders to represent the rest. By 19 Henry VII. (1504) ordinances and by-laws were required to be submitted for approval to the chancellor, chief justices of either Bench or the Justices in eyre. This act still remains in force and by-laws or ordinances which have not been thus validated are devoid of authority. The corporation lost its control over the companies, and the members of the companies ceased to be traders and householders; the liverymen were no longer a representative class, and the Reform Acts of 1832 and 1867 reformed the representation in several particulars which was practically abolished by the Representation of the People Act of 1918. The liverymen of the companies, being freemen of the city, still elect the lord mayor, sheriffs, chamberlain and other corporate officers.

Taxing the Companies.—The wealth and organization of the companies made them a most appropriate instrument for the enforcement of taxation. The loan of £21,263 6s. 8d. to Henry VIII., for his wars in Scotland, in 1544 seems to be the first instance of a pecuniary grant to the crown. The confiscation of ecclesiastical property at the time of the Reformation affected many of the trusts of the companies; and they were compelled to make returns of their property devoted to religious uses, to pay over the rents to the crown and to purchase the trusts from their corporate funds. In course of time the taxation of the companies became "a regular source of supply to government," which when money was wanted for public works, informed the lord mayor, who apportioned the sums required among the various companies, and issued precepts for its payment. Contributions towards setting the poor to work, erecting the Royal Exchange, cleansing the city ditch, discovering new countries, furnishing military and naval armaments, for men, arms and ammunition for the defence of the city, are among the purposes thus served.

The livery companies in existence in 1940 were the following:

Apothecaries	Fishmongers	Musicians
Armourers and Brasiers	Fletchers	Needlemakers
Bakers	Founders	Painter Stainers
Barbers	Framework Knitters	Pattern Makers
Basket Makers	Fruiterers	Paviors
Blacksmiths	Gardeners	Pewterers
Bowyers	Girdlers	Plasterers
Brewers	Glass Sellers	Plumbers
Broderers	Glaziers	Poulters
Butchers	Glovers	Saddlers
Carmen	Gold and Silver Wyre-drawers	Salters
Carpenters	Goldsmiths	Scriveners
Clockmakers	Grocers	Shipwrights
Clothworkers	Gunmakers	Skinners
Coach and Coach-harness Makers	Haberdashers	Spectacle Makers
Cooks	Horners	Stationers and Newspaper Makers
Coopers	Innholders	Tallow Chandlers
Cordwainers	Ironmongers	Tin Plate Workers
Curriers	Joiners	Turners
Cutlers	Leathersellers	Tylers and Bricklayers
Distillers	Loriners	Upholders
Drapers	Makers of Playing Cards	Vintners
Dyers	Masons	Wax Chandlers
Fanmakers	Master Mariners	Weavers
Farriers	Mercers	Wheelwrights
Feltmakers	Merchant Taylors	Woolmen

The Parish Clerks and the Watermen and Lightermen, though non-livery companies of the City of London, have sometimes been included.

In 1927 the Company of Master Mariners was constituted by Royal Charter and, in remembrance of the connection of the Mercer's Company, the first of all the companies, with the Merchant Adventurers and the maritime activities of earlier days, a loving cup was presented to the newly constituted company.

The following are the twelve great companies in order of civic precedence: Mercers, Grocers, Drapers, Fishmongers, Goldsmiths, Skinners, Merchant Taylors, Haberdashers, Salters, Ironmongers, Vintners, Clothworkers. The "Irish Society" was incorporated under James I. as "the governor and assistants of the new plantation in Ulster, within the realm of Ireland." The twelve companies contributed the sum of £60,000 for the scheme to settle a Protestant colony in the lands forfeited by the Irish rebels. The companies divided the settlements into twelve, under the paramount jurisdiction of the Irish Society. The charter of the society was revoked by the court of star chamber in the reign of Charles I., but a new one was granted by Charles II., under which the society still acts. The situation has been changed by the operation of the Land Purchase Act of 1903.

Livery Company Charities.—Most of the companies administer charities of large value under schemes of the Charity Commissioners, the Board of Education, the Endowed School Commissioners and the Court of Chancery. Education in particular has benefited. The Mercers' Company administers St. Paul's school under Dean Colet's will, and in 1902 built a girls' school—now of the first rank. Mercers' school is one of the oldest schools in London. The Drapers administer Bancroft's school (1727) and Howell's school for girls, Denbigh. Queen Mary College (formerly the East London college), an important centre of university education in London, was built up by the company and has received from its

[1]Properly the word should be spelled, as it was originally, "mistery"; it comes through the O.Fr. *mestier*, modern *métier*, from Lat. *ministerium*, service, employment, and meant a trade or craft, and hence the plays acted by craftsmen and members of gilds were called "mystery plays" (*see* DRAMA). For the word meaning a hidden or secret rite, with which this has so often been confused, *see* MYSTERY.

corporate funds grants approximating £400,000. This company's donations to education and charity since 1907 amount to about £1,000,000. The Merchant Taylors' company maintains their school, removed in 1933, from the City to Sandy Lodge, Northwood, Middx., with admirable results. The Skinners' school at Tonbridge is of the first order. The City and Guild of London Institute was developed from the initiative of the Cloth-workers company in 1875 by the joint action of the companies, and is now incorporated in the Imperial College. The Goldsmiths' company has given handsome sums to the Institute. In aiding science the companies have been wisely generous by founding research fellowships (Salters' company) or by grants in aid of institutions carrying on scientific investigations. By exhibitions and scholarships meritorious students are helped in their university careers. The endowment of professorial chairs and research work have also received the support of City companies.

Constitution of the Companies.—The constitution of the livery companies usually embraces (1) the court, which includes the master and wardens, and is the executive and administrative body (2) the livery or middle class, being the body from which the court is recruited; and (3) the general body of freemen, from which the livery is recruited. Some companies admit women as freemen. The freedom is obtained either by patrimony (by any person over 21 years of age born in lawful wedlock after the admission of his father to the freedom), by servitude (by *bona fide* apprenticeship to a freeman of the company) or by redemption which is in some cases wisely allowed only where an ancestor in the male line has had the freedom which his descendants have omitted to or been unable to acquire. Purchase is still regarded as rather disreputable. Admission to many of the companies is subject to the payment of considerable fees. Gift of the freedom is a recognized mode of expressing admiration for high public service. A royal commission was appointed in 1880 to inquire into all the livery companies, into the circumstances and dates of their foundation, the objects for which they were founded, and how far those objects were being carried into effect. A very valuable *Report and Appendix* (4 vols. 1884) was published, containing, *inter alia,* information on the constitution and powers of the governing bodies, the mode of admission of members of the companies, the mode of appointment, duties and salaries and other emoluments of the servants of the companies, the property of, or held in trust for the companies, its value, situation and description. The companies generally very freely made returns to the commission. The commission estimated the annual income of the companies to be from £750,000 to £800,000, about £200,000 of that amount being trust income, the balance corporate income; but these figures are now obsolete. No accounts are published, though the commission of 1880 recommended that this should be done.

Bibliography.—In addition to the *Report* referred to above the following works may be consulted: *Chronicle of London from 1089 to 1483* (ed. Sir N. H. Nicolas and E. Tyrrel, 1827); W. Herbert, *History of the Twelve Great Livery Companies* (1837); *Munimenta Gildhallae Londiniensis,* in Rolls Series (ed. H. T. Riley, 4 vols. 1859–62); H. T. Riley, *Memorials of London and London Life* (1868); J. Toulmin Smith, *English Gilds* (published by Early English Text Society), with essay by L. Brentano (1870); C. Gross, *The Gild Merchant* (2 vols. 1890); W. C. Hazlitt, *The Livery Companies of the City of London* (1892), contains a précis of the Royal Commission; P. H. Ditchfield, *The City Companies of London* (1904); J. C. Thornley and G. W. Hastings, *The Guilds of the City of London and their Livery men* (1911); G. Unwin, *The Gilds and Companies of London* (2nd ed. 1925). Rev. A. H. Johnson, *The History of the Worshipful Company of the Drapers of London,* 5 vols. 1914–22. Histories of the companies have in several cases been prepared for private circulation among their members.

LIVIA DRUSILLA (*c.* 55 B.C.–A.D. 29), Roman empress, was originally the wife of Tiberius Claudius Nero, by whom she had two sons, Drusus and Tiberius (afterwards emperor). In 38 Augustus compelled her husband to divorce her and married her himself, having first got rid of his own wife Scribonia. Her two sons were entrusted to the guardianship of Augustus, to whom she bore no children. Livia was suspected of committing various crimes to secure the throne for Tiberius. The premature deaths of Augustus' nephew Marcellus (whom he had at first fixed upon as his successor) and of his grandsons Gaius and Lucius Caesar, the banishment of his grandson Agrippa Postumus, and even his own death, were attributed to her. Augustus by his will declared her and Tiberius (whom he had adopted in A.D. 4) his heirs; Livia inherited a third of his property; she was adopted into the Julian gens, and henceforth assumed the name of Iulia Augusta. She had now reached the summit of her ambition, and at first acted as joint-ruler with Tiberius. Tiberius, however, soon became tired of her control; his retirement to Capreae is said to have been caused by his desire to escape from her. Livia continued to live quietly at Rome, in the full enjoyment of authority, until her death at an advanced age.

See Tacitus, *Annals,* i. v.; Dio Cassius liii. 33, lv. 14–22, lviii. 2, lix. 2; Suetonius, *Tiberius,* 50, 51; J. Aschbach, *Livia, Gemahlin des Kaisers Augustus* (1864); V. Gardthausen, *Augustus und seine Zeit,* i. 1018 foll., ii. 631 foll.

LIVINGSTON, EDWARD (1764–1836), American jurist and statesman, was born in Clermont, N.Y., on May 26, 1764. He graduated at Princeton in 1781, was admitted to the bar in 1785, and began to practise law in New York city, rapidly rising to distinction. He was a Republican representative in Congress, 1795–1801, where he was one of the leaders of the opposition to Jay's Treaty, taking the ground that Congress was not bound to appropriate money to carry out a treaty obligation. He opposed the alien and sedition laws, and introduced legislation on behalf of American seamen. In 1801 Livingston was appointed U.S. district attorney for the State of New York and while retaining that office was in August of the same year elected mayor of New York city. When, in 1803, the city was overtaken by an epidemic of yellow fever, Livingston helped to prevent the spread of the disease and relieve distress, and was himself attacked by the fever.

On his recovery he found himself indebted to the Government for public funds which had been lost through the dishonesty of a confidential clerk, and for which he was responsible as district attorney. He at once surrendered all his property, resigned his two offices in 1803, and removed early in 1804 to Louisiana. He soon acquired a large law practice in New Orleans, and in 1826 repaid the Government in full, including the interest.

Almost immediately upon his arrival in Louisiana, he was appointed by the legislature to prepare a provisional code of judicial procedure, which (in the form of an act passed in April 1805) was continued in force from 1805–25. In 1807 Livingston became involved in litigation over his claim to the Batture, Ste. Marie land, ending in a heated controversy with President Jefferson who upheld the public claim. Livingston's final victory in the courts brought him little financial profit because of the heavy expenses of the litigation. During the war with England from 1812–15 Livingston was active in rousing the mixed population of New Orleans to resistance, and acted as adviser and volunteer aide-de-camp to Gen. Jackson. In 1821, by appointment of the legislature, of which he had become a member the preceding year, Livingston began the preparation of a new code of criminal law and procedure, afterwards known in Europe and America as the "Livingston Code." Completed in 1824, it was accidentally burned, and reproduced in 1826, though not printed until 1833. It was never adopted by the State. It was at once reprinted in England, France and Germany, and studied all over the world, attaining wide influence. In referring to this code, Sir Henry Maine spoke of Livingston as "the first legal genius of modern times" (*Cambridge Essays,* 1856, p. 17). His code of reform and prison discipline was adopted by Guatemala. In 1823 he was appointed with Moreau Lislet to revise the civil code of Louisiana, which was substantially ratified.

Livingston was again a representative in Congress during 1823–29, a senator in 1829–31, and for two years (1831–33) Secretary of State under President Jackson. In this last position he was one of the most trusted advisers of the President, for whom he prepared a number of State papers, the most important being the famous anti-nullification proclamation of Dec. 1832. From 1833 to 1835 Livingston was minister plenipotentiary to France, charged with procuring the fulfilment by the French Government of the treaty negotiated in 1831. Livingston's negotiations were well conducted, but the French Chamber of Deputies refused to pay the first instalment of the adjudicated claims which, according to the treaty, was due in 1833. Relations between the two Governments became strained, and Livingston was finally instructed to close the legation and return to America. He died May 23, 1836 at Montgomery place, Dutchess county, New York. His works include: *Reports of the Plan of the Penal Code* (1822); *System of Penal Law for the State of Louisiana* (1826); *System of Penal Law for the United States* (1828); *Complete Works on Criminal Jurisprudence* (1873).

See C. H. Hunt, *Life of Edward Livingston* (1864); Louise Livingston Hunt, *Memoir of Mrs. Edward Livingston* (1886); Merrill Moore's "Edward Livingston" in the *Louisiana Historical Quarterly* (vol. 3, Jan.–Oct. 1920).

LIVINGSTON, ROBERT R. (1746–1813), American statesman, son of Robert R. Livingston (1718–75), a justice of the New York supreme court after 1763, and brother of Edward Livingston (*q.v.*), was born in New York city on Nov. 27, 1746. He graduated at King's college, New York (now Columbia university), in 1765 and was admitted to the bar in 1773. He was a member of the second, third, and fourth Provincial Congresses of New York (1775–77), was a delegate from New York to the Continental Congress in 1775–77, and again in 1779–80, and was a member of the committee which drafted the Declaration of Independence. He was prevented from signing that document by his absence at the time to attend a meeting of the fourth New York Provincial Congress, which on July 10 became the Convention of the Representatives of the State of New York, and by which at Kingston in 1777 the first State Constitution was adopted, Livingston having been a member of the committee that drafted this instrument. He was the first chancellor of the state, from 1777 to Feb. 1801, and is best known as "Chancellor" Livingston. In this capacity he administered the oath of office to Washington at his first inauguration to the presidency, in New York, on April 30, 1789. In 1788 he had been a member of the New York convention, which ratified for that state the Federal Constitution. He became an anti-Federalist and in 1798 unsuccessfully opposed John Jay in the New York gubernatorial campaign. In 1801 he became minister to France on President Jefferson's appointment and in 1803, in association with James Monroe, effected on behalf of his Government the purchase from France of what was then known as "Louisiana." In 1804 Livingston withdrew from public life and returned to New York, where he promoted various improvements in agriculture. He did much to introduce the use of gypsum as a fertilizer, and published an *Essay on Sheep* (1809). He was long interested in the problem of steam navigation; before he went to France he received from the State of New York a monopoly of steam navigation on the waters of the state and assisted in the experiments of his brother-in-law, John Stevens; in Paris he met Robert Fulton, and with him in 1802 made successful trials on the Seine of a paddle-wheel steamboat; in 1803 Livingston (jointly with Robert Fulton) received a renewal of his monopoly in New York, and the first successful steam-vessel, which operated on the Hudson in 1807, was named after Livingston's home, Clermont. He died at Clermont, N.Y., on Feb. 26, 1813.

See Frederick de Peyster, *Biographical Sketch of Robert R. Livingston* (1876); Robert K. Morton, "Robert R. Livingston: Beginnings of American Diplomacy," in *The John P. Branch Historical Papers of Randolph-Macon College,* i. 299–324 and ii. 34–46; and J. B. Moore, "Robert R. Livingston and the Louisiana Purchase," in *Columbia University Quarterly,* vi. 221–229 (1904); D. S. Alexander, "Robert R. Livingston," *N.Y. State Hist. Assoc. Proc.,* vol. vi., pp. 100–114 (Albany, 1906); and J. L. Delafield, *Chancellor Robert R. Livingston and His Family* (Albany, 1911).

LIVINGSTON, WILLIAM (1723–1790), American political leader, was born at Albany (N.Y.), probably on Nov. 30, 1723. He was the son of Philip Livingston (1686–1749), and grandson of Robert Livingston (1654–1725), an important figure in the early life of New York State.

William Livingston graduated at Yale college in 1741, studied law in the City of New York, was admitted to the bar in 1748, and served in the New York legislature (1759–60). However, his chief political influence was exerted through pamphlets and newspaper articles. Through the *Independent Reflector,* which he established in 1752, Livingston fought the attempt to bring the projected King's college (now Columbia university) under the control of the Church of England. Upon the suspension of the *Reflector* in 1753, he edited in the New York *Mercury* the "Watch Tower" section (1754–55), which became the organ of the Presbyterian faction.

In 1772 he removed to Elizabeth, New Jersey. He represented New Jersey in the first and second Continental Congresses (1774, 1775–76), but left Philadelphia in June 1776, probably to avoid voting on the question of adopting the Declaration of Independence, which he regarded as inexpedient. He was chosen first governor of the State of New Jersey in 1778, and was regularly re-elected until his death at Elizabeth (N.J.), on July 25, 1790. Livingston was a delegate to the Federal Constitutional Convention of 1787, and supported the New Jersey small State plan. In 1754 he joined with his brother, Philip, and others in founding what is now known as the Society Library of New York. With the help of William Smith (1728–93), the New York historian, William Livingston prepared a digest of the laws of New York for the period 1691–1756, which was published in two volumes (1752 and 1762).

See Theodore Sedgwick, Jr., *Life of William Livingston* (1833); and E. B. Livingston, *The Livingston of Livingston Manor* (1910).

His brother, Peter van Brugh Livingston (1710–1792), was a merchant and a Whig political leader in New York, and one of the founders of the College of New Jersey (now Princeton university).

Another brother, Philip Livingston (1716–1778), was a member of the Continental Congress from 1774 until his death; he was a signer of the Declaration of Independence.

William's son, (Henry) Brockholst Livingston (1757–1823), was an officer in the American War of Independence. From 1807 until his death he was an associate justice of the United States Supreme Court.

LIVINGSTON, city of south central Montana, U.S.A., on the Yellowstone river, at an altitude of 4,490 ft., 56 mi. from the northern entrance to Yellowstone park; the county seat of Park county. It is on Federal highways 10 and 89 and the main line of the Northern Pacific railway. The population was 6,642 in 1940 by the federal census. It has railroad shops, and is the trading and shipping centre for a mining, farming and stock-raising region. Surrounded by high mountain ranges, it is an important recreational centre, with many fine dude ranches and summer resorts. Livingston was settled about 1879 and incorporated in 1884.

LIVINGSTONE, DAVID (1813–1873), Scottish missionary and explorer in Africa, was born on March 19, 1813, at the village of Blantyre Works, in Lanarkshire, Scotland. David was the second child of his parents, Neil Livingston (for so he spelled his name, as did his son for many years) and Agnes Hunter. At the age of ten David entered the neighbouring cotton-mill, and by strenuous efforts qualified himself at the age of twenty-three to undertake a college curriculum. He attended for two sessions the medical and the Greek classes in Anderson's College, Glasgow, and also a theological class. In September 1838 he went up to London, and was accepted by the London Missionary Society as a candidate. He took his medical degree in the Faculty of Physicians and Surgeons in Glasgow in November 1840. Livingstone had set his heart on China, and it was a great disappointment to him that the society finally decided to send him to Africa.

The Exploring Missionary.—Livingstone sailed from England on Dec. 8, 1840. From Algoa Bay he made direct for Kuruman, Bechuanaland, the mission station established by Robert Moffat twenty years before. The next two years Livingstone spent in travelling about the country to the northwards, in search of a suitable outpost for settlement. During these two years he became convinced that the success of the white missionary in a field like Africa was not to be reckoned by the tale of doubtful conversions he could send home each year—that the proper work for such men was that of pioneering, opening up and starting new ground, leaving native agents to work it out in detail. The whole of his subsequent career was a development of this idea. He selected the valley of Mabotsa, on one of the sources of the Limpopo river, 200 m. north-east of Kuruman, as his first station. Shortly after his settlement here he was attacked by a lion which crushed his left arm. The arm was imperfectly set, and it was a source of trouble to him at times throughout his life.

To a house, mainly built by himself at Mabotsa, Livingstone in 1844 brought home his wife, Mary Moffat, the daughter of Moffat of Kuruman. Here he laboured till 1846, when he removed to Chonuane, 40 m. farther north, the chief place of the Bakwain or Bakwena tribe under Sechele. In 1847 he again removed to Kolobeng, about 40 m. westwards, the whole tribe following their missionary. With two English sportsmen, William C. Oswell and Mungo Murray, he undertook a journey to Lake Ngami, which had never yet been seen by a white man. Crossing the Kalahari Desert, of which Livingstone gave the first detailed account, they reached the lake on Aug. 1, 1849. In April next year he made an attempt to reach Sebituane, who lived 200 m. beyond the lake, this time in company with his wife and children, but again got no farther than the lake, as the children were seized with fever. A year later, April 1851, Livingstone, again accompanied by his family and Oswell, set out, this time with the intention of settling among the Makololo for a period. At last he succeeded, and reached the Chobe (Kwando), a southern tributary of the Zambezi, and in the end of June reached the Zambezi itself at the town of Sesheke. Leaving the Chobe on Aug. 13, the party reached Cape Town in April 1852. Livingstone may now be said to have completed the first period of his career in Africa, the period in which the work of the missionary was predominant, but it must be remembered that he regarded himself to the last as a pioneer missionary, whose work was to open up the country to others.

Loanda and Victoria Falls.—Having seen his family off to England, Livingstone left Cape Town on June 8, 1852, and reached Linyante, the capital of the Makololo, on the Chobe on May 23, 1853, being cordially received by Sekeletu and his people. His first object was to find healthy high land for a station. Ascending the Zambezi, he found no place free from the tsetse fly, and therefore resolved to discover a route to the interior from either the west or east coast. He started, with 27 natives, from Linyante on Nov. 11, 1853, and, by ascending the Liba, Lake Dilolo was reached on Feb. 20, 1854. On May 31 the expedition reached Loanda, Livingstone, however, being all but dead from fever, semi-starvation and dysentery. From Loanda Livingstone sent his astronomical observations to Sir Thomas Maclear at the Cape, and an account of his journey to the Royal Geographical Society, which in May 1855 awarded him its patron's medal. Loanda was left on Sept. 20, 1854, but Livingstone lingered long about the Portuguese settlements. Making a slight détour to the north to Kabango, the party reached Lake Dilolo on June 13, 1855. Here Livingstone made a careful study of the hydrography of the country. He "now for the first time apprehended the true form of the river systems and the continent," and his conclusions have been essentially confirmed. The party returned to Linyante in the beginning of September.

For Livingstone's purposes the route to the west was unavailable, and he decided to follow the Zambezi to its mouth. With a numerous following, he left Linyante on Nov. 8, 1855. A fortnight afterwards he discovered the famous "Victoria" falls of the Zambezi. Livingstone reached the Portuguese settlement of Tete on March 2, 1856, in a very emaciated condition. Here he left his men and proceeded to Quilimane, where he arrived on May 20, thus having completed in two years and six months one of the most remarkable and fruitful journeys on record. The results in geography and in natural science in all its departments were abundant and accurate; his observations necessitated a reconstruction of the map of Central Africa. When Livingstone began his work in Africa the map was virtually a blank from Kuruman to Timbuktu, and nothing but envy or ignorance can throw any doubt on the originality of his discoveries.

The Zambezi Expedition.—On Dec. 12 he arrived in England, after an absence of sixteen years. He told his story in his *Missionary Travels and Researches in South Africa* (1857) with straightforward simplicity, and with no effort after literary style, and no apparent consciousness that he had done anything extraordinary. In 1857 he left the London Missionary Society, with which, however, he remained on the best of terms, and in February 1858 he accepted the appointment of "Her Majesty's consul at Quilimane for the eastern coast and the independent districts in the interior, and commander of an expedition for exploring eastern and central Africa." The Zambezi expedition, of which Livingstone thus became commander, sailed from Liverpool in H.M.S. "Pearl" on March 10, 1858, and reached the mouth of the Zambezi on May 14. The party, which included Dr. (afterwards Sir) John Kirk and Livingstone's brother Charles, ascended the river from the Kongone mouth in a steam launch, the "Ma-Robert"; reaching Tete on Sept. 8. Livingstone then explored the river above Tete, and especially the Kebrabasa rapids. The year 1859 was spent in exploring the river Shire and Lake Nyasa, which was discovered in September; and during a great part of the year 1860 Livingstone was engaged in repatriating such of the Makololo as cared to go home. In January of next year arrived Bishop C. F. Mackenzie and a party of missionaries sent out by the Universities Mission to establish a station on the upper Shiré.

After exploring the river Rovuma for 30 m. in his new vessel the "Pioneer," Livingstone and the missionaries proceeded up the Shiré to Chibisa's; there they found the slave trade rampant. On July 15 Livingstone, accompanied by several native carriers, started to show the bishop the country, and after seeing the missionary party settled in the highlands to the south of Lake Chilwa (Shirwa) Livingstone explored (Aug.–Nov.) Lake Nyasa. While the boat sailed up the west side of the lake to near the north end, the explorer marched along the shore. He returned more resolved than ever to rouse the civilized world to put down the desolating slave-trade. On Jan. 30, 1862, at the Zambezi mouth, Livingstone welcomed his wife and the ladies of the mission, with whom were the sections of the "Lady Nyassa," a river steamer which Livingstone had had built at his own expense. When the mission ladies reached the mouth of the Ruo tributary of the Shiré, they were stunned to hear of the death of the bishop and one of his companions. This was a blow to Livingstone, seeming to have rendered all his efforts to establish a mission futile. A still greater loss to him was that of his wife at Shupanga, on April 27, 1862.

The "Lady Nyassa" was taken to the Rovuma. Up this river Livingstone managed to steam 156 m., but farther progress was arrested by rocks. Returning to the Zambezi in the beginning of 1863, he found that the desolation caused by the slave trade was more horrible and widespread than ever. It was clear that the Portuguese officials were themselves at the bottom of the traffic. Kirk and Charles Livingstone being compelled to return to England on account of their health, the doctor resolved once more to visit the lake, and proceeded some distance up the west side and then north-west as far as the watershed that separates the Loangwa from the rivers that run into the lake. Meanwhile a letter was received from Earl Russell recalling the expedition by the end of the year. In the end of April 1864 Livingstone reached Zanzibar in the "Lady Nyassa." He reached England on July 23. The geographical results of this expedition, though not comparable in extent to those of his first and his final expeditions, were of high importance, as were those in various departments of science, and he had unknowingly laid the foundations of the British protectorate of Nyasaland Details will be found in his *Narrative of an Expedition to the Zambesi and its Tributaries* (1865).

The Slavers in Lualaka.—By Sir Roderick Murchison and his other staunch friends Livingstone was as warmly welcomed as ever. When Murchison proposed to him that he should go out again, although he seems to have had a desire to spend the remainder of his days at home, the prospect was too tempting to be rejected. He was appointed British consul to Central Africa without a salary, and government contributed only £500 to the expedition. The chief help came from private friends. During the latter part of the expedition government granted him £1,000, but that, when he learned of it, was devoted to his great undertaking. The Geographical Society contributed £500. The two main objects of the expedition were the suppression of slavery by means of civilizing influences, and the ascertainment of the watershed in the region between Nyasa and Tanganyika. At first Livingstone thought the Nile problem had been all but solved by Speke, Baker and Burton, but the idea grew upon him that the Nile sources must be sought farther south, and his last journey became in the end a forlorn hope in search of the "fountains" of Herodotus.

Leaving England in the middle of August 1865, via Bombay, Livingstone arrived at Zanzibar on Jan. 20, 1866. He was landed at the mouth of the Rovuma on March 22, and started for the interior on April 4. His company consisted of thirteen sepoys, ten Johanna men, nine African boys from Nasik school, Bombay, and four boys from the Shiré region, besides camels, buffaloes, mules and donkeys. This imposing outfit soon melted away to four or five boys. Rounding the south end of Lake Nyasa, Livingstone struck in a north-northwest direction for the south end of Lake Tanganyika, over country much of which had not previously been explored. The Loangwa was crossed on Dec. 14, 1866. On Christmas day Livingstone lost his four goats, a loss which he felt very keenly, and the medicine chest was stolen in January 1867. Fever came upon him, and for a time was his almost constant companion; this, and other serious ailments, which he had no medicine to counteract, told on even his iron frame. The Zambezi was crossed on Jan. 28, and the south end of Tanganyika reached on March 31. Here, much to his vexation, he got into the company of Arab slave dealers (among them being Tippoo-Tib) by whom his movements were hampered; but he succeeded in reaching Lake Mweru (Nov. 1867). After visiting Lake Mofwa and the Lualaba, which he believed was the upper part of the Nile, he, on July 18, 1868, discovered Lake Bangweulu. Proceeding up the west coast of Tanganyika, he reached Ujiji on March 14, 1869, "a ruckle of bones."

Livingstone recrossed Tanganyika in July, and passed through the country of the Manyema, but baffled partly by the natives, partly by the slave hunters, and partly by his long illnesses it was not till March 29, 1871 that he succeeded in reaching the Lualaba, at the town of Nyangwe, where he stayed four months, vainly trying to get a canoe to take him across. It was here that a party of Arab slavers, without warning or provocation, assembled one day when the market was busiest and commenced shooting the women, hundreds being killed or drowned in trying to escape. Livingstone had "the impression that he was in hell," but was helpless, though his "first impulse was to pistol the murderers." The account of this scene which he sent home roused indignation in England to such a degree as to lead to determined and partially successful efforts to get the sultan of Zanzibar to suppress the trade. In sickened disgust the weary traveller made his way back to Ujiji, which he reached on Oct. 13.

Stanley.—Not long after his arrival in Ujiji he was inspired with new life by the timely arrival of H. M. Stanley, the richly laden almoner of Gordon Bennett, of the *New York Herald.* With Stanley, Livingstone explored the north end of Tanganyika, and proved conclusively that the Rusizi runs into and not out of it. In the end of the year the two started eastward for Unyamwezi, where Stanley provided Livingstone with an ample supply of goods, and bade him farewell. Stanley left on March 15, 1872, and after Livingstone had waited wearily in Unyamwezi for five months, a troop of fifty-seven men and boys arrived, good and faithful fellows on the whole, selected by Stanley himself. Thus attended, he started on Aug. 15 for Lake Bangweulu, proceeding along the east side of Tanganyika. His old enemy dysentery soon found him out. In January 1873 the party got among the endless spongy jungle on the east of Lake Bangweulu, Livingstone's object being to go round by the south and away west to find the "fountains." The doctor got worse and worse, and in the middle of April he had to be carried in a rude litter. On April 29 Chitambo's village on the Lulimala, in Ilala, on the south shore of the lake, was reached.

The last entry in the journal is on April 27. "Knocked up quite, and remain—recover—sent to buy milch goats. We are on the banks of the Molilamo." On April 30 he with difficulty wound up his watch, and early on the morning of May 1 the boys found "the great master," as they called him, kneeling by the side of his bed, dead. His faithful men preserved the body in the sun as well as they could, and, wrapping it carefully up, carried it and all his papers, instruments and other things across Africa to Zanzibar. It was borne to England with all honour, and on April 18, 1874, was laid to rest in Westminster Abbey. His faithfully kept journals during these seven years' wanderings were published under the title of the *Last Journals of David Livingstone in Central Africa,* in 1874, edited by his old friend Horace Waller. In Old Chitambo's the time and place of his death are commemorated by a permanent monument, which replaced in 1902 the tree on which his native followers had recorded the event.

Estimate.—In spite of his sufferings and the many compulsory delays, Livingstone's discoveries during these last years were of prime importance as leading to a solution of African hydrography. No single African explorer has ever done so much for African geography as Livingstone during his thirty years' work. His travels covered one-third of the continent, extending from the Cape to near the equator, and from the Atlantic to the Indian Ocean. Livingstone was no hurried traveller; he did his journeying leisurely, carefully observing and recording all that was worthy of note, with rare geographical instinct and the eye of a trained scientific observer, studying the ways of the people, eating their food, living in their huts, and sympathizing with their joys and sorrows. In all the countries through which he travelled his memory is cherished by the native tribes who, almost without exception, treated Livingstone as a superior being; his treatment of them was always tender, gentle and gentlemanly. By the Arab slavers whom he opposed he was also greatly admired, and was by them styled "the very great doctor." "In the annals of exploration of the Dark Continent," wrote Stanley many years after the death of the missionary explorer, "we look in vain among other nationalities for a name such as Livingstone's. He stands pre-eminent above all; he unites in himself all the best qualities of other explorers . . . Britain . . . excelled herself even when she produced the strong and perseverant Scotchman, Livingstone."

But the direct gains to geography and science are perhaps not the greatest results of Livingstone's journeys. His example and his death acted like an inspiration, filling Africa with an army of explorers and missionaries, and raising in Europe so powerful a feeling against the slave trade that through him it may be considered as having received its death-blow. Personally Livingstone was a pure and tender-hearted man, full of humanity and sympathy, simple-minded as a child. The motto of his life was the advice he gave to some school children in Scotland—"Fear God, and work hard." (J. S. K.)

See, besides his own narratives, W. G. Blaikie, *Life of Livingstone* (1880); H. H. Johnston, *Livingstone* (1891, later ed., 1912); C. J. Finger, *David Livingstone, Explorer and Prophet* (1928); the *Proceedings* of the London Missionary Society, from 1840, the *Journal* and *Proceedings* of the Royal Geographical Society; the Despatches to the Foreign Office sent home by Livingstone during his last two expeditions; and H. M. Stanley, *How I found Livingstone* (1872) and *Autobiography* (1909).

LIVINGSTONE MOUNTAINS, a range of highlands in Tanganyika Territory, forming the eastern border of the rift-valley of Lake Nyasa, at the northern end of the lake. In parts these highlands, known also under their native name of Kinga, are more a plateau in character than a true mountain range. The northern end is well marked by an escarpment facing the Ruaha valley, which is regarded as the continuation of the eastern rift-valley. Southwards the range terminates in the deep valley of the Ruhuhu. The mountains are formed of Archaean granites, gneisses and schists and are overlain in the east by sandstones with thin coal seams. (Karroo System, Permo-Carboniferous.) The gneisses form a series of north to south ridges, the one nearest the lake (which in Mount Jamimbi or Chamembe, rises to a height of 7,870ft.), falls almost sheer to the water, the same steep slope being continued beneath the surface. Only 20m. wide in the south, the range widens to 40 in the north where is the depression of

Buanyi and the highest known summit of the range (9,600ft.). North and east of Buanyi, as in the east of the range, table-topped mountains occur, composed above of the horizontally bedded quartzites, sandstones and conglomerates of the Karroo System. There is rich grass on the uplands, forests in the hollows and poor scrub near the lake. Native settlements are scattered over the whole range. The climate is healthy, and night frosts occur in the cold season. European crops are raised with success. On the lake side are the ports of Manda and Lumbira.

LIVING WAGE: *see* POVERTY LINE.

LIVIUS ANDRONICUS (*c.* 284–204 B.C.), the founder of Roman epic poetry and drama. His name indicates that he was a Greek, a manumitted slave of the Livian family, and thus typical of the early influences in Latin literature, and of the interest of the enlightened aristocracy in Greek culture. He is supposed to have been a native of Tarentum, and to have been brought, while still a boy, after the capture of that town in 272, as a slave to Rome. He lived in the household of a member of the *gens Livia,* probably M. Livius Salinator. He determined the course which Roman literature followed for more than a century after his time. To judge, however, from the insignificant remains of his writings, and from the opinions of Cicero and Horace, he can have had no pretension to original genius. His real claim to distinction was that he was the first great schoolmaster of the Roman people. We learn from Suetonius that, like Ennius after him, he obtained his living by teaching Greek and Latin; his translation of the *Odyssey* into Saturnian verse was probably always intended as a school-book and was still used as such in Horace's time; although faultily executed, it satisfied a real want by introducing the Romans to a knowledge of Greek. The Romans and Italians had an indigenous drama of their own, known by the name of *Satura.* This, however, lacked a definite plot. In 240 Andronicus produced at the *ludi Romani* a translation of a Greek play (it is uncertain whether a comedy or tragedy or both), and this representation marks the beginning of Roman dramatic literature (Livy vii. 2).

Livius himself took part in his plays, and introduced the custom of having the solos (*cantica*) sung by a boy, while he himself represented the action of the song by dumb show. In his translation he discarded the native Saturnian metre, and adopted the iambic, trochaic and cretic metres. He continued to produce plays on Greek mythical subjects (*Achilles, Equus Troianus,* etc.). In the year 207, when he must have been of a great age, he was appointed to compose a hymn of thanksgiving, sung by maidens, for the victory of the Metaurus and an intercessory hymn to the Aventine Juno. As a further tribute of national recognition the "college" or "gild" of poets and actors was granted a place of meeting in the temple of Minerva on the Aventine.

See fragments in L. Müller, *Livi Andronici et Cn. Naevi Fabularum Reliquiae* (1885); also J. Wordsworth, *Fragments and Specimens of Early Latin* (1874); Mommsen, *Hist. of Rome,* bk. iii. ch. 14.

LIVNO, a town of Bosnia, Yugoslavia, in the fertile plain of Livno, at the foot of Mt. Krug (6,581 ft.); occupied by Italy in World War II. Pop. (1931) 4,331. There are cement works and a model farm for cattle rearing, and the town has some trade in grain, livestock and silver filigree work. In 1904 a fire destroyed more than 500 of the old Turkish houses, together with the Roman citadel. Remains prove that Livno occupies the site of a Roman settlement, the name of which is uncertain.

LIVONIA, a former province of Russia, now partly in Latvia (*q.v.*) and partly in Estonia (*q.v.*).

History.—Coins of the time of Alexander the Great, found in Oesel, show that the coasts of the Baltic were at an early period in commercial relation with the civilized world. The chronicle of Nestor mentions as inhabitants of the Baltic coast the Chudes, the Livs, the Narova, Letgola, Semigallians and Kors. It was probably about the 9th century that the Chudes became tributary to the Varangian-Russian states. As they reacquired their independence, Yaroslav I. undertook in 1030 a campaign against them, and founded Yuriev (Dorpat). The Germans first penetrated into Livonia in the 11th century. In 1186 the emissaries of the archbishop of Bremen began to preach Christianity among the Ehsts and Letts, and in 1201 the bishop of Livonia established his residence at Riga. In 1202 or 1204 Innocent III. recognized the order of Brothers of the Sword, the residence of its grand master being at Wenden; and the order, spreading the Christian religion by the sword among the natives, carried on from that time a series of uninterrupted wars against the Russian republics and Lithuania. The first active interference of Lithuania in the affairs of Livonia took place immediately after the great outbreak of the peasants on Oesel; Olgierd then devastated all southern Livonia. The war of the order with Ivan IV. of Russia in 1558 led to a division of Livonia, its northern part, Dorpat included, being taken by Russia, and the southern part falling under the dominion of Poland. From that time (1561) Livonia formed a subject of dispute between Poland and Russia, the latter only formally abdicating its rights to the country in 1582. In 1621 it was the theatre of a war between Poland and Sweden, and being conquered by Sweden enjoyed twenty-five years of milder rule. In 1654, and again at the beginning of the 18th century, it was the scene of war between Poland, Russia and Sweden. It was finally conquered by Russia, the official concession being confirmed by the treaty of Nystad in 1721. From this time Livonia formed, with Courland and Estonia, the Baltic provinces, a part of the old Russian Empire. On the conclusion of the World War a German army occupied these provinces and, although required by the Armistice Convention to evacuate the territory, it did not altogether withdraw until Dec. 1919. Livonia lost its individuality in the formation (1918) of the two republics of Latvia and Estonia (*qq.v.*), which divided between them the territory of the former Baltic provinces.

See E. Seraphim, *Geschichte Liv-, Esth-, und Kurlands* (2nd ed., Revel, 1897–1904) and *Geschichte von Livland* (Gotha, 1905, etc.); H. M. Stationery Office, Peace Handbooks No. 50. Courland, Livonia, Esthonia (1920).

LIVRE. The livre is an obsolete French monetary unit and weight, the word being derived from the Latin "libra," a pound used as money; it was called the livre (Tournois) and was divided into 20 "sous" of 12 "deniers" each. This corresponds to the present English system of pounds, shillings and pence, each containing that weight of silver. Originally equal to the English pound, it early depreciated to a far greater extent. Thus the franc, whose name dates from the middle ages, circulated before the Revolution by the side of the livre, and the legal rate of conversion was that of 81 livres to 80 francs.

After the Revolution the franc became the official monetary unit, but the livre continued to circulate until 1834, when it was withdrawn.

As a measure of weight, the livre was of an indefinite character, each town having its own standard.

LIVY (TITUS LIVIUS) (59 B.C.–A.D. 17), Roman historian, was born at Patavium (Padua) in Cisalpine Gaul, some 22 m. S.W. of Venice. His mature years were doubtless spent mostly in Rome, where he enjoyed the friendship of Augustus—a friendship that was not impaired by the fact that Livy eulogized Pompey so highly that Augustus called him "a Pompeian" (Tac., *Ann.* iv. 34). Of his domestic relations we know only that he had a son (Quintil. x. 1.39), who may have been the writer referred to as one of his authorities by Pliny (*N.H.* i. 5 Livio filio, *ibid.* 6 T. Livio filio), and a daughter (Seneca, *Controv.* x. 29.2). He died in A.D. 17 at his native Padua, of which he constituted the chief title to fame (Mart. i. 61.3 *Censetur Apona Livio sua tellus*).

We have some testimony to Livy's studies in rhetoric (Quintil. x. 1.39 "that brevity which is found in Livy in a letter written to his son: Read Demosthenes and Cicero, then other authors as each is likest to Demosthenes and Cicero," *cf.* ii. 5.20, viii. 2,18) and philosophy (Seneca, *Ep.* 100.9 "You may add the name of Titus Livius: for he wrote both dialogues assignable as well to history as to philosophy, and other books avowedly containing philosophy"). But his life-work was history.

His *History of Rome* (*Ab urbe condita libri*) was in 142 books, and told the story of Rome from the arrival of Aeneas in Italy down to the death of Drusus, younger brother of the emperor Tiberius, in A.D. 9. There are indications that the work was published in parts: thus, while Bk. I. opens with a formal preface to the whole work, prefaces of a less formal nature introduce Bks. VI., XXI. and XXXI. The division into *decades* is a late one and is not heard of before the end of the 5th century, though some scholars have seen what they consider to be traces of an original decadic division, *e.g.*, Bk. LXXX. contained the death of Marius, Bk. XC. the death of Sulla.

Of the 142 books only 35 are extant, viz., I.–X., carrying the story down to 293 B.C.; XXI.–XLV. (with some *lacunae* in XLI.–XLIV.), covering the years 218–167 B.C. We have, further, a fragment of Bk. XCI. which was discovered in the Vatican in 1772. The lost books are to some extent replaced by the *Periochae* (or summaries of contents), dating perhaps from the 4th century, which we possess for all the books with the exception of CXXXVI. and CXXXVII. Further, the *Prodigia* of Iulius Obsequens (4th century A.D.) which gives a list of prodigies from 190–12 B.C., is directly taken from (probably an epitome of) Livy. The same applies to the *fasti* in the *Chronica* of Cassiodorus (6th century). An Oxyrhynchus papyrus (for which *see* J. S. Reid, *Classical Review,* July 1904) contains fragments of an epitome—excerpts from Bks. XXXVII.–XL. and XLVIII.–LV. Lastly, the substance of much of Livy's history is no doubt to be found in later writers, who made use of his work.

His Conception of History.—To understand the ideas with which Livy undertook his great work, we turn to the general preface prefixed to Bk. I.: "Whether I shall perform a work worth the doing if I write the history of the Roman people from the foundation of the city, I do not well know, nor, if I knew, would I dare to say, inasmuch as I perceive that the subject is both old and trite, new writers ever believing either that they will contribute some greater certainty in matters of fact, or that in the art of writing they will surpass the rudeness of antiquity. However that may be, it will be at least a pleasant thought that I myself also should have done my duty to the memory of the deeds of the chiefest people in the world; and if in so great a company of writers my fame should be obscured, I would comfort myself with the nobility and greatness of those who shall darken my name. My theme, moreover, is one of immense labour—an empire whose story goes back beyond 700 years, and which, starting from small beginnings, has grown to a point where it labours under its own magnitude. To the greater number of my readers, I doubt not, the story of the first beginnings and of the times nearest to the beginning will afford less pleasure, eager as they will be to reach these latter times when the powers of a long puissant people are working their own decay. I, on the contrary, will seek this reward also of my labour—to avert a little while my eyes from the contemplation of the evils which our age has seen during so many years, while with my whole mind I recall those ancient things, free from every care which might distract the mind of the writer, even if it did not deflect it from the truth.

"With regard to the traditions of times before the city was founded or its foundation contemplated—traditions adorned by the fables of the poet rather than based upon the incorruptible monuments of history—I have no intention either to affirm them or to refute. Antiquity is allowed the privilege of mingling human things with divine in order to render the first beginnings of cities more august. And, if it should be permitted to any people to hallow their origins and refer them to the authorship of the gods, such is the warlike glory of the Roman people that, though they chiefly avow Mars to be their parent and the parent of their founder, even this vaunt the nations of mankind tolerate with the same equanimity with which they tolerate the Roman rule.

"But these and such-like matters, however they may be regarded or esteemed, I shall hold of small moment. The things to which I would have everyone for himself bend his keen attention are these: what Roman life and character have been; through what men and by what arts, at home or in the field, the empire was won and extended; then let him follow with attention how, as discipline gradually relaxed, character first, as it were, declined, then lapsed more and more, then began to go headlong, until we reached these last days when we can endure neither our vices nor their remedies. Here is that supremely salutary and fruitful thing in the study of history—that you should behold examples of every pattern placed upon a conspicuous monument and therefrom, for yourself and for your country, take what you should imitate, and therefrom see what—foul in inception and foul in issue—you should avoid.

"For the rest, either my love for the task which I have undertaken deceives me, or there has never been a state either greater or holier or richer in good examples; no state into which avarice and luxury made their entrance so late; none where poverty and thrift were honoured so much and so long—nay, the less wealth, the less cupidity. Of late riches have introduced avarice, abundance of pleasures has brought to men the desire by way of luxury and lust to ruin themselves and to ruin all.

"But complaints will never be pleasing, not even when they are perhaps necessary: from the beginning at least of this great business on which I am embarking, let them be absent. Rather would I commence—were it the custom for historians as it is for poets—with good omens and vows and prayers to gods and goddesses to grant a happy issue to the great task now begun."

Livy thus had two main purposes in writing his history—apart from the personal solace which it afforded him by diverting his mind from the troubles of his own time—(1) to preserve the memory of the great deeds of the Roman people; and (2), which he regards as still more important, to teach by conspicuous examples what is worthy of imitation and what is to be avoided. His first purpose is thus identical with that of Herodotus (i. 1) who wrote his history in order that the story of the past might not be obliterated by lapse of time, and that the great and marvellous deeds performed by Greeks and barbarians might not lose their fame. His second purpose reminds us of Thucydides (i. 22) who, writing in the belief that history tends more or less to repeat itself, aims at making his work a true record of the past and thus a safe guide to the future. The only difference is that Livy's educational purpose is more ethical than political. The same sort of two-fold object is indicated also by Polybius (i. 1) as having been the purpose of almost all his predecessors (and, apparently, he adopts it as his own purpose), who declare that "the knowledge of history is the truest education and gymnastic for political affairs, and the clearest and, indeed, the only teacher of the power to support the changes of fortune nobly is the memory of the vicissitudes of others."

Sources.—The question of the literary sources used by Livy has been the subject of much discussion and research. The chief difficulty arises from the somewhat haphazard way in which he refers to his authorities. Explicit reference to his authority for specific statements is rare: xxii. 7 "The number of the slain on both sides is multiplied by other authorities. For myself, apart from the fact that I would have nothing drawn from idle rumour, I have taken as my authority, Fabius, a contemporary of this war." xxxiii. 10 "On that day there were slain 8,000 of the enemy, 5,000 taken captive. . . . If one were to believe Valerius, who extravagantly exaggerates the number of everything, 40,000 of the enemy were slain, the captives—a more modest falsehood—were 5,700. . . . Claudius, too, writes that 32,000 of the enemy were slain, while the captured were 4,300. We have not accepted the smaller numbers by preference, but have followed Polybius, no uncertain authority for all Roman affairs, but especially for those carried out in Greece." More often the reference is quite vague: x. 25 "whether of his own will . . . or summoned by decree of the senate: for there are authorities for both statements" (*in utrumque auctores sunt*). Often we have no reference to authorities at all. So far, however, as can be ascertained, his chief authorities in the different *decades* may be enumerated as follow: In the first *decade* he depended chiefly on the earlier and later annalists. Q. Fabius Pictor, the earliest of all, who served in the Second Punic War, is referred to in i. 44 (*scriptorum antiquissimus*); i. 55 "I would, therefore, rather believe Fabius, apart from his greater antiquity . . . than Piso"; ii. 40, Coriolanus "is said to have perished, but authorities differ as to the manner of his death. In Fabius, by far the most ancient authority, I find that he lived to old age"; also in viii. 30, x. 57. L. Calpurnius

Piso, consul in 133 B.C., who *"reliquit . . . annales sane exiliter scriptos"* (Cic. *Brut.* 27), is cited in i. 55, ii. 58, ix. 44, x. 9; Q. Valerius Antias (early in 1st century B.C.) in iii. 5; C. Licinius Macer (born *circ.* 110 B.C.) in iv. 7, iv. 20, iv. 23, vii. 9, x. 9; Q. Claudius Quadrigarius (about the same date), whose *Annales* (Aul. Gell. i. 25, etc.) began from the sacking of Rome by the Gauls (390 B.C.), in viii. 19, ix. 5; Q. Aelius Tubero (1st cent. B.C.) in iv. 23, x. 29. There is a single reference to L. Cincius Alimentus (who served in the Second Punic War), the celebrated annalist and antiquary (vii. 3, *diligens talium monumentorum auctor Cincius*).

In the third *decade* (Bks. XXI.–XXX.), in addition to Fabius Pictor (xx. 7), Piso (xxv. 39), Valerius Antias (xxv. 39, xxvi. 49, xxix. 35, xxx. 19 and 29), Claudius Quadrigarius (xxv. 39 *auctor est Claudius qui annales Acilianos* [*i.e.*, of C. Acilius Glabrio, 2nd century B.C., Cic. *De Off*, iii. 115, Aul. Gell. vii. 14, 9, Plut. *Cat.* 22, Macrob. *Sat.* i. 5] *ex Graeco in Latinum sermonem vertit*), Cincius Alimentus (xxi. 38), we have some new names. L. Coelius Antipater, a contemporary of C. Gracchus, who wrote a history of the Second Punic War (Cic., *De Div* i. 24, *De Or.* ii. 12, *De Legg.* i. 2, *Brut.* 26, *Ad. Att.* xiii. 8, Gell. x. 24, Valer. Max. i. 7), is cited in xxi. 38, xxii. 31, xxiii. 6, xxvi. 11. xxvii. 27, xxviii. 46, xxix. 27. Silenus (*cf.* H. Dessau, *Über die Quellen unseres Wissens vom zweiten punischen Kriegs*, Hermes 51 [1916] p. 364 *seq.*), of Calé Acté in Sicily, who was in the camp of Hannibal for part of the campaign (Corn. Nep. xxiii. 13,3: "The events of this war have been recounted by many writers, but of these, two were with him in his camp and lived with him as long as fortune permitted, Silenus and Sosilus of Lacedaemon"), and whose work was used by Coelius Antipater (Cic., *De Div.* i. 24: "This is also in the Greek history of Silenus whom Coelius follows: he was a most careful follower of the affairs of Hannibal"), is referred to in xxvi. 49. Lastly, Polybius is cited once (xxx. 45 *Polybius, haudquaquam spernendus auctor*).

In the fourth and fifth *decades* (Bks. XXXI.–XLV.) the authorities cited are Claudius Quadrigarius (xxxiii. 10, xxxv. 14), Valerius Antias (xxxii. 6, xxxiii. 10, xxxiv. 15, xxxv. 2, xxxvi. 19 and 38, xxxviii. 50, xxxix. 22, xl. 29, xli. 32, xlii. 11, xliv. 13, xlv. 40), and Polybius (xxxiii. 10, xxxiv. 50, xxxvi. 19, xxxix. 52, xlv. 45). The principle on which he proceeds is to use Polybius for matters concerning Greece and the East, the Roman writers for those concerning Italy and Western Europe. In this way is explained the comparatively small use made of Polybius in the third *decade* which is occupied mainly with Rome and Roman affairs, for which Roman authorities were naturally more abundant.

Livy's Use of His Authorities.—Livy had the reputation in antiquity of conspicuous honesty and impartiality (Tac., *Ann.* iv. 34 *Titus Livius, eloquentiae ac fidei praeclarus in primis;* Senec. *Suas.* vi. 22 *candidissimus omnium magnorum ingeniorum aestimator*), and probably no competent historian would accuse him of deliberately falsifying or misrepresenting his authorities. Macaulay, in his essay on history, says that "no historian with whom we are acquainted has shown so complete an indifference to truth," but this characteristic extravagance is somewhat discounted by the fact that in his next paragraph he proceeds to speak of Livy's attitude to the past in terms so grotesquely erroneous as to suggest that Macaulay had either never read, or had forgotten the memorable language of Livy's preface. The charges which modern scholarship brings against Livy in regard to the use of his literary authorities are mainly these: That in his selection of authorities, and in his discrimination between them, he does not proceed on adequate critical grounds; that, following now one authority, now another, he has involved himself in inconsistent accounts of the same events; that by omission in some cases, in others by addition, he has, however unintentionally misrepresented his authorities; and, lastly, that in some cases he has failed to understand the meaning of the text before him.

A few examples will illustrate his method of dealing with his authorities. Mere vague rumour is always to be neglected in favour of written evidence: vi. 1, the history of Rome down to the capture of the city by the Gauls (390 B.C.) is obscure, "first through its antiquity and then because in those times letters, the one faithful guardian of the memory of things (*litterae, una custodia fidelis memoriae rerum gestarum*), were few and rare, and because such as existed in the journals (*commentarii*) of the *pontifices* or in other public or private memorials perished when Rome was burnt." When his authorities agree, he usually accepts them without comment. When they differ, he is sometimes content to state the different accounts without deciding between them, *e.g.*, xxv. 39. More often he indicates his preference and the grounds on which it is based. In general, preference is given to the older and, if available, contemporary authority: viii. 40 "Nor is there extant any writer contemporary with those times on whom one could take one's stand as a sufficiently sure authority," *cf.* xxii. 7. Sometimes the ground is merely general probability: xxvii. 7 "The storming of Carthage I have put in this year, with many authorities, although I am not unaware that some put the capture of the city in the following year, because it seemed to me less likely that Scipio would have spent a whole year in Spain doing nothing," *cf.* vi. 21. "In the case of things so ancient I should be content if what looks like the truth were taken for true." Where the number of the slain and captured, or the amount of booty, is variously given, he prefers the middle estimate: xxvi. 49 "If we must agree with some authority, the middle estimate is likest the truth." Sometimes he admits that he can discover no ground for a decision: vii. 40 "It is not easy to prefer one account to another or one authority to another" (*aut rem rei aut auctorem auctori praeferre*). Sometimes, if he sees reason, he does not hesitate to reject all his authorities: xxii. 31 "Almost all the annalists say that Fabius was dictator when he fought against Hannibal. Coelius (Antipater) also writes that he was the first dictator created by the people. But it has escaped Coelius and the rest that only the consul Gnaeus Servilius, who was then far away in the province of Gaul, had the power to appoint a dictator. As the State, already terror-stricken by disaster, could not await the delay thus occasioned, recourse was had to the appointment by the people of a pro-dictator. The general's subsequent exploits, his eminent fame, and the exaggeration by his descendants in the title attached to his portrait, easily brought it about that he should be styled dictator instead of pro-dictator." For mere invention he has no place (xxii. 7 *nihil haustum ex vano velim, quo nimis inclinant ferme scribentium animi*), and the exaggerations of Valerius Antias (xxxiii., 10 *Si Valerio quis credat omnium rerum immodice numerum augenti*) are stigmatized with the utmost candour (xxvi. 49 *adeo nullus mentiendi modus est*).

That his somewhat haphazard use of different authorities involved him sometimes in inconsistencies (*e.g.*, xxvii. 7. 1, compared with xxvi. 51. 2), sometimes in duplications which represent a single event as two (*e.g.*, xxiii. 46 compared with xxv. 18; xxvii. 18 compared with xxviii. 13), seems undeniable. As to mistaking the meaning of his authorities, one of the best known examples is xxxiii. 35 "Cornelius came to Thermopylae, where a full convention of Greece—called the Pylaic convention—takes place on fixed days." This appears to represent Polybius xviii. 31. 6 ἧκον ἐπὶ τὴν τῶν Θερμικῶν σύνοδον: that is to say, Livy appears to have confused a convention at Thermum in Aetolia with the amphictyonic convention at Thermopylae. The slip is a very natural one, and, of course, Livy may here be following some other authority than Polybius.

It is further charged against Livy that he does not appear to have made any attempt to check his literary authorities by personal examination of official records and monumental evidence. His discussion of the inscription on the linen breastplate of A. Cornelius Cossus in the temple of Iupiter Feretrius (iv. 20) and his references to the *"magistratuum libri lintei"* (iv. 7 and 20), which he cites on the authority of Licinius Macer, appear to imply that he had not personally inspected them. We have, indeed, some phrases which suggest such personal examination (*e.g.*, ix. 18 *Paginas in annalibus magistratuum fastisque percurrere licet, etc.*), but there is certainly no sign of anything like a critical examination of all available records. And, lastly, there is no evidence that he made any study of the topography of the places in which the scenes which he described were enacted.

But whatever may be his defects as a scientific historian, there can be no doubt that in regard to the two chief aims which Livy proposed to himself—to preserve the memory of the great deeds of the Roman people and to set upon a pedestal, for imitation or avoidance, conspicuous examples of good and evil—the history is a triumphant success. Nor is it altogether too bold to hazard the conjecture that if Livy had shown more meticulous accuracy in the verification of his facts, he might have—comparatively at least—failed of his principal purpose. It is, unhappily, too often true of historians, that accuracy is a synonym for dullness which, for the end which Livy had in view, would have been the most fatal of all faults. "Never let us speak disrespectfully," says a modern critic, "of accuracy, of research, of stern veracity, of unbiassed judgments, or lightly confer the grave title of historian upon hasty rhetoricians who have refused to take pains; but the fact remains that, for the ordinary thinking man who has taken his degree, an ounce of mother-wit is often worth a pound of clergy, and that even the so-called history of an inaccurate genius may be not only more amusing, but more profitable reading than the blameless work of a duller nature."

In addition to enthusiasm for his subject—a prime, if not an indispensable, requisite in a historian,—Livy was the happy possessor of two other supreme endowments. The first is his gift of sympathetic imagination which enables him so to identify himself with the past that he becomes not so much the critical spectator of events as an interested participant. "I am not unaware," he writes (xliii. 13), "that, owing to the same indifference (*negligentia*) which nowadays leads the generality of men to disbelieve that the gods give warning of anything by portents, no prodigies are now reported publicly or recorded in our annals; but, on the one hand, when I am writing ancient history, my mind, I know not how, takes on an antique tinge (*antiquus fit animus*), and, on the other hand, a certain feeling of reverence (*quaedam religio*) constrains me to consider those things worthy of being recorded in my annals which the wisest men considered deserving of the attention of the State." It is this imaginative sympathy which lends vivacity and verisimilitude to his descriptions, whether his theme be a warlike scene, such as the sack of Rome by the Gauls (v. 41 *seq.*), the siege of Saguntum (xxi. 7. *seq.*), the battle of the Metaurus (xxvii. 47 *seq.*), or a scene of a domestic character, such as the death of Lucretia (i. 58) or the death of Philopoemen (xxxix. 50). To the same gift are largely to be attributed the brilliance of his pen-portraits, such as those of M. Porcius Cato (xxxix. 40), Hannibal (xxi. 4), and the vivid quality of the set speeches which, following established precedent, he puts into the mouth of his characters (*e.g.,* Cato xxxiv. 2.); Q. Fabius (xxii. 39), Hannibal (xxx. 30). And since nothing is so potent as imagination to stir the imagination, one may suppose that it was this quality which chiefly moved the man of Gades "who came from the ends of the earth to look upon Livy, and, having seen him, immediately departed" (Plin., *Ep.* ii. 3.).

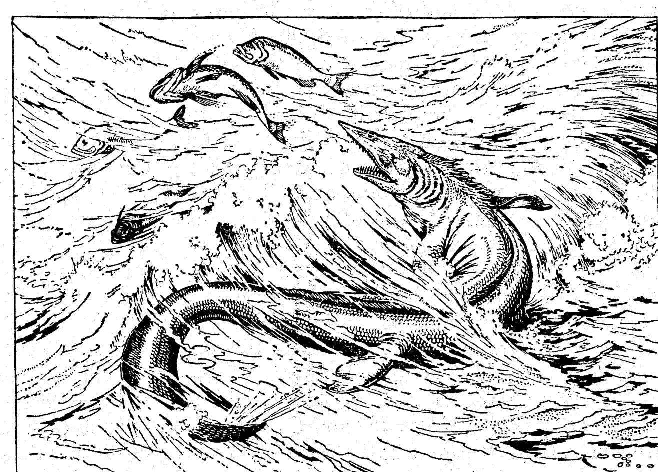
The other great endowment which Livy possessed was a gift of style such as very few historians have boasted. Asinius Pollio, indeed, is said to have found in Livy a certain provincialism (*Patavinitas*), but it is quite clear from Quintilian (i. 5. 56; viii. 1. 3), who reports the fact, that the criticism referred merely to some peculiarity in vocabulary or, at most, of idiom, which we can no longer detect. Quintilian himself in x. 1. 101, where he sums up the characteristics of Livy ("Nor let Herodotus be indignant if we claim an equal rank for T. Livius—in narrative marvellously pleasant and eminently lucid; in speeches eloquent beyond all telling—so appropriate are the sentiments both to the situation and to the speaker; the emotions, and particularly the softer emotions, no historian, to speak with the utmost reserve, has commended more"), hardly touches on the question of style, and the elusive phrase which he uses in x. 1. 32 "the milky richness of Livy" (*Livi lactea ubertas*), has produced more controversy than illumination. Macaulay, in his essay on History, supposes it to refer to his "exuberance of thought and language, always fresh, always sweet, always pure, no sooner yielded than repaired." If one remembers that the *uber* (= ἁδρόν) *genus dicendi* is the rich and ornate style, the qualities of which are "dignity and amplitude," and that the bad style which apes the ornate is the "turgid and inflated" (Aul. Gell. vi. 14), the translation of Quintilian's phrase which suggests itself is "unaffected richness" or "rich simplicity." In any case, Livy's style is a happy medium between the austerity of the republican age and the preciosity of the imperial. And by virtue of those two gifts of imagination and style her loyal and devoted son has succeeded in fashioning for the vanished republic "a winding-sheet"—to use the language of Simonides—"such as neither mould nor all-conquering Time shall destroy."

Bibliography.—*Editio princeps,* Rome (1469); Drakenborch, Leyden (1738–46); Weissenborn (1858–62), new ed. by Müller, Weidmann, Berlin (1875–94). There are numerous editions of single books. There is no worthy translation, but that of Philemon Holland (1600), has an interest of its own. (A. W. Ma.)

LIXIVIATION is equivalent to leaching and is the process of removing a soluble substance from one that is insoluble in the solvent employed. Potash was originally obtained by the lixiviation of wood ashes. In the crude industry the ashes were simply stirred with successive lots of water, allowed to settle and the solution decanted. In modern industry lixiviation is carried on in vessels which permit either batch treatment or continuous lixiviation. A typical example is percolation in the pharmaceutical industry, where liquid is permitted to pass slowly through a mass from which it dissolves out the active principles desired.

LI YUAN-HUNG (1864–1928), President of the Chinese Republic, was born in the province of Hupeh, and educated at the Pei-yang naval college at Tientsin. He served in a cruiser during the war with Japan, and later was in charge of fortifications at Nanking. He accompanied the Viceroy Chang Chih-tung to Wuchang, and twice visited Japan to study her educational system and army organisation. In 1911 he had risen to the rank of Divisional Commander and was among the first military officials to realise the force of the revolutionary movement. In consequence he was empowered to negotiate peace at Shanghai, and upon the foundation of the Republic became its first vice-president. Upon the death of Yuan Shi-kai he succeeded as president and held office until the temporary restoration of the boy Emperor in July, 1917, when he resigned, remaining for the next five years in Tientsin. In 1922 he was prevailed upon to resume the presidency, but in September of the following year he was compelled to resign in favour of Tsao Kun. Li Yuan-hung at an early date opposed "Tuchunism," *i.e.,* the system of military governorships, and advocated divesting the tuchuns of administrative duties; he worked for the reunification of the country by negotiation instead of by force, but in this he was unsuccessful and he died in retirement in Tientsin on June 5, 1928.

LIZARD. Any member of the reptilian order Sauria. These animals differ from turtles in the absence of carapace and plastron and from crocodiles and the tuatara in never having more than one bony arch across the temporal region of the skull. As a rule they may be distinguished from snakes by the presence of limbs, but there are limbless lizards that resemble snakes in so many respects that no single character or group of simple external characters serves to differentiate them; the two orders are undoubtedly closely allied and they are the two dominant groups of reptiles of the present day. Lizards, of which about 2,500 species are at present known, are a cosmopolitan group, their northern and southern limits approaching those regions where the subsoil is permanently frozen; it is in the tropics, however, that the greatest number, both of individuals and species, is to be found. None of the living forms are thoroughly aquatic though many take readily to water, and none are efficient fliers, but they have invaded almost every other type of environment. Correlated with the environmental conditions and with their habits they exhibit great variety in size, shape and structure, the structural modifications occurring chiefly in the skin, limbs, tail, tongue, teeth and digestive tract. The skin is usually beset with horny scales, which are sometimes underlain with bony plates (osteoderms), and this horny outer covering is shed at irregular intervals, not in one piece as is usual among snakes, but piecemeal; the scales themselves may be small and granular, flattened and overlapping or irregularly enlarged to form tubercles or spines. Limbs may be well-developed with five separate clawed digits on each, or entirely absent, and an uninterrupted transition from one condition to the other can be traced; in addition, the digits may have fringes of scales or be webbed in desert-dwelling species, be equipped with adhesive pads in climbing forms or be bound together to form opposable bundles. The tail varies considerably in shape and relative size and is often extremely fragile; fracture occurs in definite cleavage planes which pass through the middle of the vertebrae and the lost portion is regenerated, but on a simpler plan, without true vertebrae and usually with a more primitive type of scalation. If the fracture is incomplete a new tail is often produced from the wound and in this way double, and sometimes triple tails may be produced. The ability to shed the tail has a definite value since the detached member retains its muscular irritability for a short time and its wriggling movements may distract the pursuer's attention for the short time necessary to enable the lizard to make its escape. The tongue is usually covered with papillae which may be scale-like or arranged in parallel rows; in the majority of lizards it is flattened and only slightly notched in front but in some it is rounded, bifid and retractile into a basal sheath, like that of a snake. Teeth are generally all alike, conical and pointed but rarely they are flattened, grooved or serrated; occasionally they are differentiated into "incisors," "canines," and "molars" though the teeth so named are not homologous with the same teeth in mammals.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

RESTORATION OF A MOSASAUR, THE GREAT MARINE LIZARD TYLOSAURUS
The extinct Mosasaurs flourished in the age of reptiles

Most lizards reproduce by means of eggs which are left to hatch where they are deposited; they are elliptical, pointed at both ends and enclosed in a leathery or calcareous shell. In different families the practice of retaining the eggs within the body of the mother until the young are ready to be hatched (ovo-viviparity) has been developed but in one or two skinks the egg-shell is entirely lost and the developing embryo receives nourishment directly from the mother through a placenta-like structure (viviparity).

The species existing at the present day (a few fossil forms are known) are grouped into 21 families, based chiefly on features of the skeleton which are discussed in the general article on REPTILES.

1. *Gekkonidae.*—Geckoes, *q.v.* Small, soft-skinned lizards with the eye covered by a transparent watch glass-like covering and often with adhesive lamellae beneath the digits; cosmopolitan in distribution; all reproducing by means of hard-shelled eggs.

2. *Uroplatidae.*—A single genus in Madagascar, the best known species being *Uroplates fimbriatus;* this is a gecko-like creature with large eyes covered by a transparent membrane and with adhesive lamellae on the digits. The body is depressed and its lateral edges are produced into a fimbriated fold of skin which also borders the edges of the limbs; the tail is much flattened, leaf-like, with its outline broken by numerous indentations and the colouring so closely imitates a patch of lichen that when the animal is at rest on a tree trunk the broken outline and cryptic colouring render it very inconspicuous.

3. *Xantusiidae.*—A small Central and Western American family with well-developed limbs, no adhesive lamellae on the fingers or toes but without movable eyelids. *Xantusia* occurs in the desert regions of California and Nevada, *Lepidophyma* in Central America and *Cricosaura* in Cuba.

4. *Dibamidae.*—A single genus of burrowing forms in the Malayan region from New Guinea to S. Annam and the Nicobar Islands. Limbs are entirely absent in females but the hind ones persist in males as a pair of stylets which are probably used as claspers. The body is serpentiform, covered with small imbricating scales and the eyes are entirely covered by the skin.

5. *Feyliniidae.*—Another small family of degenerate, burrowing forms without any external rudiments of limbs and with the eyes completely covered over by the skin; *Typhlosaurus* in Madagascar and *Feylinia* in West and South Africa.

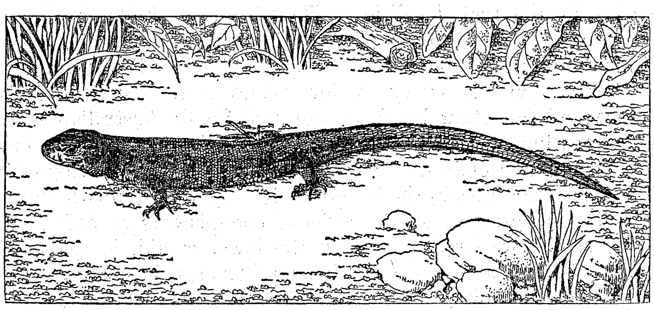
6. *Anelytropsidae.*—A single species only is known of this family, *Anelytropsis papillosus,* a burrowing creature found in the humus of the forests of Mexico; in all outward respects it resembles the members of the preceding family in which it was formerly included.

7. *Scincidae.*—This is one of the largest families of lizards and is cosmopolitan in its distribution; in America it is comparatively poorly represented but the tropical parts of the Old World possess a bewildering variety of forms. All have hard, overlapping scales beneath each of which is a bony plate embedded in the skin; limbs may be well-developed with five fingers and toes, or completely absent and every intermediate condition can be found; in some the forelimbs show greater reduction than the hinder pair but in others the converse is true and limb reduction appears to have taken place, not once, but many times within the family. The largest species is the blue tongued lizard (*Tiliqua scincoides*) of Australia, a heavy-bodied creature which may reach a length of two feet and which has relatively short pentadactyle limbs; other well-known Australian forms are the stump-tailed skink (*Trachysaurus rugosus*), with large rough scales and a short, broad tail and *Egernia stokesii* also with a short tail whose scales are enlarged to form thorn-like spines. *Lygosoma* is circumtropical in its distribution and its numerous species show every stage of limb reduction; this reduction is correlated with burrowing or cryptozoic habits and occurs in widely separated groups of species in different localities. Though most skinks are ovo-viviparous a few species in this genus lay eggs, among them the widespread blue-tailed skink (*L. cyanurum*) which occurs in large numbers on almost every Pacific Island from Tahiti to New Guinea; on the other hand, one or two South Australian lygosomas are known to be truly viviparous. Another modification, of which gradational stages can be traced, is the development of a transparent disc in the lower eyelid, apparently in correlation with life in desert or sandy regions; commencing as a few enlarged semi-transparent scales on the lower eyelid, in the more advanced forms almost the whole eyelid has lost its scaly character and become quite transparent. The same modification has also occurred in other genera and reaches its highest development in such forms as *Ablepharus* and *Ophiseps,* in which the transparent lower lid is fused with the edge of the upper and thus superficially resembles the transparent eyecovering of the geckoes and their allies. *Mabuya,* another large circumtropical genus, closely resembles *Lygosoma* and has undergone almost all the same modifications; the limbs are not, however, completely lost and no species are as yet known to be viviparous. The skink, the species which has given its name to the whole family, is a small North African and Syrian desert-dwelling form, *Scincus scincus,* with a peculiar wedge-shaped head, small eyes and very short limbs; the edges of the fingers and toes have a fringe of short, broad scales which render the hands and feet paddle-like, and by

means of these, assisted by the wedge-shaped head, the animal can dive into, and literally swim through, loose sand. *Chalcides,* a genus of southern Europe, North Africa and western Asia, shows again various stages of limb reduction and the development of a transparent disc in the lower eyelid, and one species, *C. tridactylus,* is viviparous.

8. *Gerrhosauridae.*—A small family confined to southern Africa and Madagascar. As in the skinks, the scales are large and imbricating with osteoderms beneath them but there is often a band of small scales between the armour of the belly and the back and, when the body is not distended, this region has the form of an inturned fold. *Gerrhosaurus* of South Africa and *Zonosaurus* of Madagascar have well-developed limbs but the African *Tetradactylus* shows various stages of limb reduction, the most degenerate form, *T. africanus,* having mere stumps.

9. *Lacertidae.*—The true lizards of the old world, but not found in Madagascar or the Australian region; their northern limits coincide almost with the edge of the area of permanently frozen subsoil but they are most numerous in the African region. All are terrestrial with well-developed pentadactyle limbs and long, fragile tails; the scales of the body as a rule are small, but the head is covered with large, regularly arranged shields beneath which are osteoderms. The majority of the European lizards belong to this family and to the genus *Lacerta* of which two species occur in the British Isles. The common lizard (*L. vivipara*) has a wide range through northern Europe and is fairly plentiful on heaths and commons throughout Great Britain; in Ireland its distribution is irregular. It is a small creature, rarely more than 5 or 6 in. in total length, brown or olive in colour with darker streaks and small lighter round spots on the flanks; like the majority of lizards it feeds chiefly on insects and normally it is ovo-viviparous though there are records of specimens having laid eggs. The other British lizard is the sand lizard (*L. agilis*) which, despite its scientific name, is a more heavily built, larger and less nimble species than the preceding; it is rare in England, being confined to a few isolated localities in Lancashire and the south, though common on the continent. Females are brown with rows of darker and lighter spots and patches but the ground colour of the males is a brilliant emerald green with an irregular dark stripe down the middle of the back and small, ocellar, whitish spots. The green lizard (*L. viridis*) is a much larger species, usually of a vivid green colour with or without small black dots, and is fairly common throughout France and central Europe. The commonest and most variable species in Europe is the wall lizard (*L. muralis*); it abounds throughout the centre and south and on the islands of the Mediterranean, where almost every tiny islet has it own peculiar colour variety, often endowed with the rank



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

THE SAND LIZARD OF ENGLAND AND THE CONTINENT, A SPOTTED SPECIES, NEVER ATTAINING TO A LENGTH OF MORE THAN NINE INCHES

of a separate species. On the mainland, too, the colour varieties are almost endless but all intergradations are known and it is impossible to tell whether we have to deal with a number of species which freely hybridize or with one or two which are very variable. Another very beautiful southern European species is the eyed lizard (*L. ocellata*) which reaches a length of 18 to 20 in.; the colour is brilliant green with rows of blue, black-bordered, eye-like spots along the flanks.

Acanthodactylus of southwest Europe and north Africa has the fingers and toes edged with a fringe of elongate scales, a modification which enables the animals to run over the surface of soft sands. *Cabrita* in India has a transparent disc in the lower eyelid and *Ophisops* which ranges from North Africa to India has a similar modification but has the lower eyelid fused to the upper as in the skink *Ablepharus.*

10. *Teiidae.*—An American family whose typical members superficially resemble the old world lacertids; the tongue is always narrow, deeply bifid and often retractile into a basal sheath like that of a snake; the majority are South American but a few have established themselves as far north as the southern United States. Some are arboreal, others strictly terrestrial and a number of small forms have the limbs reduced in correlation with burrowing or semi-burrowing habits. The teju or teguexin (*Tupinambis teguixin*) of the tropical parts of America is the largest species and in size and general habitus as well as habits resembles the monitors; it reaches a length of 3 to 4 ft. most of which, however, belongs to the whip-like tail. *Callopistes* of Peru and Chile is another large monitor-like creature that digs branching burrows often several yards long. *Crocodilurus* of the Amazon basin is characterized by a double, crocodile-like crest along the tail and *Dracaena,* another large species of the same region, has the lateral teeth modified to form large oval crushers in correlation with a herbivorous diet. More lacerta-like are the numerous species and varieties of *Ameiva* and *Cnemidophorus* which extend throughout tropical America, the former reaching the West Indies and the latter extending into the southern United States where they are known as the race runners. Frequenting dry and sandy localities they move with prodigious speed and are usually characterized by a number of longitudinal yellow stripes on a dark background; *Ameiva ameiva* exhibits almost as many local races and intermediates as the European wall lizard. In the smaller forms there is progressive reduction of the limbs and development of a window in the lower eyelid; *Alopoglossus* of Ecuador and Peru has a few enlarged semi-transparent scales on the lower eyelid; *Pantodactylus* of southern Brazil and northern Argentina is a rather elongate form with an undivided transparent disc and *Gymnophthalmus* and *Micrablepharus* have, like some skinks and lacertids, the transparent lower eyelid fused with the upper. *Anadia* of Central America and Ecuador is very elongate but with the limbs pentadactyle; *Scolecosaurus* is serpentiform with three or four clawed fingers and toes and burrows in humus and rotten wood, feeding principally on termites. *Bachia* of northern South America exhibits the greatest degree of degeneration in the family; the body is elongate and serpentiform, the eye minute but still equipped with functional eyelids, the scales no longer granular or overlapping but squarish and arranged in regular longitudinal and transverse rows like those of the amphisbaenids, the fingers reduced to clawless tubercles or quite absent and the hind limbs having perhaps but a single toe.

11. *Amphisbaenidae.*—Worm-like forms with soft skin divided into squarish segments arranged to form annuli, mere vestiges of scales, no visible eyes or ears, and a very short, bluntly rounded tail; all are pinkish, sometimes more or less dusted with tiny black specks and living in moist, sandy localities where they construct subterranean galleries, never appearing on the surface; they inhabit America, the Mediterranean countries and Africa. *Chirotes* of Western Mexico and lower California is the only genus with external limbs; the hind pair are absent and the forelimbs reduced to short paddles with five, four or three clawed fingers. Some of the genera; *e.g., Amphisbaena,* occur both in South America and Africa and this would appear to indicate that the species living at the present day are but the isolated remnants of a formerly widely distributed group. (*See* AMPHISBAENA.)

12. *Varanidae.*—Monitors; an old world family of large lizards with small scales, a long protrusible tongue and always with powerful clawed, pentadactyle limbs. This family contains but a single genus, *Varanus,* with about 30 species in Africa, Arabia, Southern Asia and Australia. Some of the species are semiaquatic with laterally flattened tails, others inhabit dry sandy districts but almost all are equally at home on land, in water or among trees. The largest species is the comparatively recently discovered *V. komodoensis,* the so-called "Dragon" of the East Indian islands

of Komodo, Rinja and Flores. This species differs from the majority of monitors in being heavily built with a relatively short tail, so that, although its total length probably never exceeds 10 ft., a specimen of this size is a very bulky powerful animal; they are diurnal creatures, hiding at night in dens among rocks and active during the day, and like all the other species are strictly carnivorous, eating meat of any kind whether freshly killed or not. The Nile monitor (*V. niloticus*), an agile wary animal hiding often in burrows on the banks of streams, is one of the commonest African species. *V. exanthematicus* of West Africa is more sluggish and fearless than the Nile monitor and, unlike that species, relies for defense largely on the use of its powerful whip-like tail; if, however, it does bite, the grip may be maintained for as long as half an hour. A peculiarity of this species is its habit, when frightened, of rolling over on its back, taking one hind foot in its mouth and remaining absolutely motionless until the supposed danger has passed. The kabara goya of India and the Malayan region (*V. salvator*) is a large slender species equally at home on land or in the water where it swims by means of the flattened tail, the limbs being closely pressed against the sides. Another Indian species is the bis-cobra (*V. bengalensis*) which, in common with all the other monitors, is erroneously regarded by the natives as poisonous. Australia possesses a large number of species, the largest being *V. giganteus,* a rare species from N. Queensland, and the commonest the lace monitor (*V. varius*). The whole group exhibits great uniformity both as regards structure and colouring; the latter is usually brown, gray or black with dull yellow markings taking the form of transverse bars or rows of rounded ocellar spots.

13. *Pygopodidae.*—Degenerate serpentiform lizards of Australia, Tasmania and New Guinea, with very long fragile tails, without movable eyelids or forelimbs, and with the hindlimbs reduced to a flap on either side of the vent. These lizards are not burrowers but appear to live in thick grass or similar vegetation where limbs are of little use and a snake-like method of progression is possible. Movement is accomplished by a series of side to side, wave-like movements which travel from head to tail, a system essentially similar to that of eels and sea snakes; as each undulation travels backwards it presses against the surrounding medium, water or grass, and so drives the animal forwards. *Pygopus,* distributed over almost the whole of Australia, may reach a length of 2 ft. of which two-thirds belongs to the tail.

14. *Helodermatidae.*—Lizards with small, tubercle-like scales and sometimes with recurved, grooved teeth. This family contains only two species, the Gila monster (*Heloderma*) of the deserts of Texas, Arizona and Mexico and *Lanthanotus* of Borneo. The Gila monsters are the only known poisonous lizards; they are sluggish, heavy-bodied creatures with weak limbs, short stumpy tails and a "warning" colouration of alternating rings of blackish-brown and yellow or pinkish-orange. The poison apparatus consists of a row of glands along the inside of the lower lip (contrast with snakes in which the poison glands and fangs are always in the upper jaw) whose openings lie near the bases of the grooved teeth. When the animals bite they deliberately chew the object and in this way a considerable amount of venom is worked into the wounds through the channels of the teeth. The food consists chiefly of small lizards on which the poison acts fairly rapidly, but the bite is not, as a rule, fatal to man. *Lanthanotus* known only from a few specimens from the interior of Borneo is uniformly dull brown in colour and has regular rows of enlarged tubercles; the teeth are not grooved.

15. *Anniellidae.*—Worm-like degraded forms with no external traces of limbs, eyes or ears, but with soft overlapping scales. Only two species are known from California and both are referred to the genus *Anniella.*

16. *Anguidae.*—A small family, chiefly American, but with a few species in Europe and the Indian region; all the species have large, overlapping scales with osteoderms beneath them and the tongue is retractile into a basal sheath. *Gerrhonotus* of North and Central America and *Diploglossus* of the West Indies, Central and South America are genera with well-developed, pentadactyle limbs; *Ophisaurus* has the limbs reduced to a pair of small stylets on each side of the vent and has a peculiar distribution, one species occurring in the United States, another in India and Burma, and the third in Southern Europe and Morocco. The European species (*O. apus*) is the "scheltopusik" or "glass snake," the latter name bestowed on account of the extreme fragility of its tail, which, if the creature is roughly handled, breaks into several fragments. The American species has a similar habit and the same vernacular name. *Anguis,* another genus, has no external rudiments of limbs; its sole species, *A. fragilis,* known in England as the slow-worm or blind worm, is a snake-like creature frequenting grassy banks and ditches and is remarkable as one of the few animals which preys almost exclusively on slugs.

17. *Xenosauridae.*—With but a single species, *Xenosaurus grandis* from the mountains of Mexico has four well-developed limbs, the body covered with small granules and tubercles and a distinct fold of skin along the flanks.

18. *Zonuridae.*—African and Malagasy lizards usually with rather large rough scales, regular plates on the head and often with osteoderms. *Zonurus* of East and South Africa and Madagascar has strong, hard scales which are often enlarged to form large spikes arranged in regular rows round the tail; in some the back of the head is also equipped with large spines and a few have a transparent disc in the lower eyelid; *Z. giganteus* reaches a length of about 15 in. *Chamaesaura* of South Africa is a degenerate genus whose members are small and serpentiform and live among thick vegetation; *C. aenea* has two pairs of pentadactyle limbs, *C. anguina* has four short styliform rudiments and in *C. macrolepis* the forelimbs are entirely lost.

19. *Iguanidae.*—A new world family analogous with the old world *Agamidae; see* Iguana.

20. *Agamidae.*—Old world lizards with broad, thick tongues, usually with small scales, even on the head, without osteoderms, and with the teeth usually differentiated into incisors, canines and molars; the majority are insectivorous but a few are almost exclusively vegetarian. *Agama,* common throughout the drier parts of Africa, and southwest Asia is a ground-living genus, and as a rule its members are dull brown creatures with irregularly arranged patches of enlarged scales which may form tufts of spines in the neck region; the males of many species, however, exhibit brilliant patches of red and blue. *Phrynocephalus* is an Asiatic genus of desert and steppe-dwelling forms all with very depressed bodies and coloured with neutral tints of browns, grays, dull reds and yellows. The frilled lizard (*Chlamydosaurus*) of Australia is another inhabitant of dry districts and possesses a remarkable erectile collar; this is a fold of skin supported by cartilaginous rods like the ribs of an umbrella and when not in use is folded, cape-like, about the shoulders; when the lizard is disturbed, it first seeks safety in flight, running swiftly on its hind limbs with the body inclined forwards and the long tail raised as a counterpoise; but if unable to escape, it turns at bay and tries to frighten the pursuer by erecting the frill and opening the mouth; the saffron yellow interior of the mouth contrasting with the green and brown of the frill is impressive, but actually the chief means of defense lies in the powerful, whip-like tail. Another common Australian species is the bearded or jew lizard (*Amphibolurus barbatus*), a rather large species with an array of spiny scales under the throat and fringing the head behind the ears. *Physignathus* which ranges from Australia to Tonkin is largely aquatic, frequenting the banks of streams and taking readily to the water if disturbed. Arboreal forms are represented in the Indo-Malayan region by such genera as *Calotes* with very compressed bodies and long tails; the species of this genus have a crest of large, blade-like scales along the back and possess considerable powers of colour change, which, as in the chameleons, are often called into play more by psychical disturbances and physical conditions than by relationship to the background; the bloodsucker (*C. ophiomachus*) of South India and Ceylon has acquired its name from the blood red head and neck which it acquires when excited. Most remarkable of the arboreal agamids are the flying lizards (*Draco*) of the Malayan region, which, like their mammalian analogues, the flying lemurs and squirrels, have

a fold of skin along the sides of the body that functions as a "plane" and enables them to make gliding flights from branch to branch or from tree to tree; these wings, supported by five or six elongate ribs, are often so gorgeously coloured that the animals in flight resemble gaily coloured butterflies, but the body of the animal is usually of a sober hue and, when the wings are folded at the end of a flight, the change is so abrupt and deceptive that the animal itself seems to disappear. Herbivorous forms are represented by the mastigures (*Uromastix*) of the dry regions of North Africa and southwest Asia, heavily built creatures with tails armed with whorls of large spines. Another agamid of dry regions is the Australian moloch (*Moloch horridus*) a deserticolous species which, like so many desert-dwelling animals and plants, has developed an armour of large spines; it is a small, squat animal with a short tail and is covered with relatively large spines which reach their greatest size on the head above the eyes. Bizarre ornamentation is exhibited by a number of genera in the Indo Malayan region; *Ceratophora* of Ceylon has a horn-like prominence on the tip of its snout and *Lyriocephalus,* also of Ceylon, has the sides of the head raised into bony ridges like those of some chameleons and has the tip of the snout ornamented with a large, globular boss.

21. *Chamaeleontidae.*—Arboreal lizards with the fingers and toes bound together into opposable bundles: *see* CHAMELEON.

(H. W. P.; X.)

LIZARD POINT, or THE LIZARD, the southernmost point of Great Britain, Cornwall, England, in 49° 57′ 30″ N., 5° 12′ W. There are two lighthouses on it. The cliff scenery is magnificent, and attracts many visitors; the coast is fretted into small bays, such as Housel and Kynance Cove; caves pierce the cliffs and bold isolated rocks fringe the shore. The colouring of the serpentine rock is a remarkable feature. The chasm known as the Lion's Den was formed by the falling in of a sea-cave in 1847; the Stags is a dangerous reef stretching southward from the point, and at Asparagus Island, Kynance Cove, is a natural funnel in which the waves and air cause a violent ejection of foam. Lizard Town, a mere village, is 10½ mi. distant from Helston, the nearest railway station.

LJUBLJANA, a town of Slovenia, Yugoslavia. Pop. (1931) 59,767, mostly Slovenes. It is an episcopal see, founded in 1461, with a Renaissance cathedral, lavishly frescoed, and several beautiful churches. There is a high school, a technical school, a School of Music, a university, a museum, a chamber of commerce, several banks, a theatre and societies for the promotion of science and literature. While under Austrian rule it was the centre of the Slovene national movement, the first Slovene newspaper having been published here in 1797, while the Prince Bishop was one of the chief promoters of the Yugoslav Movement. Ljubljana is an important road centre and is a busy industrial town with eight suburbs. There are cotton, woollen, porcelain, paper, furniture, boot, tobacco, soap, pottery, firehose, match and chemical factories, a bell foundry, breweries, distilleries, leather tanneries and brickfields. There is also a State forest nursery, and horses are bred and sold at the annual fair. Since the draining of the surrounding plain, the town has become a beautiful spot, and a favourite summer resort and tourist centre.

It is dominated by the mediaeval fortress on the height of the Schlossberg, from which a magnificent view is obtained.

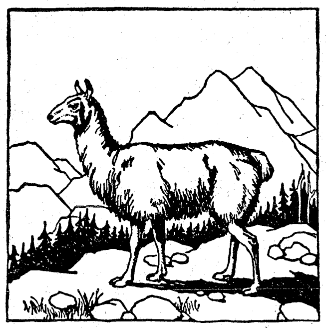
Ljubljana lies on the trade route from east to west, and legend says that it was founded by Jason. It is supposed to occupy the site of the ancient Emona or Aemona, founded by the emperor Augustus in 34 B.C. It was besieged by Alaric in 400 and desolated by the Huns in 451. In 900 it suffered much from the Magyars, who were, however, defeated there in 914. In the 12th century the town passed into the hands of the dukes of Carinthia; in 1270 it was taken by Ottokar of Bohemia; and in 1277 it came under the Habsburgs. In 1809 the town was twice taken by the French, and from 1809 to 1813 it became the seat of their general government of the Illyrian provinces. From 1816–49 Ljubljana was the capital of the kingdom of Illyria. It is historically known from the Congress of Laibach. In 1895 it suffered severely from an earthquake. In 1941 Ljubljana became the capital of the part of Slovenia annexed by Italy, and the centre of resistance to Italian occupation.

LJUNGGREN, GUSTAF HAKAN JORDAN (1823–1905), Swedish man of letters, born at Lund on March 6, 1823, was educated at Lund university, where he was professor of German (1850–1859), of aesthetics (1859–1889) and rector (1875–1885). He had been a member of the Swedish academy for twenty years at the time of his death in September 1905. His most important work, *Svenska vitterhetens häfder efter Gustav III.'s död* (5 vols., Lund, 1873–1895), is a comprehensive study of Swedish literature in the 19th century.

His other works include: *Framställning af de förniämste estetiska systemerna* (an exposition of the principal system of aesthetics; 2 vols., 1856–60); *Svenska dramat intill slutet af 17 århundradet* (a history of the Swedish drama down to the end of the 17th century, Lund, 1864); an edition (1864) of the *Epistlar* of Bellman and Fredman, and a history of the Swedish academy in the year of its centenary (1886).

His scattered writings were collected as *Smärre Skrifter* (3 vols., 1872–81).

LLAMA, the larger of the two domesticated members of the camel-tribe indigenous to South America. The llama (*Lama guanicoe glama*) is a domesticated derivative of the wild guanaco, which has been bred from time immemorial as a beast of burden, its sure-footedness and endurance rendering it almost the equal of the mule. Chiefly found in southern Peru, it attains a larger size than the guanaco and is usually white, spotted with brown or black, or sometimes altogether black. The following account was given by Augustin de Zarate in 1544:



THE LLAMA, USED IN PERU FOR CENTURIES AS A BEAST OF BURDEN

"These sheep of Peru are large enough to serve as beasts of burden. They can carry about 100 lb. or more, and the Spaniards used to ride them, and they would go four or five leagues a day. When there is a man on one of them, if the beast is tired and urged to go on, he turns his head round and discharges his saliva, which has an unpleasant odour, into the rider's face. These animals are of great use and profit to their masters, for their wool is very good and fine, particularly that of the species called pacas; and the expense of their food is trifling, as a handful of maize suffices them, and they can go four or five days without water. Their flesh is as good as that of the fat sheep of Castile."

The disagreeable habit of spitting is common to all the group.

In a wide sense the term "llama" is used to designate all the South American Camelidae. (*See* TYLOPODA.)

LLANBERIS, a village and civil parish of Caernarvonshire, Wales, 9 mi. S.E. of Caernarvon, by a branch of the L.M.S.R. Pop. (1931) 2,370. It is finely situated in a valley near the foot of Snowdon. The valley has two lakes, Llyn Paris and Llyn Padarn, formed chiefly behind moraines. From Padarn rises the Seint, called Rothell in its upper part. Dolbadarn castle is at the foot of Lake Peris. The Vaenol slate quarries are here, and hence is the easiest ascent of Snowdon, with a railway to the summit. From the road over the fine Llanberis pass (1,169 ft.) toward Capel Curig, a turn to the right leads to Beddgelert, through Nant Gwynnant. Gwynnant Lake is about 1 mi. long by ¼ mi. broad, and below it is the smaller Llyn Dinas. About 2 mi. S.E. of Lake Peris and at the foot of the Llanberis pass is the picturesque village of Old Llanberis or Nant Peris.

LLANDAFF, a ward in the county borough of Cardiff, Glamorganshire, Wales, on the G.W.R. 149 mi. from London. Pop. (1931) 27,762. It is situated on high ground sloping toward the southern bank of the Taff. The first two bishops of Llandaff, St. Dubricius and St. Teilo, flourished during the latter half of the 6th century. By the 12th century, when Urban was bishop, the see had acquired great wealth (as may be seen from the *Book of Llandaff,* a mediaeval inventory of its land), but after the reign of Henry VIII, Llandaff became impoverished, and its cathedral was left to decay. In the 18th century a new church, in debased Italian style, was planted amid the ruins. This was demolished and the old cathedral was restored, 1844–69. The oldest remaining portion was the chancel arch of Bishop Urban's building, opened in 1120. The restored cathedral was, however, very badly damaged in an air raid on Cardiff in 1941, and St. Michael's Theological college, removed to Llandaff from Aberdare in 1907, also suffered. The palace or castle built by Urban was destroyed about 1402, and only a gateway with flanking towers and some fragments of wall remain. After this, Mathern near Chepstow became the episcopal residence until about 1690, when it fell into decay, leaving the diocese without a residence until Llandaff Court was acquired during Bishop Ollivant's time (1849–82). Money bequeathed by Thomas Howell, a merchant, who died in Spain in 1540, maintains an intermediate school for girls, managed by the Drapers' company, Howell's trustees. Llandaff has been included in Cardiff since 1922.

LLANDILO or **LLANDEILO FAWR,** a town and urban district, Carmarthenshire, Wales, on the Towy. Pop. (est. 1938) 1,902. It was a natural centre for S.W. Wales during the early middle ages. The defensible site known as Dinefawr, west of Llandilo, was the capital of Rhodri Mawr (*c.* 876) and still remains in the hands of the descendants of the family. The church is dedicated to St. Teilo, a famous Celtic saint. The dedication argues the importance of this valley site in the days of Celtic Christianity. The Normans rebuilt Dinefawr castle, and under its protection a market town grew up, but remoteness both from the south coastal road and the coal valleys has limited modern development. Its market, however, has much increased in recent years owing to the rise of industrial towns within a short distance. The L.M.S.R. and G.W.R. give it railway communication and it has become an important station for motor traffic. Area, .5 sq.mi.

LLANDOVERY (*Llan-ym-ddyffri*), a municipal borough of Carmarthenshire, Wales, on the Towy, 35 mi. from its mouth. Pop. (est. 1938) 2,006. Area, 2 sq.mi. The place probably owes its Welsh name of Llan-ym-ddyffri (the church amid the waters) to the proximity of Llandingat church to the streams of the Towy, Bran and Gwydderig. Being at the head of the fertile vale of Towy, Llandovery was a strategic site in the middle ages. The 12th-century castle frequently changed hands and was partly burned by Gruffydd ap Rhys in 1115. In 1485 the borough of Llandovery, or Llanymtheverye, was incorporated by a charter from Richard III, a privilege confirmed by Henry VIII and Queen Elizabeth. Her charter is still held by the corporation. In the 17th century the vicarage of Llandingat was held by the celebrated Vicar Pritchard (1579–1644) whose book *Canwyll y Cymry* (*The Welshman's Candle,* a paraphrase of the Gospels in Welsh verse) was the most famous book produced during the Renaissance in Wales. In the early 19th century Llandovery was famous for its printing press. Many well-known books concerning Wales were published from there. A small school was founded at Llandovery by Sir Thomas Phillips in 1848. Llandovery is a small market, fair and cattle mart centre.

LLANDRINDOD WELLS, a town, urban district and health resort of Radnorshire, Wales, in a rugged district near the river Ithon, a tributary of the Wye. Pop. (est. 1938) 2,610. Area, 2.4 sq.mi. Llandrindod is on the Mid-Wales section of the L.M.S. There are evidences of early settlement, *e.g.,* the hilltop camp of Castell Collen, $1\frac{1}{2}$ mi. N. of Llandrindod, and the Norman motte and bailey of Cefn Llys. Llandrindod became known for its mineral springs as early as 1696 but it was only during the 19th century that it became a spa with tourist traffic. It is the seat of the county council.

LLANDUDNO, a seaside resort and urban district of Caernarvonshire, Wales, in a detached portion of the county east of the Conwy, on a strip of sandy soil ending in the massive limestone of Great Orme's head. Pop. (est. 1938) 15,110. Area, 7.7 sq.mi. The town is on the L.M.S.R., 48 mi. N.W. of Chester. The Great Orme has evidences of early settlement, with hut circles, a camp (probably of Romano-British age) and a 7th-century church of St. Tudno, restored in 1885. At Aeganwy, 2 mi. from Llandudno, is a mediaeval castle, Dinas Gonwy. A village in 1850, Llandudno is one of the most flourishing watering places in north Wales. Sheltered by the Great Orme on the N.W. and by the Little Orme on the E., it faces a wide bay of the Irish sea, and is backed by low sandhills. There is a promenade $1\frac{1}{4}$ mi. long.

LLANELLY, municipal borough and seaport, Carmarthenshire, Wales, on the Lliedi, a stream at the estuary of the Burry river, and on the G.W.R. main line from Paddington to Fishguard. Pop. (est. 1938) 36,890. Area, 3.2 sq.mi. The town derives its name from the dedication of the parish church to the Celtic saint Elliw or Elli. With the beginning of the industrial revolution Llanelly became important for its lead smelting works, its shipbuilding and flannel industries. In 1804 copper works were established but gradually the older industries were superseded by the manufacture of tin plates. The first tin works opened in 1847 and others followed in 1852–53 until in 1888, 92 mills were in operation. The town became a colliery centre and a collecting ground for the rich anthracite coalfield of the Gwendraeth valley. With the growth of the town, secondary industries grew up, including potteries, iron foundries and chemical works. The construction of the old L.N.W.R. (now L.M.S.) line from Llandilo via Pontardawe to Swansea seriously cut down Llanelly's coal exporting trade, as many of the coal trains from these valleys could be run direct to the larger docks at Swansea. The silting up of the Burry river seriously handicapped the Llanelly docks, but the deflection of the river to a deeper channel improved matters. Llanelly was an ancient parish and a borough by prescription under a portreeve and burgesses in the old lordship of Kidwelly. In 1918 it was merged in the east Carmarthenshire parliamentary division.

LLANES, a seaport of northern Spain, in the province of Oviedo, on the river Carrocedo and the Bay of Biscay. Pop. (1940) 2,953 (mun., 20,421). The principal buildings are a fine Gothic church and an old Augustinian monastery. It is a summer resort. Llanes is a second-class port for light-draught vessels; but the entrance is narrow, and difficult in rough weather. Trade is chiefly in agricultural produce, timber, butter and fish.

LLANFYLLIN, the only municipal borough in the whole of north Montgomeryshire, Wales, a market town in the pleasantly wooded tributary valley of river Vyrnwy (*see* MONTGOMERYSHIRE). Pop. (est. 1938) 1,319 (of which less than 1,000 dwell within the town). Area, 12.7 sq.mi. The early Llan of Saint Myllin had by the 13th century grown sufficiently to receive a municipal charter. The town was formerly the commercial and social capital of a large area of hill country, comprising much of north Montgomeryshire and several Denbighshire parishes. With the opening of a branch railway from Llanymynech (1863), the town declined, as trade drifted eastward.

LLANGOLLEN, urban district, picturesque market town and summer resort of Denbighshire, Wales, in the Dee (*Dyfrdwy*) valley, on a branch of the G.W.R., 9 mi. S.W. of Wrexham. Pop. (est. 1938) 2,893. Area, 4.9 sq.mi. Castell Dinas Brân, 1 mi. from the town, is a hilltop camp. The Dee is here crossed by a 14th-century bridge. The church of St. Collen is Norman and Early English in style. Valle Crucis abbey (*Llan Egwest*) is a Cistercian ruin at the foot of Bronfawr hill, some 2 mi. N.W. of Llangollen, founded about 1200 by Madoc ab Gruffydd Maelor, lord of Dinas Brân. Llan Egwest, dissolved in 1535, was given by James I to Edward, Lord Wotton. Llangollen manufactures flannel. Within the parish, an aqueduct carries the Ellesmere canal across the Dee.

LLANIDLOES, market town and municipal borough, Montgomeryshire, Wales, in the upper Severn valley, where the Clywedog stream joins the Severn which there turns E.N.E. towards Caersws after its torrent course from Plynlymon. Pop. (est. 1938) 2,324. Area, 1 sq.mi. The history of the settlement commences with the local saint (Idloes) and the Llan (church) which he founded. The fine old parish church dedicated to him is the successor to his original foundation. The belfry is of a type widespread in the county and the English border. In 1286 the prince of Powys (Owen of Arwystli) obtained a charter establishing the fairs and markets of Llanidloes, and from the 13th century, or perhaps earlier, the town has retained its civic privileges. A link with the past is the half-timbered market-house at the town centre. For many years Llanidloes was an important publishing centre for the Welsh language, doubtless owing to its central position. The development of industrial life in the 19th century (lead mining and flannel making) led to an increase of population from 2,500 in 1830 to 3,400 in 1870. Shawls and tweeds were still made until 1918, but the industry then declined. The best years of lead mining were from 1860 to 1880, when 16 companies were conducting operations in the Plynlymon district. At the Van mine alone 700 men were employed, and the town flourished as an industrial and intellectual centre. Llanidloes has a station on the Mid-Wales railway (G.W.R.). Its interests are now mainly agricultural. A museum of local history and industry was opened in 1933.

LLANQUIHUE, a province of southern Chile bordering on the northern shores of the Golfo de Ancud, bounded on the north by Osorno and extending from the Pacific to the Argentine frontier. Area, 7,107 sq.mi.; pop. (1940) 117,225. It is a region of forests, rivers and lakes, and the eastern part is mountainous. The rainfall is excessive, the average at Puerto Montt being 104 in. a year, and the temperature is singularly uniform, the average for the summer being 58½°, for the winter 47½° and for the year 53° F. There are several large lakes in the eastern part of the province, chief among which is Llanquihue, the largest body of fresh water in Chile, having an extreme length from north to south of about 33 mi. and an extreme breadth of nearly the same. The southern coast of the province is indented by a number of inlets and bays affording good fishing, but the mouths of the rivers flowing into the Pacific are more or less obstructed by sand-bars. Apart from the lumber industry, which is the most important, the productions of Llanquihue include wheat, barley, potatoes, cattle and sheep. The white population is composed in great part of German colonists and their descendants, who have turned large areas of forest lands in the northern districts into productive agricultural land. Puerto Montt, the capital of the province, is on a nearly land-locked bay called Seno Reloncaví and is the southern terminus of the longitudinal railway, 670 mi. south of Santiago. Pop. (1940) 21,552.

LLANTRISANT, a town and civil parish of Glamorganshire, Wales, situated where the hill lands of the county abut on to the vale. It is served by the G. W. R. though the station is 2 mi. S. of the town (Cross Inn station ½ mi.). Pop. (1931) 22,276. The castle dates from Henry III or Edward I. Of the original building nothing remains, and of a later building only slight ruins. It was the head of the lordship of Miskin, a great part of which was in the hands of native owners until Howel ap Meredith was expelled by Richard de Clare (1222–62). Since then it has been in the hands of the lord of Glamorgan. The church was dedicated to three saints (Illtyd, Gwyno and Tyfodwg), whence the name Llantrisant. Originally a Norman building, most of the present fabric belongs to the 15th century. The mediaeval records show evidences of intensive agriculture and the use of the three-field rotation system. In 1426 the lord of Glamorgan granted a charter confirming grants made by his predecessors in 1346, 1397 and 1424. The corporation was abolished in 1883, and its property (including 284 ac. of common land) is administered by a town trust under a scheme of the charity commissioners. The "freemen" of the borough, however, still hold a court leet in the town hall. The great increase in the surrounding population was due to the numerous collieries, but the area suffered the general depression of the Rhondda valley.

LLANTWIT MAJOR, a village and civil parish on the south coast of Glamorganshire, Wales, on the G.W.R., 5 mi. S. of Cowbridge. Pop. 1,541. About 1 mi. N.N.W. there were discovered in 1888 the remains of a large Roman villa which was identified as part of a settlement mentioned in Welsh writings as Caer Wrgan. On the sea coast are two camps, one known as Castle Ditches, commanding the entrance to the creek of Colhugh, once the port of Llantwit. In the time of Henry I a small colony of Flemings settled in the district. The town and church derive their name from St. Illtyd or Iltutus, a native of Brittany and a great-nephew of Germanus of Auxerre. Having come under the influence of St. Cadoc, abbot of Llancarvan, 6 mi. E.N.E. of Llantwit, Illtyd established at Llantwit in the 6th century a monastic college which became famous as a seat of learning. The place had associations with Brittany and the Celtic Saint movement in Wales. After the Norman conquest Llanilltyd Fawr passed to the abbey to Tewkesbury. The present church of St. Illtyd is the result of a sequence of churches which have sprung from a pre-Norman edifice, almost entirely rebuilt and greatly extended in the 13th century and again partially rebuilt in the 14th century. It consists of an "eastern" church—the only part now used for worship, a western one used before the dissolution, and still farther west a chantry, now in ruins. In the church and churchyard are preserved some early monuments of Celtic Christianity. They include two cross-shafts and one cross with inscriptions in debased Latin (one being to the memory of St. Illtyd) and two cylindrical pillars, most of them being decorated with interlaced work. The town is situated in a fertile district and its people depend mainly on agriculture.

LLANWRTYD WELLS (ɫahn-ōōr'tĭd), urban district, Breconshire, South Wales, on the L.M.S. Pop. (est. 1938) 662. Area, 2.6 sq.mi. It is in the midst of mountain scenery on the Irfon, a branch of the Wye, and is noted for its sulphur and chalybeate springs. The importance of these was emphasized in 1732 and since then they have formed the nucleus of the settlement. The old village with the parish church lies higher up the valley.

Lower down the Irfon valley, at the junction of the Cammarch and Irfon, is Llangammarch village, noted for its barium springs. The ancient parish of Llangammarch consists of the townships of Penbuallt and Treflis. The region was a centre of early puritanism and has had associations with John Penry and Charles Wesley.

LLEWELLYN, SIR WILLIAM (1863–1941), British painter, was born in Dec. 1863, and studied at South Kensington, and in Paris under Cormon, Lefebre and Ferrier. He became A.R.A. in 1912, R.A. in 1920, and was president of the Royal Academy from 1928 to 1938.

In 1918 he was created K.C.V.O., and in 1931 G.C.V.O. His many portraits include the State portrait of Queen Mary, and the United Services Club portrait of her.

LLEWELYN, the name of two Welsh princes.

Llewelyn I, Ap Iorwerth (d. 1240), prince of North Wales, was born after the expulsion of his father, Iorwerth, from the principality. In 1194, Llewelyn recovered the paternal inheritance. In 1201 he was the greatest prince in Wales. At first he was a friend of King John, whose illegitimate daughter, Joanna, he married (1201); but the alliance soon fell through, and in 1211 John reduced Llewelyn to submission. In the next year Llewelyn recovered all his losses in North Wales. In 1215 he took Shrewsbury. His rising had been encouraged by the pope, by France, and by the English barons. His rights were secured by special clauses in Magna Carta. But he never desisted from his wars with the Marchers of South Wales, and in the early years of Henry III he was several times attacked by English armies. In 1239 he retired into a Cistercian monastery.

See the lists of English chronicles for the reigns of John and Henry III.; also the Welsh chronicle *Brut y Tywysogion* (ed. Rolls Series); O. M. Edwards, *History of Wales* (1901); T. F. Tout in the *Political History of England,* iii. (1905).

Llewelyn II, Ap Gruffydd (d. 1282), prince of North Wales, succeeded his uncle David in 1246, but was compelled by Henry III to confine himself to Snowdon and Anglesey. In 1254 Henry granted Prince Edward the royal lands in Wales. The steady encroachment of royal officers on Llewelyn's land began immediately, and in 1256 Llewelyn declared war. The Baron's War engaged all the forces of England, and he was able to make himself lord of south and north Wales. Llewelyn also assisted the barons. By the treaty of Shrewsbury (1265) he was recognized as overlord of Wales; and in return Simon de Montfort was supplied with Welsh troops for his last campaign. Llewelyn refused to do homage to Edward I, who therefore attacked him in 1276. He was besieged in the Snowdon mountains till hunger made him surrender and conclude the humiliating treaty of Conway (1277). He was released, but in 1282 he revolted again, and was killed in a skirmish with the Mortimers, near Builth in central Wales.

See C. Bémont, *Simon de Montfort* (1884); T. F. Tout in the *Political History of England,* iii. (1905); J. E. Morris in *The Welsh Wars of Edward I.* (1901).

LLOYD, EDWARD (1845–1927), English tenor singer, was born in London on March 7, 1845, his father, Richard Lloyd, being vicar choralist at Westminster Abbey. From 1852 to 1860 he sang in the abbey choir, and was thoroughly trained in music, eventually becoming solo tenor at the Chapel Royal. His voice never broke, but developed gradually from treble to tenor. He began singing at concerts in 1867, and in 1871 appeared at the Gloucester Musical Festival. His fine, evenly-produced voice and pure style at once brought him into notice, and he gradually took the place of Sims Reeves as the leading English tenor of the day, his singing of classical music, and especially of Handel, being particularly admired. At the Handel Festivals after 1888 he was the principal tenor, and even in the vast auditorium at the Crystal Palace he triumphed over acoustic difficulties. He was one of the greatest Wagner platform-singers. In 1888, 1890 and 1892 he paid successful visits to the United States; but by degrees he appeared less frequently in public, and in 1900 he formally retired from the platform. Lloyd died at Worthing on March 31, 1927.

LLOYD, MARIE (1870–1922), English music-hall artist, was born on Feb. 12, 1870, the daughter of John and Matilda Wood. She first appeared at the Eagle music-hall in 1885 under the stage name of Bella Delmore. Six weeks later she adopted the stage name of Marie Lloyd, which she afterwards retained to the end of her career. After a series of engagements at various East End music-halls, during which she made her first real success with "The boy I love sits up in the gallery," she was engaged for twelve months at the Oxford music-hall, and in 1891–92–93 appeared in pantomime at Drury Lane theatre. From this time on until her death, she was responsible for a series of music-hall entertainments, songs, sketches, etc., which placed her in the front rank among the music-hall artistes of her generation. In particular she introduced to the British public a remarkable series of studies in cockney humour, chief among which may be mentioned "Everything in the garden's lovely," "I do like to be beside the seaside," "Oh, Mr. Porter, whatever shall I do" and "One of the Ruins that Cromwell knocked about a bit." She was married three times (1) to Percy Courtney, (2) to Alec Hurley, a singer of coster songs (d. 1913), and (3) to Bernard Dillon, a well-known jockey. She died, practically "in harness," on Oct. 7, 1922.

Marie Lloyd may be said without exaggeration to have been the incarnation of the London, or cockney genius for low comedy, which grew to its height in the 19th century. (E. I. J.)

LLOYD, WILLIAM (1627–1717), English divine, successively bishop of St. Asaph (1680), of Lichfield and Coventry (1692), and of Worcester (1699), was born at Tilehurst, Berks., and was educated at Oriel and Jesus colleges, Oxford. Lloyd was an indefatigable opponent of the Roman Catholic tendencies of James II., and was one of the seven bishops who were arrested and tried for refusing to have the Declaration of Indulgence read in their dioceses. Lloyd was a stanch supporter of the revolution. His chief publication was *An Historical Account of Church Government as it was in Great Britain and Ireland when they first received the Christian Religion* (London, 1684, reprinted Oxford, 1842). He died at Hartlebury castle on Aug. 30, 1717.

LLOYD GEORGE, DAVID (1863–1945), British statesman, was born at Manchester on Jan. 17, 1863. His father, William George, a Welshman of yeoman stock, had left Pembrokeshire and lived in Liverpool and Haverfordwest, and then was headmaster of an elementary school at Pwllheli, Carnarvonshire, where he married the daughter of David Lloyd, a neighbouring Baptist minister. Soon afterwards William George became headmaster of an elementary school in Manchester, but after the birth of his eldest son David his health failed, and he gave up his post and took a small farm near Haverfordwest. Two years later he died, leaving his widow in poor circumstances; a second child, another son, was posthumously born. Mrs. George's brother, Richard Lloyd, a shoemaker at Llanystumdwy, and pastor of the Campbellite Baptists there, now became her chief support; it was from him that young David obtained his earliest views of practical and political life, and also the means of starting, at the age of fourteen, on the career of a solicitor.

Having passed his law preliminary, he was articled to a firm in Portmadoc, and in 1884 obtained his final qualifications. In 1888 he married Margaret, daughter of Richard Owen of Criccieth. From the first he managed to combine his solicitor's work with politics, becoming secretary of the South Carnarvonshire Anti-tithe League; and his local reputation was made by a successful fight, carried to the High Court, in defence of the right of Nonconformists to burial in the parish churchyard. In the first county council elections for Carnarvonshire he played a strenuous part on the radical side, and was chosen an alderman; and in 1890, at a by-election for Carnarvon Boroughs, he was returned to parliament by a majority of 18 over a strong conservative opponent. He held his seat successfully at the contests in 1892, 1895 and 1900, his reputation as a champion of Welsh nationalism, Welsh nonconformity and extreme radicalism becoming thoroughly established both in parliament and in the country. In the House of Commons he was one of the most prominent guerrilla fighters, conspicuous for his audacity and pungency of utterance, and his capacity for obstruction while the conservatives were in office. During the South African crisis of 1899–1902 he was specially vehement in opposition to Chamberlain, and took the "pro-Boer" side so fiercely that he was mobbed in Birmingham during the 1900 election when he attempted to address a meeting at the town hall. But he was again returned for Carnarvon Boroughs; and in the ensuing parliament he came still more to the front by his resistance to the Education Act of 1902.

As the leader of the Welsh party, and one of the most dashing parliamentarians on the radical side, his appointment to office when Sir H. Campbell-Bannerman became premier at the end of 1905 was generally expected; but his elevation direct to the cabinet as president of the board of trade was somewhat of a surprise. The responsibilities of administration have, however, often converted a political free-lance into a steady-going official. His settlement of the railway dispute in 1906 was universally applauded; and the bills he introduced and passed for reorganizing the port of London, dealing with merchant shipping, and enforcing the working in England of patents granted there, and so increasing the employment of British labour, were greeted with satisfaction by the tariff-reformers, who congratulated themselves that a radical free-trader should thus throw over the policy of *laisser faire.* The president of the board of trade was the chief success of the ministry, and when Asquith became premier in 1908 and promoted Lloyd George to the chancellorship of the exchequer, the appointment was well received even in the City of London. For that year the budget was already settled, and it was introduced by Asquith himself, the ex-chancellor; but the provision of the finance for old age pensions was left to Lloyd George. The money was raised by the new taxation provided for in the budget of 1909–10.

Chancellor of the Exchequer.—For 1909–1910 a considerable deficit, of about £16,000,000, was in prospect. Lloyd George and Winston Churchill were conspicuously in alliance in advocating the use of the budget for introducing drastic reforms in regard to licensing and land, which the resistance of the House of Lords prevented the radical party from effecting by ordinary legislation. When Lloyd George, on April 29, introduced his budget, its trenchant character, however, created widespread dismay in the City and among the propertied classes. In a very lengthy speech, which had to be interrupted for half an hour while he recovered his voice, he ended by describing it as a "war budget" against poverty, which he hoped, in the result, would become "as remote to the people of this country as the wolves which once infested its forests." The excitement over the budget entirely monopolized public attention for the year, and while the measure was defended by Lloyd George in parliament with much suavity, and by Asquith, Grey and Haldane outside the House of Commons with tact and moderation, the feelings of its opponents were exasperated by a series of denunciatory public speeches at Limehouse and elsewhere from the chancellor of the exchequer, who kindled the passions of the working-classes against the landed classes and the peers. When the Finance Bill went up to the House of Lords, Lord Lansdowne gave notice that on the second reading he would move "that this House is not justified in giving its consent to this bill until it has been submitted to the judgment of the country," and on the last day of November this motion was carried by an overwhelming majority of peers. The government passed a solemn resolution of protest in the House of Commons and appealed to the country; and the general election of January 1910 took place amid unexampled excitement. The Unionists gained a hundred seats over their previous numbers, but the constitutional issue undoubtedly helped the government to victory, won indeed the votes of the labour members and Irish nationalists.

Events had now made Lloyd George and his financial policy the centre of the liberal party programme; but party tactics for the moment prevented the ministry, who remained in office, from simply sending the budget up again to the Lords and allowing them to pass it. There was no majority in the Commons for the budget as such, since the Irish nationalists only supported it as an engine for destroying the veto of the Lords and thus preparing the way for Irish Home Rule. Instead, therefore, of proceeding with the budget, the government allowed the financial year to end without one, and brought forward resolutions for curtailing the powers of the Lords, on which, if rejected by them, another appeal could be made to the people. (*See* PARLIAMENT.) Hardly, however, had the battle been arrayed when the King's death in May upset all calculations. An immediate continuance of hostilities between the two Houses was impossible. A truce was called, and a conference arranged between four leaders from each side—Lloyd George being one—to consider whether compromise on the constitutional question was not feasible. The budget for 1909–10 went quietly through, and before the August adjournment the chancellor introduced his budget for 1910–11, discussion being postponed till the autumn. It imposed no new taxation, and left matters precisely as they were. (X.)

The 1910 conference of British party leaders lasted from June till November. The conferring leaders nearly arrived at a very comprehensive and far-reaching scheme of agreement, affecting all the disputed issues—the House of Lords, Home Rule, tariffs and conscription. But the six months of secrecy ended in detaching the leaders from their followers. While the leaders had passed into a mood of conciliation, the followers were still living in an atmosphere of party warfare. On both sides the proposals put forward were regarded as surrenders.

It is a fit reflection now that, but for the World War, this conference presented to Great Britain at that moment the last solid alternative to Irish civil war. Lloyd George was ready to come to very bold settlements if they would save the country from civil strife. He and Balfour agreed in this attitude, but party tides still ran too strong.

SCHEMES OF SOCIAL REFORM

National Insurance.—In December there took place the second of the two 1910 general elections. The Liberal Government had refused to go to the polls until they obtained the promise of the King that, if they were successful, he would consent to employ his prerogative of peer-making in order to carry the Parliament bill. That promise was reluctantly given by King George V. Lloyd George was returned for Carnarvon Boroughs for the seventh time with an enhanced majority (1,208). But a second national campaign within one year proved too much for his strength, and he was struck down by serious throat trouble for some months. During this compulsory retirement he prepared the National Insurance bill of 1911. This was the first of a series of measures for improving the condition of the British working class by the method of social insurance. The idea was first applied by Bismarck, and Lloyd George had made a study of the German insurance system during a holiday visit to Central Europe in the autumn of 1908. Old age pensions had been already passed into law before that visit; and thus it was that the British system of old age pensions originally took a non-contributory form.

Lloyd George's first general application of the contributory insurance principle was to sickness and invalidity, and the proposal produced a formidable social and political crisis in the autumn of 1911. Lloyd George was proposing a new habit to the British people, and at the first shock it was profoundly unpopular. All classes rose against it. There followed a succession of political revolts; and it seemed as if the combination of forces—of the conservatives—of the press and the public—opposed to the bill would be sufficient to swamp it. By-election after by-election was lost by the Liberal Government. The party managers were in favour of postponement; but Lloyd George held on. He eased the passage of the bill by a series of conferences with all the disturbed parties, and achieved its third reading early in December 1911. This was followed by Lloyd George with an Unemployment Insurance bill which broke new ground. It was extended in subsequent years over the whole working class, and did much to carry the country through the dark years of unemployment which followed the World War.

The "Marconi Affair."—In 1912 Lloyd George approached the reform of the English land system by way of a land committee. He sketched the main lines of his policy in a series of speeches throughout 1912 and 1913. But just as he approached this venture his way was barred by two events—one personal and the other national. The first was known as the "Marconi Affair," which produced a grave crisis in Lloyd George's career. He had been persuaded by his friend Sir Rufus Isaacs (later Lord Reading) to take £1,000 worth of shares in the American branch of the great Marconi company at a moment when the British Post Office was discussing the terms of a contract with the British company. The two companies were separate, and there could in fairness be no accusation of anything beyond carelessness. But Lloyd George—at that moment chancellor of the exchequer—was too formidable a political figure to be let off lightly. The proceedings became the subject of an inquiry by a committee of the House of Commons, and he was gravely censured in the report of the chairman, Sir Albert Spicer, a prominent Liberal member of Parliament, although the majority of the committee acquitted him of serious blame. A majority of the House of Commons replied to the opposition attacks by a vote of confidence in Lloyd George. But for the moment his position was shaken.

The Curragh Revolt.—Already overshadowed by these events, the land proposals were now effectively blocked by the far greater crisis of Irish civil war. Ulster, organized by Sir Edward Carson (later Lord Carson), threatened an armed defiance of the Government. This defiance had now its first effect in the revolt of the officers at the Curragh against the orders issued for carrying out the prospective Home Rule policy. Faced with the possibility of a military revolt both at the Curragh and at Aldershot, Lloyd George took a very grave view of the situation and devoted all his energies to preserving civil peace. But at this moment, at the very heart of this Irish crisis, there came the vaster and more momentous challenge of the World War.

THE FIRST WAR YEARS

Lloyd George's Position.—Lord Grey of Fallodon in his memoir, *Twenty-Five Years, 1892–1916* (1925), gives a vivid account of the state of division that prevailed in the liberal cabinet in the fortnight before the outbreak of war. During that period the attitude of Lloyd George was deeply affected by his position as chancellor of the exchequer. On the Saturday before the declaration of war—Aug. 1, 1914—the governor of the Bank of England headed a deputation to 11, Downing Street, urging the policy of neutrality upon the Government. The same governor on Monday, Aug. 3, when the Germans invaded Belgium, telephoned to Downing street withdrawing the opposition of the City, and declaring that they were now in favour of war. This change of opinion in the City was highly dramatic, but it reflected the attitude of the chancellor of the exchequer. Lloyd George at first was not in favour of Great Britain being drawn into a contest between the two great warring groups of Europe unless some British interest or some British obligation were clearly involved. Accordingly during the previous week he did not take up the decisive attitude against Germany which he adopted in 1911, when he held the view that the claim of Germany to go to war with France over Morocco clearly involved a British guarantee (under the Entente). Once Belgium was invaded, however, and the neutrality treaty of 1839 defied, all hesitation left him; and never from that moment forward did he doubt that the military machine of the Central European Powers must be destroyed. Thus it was that Lloyd George entered upon a new phase of his career—that of war statesman.

The first great civilian duty of the war fell on Lloyd George. As chancellor of the exchequer, he had to secure the finances of the country. While Lord Kitchener at the war office was organizing the armies, Lloyd George had to see that the credit of the country did not collapse. At the very opening of the war he called together the governors of the leading banks and arranged a moratorium which prevented a panic. All the gloomy forecasts of the breakdown of finance so freely indulged in by the opponents of the war were in a moment dissolved into thin air. During the first 10 months of the war he remained chancellor of the exchequer; and thus on him fell the main financial responsibility. By common agreement of all parties he placed British finance on an impregnable foundation.

The Ministry of Munitions.—The insufficient supply of shells and guns at the front was exposing British armies to an intolerable inequality of loss. The crisis which followed on the general realisation of this fact in England broke up the liberal government, May 19, 1915, and substituted for it the first coalition administration, of Asquith and Bonar Law. The government was entirely reconstituted. Perhaps the most important change was the creation of a ministry of munitions—offered to and accepted by Lloyd George. This ministry was boldly entrusted with the whole function of providing war armaments, hitherto part and parcel of the duties of the war office. It was natural that the war office should resent this subtraction from their powers. But it was now quite clear that, in so great a war, the supply of munitions would be a function on a scale so large as to require a separate department. The new enterprise was rather a national movement than an ordinary office of state. The government workshops at Woolwich and elsewhere had been modelled to supply arms for a small peace army. Now that Kitchener was calling forth from the nation by his magnetic appeal an army of 2,000,000 there had to be a corresponding effort to supply them with weapons. In order to achieve this, Lloyd George put forth all his powers as a democratic orator and organizer. He first called on the private armament firms to make a new and gigantic combined effort; and they gave him splendid support. But this was not enough. He was compelled to create a vast network of new factories and workshops, and to rally to his effort a huge army of workers, both men and women. He set out to supply the army not only with sufficient shells, but also with the great guns and explosives rendered necessary by Germany's extensive preparations. Above all, he had to create the machine-guns, hand grenades, trench mortars, and other equipments which were now absolutely necessary for the efficient conduct of a war which was from day to day taking on new types and forms.

It was one thing to raise so gigantic an army. It was another thing to apply it to its full use and value. On all these questions Lloyd George in 1915–16 held vigorous views. He was not content to confine himself to the function of creating guns and shells. In the beginning of 1915 he began to pour out to the cabinet a succession of memoranda, in which he endeavoured to put before them the full seriousness of the military situation following upon the collapse of the Russian attack in the spring and summer of 1915.

Lloyd George and the Eastern Front.—The policy and strategy laid before the cabinet in the Lloyd George memoranda in the year 1915 were never fully adopted. In the language of the time, the cabinet was divided between "Westerners" and "Easterners"—those who looked for a decision only on the Western Front, and those who believed that victory could be quickened by transferring part of the British effort to the Near East. It ended in a compromise which resulted in the expedition to Salonika. But Lloyd George aimed at something far larger—nothing less than a considerable diversion of armies from the West to the East of Europe. He proposed and contemplated the diversion of an army of at least 1,000,000 from the Western to the Eastern Front. With the development of the German submarine warfare Lloyd George's Eastern idea became less and less practicable; and with the increase of the German armies the danger of a German break-through on the West finally held the British armies to their task. But in early 1915 these facts had not been fully disclosed.

As the year 1915 advanced, Lloyd George's general discontent with the conduct of the war grew stronger with every month. It extended to home policy as well as foreign. The war required a continual supply of vast armies. Such armies, Lloyd George now began to perceive, could not be secured by the voluntary principle alone. Having once made up his mind on that point, he became a vehement advocate of conscription in the autumn of 1915. But liberal sentiment was against it, and Asquith hesitated. At last Lloyd George swung the cabinet into conscription; and only one minister—Sir John Simon—resigned. Everything possible had now been done to supply the generals both with men and with munitions. But the question of policy remained, and there Lloyd George's discontent continued to grow. The tragic death of Kitchener by the sinking of the cruiser H.M.S. "Hampshire" on June 5, 1916, created a vacancy at the war office which could only be filled in one way. So in that month Lloyd George passed from the ministry of munitions to the war office. In this new position of power he obtained a firmer grip on the military machine at the front, and in particular he carried out a drastic reform of communications in France.

From these lesser tasks his mind was diverted to the main issue of victory or defeat by the tremendous tragedy that befell the Allied cause in the autumn of 1916. Rumania, tempted by Russia into the War on the side of the Allies at an unseasonable moment, was violently attacked by General Mackensen and dramatically crushed before the eyes of her distant and helpless Allies. In vain Lloyd George appealed to the cabinet to make some effort to save Rumania. Italy had entered the war in the previous year, and the Russian armies were still in being—could nothing be done? Nothing was done; and for the moment Rumania was blotted out. But the event had a profound effect on the mind of Lloyd George. It brought him to the parting of the ways. "Is it necessary," he used to say, "that a little nation should be laid on the altar of this war every Christmas? It was Serbia in 1915, now it is Rumania. What nation will come next?" Possessed with this dread, he decided to raise the issue in a definite form, and on Friday, Dec. 1, 1916, he laid his views before Asquith.

Collapse of the Asquith Government.—His main contention was that so large a war committee as then existed could not conduct the war to victory. He proposed a smaller and more efficient body of three or four men, solely devoted to this one object of winning the war. What was wanted was unified and unsleeping control. But he proposed—and here was the crux of the political situation—that the existing prime minister should not be chairman of the committee. That was where the dividing line came. For frankly and definitely Lloyd George had ceased to believe in Asquith as war leader. Asquith's pride was touched to the quick; and it was quite clear that he profoundly resented the proposal, although he himself had first named Lloyd George as chairman of the new war committee. On Saturday, Dec. 2, Lloyd George was under the impression that his proposal had been accepted. But friends intervened on both sides: the Northcliffe Press in favour of Lloyd George, and Asquith's friends in favour of a chief whose loyalty had always commanded a fit return of personal devotion. On Monday, Dec. 4, 1916, *The Times* published a leading article displaying exultation over Asquith's defeat, and immediately Asquith wrote to Lloyd George breaking off the agreement. In the afternoon of that day Asquith resigned office. He received authority from the king to form a new ministry. He wrote to Lloyd George asking him to join on condition that he—Asquith—as prime minister should be chairman of the new War

Committee. Lloyd George refused that condition and placed his office at Asquith's disposal.

Already, on Sunday, Dec. 3, the conservative rank and file had met. They had decided at first against following Lloyd George, whereupon Bonar Law had emphatically said that, in that case, they could not count on his leadership. He and his friends refused to join the new ministry and so Asquith's efforts to reform his coalition without Lloyd George broke down. The king then sent for Bonar Law. But as some of the Liberals and the Labour party refused to support him, he too failed to form a government, although Lloyd George offered to serve under him. The king then called a conference at Buckingham Palace and tried to form a new coalition ministry under Bonar Law, with the offer of the Woolsack to Asquith. Asquith refused. Thereupon the king sent for Lloyd George, as he was clearly the only possible premier.

LLOYD GEORGE AS PREMIER

The New War Policy.—There was nothing left for Lloyd George but to accept the call. He attempted to rally all parties behind him. He succeeded with the conservatives and the labour party, and a certain number of liberals. But the bulk of the liberal ex-ministers stood aside and began to form a group known as the Independent Liberal party. Lloyd George was now in sole command of his own war policy. The small war committee which he instantly appointed fully carried out the hopes of its founders. It sat from day to day, and very often twice a day. It practically took the place of the cabinet. Records were kept of its meetings, and Lloyd George formed a small Downing Street secretariat in order to keep in close touch with the various ministries. The result was a general quickening up of war decisions and a more decisive control of the whole machine of government.

During the year 1917 Lloyd George pressed forward his idea of unified command of the Allied armies. He was now completely convinced that the war could only be won if the Allies were to face Germany with the same concentrated authority that Germany had established over her own partners. He was faced, however, with a very steady resistance from the high military command.

On Oct. 24, 1917, there occurred an event which finally decided him to force the matter of unified control to a decision. On that day the Austro-German armies under Von Bülow broke through the lines of the Italian armies and drove them back to the line of the Tagliamento with the loss of 300,000 men and 2,000 guns. Italy stood for the moment in peril of a defeat equal to that of Serbia and Rumania in the preceding years. Lloyd George was determined that this defeat should not take place. He compelled the Western commands to send an army of infantry and artillery, English and French, under General Plumer through the Mont Cenis tunnel to northern Italy. These reinforcements arrived in the nick of time.

The End of the War.—Having achieved this task, Lloyd George, with characteristic swiftness, determined to press on with the matter of unified control. On his journey back to England he stopped in Paris on Nov. 12, 1917, to make a speech in which he plainly announced that divided control meant defeat. But that speech for the moment only aroused fresh opposition. Full unity of control was not really achieved until the terrible events of March 1918 brought home to all parties in England the nearness of the peril. During the winter the Germans brought across Europe a fresh army of 2,000,000 men released by the collapse of Russia after the Bolshevik revolution of November 1917. This gigantic new army created a fresh situation in the West, and the first blow fell on March 21, when 40 German divisions attacked and broke through the British line west of St. Quentin. On the following days the British line withdrew 15 miles, and the military struggle that followed lasted through five terrible months. Lloyd George was indomitable in this supreme crisis and met it by two principal steps. One was the assertion of full unity of control, and the other was the bringing over of the American armies.

President Wilson had not contemplated sending his armies to Europe until they were fully trained. In that case the American armies would be too late. Lloyd George therefore made a definite appeal to President Wilson to send all he could immediately, and the President instantly responded by a promise to do so on condition that Great Britain provided the transport. Thus with the combined effort of the American command and the British Navy and Marine no less than 2,000,000 American soldiers were carried across the Atlantic, in spite of the submarines, during the months of April and May 1918. But mere numbers were still useless without unity. Visiting France in the first week of May 1918, Lloyd George held a decisive combined meeting of the military and civil powers, in which, supported by Lord Milner and Clemenceau, he was at last able to persuade the British generals to accept the supreme command of the great French soldier Marshal Foch. During the final months of the War the British armies fought loyally under that command. It was by the combined attacks of British and French troops, storming the German lines east of Amiens, that the tide was turned on Aug. 8, 1918. Seven great battles were fought after this event, but from August until November the German armies were steadily driven back. Finally, on Nov. 11, came the collapse of the German resistance and the acceptance of armistice terms of defeat by the new German Government. "Germany is doomed," cried Lloyd George, speaking at the Mansion House on Nov. 9, 1918, and he proved a true prophet. The Allies had won the war.

The Peace Conference.—Victory having been achieved, it now remained to make peace. There were inevitable delays. Lloyd George deemed it necessary first to strengthen his position by an appeal to the country. The polls took place on Dec. 14, 1918, and the results were declared on Dec. 28. The effect was an overwhelming victory for Lloyd George, he being returned to power by a majority of 249 over all the independent groups. He himself was returned for the eighth time as member for Carnarvon Boroughs with a majority of 12,898. These events filled up the pause rendered inevitable by the waiting of Europe for the arrival of President Wilson, who had decided to attend the Peace Conference as American representative. The first meeting of the conference took place on Jan. 18, 1919, at the Palace of Versailles, and it proved an impressive gathering of the representatives of all the 30 countries who had taken part in the defeat of the Central Powers. The whole British empire was represented at Paris among the colleagues of Lloyd George.

It soon became obvious that so big an assembly could not really arrive at peace. There were too many conflicting views, there was no possibility of secrecy. The allied negotiators gradually narrowed to an inner council of ten, which was soon reduced to five; then from five to four; and finally from four to three—Lloyd George, Wilson and Clemenceau. What happened behind the scenes was this: roughly speaking, the position was that Lloyd George and Wilson worked for a peace of conciliation, while Clemenceau worked for a peace of victory. The French started with a claim to extend their frontier up to the left bank of the Rhine. Wilson and Lloyd George together succeeded in moderating this claim. But they were compelled to hand over the Saar Valley for 15 years as part of the compromise. Other compromises took place in regard to Silesia and the Polish corridor. No one was completely satisfied, but every country had its say. Wilson's unique contribution to the settlement was the League of Nations Covenant. When the crisis came and President Wilson threatened to leave the conference unless the Covenant was placed first in the treaty, Lloyd George supported the view of President Wilson.

The Treaty of Versailles.—Lloyd George's freedom was much hampered by Press attacks from home, and at one moment Lord Northcliffe organized a mandatory telegram from over 200 members of Parliament rebuking him for a tendency to weaken on the demands to Germany. Lloyd George returned to London to face his critics in parliament and secured a huge majority. There can be no doubt, however, that these symptoms of discontent at home diminished his authority and weakened his resistance to the military policy of France. At this point, for instance, he agreed, (as he found Wilson had already done) to the French claim to occupy the left bank of the Rhine for 15 years, which he had hitherto attempted to limit to a much shorter period. On May 6 a draft of the treaty was completed, and was presented to the German foreign minister, Count Brockdorff-Rantzau on the following day. Germany instantly pleaded for various important modifications. During the six weeks of parley with Germany that followed Lloyd George played the part of conciliator. Wilson hardened against Germany, and took the view that he was pledged to the treaty as it stood. On June 22 the National assembly authorized the signing of the treaty, and on June 28 it was signed at Versailles by the German envoys. Lloyd George returned to England and defended the treaty before parliament, which unanimously ratified it on July 3. Shortly after he was awarded the Order of Merit.

Domestic Discontents.—Having made peace abroad, Lloyd George returned to restore peace at home, which was just as much in peril. The long strain of the World War and the terrible losses of men and material had left Great Britain gravely wounded and weakened. The impulse of patriotism passed away; and the idea seemed to spread that every class was to be enabled to "get rich quickly" by the achievement of victory. The result was a series of industrial struggles, beginning with the London railway strike in February 1919, followed a few weeks later by the first of the coal crises. Lloyd George averted a strike on the coalfields by appointing a royal commission with Mr. Justice Sankey as chairman, with a promise that the commission should report on wages and hours by March 20. The Sankey commission reported on that day, recommending a two-shillings' increase in wage and an immediate seven-hours' day. The concessions were granted and a strike was averted. But when the majority of the commission went on to recommend nationalization of the mines, Lloyd George refused to adopt the suggestion. In October 1919 the railwaymen precipitated a national strike; and once more Lloyd George had to play the part of national conciliator. He brought the strike to an end by a compromise settlement fixing wages according to the scale of living.

During the next two years the Lloyd George coalition government passed a series of agreed measures on housing, suffrage and land. But as time went on it became clear that the country was financially more exhausted than had been supposed. The first after-War "boom" gradually passed into a "slump," and there arose from the whole country a cry for economy which expressed itself in an "Anti-Waste" campaign of the utmost vigour. By-election after by-election was lost to the government, and the country was swept by financial panic. Lloyd George met it by a drastic measure. He appointed a small committee, with Sir Eric Geddes as chairman, to revise the whole of Britain's national finance. As a result of its sweeping report—the "Geddes Axe"—widespread economies were effected in all departments. The agricultural subsidy was withdrawn and the agricultural wages boards were suspended. A halt was called in housing, pending a fall in prices, and progress involving expenditures on other matters (including education) was checked.

Fall of the Ministry.—Those concessions weakened the radical support of the coalition. In the autumn of 1922 a similar weakening occurred on the unionist wing of the Conservative party owing to the policy to which Lloyd George was driven in Ireland by the course of events. The Sinn Fein trouble which had broken out in the later period of the war worked up in 1920–21 to an actual rebellion. All Lloyd George's efforts to effect a compromise between Northern and Southern Ireland proved vain. In the spring and summer of 1921 the condition of Ireland grew rapidly worse. Murder and outrage were rampant. The coalition government initiated a special force, who received the nickname "Black and Tans," to deal with the violent methods of the Sinn Feiners by vigorous reprisals. This produced in England a divided feeling as to the equity of the struggle. In the autumn of 1921 peace overtures began to pass from one side to the other. Lloyd George decided to make a real effort after a settlement. A truce was declared, and the picked leaders of Sinn Fein came to Downing street, where, after several weeks of discussion, a settlement was reached, at midnight, Dec. 6, 1921. This great concession to Ireland was followed by resistance to the Turks at Chanak on the Dardanelles (September 1922), and the two events produced the downfall of the Lloyd George coalition. The Unionist party, created on the principle of resistance to Home Rule, was riven asunder by so great a concession as that of Dominion Home Rule to Southern Ireland. The threat of renewed war with Turkey was profoundly unpopular, and presented the enemies of the government with an opportunity. Bonar Law, who had retired from the government, returned to a meeting of the Conservative party at the Carlton Club on Oct. 19, 1922, at which it was decided that the conservative party should leave the coalition. Lloyd George instantly resigned, and in the election that followed (1922) Baldwin—who succeeded on the death of Bonar Law—obtained a majority. (*See* ENGLISH HISTORY.)

AN OPPOSITION LEADER

Throughout the vicissitudes of the general elections which followed in the autumns of the following years (1923 and 1924) Lloyd George remained a leader of opposition. He reunited his followers with the independent Liberals after the election of 1922, and devoted his energies to identifying the Liberal party with a policy of economic reconstruction. In 1924 he published *Coal and Power,* which outlined a comprehensive scheme for the more efficient utilization of the natural resources of the country. Nevertheless the reunited Liberal party failed to gain strength and in the general election of 1924 its numbers in the House of Commons, controlled by Asquith and Lloyd George, sank to 40 members. Lloyd George continued his active efforts to rouse the country to the need of further domestic reform to meet the home crisis: and in the early autumn of 1925 he issued a big land programme which he proceeded to advocate throughout the country.

By the elevation of Asquith to the peerage as the Earl of Oxford and Asquith (1925) Lloyd George earned the succession to the Liberal leadership in the House of Commons, and was elected to that office in the sessions of 1925 and 1926, and in subsequent sessions. In February 1926 he carried his land proposals, with few modifications, through a Liberal convention assembled at the Kingsway Hall in London. But the Liberal party still showed no signs of revival in the country. His national and parliamentary position was in strange contrast to the size of his following; and that created a strange diversity of opinion in the forecasts of his future. In May, during the course of the general strike, Lloyd George expressed opinions that were not in accord with those of Lord Oxford and the other Liberal leaders. His idea was that the government should negotiate with the strike leaders without delay, instead of declining to do so until the strike had been called off. He ridiculed the view that the general strike was aimed at the constitution. A somewhat acrimonious correspondence between him and Lord Oxford followed, and the party, both in and out of the House of Commons, was acutely divided upon the question. At last in October 1926, Lord Oxford resigned the liberal leadership. For a time worse dissensions followed. Lord Grey's very small but weighty group reprobated Lloyd George. The latter, however, was soon recognized by almost the whole of Liberalism as the indispensable man and he secured its enthusiastic allegiance. He provided a fighting fund out of the large resources placed under his personal trusteeship by his supporters when prime minister. From the spring of 1927 onwards he threw himself with ceaseless energy into the task of stirring up his party throughout the country. An important committee working in the same spirit proposed in the "Yellow Book" an elaborate industrial policy. For some time the by-elections seemed to show signs of a real "Liberal Revival," but at length the Labour party resumed its old rate of progress chiefly at Liberal expense. The position of Lloyd George in the late autumn of 1928 was unprecedented and enigmatical. In the general election of 1929 the Liberal party (*q.v.*) under his leadership returned 59 members.

After the formation of the National Government, and the general election of 1931, Lloyd George remained in opposition, but held aloof from party politics. His *War Memoirs* were published in six volumes (1933–36). On Dec. 31, 1944, he was elevated to the peerage as Earl Lloyd George of Dwyfor. He died March 26, 1945. (*See* LIBERAL PARTY.)

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LLOYD OF DOLOBRAN, GEORGE AMBROSE LLOYD, 1st Baron, cr. 1925 (1879–1941), British politician and administrator, was born on Sept. 19, 1879, at Dolobran, Montgomeryshire, and was educated at Eton and Cambridge. He travelled widely in Burma, India, Little Tibet, the Himalayas, Egypt, Morocco and Asia Minor. In 1905 he was appointed attaché to the British embassy at Constantinople. During the World War of 1914–18 he saw service in Egypt, Gallipoli, Russia, Mesopotamia and with the sherif of Mecca's forces in the Hejaz, gaining the D.S.O. in 1917. He was Conservative M.P. for West Staffordshire from 1910 until 1918, governor of Bombay from 1918 until 1923, and M.P. for Eastbourne from 1924 to 1925. From May 1925 until 1929 he was high commissioner of Egypt and the Sudan. He was created G.C.I.E. in 1918 and G.C.S.I. in 1924. In 1940 he entered the Churchill cabinet as colonial secretary. He was appointed leader of the House of Lords shortly before his death Feb. 4, 1941.

LLOYD'S. The corporation of Lloyd's, which in March 1928 entered into possession of a fine building erected for it from the designs of Sir Edwin Cooper, F.R.I.B.A., upon the site of the East India House, is an old London institution in which all forms of insurance, except long term life insurance, can be effected. Its constitution and methods are unique because the corporation as such does not subscribe policies, the risks being accepted by individuals each signing for a specified sum for which he alone is responsible. Policies can be subscribed only by underwriting members each of whom has before election to place with the corporation securities to an amount fixed by the committee, in no case less than £5,000 and in most cases much more, the amounts required being proportionate to the business underwritten. In 1938 the total amount of securities deposited was £18,960,382, and the number of underwriting members was 1,883. Elaborate precautions have been taken to render the security of Lloyd's policy unimpeachable. The liability of each individual is unlimited. Each underwriter's accounts are subjected to an annual audit, when the auditor must certify that the underwriting assets of each underwriter are sufficient to meet his underwriting liabilities calculated in accordance with stringent regulations laid down by the committee.

Lloyd's has for two centuries been a centre for the collection and diffusion of maritime information. At every seaport of any importance and at many inland towns throughout the world Lloyd's agents are established to collect information, to give assistance in casualties and to survey and assess damaged cargo. There were in 1938 approximately 1,500 such agencies and subagencies. Lloyd's has also established signal stations of which in 1938 there were 21 in Great Britain and 115 abroad.

Lloyd's Coffee House.—The present institution has had a remarkable and indeed a romantic history. A certain Edward Lloyd, the oldest record of whom is in the year 1689, kept a coffee house first in Tower street and afterwards in Lombard street which, with other similar houses, became the resort of business men, some of whom were willing to subscribe policies insuring against sea risks. It thus became convenient for those seeking insurance, instead of going from office to office in search of insurers, to go to a coffee house where, instead of only one, several insurers might be found. At this time this was the only means of placing marine risks, but in 1720 charters were granted to the London and the Royal Exchange Assurance Corporations, but no other companies nor partnerships were allowed to insure marine risks. The grant of these charters was strenuously opposed by private underwriters but it had the effect of conferring a monopoly, and, as the Corporations transacted a comparatively small amount of marine insurance, the virtual monopoly thus created became a powerful factor in stimulating the growth of insurance by individuals. As Lloyd's coffee house gradually became the centre for such insurance its power and importance developed during the early 18th century. In 1696 Lloyd printed a news sheet called *Lloyd's News* which, however, was soon dropped owing to its publication of an erroneous statement of no importance in a report of the proceedings of the House of Lords. *Lloyd's News* was not a specialized shipping paper and it was not until 1734 that *Lloyd's List* was established. This was devoted mainly to shipping news and as it has appeared continuously ever since it is the oldest London newspaper excepting the *London Gazette*. In the meantime, Lloyd had died in 1713 but the coffee house in Lombard street (on part of the site now occupied by Coutts' Bank) was carried on under the same name, a name which has survived all the vicissitudes of the institution which bears it and which has been adopted all over the world as that of a sort of tutelary genius of shipping. It is for example curious to note that an air fleet in Germany, the "German Aero Lloyd," bears the name of an English coffee house keeper of the 17th century.

In 1774 Lloyd's, under the guidance of John Julius Angerstein, perhaps the most outstanding personality who has appeared in its history, took up its abode in the Royal Exchange where it remained for more than a century and a half during a tenancy broken only by the period of rebuilding after the fire of 1838. The move to the Royal Exchange was signalized by a departure from the status of a proprietary coffee house, the "Masters" as they were called becoming tenants at will to the subscribers. The outbreak of the French war in 1793 led to a period of remarkable expansion during which Lloyd's advanced in wealth and importance although the underwriters were at times subjected to losses which strained their resources; in 1794–95 one underwriter, Robert Sheddon, paid out losses of £190,000. During 1793–1815 Lloyd's became an institution which exerted a salutary influence on the direction of naval operations in relation to sea-borne trade. It carried an insurance of over £600,000 on bullion and specie from Vera Cruz. It is found constantly influencing the Admiralty in regard to convoys. At a time when the State made no provision for war victims, Lloyd's inaugurated many subscriptions for that purpose, culminating in the "Patriotic Fund" established in 1803, which still exists and which received a great augmentation during the World War. Gifts of plate were made to Nelson and to the captains at Trafalgar. A portion of the Nelson plate and a Trafalgar cup designed by Flaxman are now in the possession of Lloyd's.

In 1811 under the influence of Joseph Marryat, M.P., father of the novelist, and himself a man of unusual ability, Lloyd's prepared the way for incorporation by the curious expedient of inducing the subscribers to sign a trust deed vesting the corporate funds in the "committee of treasury" and imposing by-laws on the subscribers. It was moreover at this period that the system of Lloyd's agencies was initiated, and the duties defined.

Incorporation, 1871.—After the destruction by fire of the Royal Exchange, and the return to improved premises, business was continued under the old system until 1870 when the control of the society over its members was found wanting. This led to the Act of Incorporation (Lloyd's Act 1871) which formed the constitution of Lloyd's as it exists to-day. The society was given power to make its own by-laws, to acquire real and personal property, and to do all acts in its corporate name. By the Act of Incorporation the society was restricted to marine insurance but by Lloyd's Act 1911 the power was given to carry on insurance of every description. Although individual initiative is still a most striking characteristic of Lloyd's the powers and activities of the corporate body have increased. The measures designed to make the security of a Lloyd's policy unquestionable have been taken almost entirely since the Act of 1871. Under the Assurance Companies Act 1909 special provisions are included with which Lloyd's underwriters comply.

There is no more striking illustration of the practical conservatism characteristic of Lloyd's, than the Lloyd's policy of marine insurance. Its germ is found in a Florentine policy of 1523. Its substance goes back to the 17th century, when a common printed form was gradually evolved. One of the first acts of Lloyd's, as a society, was to revise this form, with a view to resisting certain attempted innovations, and the policy "revised and confirmed" on Jan. 12, 1779, is still in use, with practically no alterations and only three additions, the "Waiver Clause" (1874), the clause excluding War Risks (1898) and the "Frustration Clause" (1919). In many respects the old form is inadequate to the requirements of modern commerce; but almost every phrase has been judicially interpreted and it is felt that revision would lead to much litigation.

Its inadequacy has been rectified by the use of clauses devised to meet the special requirements of each class of insurance, which are printed separately and then affixed to the policy.

See Chas. Wright and C. Ernest Fayle, *History of Lloyd's* (1928), the leading authority; and F. Martin, *History of Lloyd's and Marine Insurance* (1875). (C. W.; X.)

LLOYDS BANK LIMITED, one of the great British joint-stock banking companies familiarly known as the "big five." It was established as Taylor and Lloyd in 1765 by Sampson Lloyd II and John Taylor and in 1853 the name was changed to Lloyds and Company. The Bank was incorporated in 1865 as a joint stock company under the name of Lloyds Banking Company, Limited upon the amalgamation of Lloyds and Company with Moilliet and Sons. This was a direct outcome of the passing of the Limited Liability Act of 1862. The two firms which founded the new business had a high reputation, and a few months after its formation the private banking firm of P. and H. Williams, of Wednesbury, became amalgamated with it. During the whole of the bank's history there has been a continuous increase in its resources from natural growth, but the policy of amalgamation has had a great deal to do with its expansion. In the early days of its history, the bank absorbed, among others, the Warwick and Leamington Banking Company, the Shropshire Banking Company and the Coventry and Warwickshire Banking Company, and had spread its operations well over the counties of Warwickshire, Staffordshire and Shropshire. In 1884 the businesses of Barnetts, Hoares and Co. and Bosanquet, Salt and Co. were taken over.

After four years, during which the combination of town and country business was thoroughly organized, the bank in 1888 recommenced the process of absorption, and hardly a year passed for a long period which did not bring the announcement that Lloyds had absorbed one or more banks. Altogether about 38 private and 15 joint stock banks were taken over, amongst the most important of them since 1888 being the Birmingham Joint Stock, the Worcester City and County, the Burton Union, the Liverpool Union, Hodgkin Barnett and Co., Lambton and Co., the Devon and Cornwall, the Wilts and Dorset, and more recently the Capital and Counties. The most recent amalgamation took place in 1923, when the businesses of Cox and Co., the well-known army bankers, and H. S. King and Co. were acquired. As a consequence Lloyds Bank has several branches in India and Burmah. After the amalgamation with the two Lombard Street firms, the bank was known for a few years as Lloyds, Barnetts and Bosanquets Bank, Ltd., but in 1889 this name was cut down to the present short title Lloyds Bank Limited.

The growth of the bank has been remarkable. At the end of 1865 the offices numbered 14, its staff 50, and its shareholders 865; the authorized capital was £2,000,000, the deposits amounted to £1,166,000, and the total of the balance sheet to just over £1,346,000. In 1938, the bank had over 1,900 offices, a staff of nearly 14,000, and the shareholders numbered 72,000. The authorized capital was £74,000,000, the paid-up capital £15,810,252, and the reserve fund £9,500,000. Deposits amounted to over £398,000,000, advances to customers to about £164,000,000, and the total of the balance sheet to over £464,000,000. The head office is in London.

In 1918 Lloyds Bank effected a union of interests with the National Bank of Scotland Limited by a purchase of its stock, and with the London & River Plate Bank (now the Bank of London and South America Limited) by a purchase of shares. Each of these two banks, however, preserves its separate existence.

Lloyds Bank and the National Provincial Bank of England (*q.v.*) are joint proprietors of Lloyds and National Provincial Foreign Bank Ltd., which has 9 offices in France, 2 in Belgium, and 1 in Switzerland, as well as its head offices in London. In addition Lloyds Bank has agents and correspondents throughout the British Empire and all over the world. (*See* also BANKS, HISTORY OF.) (L. C. M.; X.)

LLOYD'S REGISTER OF SHIPPING. A society with head office in London, for the survey and classification of mercantile shipping and which may be said to have set the recognized standard for the construction of vessels throughout the world during the last century. In all essentials it is a public body having no pecuniary or commercial purpose to serve other than those of the shipping interests in general.

The society had its origin, like the parent institution of Lloyd's, in the coffee house of Edward Lloyd in the reign of Charles II. For the assistance of the underwriters and merchants frequenting the coffee house, a list became necessary of the vessels offered for insurance of hulls and cargo. These lists, at first in manuscript, attained the dignity of a printed volume in 1760, and were strictly limited in circulation. The Register for 1775–76 is interesting as being the earliest book containing the familiar class of A1, which has been replaced in modern times by the class 100A1 for steel and iron vessels.

Differences arose regarding the standards adopted for classification, and in 1800 the shipowners published a book of their own. The two registers continued in independent circulation until 1833, when a reorganization took place, and Lloyd's Register of Shipping became an independent institution, and for the first time standard rules for shipbuilding were issued. In the reconstituted society the management was vested in a committee elected by the merchants, underwriters and shipowners of London, and from time to time representatives have been added of shipping centres in the country, and of shipbuilders, engineers, and steelmakers, so that it now numbers 81 members. There are in addition local committees at Liverpool and Glasgow, together with committees abroad; viz., in the United States of America, France, Sweden, Holland, Denmark and Japan.

The register book, containing all particulars of all sea-going merchant ships afloat of 100 tons and upwards, is published annually in two editions. One consists of two volumes, and the other, known as the "posted" edition, is bound in three volumes. This posted edition is remarkable for the fact that the books are collected weekly for the purpose of being corrected up to date, in type, by hand at the society's printing house. Lists of shipowners, shipbuilders, telegraphic addresses and docks and harbours of the world are included, together with much statistical information relating to shipping. A register of yachts is also being published; the society compiles and issues to the press and shipping public periodical statistics regarding vessels under construction and of merchant vessels totally lost, broken up, etc. The society's activities comprise the supervision of the construction of a vessel and her machinery from the submission of plans and the testing of the steel material, through the various stages of building up to the trial trip, and surveys are continued throughout the vessel's life if the society's class is to be retained. The society issues very comprehensive rules relating to the construction of ships and machinery, steel testing, etc. For the purpose of carrying out its numerous and highly specialized duties, the society employs a large staff of surveyors of both ships and engines, steel testing surveyors, forging inspectors and electrical engineers; and its representatives are stationed at all the principal ports throughout the world. Some idea of the magnitude of the operations of Lloyd's Register may be gathered from the fact that of 29,763 steam and motor vessels of 100 tons and upwards—of a total tonnage of 68½ millions—afloat in the world in 1939, 13,694 vessels of more than 42 million tons were built under the survey of the surveyors to the society with a view to classification in the register book. (M. K. S.)

LLOYD TRIESTINO LINE. The Lloyd Triestino Steamship Company started its activities in 1833. The capital of the Company amounting to one million florins was gradually raised to four millions in 1851, and to 15,750,000 florins in 1855. The rapid increase of the fleet made it desirable to build a shipyard, that has since been transformed into an arsenal for the repair of ships.

The opening of the Suez canal gave scope to the Lloyd Triestino for organizing services further afield and in 1873 the company's vessels were calling regularly at Colombo, in 1879 they were going as far as Calcutta and in 1880 to the ports of the far east. At the outbreak of World War I the Lloyd Triestino had a fleet of 66 vessels. The war checked its expansion but immediately after the war a new impulse was given to the company under Italian government. In 1937 the Italian mercantile services were reorganized and the Lloyd Triestino company was allotted all the services to India and the far east; Australia; East, West and South Africa. The company had in 1939, 73 vessels with gross tonnage of 603,682. (W. Sto.; X.)

LOACH. The loaches (Cobitidae) are cyprinoid fishes, elongate in form, naked or with very small scales, with three to six pairs of barbels, with the air-bladder reduced and wholly or partly enclosed in a bony capsule, and with the pharyngeal teeth in a single series. More than 200 species are known, mostly from mountain streams in central and southern Asia; three species occur in Europe, and one in Abyssinia. They are small fishes, few species attaining a length of 12 in. In low and stagnant ponds, loaches come to the surface and swallow air, the intestine serving as an organ of respiration. The British species, both of which extend through Europe and northern Asia to Japan, are the stone loach (*Nemachilus barbatula*) and the spined loach (*Cobitis taenia*); the latter has a movable lateral ethmoid, forming a bifid spine, which at rest lies in a groove below the eye.

LOAD LINE. A line (or rather the combination of a circular disc with horizontal line passing through its centre) which is placed on the side of a vessel, to indicate the limit of loading when going into the open sea. The disc is 12 in. in diameter, and the upper edge of the line passes through the centre of the disc. The distance between this centre of disc and the edge of the uppermost continuous deck of an ordinary ship at the middle of the length is termed the "freeboard" (*q.v.*). The centre of the disc indicates the appropriate freeboard for the summer season; other lines give the loading for the Indian summer, winter and winter North Atlantic seasons. (*See* SHIPPING: REGISTRATION, CLASSIFICATION AND STATE REGULATION.)

LOAM, a fertile soil composed of sand, clay and decomposed vegetable matter, the quantity of sand being sufficient to prevent the clay massing together; also, a mixture of sand, clay and straw used for making casting-moulds and bricks and for plastering walls, etc. (*See* SOIL.)

LOANDA (LUANDA): *see* ANGOLA.

LOANGO, a region of the west coast of Africa, extending from the mouth of the Congo to the mouth of the Ogowe. Prior to Africa's partition by European powers, it formed a kingdom by that name (also known as Brama) but now is divided between French Equatorial Africa, the Portuguese district of Kabinda and the Belgian Congo. The roadstead of Loango, an insignificant coastal place, is the only testimony of former grandeur. The inhabitants belong to the Bantu groups of Mayombe and Bakongo; older reports refer to the Loango inhabitants as Bafiote.

The early history of Loango is unknown. During the 15th and 16th centuries Portuguese merchants visited the kingdom which appears to have been founded by the king of the kingdom of Congo, located south of the river Congo. Although a vassal state as late as 1570, it achieved independence toward the end of that century and began to conquer some of the adjacent kingdoms. In the 17th century Loango became divided into many small, politically ineffective states. During this time the country was an important source of slaves for the new world. It was largely under Portuguese control, except for a brief period (1641–48) when the Dutch assumed control of the country's lucrative slave trade. By the middle of the 19th century the kingdom had been reduced in influence. In 1883 the king of Loango signed a treaty placing his country under the protection of France; it became part of the middle Congo territory. (H. A. Wf.)

LOATUKO, the name by which a tribe formerly variously known as Latuko, Lotuko, Latouka, Latuka, etc., is known. The language known by this name is spoken over an area to the east of Bahr-el-Jebel, between 5° and 4° N. latitude. The language is one of a group of 26 designated the Nilo-Equatorial group containing such well-known tongues as Bari, Nandi, Masai and Turkana. These languages have an interesting feature in the use of tones whose object is the fixation of the meaning of a word in cases where its position in the sentence is not sufficient to show this. In some of the allied languages the rôle of the tones is definite and fixed, for example, in Masai, the high tone indicates that the word is the subject of the sentence, while the low tone shows that the word is the complement of the next.

The Loatuko-speaking tribes, so far as they are known, comprise the Loatuko, the Lokoiya and the Lango (*q.v.*), the last named apparently a northern section of the originally Shilluk-speaking Lango of Uganda, who have been dominated by the Loatuko and come to speak their language. All are dolichocephalic, but the Loatuko, with an average stature of about 70 in., are taller by about 2 in. than the Lokoiya and Lango.

The social organization of the Loatuko, by far the best known of the group, has been described by Somerset ("The Lotuko," *Sudan Notes and Records,* vol. i, 1918) and by C. G. and B. Z. Seligman ("Social Organization of the Lotuko," *Sudan Notes and Records,* vol. viii, 1925). Each of a number of independent territorial groups, often at enmity, has at its head a rain-maker, who is its supreme chief. There is a clan organization with descent in the male line, and at death everyone becomes the animal associated with his clan. In spite of a certain feeling of sympathy or friendliness between the clan and its animal it is not unusual for the clan animal to be killed, though it will not generally be eaten. Besides the rain-maker, there are a number of "fathers of the land," of very real power in the magico-religious sphere. There are large stockaded villages, such as Tirangore (Tirangole), as well as hill villages, such as Logurun, with its homesteads scattered irregularly about the hillside. In some hill villages there are megalithic stone circles, with stones up to 5 or 6 ft. high, built up to the present day and used as squatting places for the men, though they seem to be of relatively little social importance. The Loatuko have initiation ceremonies into manhood, in which the lighting of a new fire by friction is one of the essential features, and a system of age classes, which probably are of relatively little importance apart from military organization.

There is a cult of the dead, concerning which not very much is yet known, while the nature of Naijok, perhaps associated with the firmament, is even less understood. The remains of near relatives are dug up some months after burial and the bones exposed in pots under trees and in rock shelters, the reason as stated being the promotion of the fertility of their women. The bones of rain-makers are treated with considerably more ceremony and form the chief contents of the rain shrines at which the great rain ceremonies take place. The Loatuko occupy the mountainous country east of Gondokoro on the upper Nile. (C. G. S.; X.)

LOBACHEVSKI, NIKOLAI IVANOVICH (1793–1856), Russian mathematician, was born at Makariev, Nizhni-Novgorod, on Nov. 2 (N.S.), 1793. He studied at Kazan university, and began teaching there in 1812. In 1823 he succeeded to the ordinary professorship of mathematics, and retained the chair until about 1846. Lobachevski was one of the first thinkers to apply a critical treatment to the fundamental axioms of geometry, and he became a pioneer of the modern geometries which deal with space other than as treated by Euclid. The subject of non-Euclidean geometry is treated in his *Geometrische Untersuchungen zur Theorie der Parallellinien* (Berlin, 1840; new edition, 1887), and *Pangéométrie* in which he summarized the results of his geometrical studies, and is described in the subtitle as a précis of geometry founded on a general and rigorous theory of parallels. (*See* GEOMETRY: *Non-Euclidean.*) He died at Kazan on Feb. 24 (N.S.), 1856.

Pangéométrie was translated into German by H. Liebmann, 1902; and *Geometrische Untersuchungen* was translated into English by Halsted, 1891. *See* F. Engel, *N. I. Lobatchewsky* (Leipzig, 1899).

LOBANOV-ROSTOVSKI, ALEXIS BORISOVICH, PRINCE (1824–1896), Russian statesman, was born on Dec. 30, 1824, and educated at the lyceum of Tsarskoe Selo. At the age of 20 he entered the diplomatic service, and became minister at Constantinople in 1859. In 1863 he retired but at the close of the Russo-Turkish war in 1878 he was sent as ambassador to Constantinople. In 1879 he was transferred to London, and in 1882 to Vienna; and in March 1895 he succeeded de Giers as foreign minister. In this position he showed much of the caution of de Giers, but adopted a more energetic policy in European affairs generally. Russian influence in the Balkan peninsula suddenly revived, and Russia's Balkan policy in the next years seemed to foreshadow the creation of a Balkan confederation hostile to Turkey; in reality Lobanov was merely trying to establish a strong Russian hegemony among these nationalities, and he did not desire a new crisis in the Eastern Question until such time as Russia could act independently of foreign powers. Accordingly, when Lord Salisbury proposed energetic action to protect the Armenians, Russia assumed the rôle of protector of the sultan and vetoed the proposal. At the same time efforts were made to weaken the Triple Alliance, the principal instrument employed being the *entente* with France, which Lobanov helped to convert into a formal alliance. In the far east he became the protector of China. Japan was compelled to give up her conquests on the Chinese mainland, so as not to interfere with the future action of Russia in Manchuria.

Lobanov died on Aug. 30, 1896.

LÖBAU, a town of Germany, in the *Land* of Saxony, on the Löbau water, 12 mi. S.E. of the town of Bautzen, on the Dresden-Görlitz railway. Pop. (1939) 13,763. Löbau is first mentioned as a town in 1221; it received civic rights early in the 14th century and, in 1346, became one of the six allied towns of Lusatia. It suffered severely during the Hussite war and was deprived of its rights in 1547. There is a spa, largely frequented during the summer. The town has agricultural implement, pianoforte, sugar, machine-building and button works, and trade in grain, yarn and stockings. Other industries are spinning, weaving, dyeing, bleaching and brewing.

LOBBY, a corridor or passage, an ante-room, or entrance hall in a building. The two corridors into which the members of the house of commons and other legislative bodies pass on a division are known as "division lobbies," their votes being recorded according to which "lobby," "aye" or "no," they enter. The entrance lobby to a legislative building is open to the public, and thus is a convenient place for interviews between members and the public. The pressure thus brought to bear upon members of legislative bodies has given rise to the expressions "lobbying," "lobbyist." *See* below.

LOBBYING, in the United States, is the practice by non-members of influencing members of legislative bodies either for or against proposed legislation. Such influence may be exerted by entirely open and desirable methods, as giving testimony before congressional committees or bringing printed literature to the attention of congressmen, by debatable methods such as personal interviews with members, which are usually secret and therefore cannot be checked or controlled, or by definitely undesirable methods such as bribery. Lobbying is usually thought of as being conducted chiefly by business corporations and private interests, but it may be carried on as well by chambers of commerce, boards of trade, labour organizations, farmers' alliances, philanthropic agencies and welfare organizations. Indeed, the work of such organizations has in recent years assumed larger importance, and their influence is perhaps greater than private corporations were ever able to exercise. Examples of such powerful organizations after World War I were the various peace societies, soldier associations, prohibition and anti-prohibition interests. Lobbying in so far as it helps to place first-hand facts and reliable arguments before congressmen may be of great assistance and is indispensable. However, to the extent that biased information is given which may unduly influence congressmen who do not verify its claims, such lobbying is also decidedly pernicious. The type of lobbying most dangerous to public interests is the secret work of agents of powerful corporations which seek to institute or influence legislation in their favour regardless of the general welfare. These agents are usually attorneys, or former congressmen who are well versed in legislative procedure and keep in close touch with the passage of business in both houses, so that by a little pressure and manipulation at favourable times they exert an undue influence, even when their methods are honest.

The lobbying evil became serious by the end of the 19th and beginning of the 20th century when trusts and corporations were at the zenith of their power and largely uncontrolled. A number of investigations with startling disclosures resulted in a movement to curb undesirable features. All states have laws severely punishing the actual giving and taking of bribes. Most states have constitutional provisions prohibiting the legislature from passing acts of a local or private nature. The Massachusetts Anti-Lobbying Act of 1890, which served as a model for legislation in other states, provided that lobbyists must register with the sergeant-at-arms, giving the names and addresses of their employers and the terms of their employment. Most states have anti-lobbying laws, but they are difficult to enforce and in many states there is little attempt to enforce them. Senator R. M. LaFollette (*q.v.*) a leader in the anti-lobbying movement, argued that "every legal argument which any lobbyist has to offer, and which any legislator ought to hear, can be presented before committees, before the legislature as a body, through the press, from the public platform, and through printed briefs and arguments placed in the hands of all members and accessible to the public." On the other hand, hearing testimony before committees is possible for only a small number of the members of any legislative body, while few congressmen have time to read a tithe of the literature submitted to them or of the information contained in the public press. Little is left but uncontrolled contact with men directly interested.

Lobbying by private interests has become a potent factor in both federal and state legislation. So incriminating were the disclosures revealed in an investigation of certain company activities in 1928, and so active were other organizations, that the U.S. senate was moved to pass an anti-lobbying bill without a dissenting vote, only to see it die in the house. Renewed investigation in 1930 and again in 1935 disclosed the undercover activity of pressure groups seeking favourable legislation on tariffs, utilities, armaments and what not. Senator Black's bill providing for the registration and regulation of lobbyists passed the senate in May 1935 but stopped in the house judiciary committee.

See P. S. Reinsch, *American Legislatures and Legislative Methods* (1907); R. Luce, *Legislative Assemblies* (1921). The activities of a typical lobby, that of the power companies, can be followed in the *Congressional Record,* vol. lxix, pp. 10,229–10,254.

LOBE, any round projecting part, specifically the lower part of the external ear, one of the parts into which the liver or lung is divided, also one of several parts of the brain, divided by marked fissures. (*See* LIVER, ANATOMY OF; RESPIRATORY SYSTEM, ANATOMY OF; BRAIN: *Anatomy of the Brain.*) The diminutive "lobule" is applied to a similarly shaped portion of a gland, *e.g.,* breast, liver, when of microscopic size.

In architecture a lobe is a curve-sided projection; also a hollow form of similar shape, as, in tracery, the curved segments or foils separated by cusps. Technically, in ornament, lobe is sometimes used synonymously with leaf.

LOBELIA, the typical genus of the family Lobeliaceae, named after Matthias de Lobel, a native of Lille, botanist and physician to James I. It numbers about 250 species, natives of nearly all the temperate and warmer regions of the world, excepting central and eastern Europe as well as western Asia. They are annual or perennial herbs or under-shrubs, rarely shrubby; remarkable arborescent forms are the tree-lobelias found at high elevations on the mountains of tropical Africa. The water lobelia (*L. dortmanna*) (named by Linnaeus after Dortmann, a Dutch druggist), occurs throughout the north temperate zone. *L. urens* is only found in England, on heaths, etc., in Dorset and Cornwall. The genus is distinguished from *Campanula* by the irregular corolla and completely united anthers, and by the excessive acridity of the milky juice. The species earliest described and figured appears to be *L. cardinalis,* under the name *Trachelium americanum sive cardinalis planta,* "the rich crimson cardinal's flower"; Parkinson (*Paradisus,* 1629, p. 357) says, "it groweth neere the riuer of Canada, where the French plantation in America is seated." It is a native of the eastern United States. This and several other species are in cultivation as ornamental garden plants, *e.g.,* the dwarf blue *L. erinus,* from the Cape, which, with its numerous varieties, forms a familiar bedding plant. *L. splendens* and *L. fulgens,* growing from 1 to 2 ft. high, from Texas and Mexico, have scarlet flowers; *L. tupa,* a Chilean perennial 6 to 8 ft. high, has reddish or scarlet flowers; *L. tenuior* with blue flowers is Australian and grown in the greenhouse, while *L. amoena,* from North America, as well as *L. siphilitica* and its hybrids, have also blue flowers. The last-named was introduced in 1665. The hybrids raised by crossing *cardinalis, fulgens, splendens* and *siphilitica,* constitute a fine group of fairly hardy and showy garden plants, little known in America.

The species *Lobelia inflata,* the Indian tobacco of North America, was used in medicine, the entire herb, dried and in flower, being employed. The species derives its specific name from its characteristic inflated capsules. It is somewhat irritant to the nostrils, and is possessed of a burning, acrid taste. The chief constituent is a volatile liquid alkaloid (*cf.* nicotine) named lobeline, which occurs to the extent of about 30%. This is a very pungent body, with a tobacco-like odour. It occurs in combination with lobelic acid and forms solid crystalline salts.

LOBENSTEIN, a town of Germany, in the *Land* of Thuringia, on the Lemnitz, 25 m. N.W. from Hof by railway. Pop. (1933) 3,391. The town is grouped round a rock, upon which stands the ruins of the old castle. It contains a palace, until 1824 the residence of the princes of Reuss-Lobenstein-Elersdorf, and a hydropathic establishment. The manufactures include metal wares, brewing and cigar-making.

LOBI, a long-headed, light-complexioned and well-proportioned people living in the Gaoua district of Upper Volta. There are traces of exogamy. They live in scattered groups of one or more united households without social organization, and there are no considerable villages. Descent is matrilineal. Inheritance goes to the brother and then to the son. The Lobi practise private vendetta, and use poisoned arrows (stropanthus). They are cultivators and cattle-raisers, and animists in religion.

See H. Labouret, "La terre, la chasse et la guerre parmi les populations du Lobi," *Annuaires et Mémoires, Comité Études Hist. et Scient., Dakar* (1916–17).

LOBITO: *see* ANGOLA.

LOBO, FRANCISCO RODRIGUEZ (*c.* 1580–1622), Portuguese bucolic writer, was born of rich and noble parents at Leiria, and wrote of shepherds and shepherdesses by the rivers Liz and Lena. He studied at the university of Coimbra, took the degree of licentiate about 1600, and entered the service of Theodosio, duke of Braganza. He died some time before the end of 1622 by drowning on his way to Lisbon as he was descending the Tagus from Santarem. Though his first book, a little volume of verses (Romances) published in 1596, and his last, a rhymed welcome to King Philip III., published in 1623, are written in Spanish, he composed his eclogues and prose pastorals entirely in Portuguese, at a time when Castilian was the language preferred by polite society and by men of letters. His *Primavera,* a book that may be compared to the *Diana* of Jorge de Montemôr (Montemayor), appeared in 1601, its second part, the *Pastor Peregrino,* in 1608, and its third, the *Desenganado,* in 1614. The dullness of these pastoral romances is relieved by charming and ingenious songs named *serranilhas.* His eclogues in endecasyllables are an echo of those of Camoens, but like his other verses they are inferior to his *redondilhas,* which show the traditional fount of his inspiration. In his *Corte na Aldeia* or *Noites de Inverno* (1619), a man of letters, a young nobleman, a student and an old man of easy means, beguile the winter evenings at Cintra by a series of philosophic and literary discussions in admirable prose dialogue. Lobo also wrote an epic in twenty cantos in *ottava rima* on the Constable D. Nuno Alvares Pereira, a volume of *Eglogas* (1605), and of *Romances* (1596), the latter in Spanish. His descriptions of natural scenery are unsurpassed in the Portuguese language, and generally his writings strike a true note and show a sincerity that was rare at the time. An edition of his collected works was published in one volume in Lisbon in 1723, and another in four volumes, but less complete, appeared there in 1774.

LOBO, JERONIMO (1593–1678), Jesuit missionary, was born in Lisbon, and entered the Order of Jesus at the age of 16. In 1621 he was ordered as a missionary to India, and in 1622 he arrived at Goa. With the intention of proceeding to Abyssinia, whose negus (emperor) Segued had been converted to Roman Catholicism by Pedro Paez, he left India in 1624. He disembarked on the coast of Mombasa, and attempted to reach his destination through the Galla country, but was forced to return. In 1625 he set out again, accompanied by Mendez, the patriarch of Ethiopia, and eight missionaries. The party landed on the coast of the Red sea, and Lobo settled in Abyssinia as superintendent of the missions in Tigré. He remained there until the death of Segued. Forced by persecution to leave the kingdom, in 1634 Lobo and his companions fell into the hands of the Turks at Massawa, who sent him to India to procure a ransom for his imprisoned fellow-missionaries. He obtained the ransom, but could not induce the Portuguese viceroy to send an armament against Abyssinia. He embarked for Portugal, and after he had been shipwrecked on the coast of Natal, and captured by pirates, arrived at Lisbon. He obtained no support, and in 1640 he returned to India, and was elected rector, and afterwards provincial, of the Jesuits at Goa. He died in Lisbon on Jan. 29, 1678.

Lobo wrote an account of his travels in Portuguese, which appears never to have been printed, but is deposited in the monastery of St. Roque, Lisbon. Balthazar Telles made large use of the information therein in his *Historia geral da Ethiopia a Alta* (Coimbra, 1660), often erroneously attributed to Lobo (*see* Machado's *Bibliotheca Lusitana*). Lobo's own narrative was translated from a ms. copy into French in 1728 by the Abbé Joachim le Grand, under the title of *Voyage historique d'Abissinie.* In 1669 a translation by Sir Peter Wyche of several passages from a ms. account of Lobo's travels was published by the Royal Society (translated in M. Thévenot's *Relation des voyages* in 1673). An English abridgment of Le Grand's edition by Dr. Johnson was published in 1735 (reprinted 1789). In a *Mémoire justificatif en réhabilitation des pères Pierre Paez et Jérôme Lobo,* Dr. C. T. Beke maintains against Bruce the accuracy of Lobo's statements as to the source of the Abai branch of the Nile. *See* A. de Backer, *Bibliothèque de la Compagnie de Jésus* (ed. C. Sommervogel, iv., 1893).

LOBSTER, an edible crustacean found on the coasts of the north Atlantic and Mediterranean. The name is sometimes loosely applied to any of the larger Crustacea of the shrimplike or macrurous Decapoda, especially to such as are used for food.

The true lobsters, forming the family Homaridae, are distinguished by having the first three pairs of legs terminating in chelae or pincers. The first pair are large and massive. The common lobster (*Homarus gammarus*) is found on the European coasts from Norway to the Mediterranean. The American lobster (*H. americanus*), which should perhaps be ranked as a variety rather than as a distinct species, is found on the Atlantic coast of North America from Labrador to Cape Hatteras. A third species, found at the Cape of Good Hope, is of small size and of no economic importance.

Both in Europe and in America the lobster is the object of an important fishery. It lives in shallow water, in rocky places and is usually captured in lobster-pots, or creels, made of wickerwork or of hoops covered with netting, and having funnel-shaped openings permitting entrance but preventing escape. These traps are baited with pieces of fish, preferably stale, and are sunk on ground frequented by lobsters, the place of each being marked by a buoy. In Europe the lobsters are generally sent to market in the fresh state, but in America, especially in the northern New England States and in the maritime provinces of Canada, the canning of lobsters is an important industry. The European lobster rarely reaches 10 lb. in weight, though individuals of 15 lb. have been found, and in America there are authentic records of lobsters weighing from 30 to 34 lb. The latter specimen was just about 2 ft. long and had a crushing claw (the larger) measuring 15 in. in length and 20½ in girth.

Nearly 2,000,000 lobsters are taken yearly in European waters. Three-fourths of the United States catch comes from Maine, where 14,500,000 lb. were marketed by the fishermen in 1944 at a record average price of 28 cents per lb., the largest catch in more than 50 years. In 1942 Canada produced 28,025,000 lb. as compared with 12,299,000 lb. for the United States.

The Norway lobster (*Nephrops norvegicus*) is found, like the common lobster, from Norway to the Mediterranean. It is a smaller species, found in deeper water and is generally captured by trawling.

The names rock lobster, spiny lobster, sea-crawfish and "langouste" refer to members of the family Palinuridae, readily distinguished from the Homaridae by the fact that the first legs are not provided with chelae or pincers. The European rock lobster (*Palinurus vulgaris*) ranges from southern Britain to the Mediterranean. All species are taken for food wherever they occur, especially in Florida and the West Indies, the Pacific coast of North America, Juan Fernandez, Australia, New Zealand and South Africa. Spears, traps and hoop-nets are used in their capture. Available European Atlantic statistics lump Norway and rock lobsters together, the annual prewar catch averaging nearly 3,000,000 lb. The spiny lobster catch of Florida (*Panulirus argus*) totalled nearly 500,000 lb. in 1940 as compared with more than 1,000,000 lb. for California (*P. interruptus*), but all spiny lobster fisheries are dwarfed by South Africa (*Jasus lalandii*) which produces (1939) upward of 18,000,000 lb., of which the greater part was exported in the shape of frozen tails, or canned.

The "Murray lobster" of Melbourne and Sydney is a large species of crayfish (*Euastacus armatus*), much used for food. (*See* CRUSTACEA; MALACOSTRACA; CRAYFISH.) (W. L. ST.)

LOCAL GOVERNMENT. Some degree of local government characterizes every state in the world: the degree is all-significant. Local government means authority to determine and execute measures within an area inside and smaller than the whole state. Local means a restricted area. The variant, local self-government, is important for its emphasis upon the freedom of the locality to decide and act. Local self-government has been traditionally used of local government in Great Britain. The Weimar constitution of 1919–33, art. 127, prescribed self-government to accentuate the principle of free self-government in the great tradition of German liberal jurists like Heinrich Rudolf H. F. von Gneist and Otto von Gierke, admirers of British practice.

There is more than a technical importance in the difference between the two terms, because they are related to the distinction sometimes drawn between decentralization and deconcentration. Local government is often, but not necessarily related to the former; local self-government to the latter. That distinctions have been made is important, even if they are blurred. By deconcentration some have meant that for the mere convenience of a congested central government some functions have been devolved to administration on the spot, rather than from the centre, but through officials appointed by and responsible to the centre. Authority and discretion are vested in the centre. On the other hand, decentralization represents local government in areas where the authority to decide has been devolved to a council of locally elected persons, acting in their own discretion, with their own officials. This is almost synonymous with the British and German traditional forms of local self-government. There are in actual fact examples of simple deconcentration—for example, the placement offices of the United States employment service or the tractor stations of the soviet republics. However tightly bound to the central office's authority and regulations, a degree of discretion in its local officials is unavoidable. Often, again, the fairly pure organs of local self-government, for example, a British county borough council or a French *commune*, are obliged to execute the purposes of the central government. Primarily units of local government, they are simultaneously units of local obligation acting as ordered.

Thus, modern local government has a twofold aspect—it is a mixture of both deconcentration and decentralization, of central convenience and an acknowledgment that not all authority ought to be exerted by the centre. The mixture is revealed by the extent to which some of the powers exercised by local government units are exercised compulsorily and under fairly strict control by central authority with financial assistance, and others not. This mixture produces the high complexity of modern local government. Further, local government is a departmentalization of the state's work, based on the territorial distribution of services, as contrasted with (a) division into departments at the centre, or, (b) as in the Italian corporate state, the decentralization of functions to authorized economic groupings. In local government, territorial distribution of power is the essence.

The importance of local government in the modern state can hardly be overestimated. The sheer weight of its functions recommends it. The possibility of the abuse of powers through usurping tendencies, the need for lively political opinion throughout a democratic nation, the significance of a plurality of political experience and confidence—and even vested interests—dictate decentralization.

The history of local government in western Europe, Great Britain, the United States and Russia, exhibits the growing awareness of its significance. This awareness is a product and not the origin of a development of parochial and town life beginning centuries before the modern state emerged between the 15th and 17th centuries. Any central control over these and other areas was, until the 18th century, rather exiguous, though sometimes, as under Jean Baptiste Colbert in France, or Frederick the Great in Prussia, liable to spurts of centralizing zeal. Many Germanic states were nothing but cities: the Hanse towns are examples. In England and New England, especially in the latter, the local units, parishes, towns, cities emerged from their origins as spontaneous self-governing units; so, also, in Russia, although in this instance the state colonized some cities *ab initio*. The various local units were gradually integrated by the state which exacted obligations from them—peace, crime and police duties, taxes, military supplies, assistance to the poor, highways. By ordinances or statutes or judicial decisions they were subordinated, so that the idea of an inherent right to self-government was extinguished. By the 19th century all local units were legal creatures of the state, subsidiary in authority and acting independently by sufferance alone.

Indeed, the battle for the continuance of local self-government is desperate though not hopeless. The local freedoms of the 19th century have been challenged by (1) speed of communications which has reduced administrative space-time; (2) demands for economy; (3) growth of nation-wide parties with social service programs uniform for all parts of the nation; (4) the growth of a consciousness favouring a national minimum of services; (5) realization that best technical administration of modern utilities requires areas different from the traditional, knitted together by a central plan. These are powerful forces working against claims to purely self-regarding government. But on the other hand, local freedom is supported by need for (1) intimate local knowledge and variation; (2) intensity of local interest and enlistment of loyalty and co-operation; (3) small areas for easy impact of the citizen-consumers upon officials-producers; (4) an accessible area of political education. Planning ideas force a reconsideration of all aspects of local government. In all plans, decentralization, whether to a regional corporation like the Tennessee Valley authority, or to reformed traditional units, is exigent, necessary and fruitful.

COMPARATIVE STUDY OF CHARACTERISTICS

The chief characteristics of local government, which may be studied by comparison of Great Britain, France, Germany, the U.S.A. and the U.S.S.R. are (1) constitutional status; (2) areas and authorities; (3) powers; (4) finance; (5) organization; (6) central controls.

Constitutional Status.—In Great Britain, the local authorities are subordinate corporations formed by acts of parliament or charters. Their powers and immunities derive from statute and judicial interpretation. They have many obligatory duties; a vast field of permissive powers. Each authority is independent within the sphere of power authorized by the central government: there is no hierarchy of layers of authorities. Slight tutelary control over the health and roads services of the urban and rural districts has been given to the counties. Local councillors are freely elected and constitute the local executive as well as the legislature. There is no appointment or ratification of local executives by the central government, though certain important local officials require qualifications stipulated thereby. The local authorities are compendious, *i.e.*, combine many functions, and are not, like the school committees so frequent in the U.S.; single function or *ad hoc* authorities. The local finances—rates—are locally raised and appropriated with practically no interference by the centre. Though they have considerable freedom to use their permissive powers, and even the obligatory, they operate within judicial controls lest they act *ultra vires* or are negligent, and under continuous central administrative controls. A condition of local central partnership characterizes the system. Though the central controls have increased markedly in the last 30 years, local powers have also greatly increased. The local units are very virile. They exercise an important influence over the central administration through their M.P.'s, and through their increasingly large representation on advisory councils and committees officially attached to the several departments. The nation-wide associations of the different classes of local authorities exercise an advisory and representative influence on the centre and keep up the standard of local administration.

French local government differs from the English in being both hierarchical and centralized. Though the municipal code of 1884 gives the municipalities a wide general scope of activity, these *communes* and *départements* are limited by strong controls over their budgets, modified for the bigger cities by political influence. The inspectorial system, strong in the English system, because the relationship of government to the localities is direct, is of less consequence in the French, where hierarchical control seeps down through the *préfet* of the *département.* Obligatory functions which must be carried out by the municipalities can be inscribed by both the *maire* and the *préfet.* The *préfet* may be removed by the central authority at its discretion—he is appointed by it; the mayor, until 1884 appointed by the central government, since elected by the local council, is removable by the central government for default in acting as the law requires, and is suspendible by order of the *préfet* for similar cause for from one to three months. Judicial control over the activities of local government is very heavy, culminating in the supreme administrative court, the *conseil d'état.* The rather severe centralization of French local government, a legacy of the *ancien régime* hardly affected by the Revolution, is considerably criticized, but decentralization is very unlikely. The rural nature of France, despite many cities, retards change.

German local government (omitting the nazi interlude) attempted to unite the age-long pride in free and enterprising civic life with the full popular enfranchisement of 1919. Its hierarchical system reaching back to the 18th century, with strong central surveillance, was a little eased during the Weimar period. The position of the local executives, *burgermeister* or *magistrat,* ratifiable by the central government, was much troubled by the universal suffrage of 1919 which replaced the oligarchic three class system. A very wide scope of authority was accorded to the *gemeinde,* whether rural or urban, by the basic laws, such as the Prussian *städteordnung* of 1808, the *kreisordnung* of 1872 and the *provinzialordnung* of 1873. But this came to be limited by the financial stringency induced by World War I, so that local revenues were subordinated almost completely to state and reich. But local government flourished: German cities showed great enterprise and developed many utilities. The nazi system was fortunately destroyed, for this had in general kept the framework of areas and authorities, but abolished all elections, and substituted appointed councillors and executives. The future in 1946 was promising for the revival of local government.

In the U.S. the main features of the constitutional status of local authorities are the variety of arrangements in the various states, the large degree of freedom of the local units deriving from early English township forms and reinforced by migration into new lands. Nevertheless, that freedom is subordinate and defined by state statutes and charters giving corporate status. The special charter, referring to individual cities; the general charter, which is a state-wide municipal code; the charter which confers status by classifying the local units for privileges—these are varieties of the attempt to give the local units a status which relieves them of the need for repeated application to the legislature, while subjecting them to a firm pattern of permissions and limits. Amendments, however, still require suppliancy to the legislature; and growth requires powers in addition to the general grant. In more than 20 states home rule charters, granted by the legislature, allow the city to draft its own charter by a local convention, sometimes requiring legislative ratification, sometimes not. Another system allows the local units to choose from among several forms of charter provided in a state general law. There is much independence and vigour, no hierarchy, little central administrative control, much judicial control to hold the units within their charter and statutory position. There are growing direct relations between federal government and local units.

The local government system of tsarist Russia was one of strict centralized hierarchy, executed through the governors of the 78 *guberniya,* with police, military and taxation powers and the scantiest recognition of rights of local government. Provincial and village governments were dominated by the landlords, who had an *ex officio* right to chairmanship of local administration, especially of the *zemstvo,* set up in 1864, to govern the provinces under strict control of the imperial governors. The *zemstvo,* nevertheless, made progress in educational, health, welfare and agricultural development. The soviet constitution of 1936 and the decree on the city soviets (1933) together introduce extraordinarily wide specified powers for the local units, and simultaneously rigorous submission to hierarchical control of the next higher authorities upwards to the central government of the various republics, and in some cases to the union itself. Authority and direction are heavily centralized and animated in the last resort by the all-union supervisory commission. All units from lowest to highest are linked by the ubiquitous activities of the Communist party.

Generally speaking, then, local government as local self-government, is discernible more fully in the British and American environment than elsewhere, and more in the German than in the French. Yet *post hoc* centralization and control are not inconsistent with virile first-line activity by the local units in the matters entrusted to them.

Areas and Authorities.—Local authorities in England and Wales are (from smaller units upwards): 13,000 parishes (of minimal importance even in rural areas); 1047 rural districts and urban districts (mainly health and minor roads authorities and some water supply and other utilities where large); 309 non-county boroughs (similar to the districts but some have police forces and elementary school duties—both about to disappear); 83 county boroughs, being great towns of 50,000 population and above, with the greatest scope of local services including the public utilities; and 62 county councils, being mixed urban and rural areas. The county boroughs are independent of the counties; all other units have some of the services in their area rendered by the county council in whose area they fall. In addition to these authorities, there are 2,000 joint authorities, councils, committees or boards, established to administer burials, water and electricity, and sewerage and hospitals. There is a tendency to rely more upon such unions where the services are of a large-scale nature compared with the traditional units having responsibility. Local authorities are mutually independent: unanimity is required for joint schemes of large-scale administration, for which ample permissive provision is contained in the statutes. Even some counties are far too small for large-scale administration, while extremes of size in area and population may be encountered in each of the above-named classes of authorities. Under the Local Government acts of 1888, 1926, 1929 and 1933, areas could be reformed after a procedure of local inquiry conducted by the ministry of health (the central supervising department over local government), followed in the case of the creation and extension of county boroughs by legislation, and in the other cases by central administrative sanction. For the districts a maximum decennial review of areas is called for. In 1926 the creation of county boroughs was set back by the stipulation that the minimum population must be 75,000 in place of 50,000, as the counties suffered from the subtraction of area and taxable capacity. Civil resistance all through the system prevents more serious change. The movement for regions is strong, but cannot prevail against local inertia and the claim that small areas are needed to activate democratic vitality.

The French local government units are, in a downward order: 90 *départements;* 279 *arrondissements;* 3027 *cantons;* and more than 38,000 *communes.* The first and the last are genuine units of local governments; the middle two are only lower judicial, electoral, tax and *gendarmerie* districts. The *départements* vary in size from 185 to more than 4,000 sq.mi., with average population of 500,000. This framework, which serves the centralizing authority of the state, was established in 1790 to unify France by abolishing the traditional 35 *généralités* which partly coincided with and partly cut across the ancient provinces, for symmetry and centralization. The *communes* are the basic roots of local government. The name comprises the smallest village up to the capital. The span is from several acres to 400 sq.mi.; and less than 100 people to Paris with 3,000,000. There are only 7,000 having more than 1,000 inhabitants. Naturally the range of powers and practical hierarchical control vary accordingly, within the uniform pattern of the law. Until 1938, area alterations could be made only by parliamentary statute, preceded by local vote, inquiry and acceptance by the *département* and *conseil d'état.* Practically no changes occurred. Not even after an easier form was introduced in June 1938 did changes occur. As in England there is a movement for regions; and its fate is similar.

The German areas of local government are (proceeding upward): more than 50,000 *gemeinden* (like the *communes*) divisible into *stadt* and *land,* urban and rural (one-third of the population live in the latter). Then, upwards, the *kreis* (equivalent roughly to county in England and the U.S.A.); above this again, the *regierungsbezirk* (government district), a unit of central government control and police authority; and, above, the *provinz.* There are also 15,000 joint authorities for special purposes—roads, schools, health, fire, agriculture, water, gas, electricity. The *gemeinden* exhibit an enormous diversity of area and population. Increasing urban concentration after World War I was highly marked. The *kreis* is notable for the distinction between *stadtkreis* and *landkreis,* the former where the population is above 25,000 is a city-county (like the English county borough): the next higher level of hierarchy is the *bezirk* and *provinz.* There is a rather special kind of holding company local authority—the *amt,* to administer the common affairs of some contiguous villages while they still remain separate *gemeinden. Gemeinden* can be raised to be cities by the ministry of the interior (the local government supervisory authority) after neighbouring areas have stated their case. More important area changes require parliamentary statute. Free agreement among the local authorities is practically unobtainable. The impetus toward city-countyship is enormous, for the same reasons as toward county boroughship in England. In 1929, the rural authorities were allowed to assume any functions desirable in the public interest. Many joint authorities were formed by agreement and administrative approval, the Frankfort-Höchst experiment being of special interest. The nazi municipal order of 1935 gave wide powers of areal change to the national cabinet. In 1937 followed the creation of the greater Hamburg area. Here also the struggle of the traditional with the rational area is obvious.

The area structure of local government in the U.S. has a different foundation according to the historic settlement of the part of the nation. In the south and south central region the chief unit is the county; in the north central, the combined county and township; in New England, the town. In some states, the people of each county may vote to divide the county into townships. There are, altogether, 3,050 counties. There are nearly 19,000 towns and townships; 16,220 municipalities or cities; nearly 109,000 school districts, and about 8,300 other special function districts—in all, 155,000 local government units. Change is in store around the traditional area of the county, for in their midst townships and cities grew apace after 1860, while the nation suffered great rural depopulation. As in the other nations, wealth and people have left for the towns. Only one in five of the counties contain urban communities with more than 10,000 population. The area varies from 22 to 20,000 sq.mi.—most generally, 400 to 600 sq.mi. The smallest has 42 inhabitants, the largest (Cook county, Illinois, with Chicago) more than 4,000,000. The median is 17,000. Some of the functions are those of modern central rather than local authorities: taxation, judicial registrations and records, first instance judicial action through the county court and justices of the peace, elections. Others like education, highways and bridges, social welfare, poor law, hospitals, pensions, health, defectives and delinquents are serious burdens on nonpopulous areas. Either the services remain inefficient or the state takes them over in whole or in part. The consolidation of counties is difficult: reduction to one-third the number has been recommended. Here and there unions of counties have been formed for hospital and poorhouse purposes.

Inset in the county is the city, with its own powers, and in direct relationship with the state government. Sometimes both conduct for two concentric areas many similar services with substantial duplication of staff and organization. The cities are the areas of the heaviest integration of local government services. As elsewhere, there is antagonism between city and county, and the federal authority, after the '30s, became an important direct supporter of city unemployment, public works, municipal utility and housing schemes. Towns, mostly, but not exclusively, semirural communities, some fairly populous, in New England, New York, Pennsylvania and the north central states, play the part of the counties elsewhere and have city functions and sometimes city status also. As a part of a township or a county, there are habited centres, called villages or boroughs, a minimum of population usually being demanded by the state legislature before such a subdivision may become self-governing. Area problems in the U.S. revolve round the adjustment of county and city, and the problem of metropolitan areas. Here also, political vested interests and simple inertia obstruct modernization. The legislatures are slow in enacting reforms.

In Russia the tsarist 78 *guberniyas,* 21 *oblast* (or regions), the many *uyezd* (districts) within the *guberniya,* and the *volost* (counties) within these again, have been replaced by a soviet pattern traced in the constitution of May 1925, the municipal decree of 1925 and the constitution of 1936. Upward from the 75,000 village or city soviets of the most varied size, are the *raion* (or circuit), the *oblast* or *krai* (region). At the top of the pyramid is the republic soviet. Their upward relationship may be expressed in Lenin's phrase, "centralized supervision with decentralized activity." Within the cities of 100,000 there are ward soviets, of which Moscow has 24; they are subordinate as to budget and action to the city soviet. Cities of more than 50,000 and specially important places of lesser population receive a status independent of the *raion* hierarchy and are directly subordinate to the republics. Attached to these cities are surrounding rural settlements which fully participate in the city government, but possess village soviets also. The republics decree these connections. An experimental process led, by 1930, to the areal pattern which prevailed in 1946, and produced a reduction of the provincial units of government from 13,000 before the revolution to less than 2,500. With an urbanization which had increased nearly ten-fold to 30,000,000 by 1946, the problem of soviet areas is not one of solution by flux.

The problem of modernizing areas has nowhere been tackled radically. A process of slow boundary adjustment is accompanied by the creation of joint authorities for special purposes. The maintenance of small areas, locally elected, and therefore locally minded, is a not negligible ingredient of a robust and animated democracy which may give a long run efficiency superior to that offered by unwieldy large-scale organization.

Powers.—Broadly speaking, the big authorities in the level of the hierarchy are concerned with financial and administrative supervision of the primary units, the provision of environmental and institutional and police services, and supplements and assistance to the smaller authorities.

Authority to act is set down as already suggested: it is always a combination of specific grant and general grant by the central authority sometimes with limited additions made by the administrative supervisory authorities and the decisions of the courts on common law principles. In Great Britain, the specific grant of power is supreme. This is effectuated by grants of power to the various classes of local authorities by general statutes, and in special addition to individual local authorities by private or local acts. The powers granted by general statute are either permissive (*e.g.,* libraries) or compulsory (*e.g.,* education or hospitals for infectious disease) and they appear in the great statutes like the Municipal Corporations act, 1835, or the Local Government act, 1933, which may be termed constitutive, or in acts like those on education or police, which may be called functional. The permissive powers offer remarkably wide opportunities of initiative. Where local authorities petition parliament for private acts, they may obtain the opportunity to pioneer, if they prove desirability and financial capacity, and successful administration is sometimes followed by grant to all authorities of these novel ones. The merit of the system of specific grant is the addition of the good sense of the central authority to that of the local electorate in determining new services, which also means control over local citizens and power to raise taxes. All the bigger authorities have a rather restricted by-law making power, heavily controlled by the courts.

In France and Germany, the municipalities are given by the constituent statutes a general or universal power to act for the good proper to the municipality. But what is proper is legally challengeable by citizens, and administratively by the state departments. Initiative is limited by the claims of other communities, private enterprise and the state organs. Also there are functions obligatory on the local units—from 50 to 80% measured in expenditures—prior to the discretionary ones. Even the decree of 1926 in France, which aimed to free the power of the communes to undertake utilities without hindrance from the courts at the instance of private enterprise, still required the approval of the higher administrative authorities, so that very little was accomplished. In Germany from 1890 on, the cities proceeded remarkably with municipal enterprise, because it suited the genius of the nation. Despite general powers in France, there was small municipal enterprise; despite specific grant in Great Britain, that country is probably unmatched in the extent of municipal management of utilities.

The powers of United States counties have come by a series of specific grants. The cities receive their powers in the charters as earlier suggested—these are stated specifically, but in broad outline, while additional powers are granted specifically from time to time. The general limitations of not encroaching on state functions as defined in the state constitution, must be remembered. Though unchartered the towns have a like freedom of action.

The Russian republic constitution (sect. 79) grants to all local authorities the power to "direct the cultural, political and economic construction of their respective territories," and the power to make decrees within the laws of the union and the republic, and then specifies further by its directive (sect. 92) regarding the departments to be set up by the municipalities. The local soviets are generically unbounded in their powers: but in almost all are subject to superior political plans or trust plans.

The powers actually exercised by modern local authorities are immensely in advance of anything known in the early 19th century. Then the main services were highways, police, public assistance, the removal of health nuisances, perhaps fire-fighting, perhaps infectious diseases, here and there public education. In Great Britain something like 80% of the work of the local authorities is the modern social services and municipal enterprise: in other countries the situation is or grows similar. We may list the powers usually exercised by local authorities: education up to high school and technical schools (in the U.S. sometimes colleges and universities); public health in a variety of environmental and personal services; mental diseases; housing provision and management; town planning, zoning, building regulation; poor relief, and in the U.S., local administration of social security services; small holdings, allotments; parks and open spaces and playgrounds; agricultural improvement and land drainage, agricultural education; roads and bridges; streets; public lighting; fire-fighting; police (larger authorities only except in the U.S.); lower instance justice; foods and drugs, and weights and measures inspection; enterprises of gas, electric power, transport by trams and bus, water supply (and in the German cities, laundries, milk supply, bakeries, theatres, concerts); land purchase in relationship to specific municipal powers, but as a general power in Germany. In the soviet system, where special decentralized units of the big enterprises under the state planning commissions are in charge of the utilities, there is some participation by the local soviet.

The tendency is towards more local powers, but also to more integration with the higher authorities, with emphasis on large-scale organization. The development of planned economy, social security and public medical care, must take the task of higher direction to the bigger authorities, though not excluding the smaller from direct execution with much latitude therein.

Finance and Local Freedom.—The finances of local authorities have a bearing upon their administrative freedom. The crucial points are (a) their authority to raise revenue; (b) freedom of budget making; (c) the revenue basis; (d) the magnitude of their expenditures. Only (a) and (b) are discussed.

(a) Revenue may be raised by authority of the general codes or the special statutes conferring powers. In France, tax freedom is limited by the need of superior authorization for the budget. In the soviet union the planned economy limits tax freedom, especially as there is much sharing of taxes between the higher and the municipal authorities.

In Great Britain and the United States, the principal financial limitations are on loans. In the former, previous administrative authority is required; in some states of the latter, limitations of total indebtedness are prescribed. The former permits higher technical examination of the projects. The latter is not infallible against default. Before Hitler, German cities had wide financial freedom, though loans required provincial sanction.

(b) Local budgets need no superior approval, either in Great Britain or the U.S.A. In France, the *préfet's* approval is required and he may require balancing and inscribe mandatory or invalidate optional expenditures. The German system requires compulsory appropriations when higher authorities consider that provision is inadequate. In soviet government, the strictest control is exercised by the higher authorities over revenue raising, appropriations and budget.

In Great Britain grants-in-aid from the central authority play a very important financial and administrative role; in the U.S. rather less so, but with growing importance in 1946. In France and Germany the sharing of taxes with the central government was more important relatively than the grant-in-aid. The subject is of the highest importance because a grant, and the form it takes, is an instrument of superior control, regulation and stimulation administratively.

Organization.—Local councils are elected by practically universal franchise for terms of three or four years, soviets for two. The nazis suspended that freedom. Soviet local elections are organized by the Communist party; but nonparty members nominate and are nominated and nearly 80% are members of the village soviets, and 44% of the city soviets; but only four out of ten chairmen of the village soviets and practically none of the city soviets are nonparty. The local government statutes of all the countries concerned prescribe certain kinds of internal organization—mayor, chairman, alderman, committees, commissions. Everywhere the councils establish committees for executive and preparatory legislative operations and to keep contact with the central authority and their own permanent staffs.

Some significant differences deserve notice. The English form of internal organization is that of all-party committees, each in touch with the technical or expert directors of departments. The only coordinator is the town or county clerk, in collaboration with the mayor or chairman who is annually elected from the council. The committees are virtually subcouncils, with a very large degree of delegated authority, subject to ratification by the council, but not to tax, raise a loan or make a contract. Some committees are prescribed by statute. The French system has the centrally appointed *préfet* dominating the *département* council; in the municipalities, the council elects the mayor. The former works with a secretary-general appointed by the central government. A small standing committee of the council, called the *commission départementale* controls and cooperates with the *préfet* as regards the budget, the audit of expenditures, civic property. It has further delegated powers from the council, but not to tax or spend. The *maire* is served by a number of *adjoints,* chosen from the council by seniority and value of services to the commune. They supervise the various departments of municipal activity, and jointly act as advisory body to the *maire* and draw up the budget. In the German system, the *provinz* is headed by a centrally appointed *oberpräsident,* for central government purposes, and a *landesdirektor* selected by the provinzial diet for local purposes, and he acts with an executive committee thereof. In the county, the chief executive is the *landrat,* appointed by the central government and cooperating with a small executive committee of the county council. In the rural communes, a chairman or bürgermeister is elected by the council, and works with assistants or aldermen chosen by the councillors. In the cities of East Prussia, the *magistrat* system prevails; in West Prussia, the *bürgermeister* system. In the former the elected council and its own chairman collaborate with the *magistrat,* which is an administrative board of professional officials and some laymen chosen by the council, organized and led by the *bürgermeister.* It is a kind of bicameral system, and on the decline. Neither of the bodies could separately decide an issue; agreement is necessary. The *magistrat* members headed the departmental offices, and were paid, subject to confirmation by the central authority. Municipal ordinances and the budget are introduced by the *magistrat.* Where the *bürgermeister* operates, this officer, a career official, is rather in the position of the whole *magistrat.* The advent of full responsible government and universal suffrage in 1919 opened an era of deadlock between the councils and the executives, broken by the central government's assumption of powers.

In the U.S. system there are four conspicuous forms of organization: the town meeting, the commission system, the council and mayor system, the city manager system. In the first, the meeting of taxpayers settles main lines of policy, chooses select men and officials, accepts the budget, controls administration and checks expenditures. It is unwieldy for large cities. These then may be administered by a small number of commissioners elected simultaneously as severally heads of the executive departments and collectively the general government of the city. It encourages disintegration of leadership, and is on the decline. Elsewhere council and some officials and the mayor are elected at the same time, and there is a separation of legislative and executive authority—at enormous cost of energy which produces some but not all the desirable progress. In the 30 years from 1916 to 1946 the city manager system developed strongly, until it applied to 572 cities. The elected council appoints an executive, a career official, to energize, manage, appoint the officials, to co-ordinate and make the budget—this, side by side with its elected mayor. The city manager is no czar; he serves the council and the local statutes give him a strong status, but it cannot be stronger than the authority of the council. His indefinite tenure may be cut short. Yet on the whole this is an improvement on other United States forms of local government organization. In general, the United States system is distinguished by its use of the initiative and referendum, especially necessary in the commission form.

In the soviet system, the local soviet elects a presidium or executive committee from its members. A small number of this body together with the president form a working inner cabinet. In the larger cities the technical officers must work under the direction of the presidium, and some may be actual members of it. This body is the formulator of policy as well as the executive—the council discusses, and ratifies. The municipal code prescribes committees of the council, called sections. Councillors may be recalled by dissatisfied constituents, but this happens very rarely.

During the 19th century, local administration, having small power, could be a field of much unpaid service, patronage and spoils. The merit and career system has advanced. Appointments are made by the chief executive officials in the French and German systems, but according to statutory qualifications and tests. In England the central government by law prescribes the basic qualifications of some officials—the medical officer of health, the sanitary inspector, the police, teachers, etc., but appointment and management are fully by the local authorities. Other appointments are entirely in their discretion. Some officers have the right of appeal to the central authority against dismissal—*e.g.*, medical officers of health. The purpose is obvious. In practically all large authorities and most small, a career service prevails. In the U.S. it has been estimated that civil service appointments total about 60% in the cities, and about 15% in the counties.

Central Control.—The intensity and techniques of administrative control by the central authorities are indexes of the limitation of local self-government. General tutelage is characteristic of France, Germany and Russia. It operates through continuous organized hierarchical vigilance and intervention downward from the appropriate central department through the higher to the lower levels of local authorities. As far as tutelage in Great Britain is concerned, it is exhibited in the form of the statutory rules and orders made by the designated central department in the course of administering the provisions of statutes relating to local functions, as well as advice, admonition, exhortation, preparation of scientific memoranda, reports of experience.

The sanction of administrative schemes is a more severe and specific form of central control: it is strong though not fully comprehensive in England, rather the same in France, less coverage in Germany and more comprehensive in the soviet than in any other country. In the U.S., sanction is rare, and applies to welfare and public works schemes assisted by the federal authority, and occasionally to highways, education and hospitals, financially assisted by the states.

Submission of periodic reports, when functions are financial or otherwise capable of statistical tabulation according to centrally designed forms is universal, but applies in the U.S. mainly to the services already mentioned, and in some states to the local accounts. The growth of standards, scientific definition, forms and statistical analysis after the middle of the 19th century has been a powerful instrument of centralization, since both local and central officials can be of one mind in reporting and deciding answers to governmental problems.

Audit of local accounts by central officials is severe and important in England; in France and Germany it is hierarchical, going finally in each case to the special courts of accounts. In the U.S., though accounting and fiscal practices are in some cases state regulated, and the election of local auditors required, external and compulsory audit hardly exists. Inspection by central officers is the most distinctive feature of the English system, having been carried to a highly comprehensive and efficient stage, in which the inspectors are not only investigating and enforcement-assisting agents, but counsellors on good practices, and flexible intermediaries between the capital and the localities. There is also inspection in the French and German systems, but it is overshadowed by the centralist quality of the system. In the U.S. the small amount of inspection is related only to the services already mentioned: in the counties, because of the nature of county services, it is hardly distinguishable from central action. Action in default is very limited and rare in England; practically nonexistent in the U.S.; has been practiced in Germany; in France, it is unnecessary because the power of supervision coupled with the inscription of obligatory expenditures prevents the rise of conditions needing action by the centre on local default; higher pressure in the soviet system obviates it. The power to remove the French mayor or the *préfet* may be borne in mind.

Finally, personnel rules are laid down by the English central authority for some key officials; *préfet* and *maire* are auxiliaries of the central authority in France; a few states in the U.S. exert some small influence on the civil service conditions of the localities; in Germany, local appointments were free except, as in France, state laws regulated general conditions of appointment and service; in Russia, the local soviets have little formal limits on their appointing power. It should be remembered that where the central authority makes regular financial grants to the local authorities, the payment or withholding of these constitutes a sanction of these various instruments of its control. This is especially strong though flexible in England; much less so in France and Germany; firm over its small field in the U.S.; while the soviet system relies on other incentives. But the grant-in-aid as sanction is replaced by other exertions of authority in France and Germany.

Variety and development are marks of contemporary local government. Larger areas are on the way as is more central direction. Many new functions are impending. The feeling of attachment to the old areas is a retarding factor; the recognition that the small area has continuous nontechnical values, and certain long run technical advantages in assisting consumer control over administrators will force centralization to assume accommodating forms. The great associations of municipalities and the professional officials already contribute considerably to the efficiency of the localities, and their services are destined to be even more valuable still.

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LOCAL OPTION. In its application to the drink trade, local option may be described as a policy of decentralization which transfers the question of the continuance or non-continuance of the common sale of alcoholic beverages from the central authority to the registered electors in each local area. It is local self-government with a difference. In ordinary matters of local government the self-determination of local communities is achieved indirectly through a popularly-elected local authority. In the case of local option the action of public opinion is direct. Initiative rests with the local electors and decision is reached by a popular vote.

Under local option the power to grant or not grant licences for the sale of alcoholic liquors is transferred from the licensing justices (acting as the statutory representatives of the central authority) to the electors of the local area, who register their decision at a poll taken for the purpose. Local option laws differ in character and in scope in different countries. In most cases they are purely suppressive in character and the options offered are restricted to the two alternatives of licence or no-licence. In a few cases a third option of limitation is offered, while in one or two instances (*e.g.*, in South Australia) a right to increase the number of licences is conceded. This latter right is rarely exercised. The three-fold form of local option (*i.e.*, no-licence, limitation and no-change) was at one time generally favoured in Great Britain and in certain of the British dominions, but in recent years the "limitation" option has declined in favour and local option policy has tended more and more to revert to its original form of a direct veto upon the grant of licences.

The history of local option is in large part one of American experience. It was in the United States that the policy originated and it was there that it made its widest appeal. It grew up in the United States "as a kind of natural fungus upon the licence system stock." The original licensing laws were State laws applicable to the whole of the territory of the State, but the actual administration and use of the State law was left to the local authorities who not only granted the licences, but in many cases fixed (or supplemented) the amount of the licence fee, the proceeds from which went in whole or in part to the city or county revenue. In these local autonomous powers lay the germ of the modern local option policy. The development of the policy was at first indirect. In 1833 the State legislature in Georgia gave to the local courts in two counties the right to grant or to withhold retail licences. As the members of the courts were popularly elected the right constituted a form of indirect local option. A few years later (in 1838) two other States (Rhode Island and Connecticut) transferred the power to grant or not grant licences to the towns. Another State (Illinois) followed by empowering both counties and towns to suppress the liquor trade on the petition of a majority of the male inhabitants. And so the movement spread, developing rapidly from its initial form of an indirect restraint to its modern plebiscitary form of direct popular veto. Local option in the United States, although in its earliest stages a regulative system, quickly became in intention and effect a purely prohibitionist policy. It prepared the way for State prohibition into which it at first slowly and then rapidly developed. National prohibition superseded both of these devices for a time; since repeal state control appears to be favoured over local option in most states.

In the British Isles local option as a political issue dates back to 1857, when the United Kingdom Alliance first launched its "Permissive Bill." The only statutory recognition that the policy has received in the United Kingdom so far is contained in the local option sections of the Scottish Temperance Act of 1913, which came into force in 1920 with results which, if useful, have been inconsiderable. Local option has found a large place in the liquor laws of the British dominions, especially in Canada, where, however, it has since been largely superceded by provincial-wide experiments in prohibition (now for the most part replaced by provincial schemes of public management and control, in some of which the principle of local option is recognized).

In Europe generally, with the exception of Norway and Sweden, local option has made little progress. In Norway and Sweden it has operated chiefly in restraint of the grant of licences in rural communes, in which licences were always few and in many cases non-existent, and in an indirect and non-plebiscitary way (*i.e.*, by use of the ordinary machinery of parochial government). In 1894 a direct power to veto the retail sale of spirits was for the first time conceded to the Norwegian towns, with the result that when, during the later years of the World War, national prohibition was resorted to, there remained only 13 towns in which the retail sale of spirits was still allowed. Following the recent repeal of prohibition of spirits in Norway, the right of local option has been restored.

(*See* also TEMPERANCE; PROHIBITION; GOTHENBURG LICENSING SYSTEM; DISINTERESTED MANAGEMENT.)

LOCAL TAXATION: *see* TAXATION, LOCAL.

LOCARNO (Ger. *Luggarus*), a town in the Swiss canton of Ticino (Tessin), of which until 1881 it was one of the three capitals (the others being Bellinzona and Lugano, *qq.v.*). It is a health resort (population 6,575) built at the north end of Lago Maggiore. It is 14 m. S.W. of Bellinzona by rail. An electric railway, opened in 1923, connects it with Domodossola and the Simplon via the Centovalli; another electric railway runs from Locarno along the Maggia valley. It was taken from the Milanese by the Swiss in 1512 and was subject to them until 1798, when it became a part of the canton Lugano in the Helvetic republic. In 1803 it became part of the new canton of Ticino. In its Palace of Justice in 1925 were held the sittings of the Locarno conference. (*See* LOCARNO, PACT OF.)

LOCARNO, PACT OF, a series of diplomatic instruments for peace and arbitration drawn up at Locarno in 1925, whereby (1) Germany, Belgium, France, Great Britain and Italy mutually guaranteed the peace in Western Europe and (2) Germany undertook to arbitrate about disputes with France, Belgium, Poland and Czechoslovakia.

The ceremony which took place at Locarno on Oct. 16, 1925 (Austen Chamberlain's birthday) was the initialling of the instruments by the delegates, namely Dr. Luther and Herr Stresemann (Germany), M. Emile Vandervelde (Belgium), M. Aristide Briand (France), Mr. Austen Chamberlain (Great Britain), Signor Benito Mussolini (Italy)—who arrived at Locarno by boat on Oct. 16 and left again the same day—Count A. Skrzynski (Poland) and Dr. Edouard Beneš (Czechoslovakia). The treaties were signed in the Foreign Office, London, on Dec. 1, 1925.

That achievement made an impression on popular opinion in all the countries concerned because it marked a definite break from the war atmosphere; the words "allies" and "enemies" were never uttered by any delegate throughout the conference; and the chief countries concerned in the World War committed themselves to a pacifist policy, as between themselves, for the future. For the first time in history great powers surrendered their absolute "right to make war." The surrender was localized to one particular storm centre, namely the Rhine, but it started a diplomatic fashion in Europe.

Although the technical origin of the Locarno idea was contained in a memorandum communicated on Feb. 9, 1925, by the German Ambassador in Paris to M. Herriot, yet it was recognized that Austen Chamberlain personally had played the decisive part in leading up to it. Lord D'Abernon, British Ambassador in Berlin, had prepared the ground. Lloyd George in 1922, Dr. Cuno in 1923, Ramsay MacDonald in 1924, had conceived essentially similar ideas, and the Dawes Conference of 1924 created the propitious atmosphere for what fructified in 1925; but Chamberlain forced the issue. Sir Austen Chamberlain (as he now became) had the Order of the Garter specially conferred on him in Dec. 1925 for the part he had played. During the spring and summer of 1925 difficult and brittle preliminary diplomacy had had to be faced. Chamberlain sustained his faith in success, and at Locarno it was generally agreed that he had supplied the main motive spirit. Upon Great Britain fell a special responsibility under the treaties. There were those who held the importance of the treaties to be psychological rather than technical; but realistically the kernel was implicit in article 4 of the Security Pact, by which Great Britain and Italy were committed to declare war on Germany if Germany attacked France, and to declare war on France if France attacked Germany.

Content of Treaties.—The instruments consisted of (1) a treaty of mutual guarantee between Germany, Belgium, France, Great Britain and Italy; (2) two arbitration conventions between Germany on the one side and Belgium and France severally on the other, and two arbitration treaties between Germany on one side and Poland and Czechoslovakia severally on the other; (3) a collective note of the "Allies" to Germany explaining the implications of article 16 of the League Covenant; and (4) two treaties of guarantee between France on the one side and Poland and Czechoslovakia severally on the other.

The treaty of mutual guarantee, or Security Pact, provided in its main purport (1) that the parties guaranteed the inviolability of the German-Belgian and the German-French frontiers as fixed by the Treaty of Versailles (article 1); (2) that Germany, Belgium and France undertook never to attack, invade or wage war against each other except in "legitimate defence" or as a result of a League of Nations obligation (article 2); (3) those three countries undertook to settle their disputes by pacific means (article 3); (4) in case of an alleged breach of article 2 above each of the five contracting parties undertook to come to the defence of the party adjudged by the League of Nations to be the party attacked, or in the case of a "flagrant" violation, to come immediately to the defence of the party attacked (article 4). The particular treaties between France and her eastern associates provided for mutual support against unprovoked attack resulting from a failure of the Security Pact.

In the year following the signing of the treaties the two main practical consequences that logically were to be expected were (1) the evacuation of the occupied Rhinelands and (2) Germany's entry into the League of Nations. Both those contingencies were connoted by the restoration of equal status between Germany and her former enemies. Germany duly entered the League of Nations in Sept. 1926.

Early in March, 1936, Germany broke the Pact of Locarno by marching troops into the Rhineland as a preliminary to fortifying the demilitarised zone. Germany sought to justify her action by arguing that France had changed the situation, including the Pact, by entering into an alliance with Soviet Russia. No restraining action was taken against Germany which, in effect, meant the acceptance by the Council of the League meeting in London.

Bibliography.—British White Book, *Final Protocol of the Locarno Conference, 1925* (Cmd. 2525 of 1925); George Glasgow, *From Dawes to Locarno* (London, 1925; New York, 1926); *Final Protocol of the Locarno Conference*, 1925; C. A. Macartney and others, *Survey of International Affairs for 1925* (1928). (G. G.)

LOCH, HENRY BROUGHAM LOCH, 1st Baron (1827–1900) M.P., of Drylaw, Midlothian, was born May 23, 1827. After two years' naval service, he entered the East India company's military service, and in 1842 was commissioned in the Bengal light cavalry. In the Sikh war in 1845 he served on the staff of Sir Hugh Gough. In 1852 he became second in command of Skinner's Horse. At the outbreak of the Crimean war in 1854, Loch left India, and raised a body of irregular Bulgarian cavalry, which he commanded throughout the war. In 1857 he was appointed attaché to Lord Elgin's mission to the East, was present at the taking of Canton, and in 1858 brought home the treaty of Yedo. In April 1860 he again accompanied Lord Elgin to China, as secretary of the new embassy sent to secure the execution by China of her treaty engagements. The embassy was backed up by an allied Anglo-French force. With H. S. Parkes he negotiated the surrender of the Taku forts. During the advance on Peking Loch was chosen with Parkes to complete the preliminary negotiations for peace at Tungchow. They were accompanied by a small party of officers and Sikhs. On the discovery that the Chinese were planning a treacherous attack on the British force, Loch rode back and warned the outposts. He then returned to Parkes and his party under a flag of truce. All were made prisoners and taken to Peking, where the majority died from torture or disease. Parkes and Loch were at first put in irons, but were afterwards more leniently treated. After three weeks their release was agreed, but they had only been liberated ten minutes when orders were received from the Chinese emperor, then a fugitive in Mongolia, for their immediate execution. Loch never entirely recovered his health after his experience in a Chinese dungeon. Returning home he was made C.B., and for a while was private secretary to Sir George Grey, then at the Home Office. In 1863 he was appointed lieutenant-governor of the Isle of Man. In 1882 Loch accepted a commissionership of woods and forests, and two years later was made governor of Victoria. In June 1889 he succeeded Sir Hercules Robinson as governor of Cape Colony and high commissioner of South Africa.

As high commissioner his duties called for the exercise of great judgment and firmness. The Boers were at the same time striving to frustate Cecil Rhodes's schemes of northern expansion and planning to occupy Mashonaland, to secure control of Swaziland and Zululand and to acquire the adjacent lands up to the ocean. Loch firmly supported Rhodes, and, by informing President Kruger that troops would be sent to prevent any invasion of territory under British protection, he effectually crushed the "Banyailand trek" across the Limpopo (1890–91). Loch, however, with the approval of the imperial government, concluded in July–August 1890 a convention with President Kruger respecting Swaziland, by which, while the Boers withdrew all claims to territory north of the Transvaal, they were granted an outlet to the sea at Kosi bay on condition that the republic enter the South African Customs union. This convention was concluded after negotiations conducted with Kruger by J. H. Hofmeyr on behalf of the high commissioner, and was made at a time when the British and Bond parties in Cape Colony were working in harmony. The Transvaal did not, however, fulfil the necessary condition, and in view of the increasingly hostile attitude of the Pretoria administration to Great Britain Loch advocated the annexation by Britain of the territory east of Swaziland, through which the Boer railway to the sea would have passed. He induced the British government to adopt his view and on March 15, 1895, it was announced that these territories (Amatongaland, etc.), would be annexed by Britain. Meantime Loch had travelled to Pretoria to use his personal influence with President Kruger on behalf of the Uitlanders, and obtained the withdrawal of the obnoxious commandeering regulations. In the following year he entered a strong protest against the new Transvaal franchise law. In 1895 he returned home and was raised to the peerage. He died in London on June 20, 1900.

LOCHABER, a district of southern Inverness-shire, Scotland, to the east of Loch Linnhe. The scenery is wild and beautiful, Ben Nevis being the chief mountain. The Lochaber hydro-electric scheme is designed to make use of a catchment area of 303 sq.m. extending from the head of Loch Linnhe north-eastward to Laggan, with a power-house close to Fort William.

LOCHES, a town in France, capital of an arrondissement of Tours, in the department of Indre-et-Loire, 29 mi. S.E. of Tours by rail, on the left bank of the Indre. Pop. (1936) 3,585. Loches (the Roman *Leucae*) grew up round a monastery founded about 500 by St. Ours and belonged to the counts of Anjou from 886 until 1205, when it was seized from King John of England by Philip Augustus, and from the middle of the 13th century until after the time of Charles IX the castle was a residence of the kings of France. The picturesque town lies at the foot of the rock on which stands the castle of the Anjou family, surrounded by an outer wall and consisting of the old collegiate church of St. Ours, the royal lodge and the donjon. The church of St. Ours (10th, 12th centuries) has huge stone pyramids surmounting the nave and a beautifully carved west door. The royal lodge, built by Charles VII and used as the subprefecture, contains the tomb of Agnès Sorel and the oratory of Anne of Brittany. The donjon includes, besides the ruined keep (12th cent.), the Martelet, celebrated as the prison of Lodovico Sforza, duke of Milan, who died there in 1508, and the Tour Ronde, built by Louis XI and containing the famous iron cages in which state prisoners were confined.

Beaulieu ès-Loches, suburb of Loches, contains the remains of the 11th century abbey church of the Holy Sepulchre. The chancel is of the 15th century. The Romanesque nave is in ruins, but one tower is intact.

LOCHGELLY, a small burgh, Fifeshire, Scotland, 7½ mi. N.E. of Dunfermline by the L.N.E. railway. Pop. (1938) 9,238. The town is modern and owes its prosperity to the iron works and collieries in its immediate vicinity. Loch Gelly, from which the town takes its name, is situated ½ mi. S.E., and has on its west bank Lochgelly House, a seat of the earl of Minto. To the N.E. rises the hill of Benarty (1,131 ft.). Hallyards, about 2 mi. S.E. of Lochgelly, is a ruined house that once belonged to Sir William Kirkaldy of Grange, who held Edinburgh castle for Queen Mary. Here James V was received after his defeat at Solway Moss in 1542.

LOCHGILPHEAD, a small burgh of Argyllshire, Scotland, at the head of Loch Gilp, a small arm on the western side of Loch Fyne. Pop. (est. 1938) 1,082. The herring-fishery is the chief industry, but there is some weaving of woollens and, in summer, a considerable influx of visitors.

LOCHMABEN, a royal and small burgh in Dumfriesshire, Scotland, 8 mi. N.E. of Dumfries, with a station on the L.M.S. railway company's branch from Dumfries to Locherbie. Pop. (1938) 1,045. It is delightfully situated as a holiday resort, with several lakes, the river Annan and the Waters of Ae, Kinnel and Dryfe in the neighbourhood. In the parish church is a bell said to have been presented to Robert Bruce by the pope after reconciliation with him. A statue of the king stands in front of the town hall and at the south end of Castle Loch are the ruins of Lochmaben castle, dating from the 13th century, where local tradition declares that Bruce was born. In any case Bruce was closely associated with Lochmaben. He exempted his followers in the district from feudal service and their descendants—the "kindly tenants of Lochmaben"—were confirmed in their tenure by the court of session in 1824. The Castle Loch is the only fresh water in Scotland, and possibly in the British Isles, where the vendace occurs. This fish is netted in August, and esteemed as a delicacy. Lochmaben is famous for curling, and a team entirely composed of shoemakers (souters) who held their own against all comers once added the phrase "to souter" to the vocabulary of the sport, the word indicating a match in which the winners scored "game" to their opponents' "love."

LOCHNER, STEPHAN (*c.* 1400–1451), German painter, the most distinguished representative of the Cologne school. He came to Cologne from Meersburg on the Lake of Constance about 1430. Archives prove that he bought houses in Cologne in 1442 and 1444, that in 1447 and 1450 he was elected a councillor by his gild and that he died in 1451. The painter's name has been preserved to us by an entry in the diary of Dürer, who, on his way to the Netherlands, stopped at Cologne and paid two *weisspfennige* to see the famous altarpiece which Lochner had painted for the chapel of the town hall. This triptych is now in Cologne cathedral. The Virgin, friendly and majestic, sits in the midst with the Child. Around are the three kings, patrons of Cologne, and their followers. On the wings are the saints of Cologne, on one side Ursula with her company of English maidens, on the other Gereon with his fellows of the Theban Legion. The outside wings, now in the Cologne museum, show an Annunciation, beautifully spaced. The background is diapered gold, and a florid arcade of carved wood runs across the top of the panels. Compared with the earlier work of the Cologne school, this altarpiece constitutes a step towards naturalism and plasticity. The old Cologne ideal of graceful line and pattern design are sacrificed to truth of form. The heads are lifelike; the men wear the steel and chain armour of Burgundian knights, and the ladies are in the costly costumes of a 15th century court. It is suggested that the artist received his early training in the same school, which under Burgundian influence, produced his contemporary, the strong and realistic Conrad Witz, on the Lake Constance. Moreover, between 1414 and 1418 the famous Council met at Constance which elected Pope Martin V., the art loving patron of Fra Angelico. Constance was then a great gathering place of famous people, and young Lochner must have witnessed many a court display and seen many a fine work of art. On the other hand, the realistic tendency in his art may have been a reflection from the Netherlands. Cologne stood in close relation with the Low Countries, where the Van Eycks were carrying everything before them, and where Campin was founding his school.

To the Cologne school Lochner owed his love for rich colour, for grace and splendour. He was so completely absorbed that he became Cologne's most famous artist. Other works by the artist are "the Virgin and Child in the Rose Bower surrounded by Angels Playing Music," and "the Virgin Crowned by Angels in the Garden of Paradise," both in the Wallraf-Richartz museum of Cologne. "The Virgin handing a Violet to the Child with a small Kneeling Figure of Elsa von Reicherstein" is now in the Archiepiscopal museum at Cologne. He is at his best in these representations of the Virgin as a fair and gentle maiden seated in rose gardens with saints and angels playing music, an interpretation reminiscent of the Minnesinger's worship, which was favoured by the Rhineland mystics. The Museum of Darmstadt has a "Presentation of Christ in the Temple" (1447) of very fine quality. There are small panels with "standing saints" at the Munich, London and Cologne museums. "The Last Judgment," also at the Cologne museum, is most succesful in the part which depicts the procession of saints passing through a late Gothic portal leading to heaven—while his interpretation of hell is unconvincing and burlesque.

His work forms the transition from the Gothic to naturalism. He was a lyric poet, and he preserved some of the old grace of sentiment and line of the old school. His school continued to about 1466. To it are ascribed the paintings of the legend of St. Ursula in the church of that saint at Cologne, and a Crucifix dated 1458 in the Cologne museum. His style can be traced also in several stained glass windows of the city.

See Ludwig Scheibler and Carl Aldenhoven, *Geschichte der Kölner Malerschule* (Lübeck, 1902).

LOCK, MATTHIAS, English 18th-century furniture designer and cabinet-maker. The dates of his birth and death are unknown. He was a clever craftsman, a disciple of Chippendale, and was possibly in partnership with Henry Copeland (*q.v.*). He belonged to that flamboyant school which derived its inspiration from Louis XV. models, until he fell under the classical influence of Robert Adam so completely that it is often difficult to distinguish between them. Many of his original drawings are preserved in the Victoria and Albert Museum, South Kensington, while the pieces themselves are often bolder and more solid than is suggested by the author's representations of them.

Among his works, some of which were issued in conjunction with Copeland, are: *A New Drawing Book of Ornaments* (n. d.); *A New Book of Ornaments* (1768); *A New Book of Pier Frames, Ovals, Girandoles, Tables, etc.* (1769); and *A New Book of Foliage* (1769).

LOCK. A mechanical device for securely fastening a door or lid, usually including a sliding bolt which may be shot by a removable key.

The Egyptian locksmith was probably the first whose products have been preserved. One of his locks was found in the ruins of Nineveh, and was apparently used to secure the door of a room in the Palace of Khorsabad. Isaiah probably referred to a similar lock when he said "and the key of the house of David will I lay upon his shoulder" (xx. 22). Fig. 1 shows an Egyptian lock dismantled. Both the lock and the key are constructed entirely of wood.

The vertical piece of wood, the staple, is fixed to the door post and contains in the upper part movable pins, in this case six in number; the cross piece is the bolt. The pins in the staple fall into corresponding holes in the bolt and so prevent the latter moving until they are raised to the level of the top of the bolt by pins fixed on the key. Only the key made specially to fit the lock could operate it and quite a reasonable degree of security was achieved. This lock, the earliest of which the construction is known, is as will be seen later, the prototype of the modern cylinder lock.

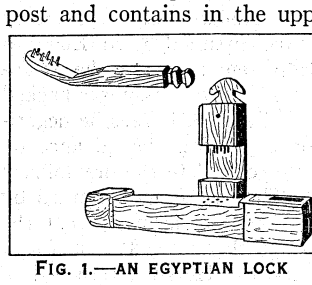
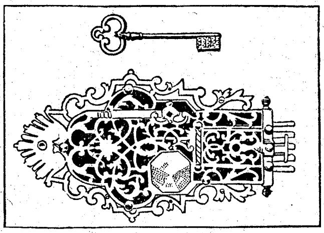


FIG. 1.—AN EGYPTIAN LOCK

Next in order came the fabricator of the "doore fastenings of dyverse colours made of brass and ivory," of ancient Rome, followed by the maker of the still more elaborate *Serrure de Tabernacle* in the mediaeval age, immortalised in early Christian missals. The Chinese locksmith also made "strange instruments "having wooden slides," the architecture of which was peculiarly adapted to the Summer House of willow pattern fame. In England, by the time of Queen Elizabeth, the operations of the craft were fully established "in the townes of Staffordshire, to wit, Wolverhampton, Willenhall and Wednesbury."

The mediaeval period up to the late 18th century produced locks of very beautiful design as regards their exterior cases, but small attention was paid to security and convenience. Fig. 2 is a 17th century lock of French origin. It measures $17\frac{1}{4}''\times 9\frac{1}{2}''$ and the key is $7\frac{3}{4}''$ long. Fig. 3 shows a lock $14''\times 8''$ which belonged to Henry VIII. It is said that wherever he went the lock went with him and was screwed to his bedroom door.



BY COURTESY OF PARKES & SONS

FIG. 2.—17TH CENTURY LOCK AND KEY FROM TOURNEY. AIX-LA-CHAPELLE

Modern Improvements and Inventions.—A study of the history of locks reveals the fact that their design has followed the various periods of art until, in the 20th century, utility has almost entirely displaced the beautiful specimens of earlier days. Until Robert Barron in 1778 invented his double acting tumbler lock, security depended on immovable obstructions fixed inside the lock. The single acting tumbler (fig. 4) gave practically no security as, so long as the tumbler was lifted high enough for the talon on the bolt to pass underneath, the bolt was free to move. Many cheap door locks are, however, still made with this single acting tumbler.

In England and America a ward is added for greater security, and on the Continent of Europe and in America the key-hole in the case of the lock is of a peculiar design. The most common wards are: (1) Sash (fig. 5) (2) Fine (3) Solid. A Sash ward is the most used on account of its adaptability in conjunction with levers. It is made of brass, and has circular steps which vary in height, so that many different combinations may be obtained. This ward is fixed on the inside of both the case and the cap of a door lock. Fine and Solid wards are fixed in the middle of the lock, the former made of steel and the latter of brass.

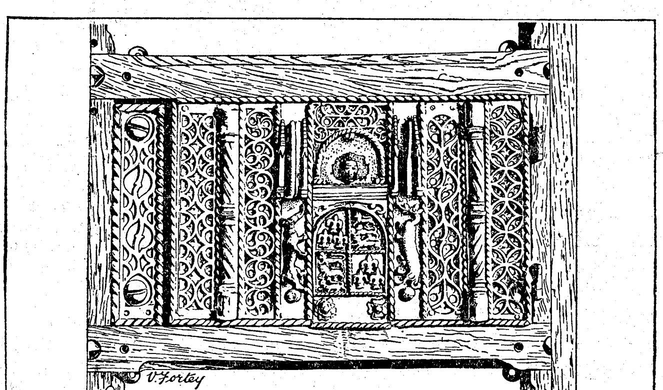


FIG. 3.—THE BEDDINGTON LOCK, OF THE EARLY 16TH CENTURY

Barron's lock could only be opened by a key which lifted both the tumblers to an exact height, so that the talon on the bolt could pass through. A modern lever works upon this same principle, and nearly all best quality locks are now made with one or more levers.

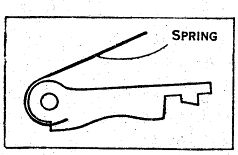


FIG. 4.—TUMBLER LOCK

English Lever Locks.—In 1818 Jeremiah Chubb patented his detector lock, since which no great improvement in the security of locks has been made. It is constructed of several levers, usually at least six, which are protected by what is termed a "detector" lever, which comes into operation if any key other than the correct one is used in an attempt to open the lock. The "detector" lever in that event is lifted too high, where it remains until the correct key is turned in the reverse direction, when the lock may again be operated. The owner of the correct key is informed by this means when some unauthorized person has tampered with his lock.

It was as a result of this invention that the modern English lever was brought into general use. Different combinations, which are almost unlimited, are obtained by raising or lowering the position of the horizontal slot, or gate, through which passes the talon on the bolt. The correct key will raise the lever (shown in its lower position in fig. 6) so that the talon (c) on the moving bolt will pass through the gate (b). An American named Hobbs invented the safety lever.

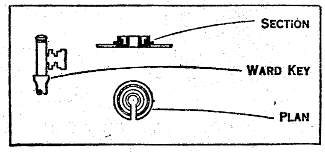


FIG. 5.—SASH WARD

Linus Yale's Cylinder Lock 1848.—The other outstanding invention is that of Linus Yale, an American, who, in the year 1848 conceived the idea of adapting the Egyptian lock to modern requirements. To do this he brought about a revolutionary change by separating the key mechanism from the lock itself, thereby making it possible for a very small key to be used, as it did not have to pass through the door. The cylinder (*see* fig. 7) or the part in which the key operates, consists of an outer barrel which is fixed to the door and a cylindrical plug which is rotated by the key and has a tongue on its back end which projects into the lock. The upper pins, five in number, in the fixed part of the cylinder, fall down into corresponding holes in the plug, which contains five similar pins which are raised to the level of the circumference of the plug by the correct key, the top pins being kept in the required position by means of phosphor bronze springs, *vide* fig. 7. If a key is inserted which does not raise the pins in the plug to the required height, the plug cannot be turned.

A further degree of security is provided by the irregular shape of the key. The notches of the average key may be cut in eight depths, so that, as there are five notches, the number of different keys possible is eight to the power of five, *i.e.*, 32,768. The notches are cut automatically in a milling machine to the required depth, and the pins in the plug are made afterwards to correspond.

Still a further number of key changes is obtained by milling grooves lengthwise on the sides of the keys to correspond with similar grooves in the keyway in the plug. By varying the shape and location of these grooves quite a large range of key changes are made possible.

The illustration (fig. 8) is of the most common form of cylinder lock, *i.e.*, the cylinder rim night latch, the term meaning a spring bolt cylinder lock operated by a key from outside and a knob from inside. This lock is almost universally accepted as a front or street door lock. The invention was therefore of great importance. It is the cheapest lock offering such a degree of security and having so many differing keys. The invention of Joseph Bramah, in 1784, of a lock also depending for its security on moving parts, has to a large extent fallen into disuse, but Bramah's name was an important one in the trade when he placed his patent on the market.

Keyless Locks.—There are several kinds of keyless locks, the two principal being those which are operated by an arrangement of letters or numbers, and special safe locks which are made to open only at a given time. In both cases the opening position in the disc or levers is achieved without the aid of a key. It is usual in the case of time locks to make use of three watch movements, in order to reduce to a minimum the possibility of failure which would be likely to occur if only one were used. The movements are wound up until the time at which the safe is to be opened is indicated on the clock faces inside the lock. When the lock is set in this manner it automatically goes off guard at the appointed hour, allowing the safe then to be opened.

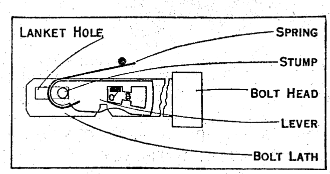


FIG. 6.—ENGLISH LEVER

The growth of safe deposits from the latter half of the 19th century has necessitated the design of special locks, one of the conditions required being that each locker should be opened only by the renter and the guardian together. These are termed duplex key action locks, a number being operated through a single keyhole and others through two. Another variety of safe deposit lock has changeable keys, *i.e.*, all the locks are identical in every respect, but all keys are different. Any lock may be set to any key by the simple action of locking out the bolt with the desired key, which then becomes the only key which will unlock until the lock is set to another key.

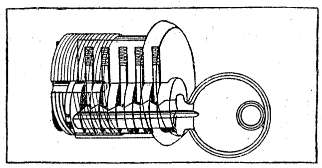


FIG. 7.—PIN TUMBLER CYLINDER WITH ITS CORRECT KEY

Construction of Modern Locks.—Most door locks are used to keep the door in a shut position besides securing it. Indeed this is one of the principal functions of a lock, and for this purpose it is provided with a bevelled spring bolt which is operated by a knob or lever handle, the dead bolt being thrown out or withdrawn by the key. The method of moving this spring bolt is called the "action" of the lock, and upon the action the easy and sweet closing of the door depends. When it is considered the different sizes, weights and types of doors that are in use, it will be understood that many different kinds of actions must be designed so that the lock may correctly perform its function.

In England, because the doors are provided with a lock rail, or style, below the middle line of the door, horizontal rim and mortice locks (usual size 6″ long$\times 3\frac{1}{2}'' \times \frac{1}{2}''$) are generally used.

The three most common actions employed in medium quality door locks are the Palace motion (fig. 9), the Easy action and the Scotch spring (fig. 10) types. The action in figure 12 is termed "Easy," because the striking plate on the door post pushes back the bolt against only one of the springs, but when the knob is turned both the feather and the coil springs come into operation. The Scotch spring in figure 10 is riveted at the end further away from its point of operation, so that the movement of the spring being very small, its life is long.

On the Continent of Europe and in South America doors are made with one large panel, and so the type of lock in use to meet this style is a high upright lock, the usual size being $3'' \times 6''$ high$\times \frac{1}{2}''$. The latch bolt is operated in this lock by spiral springs and can be made easy or hard as required.

In America the doors are made with six or more panels, and the rails, or stiles, are too small to take a lock, so that a small upright lock, usually $3'' \times 3\frac{1}{2}''$ high$\times \frac{3}{8}''$ is fitted inside the frame. The American action is as a rule of the "Easy" type, involving the use of two or more coil springs. A typical action is illustrated in figure 12.

The three principal lock producing countries of the world are England (6,000 operatives), United States of America (9,000 operatives), and Germany (7,500 operatives). Each country has her own special types of padlocks and cabinet locks, as well as of door locks.

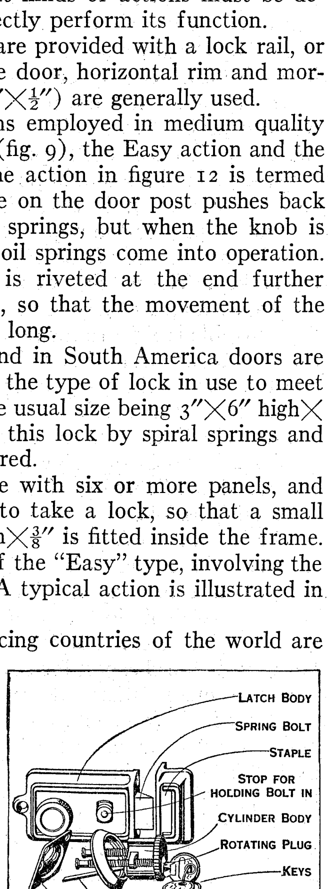


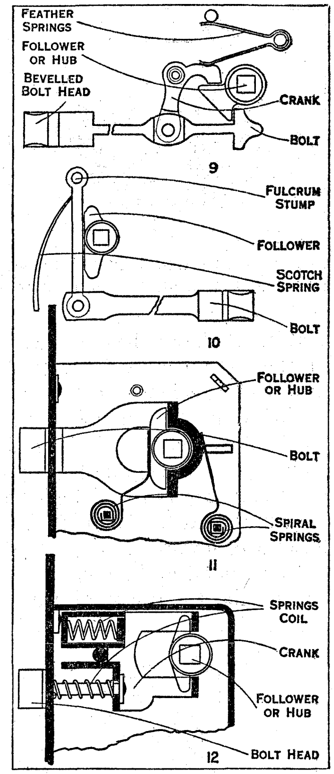
FIG. 8.—MODERN RIM CYLINDER NIGHT LATCH, WITH KEY

Locks Arranged in Groups.—It has been estimated that there are upwards of 150 locks of all kinds in use in and about a 20th century house of average size. Locks are also required for many other purposes, involving a large variety of patterns. For the sake of cataloguing they are divided into four main groups.

1. *Rim locks*—all locks in this group are fixed to the surface of door.
2. *Mortice locks*—which are, as the name implies, fixed in the door.
3. *Padlocks*—the origin of this word being descriptive of their function. The word "pad" is taken from "foot-pad," as this type of hanging lock was used to secure packages being transported on the old-fashioned pack-horse, when road thieves abounded.
4. *Cabinet locks*—which term includes the whole range of locks used on household furniture.

In addition there are the safe locks referred to above which are almost a separate branch of the trade. All these groups are subdivided into many sections, the varieties of size, finish and quality in each one being very large. One English manufacturer alone offers 1,250 different kinds.

Modern Methods of Manufacture.—Great changes have taken place in the manufacture of medium quality locks in the last 25 years. These changes are not dissimilar from those which have evolved in all other metal working industries, and have been brought about by the increased use of machinery and the necessity for cheap production. To some extent manufacturers are endeavouring to standardize their products. It may be that an action is fitted into several different cases, and that one type of case may be suitable for several different actions. Costs of production are reduced in this way, fewer parts being made and a greater quantity of each part, this lending itself to mass production methods. In some locks there are as many as fifty separate parts, each of which must be accurately made, in order that it may successfully perform its function.



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SEVERAL TYPES OF MODERN LOCKS
Fig. 9, Palace motion; fig. 10, Scotch spring action; fig. 11, Continental type action; fig. 12, easy action for upright locks

Until the end of the 19th century almost all locks were hand made by skilled craftsmen, whose title of "locksmith" conveys the true idea that his art is a branch of the ancient art of blacksmithing of earlier times. The skilled men of the trade are now, to a large extent, located in the toolroom, which has become the heart of the modern factory. The drawing office also plays an important part. Not only is it responsible for the design of the lock, both as regards its external and internal parts, but it is there that the charts of numbers are prepared from which the keys of a suite of locks are made, so that very little responsibility rests upon the operator of the machine making the parts, or on the assembler. Unskilled labour is employed in assembling the machined parts but there are, nevertheless, a considerable number of skilled craftsmen in the trade who make the heavier types of locks. Their labours are, however, lightened by machines which perform many operations for them which until recently were done by hand. Owing to the comparatively small sale of these heavier locks, the cost of manufacture of tools for their production would more than counter-balance the resultant saving in assemblers' wages.

The materials used in the manufacture of locks vary with the type, quality and the purpose for which the lock is required. Medium quality rim and mortice locks are of cast iron or steel cases, with brass bolts, wards and levers. Padlocks are made of steel, pressed brass, cast brass, bronze, grey iron or malleable iron, and cabinet locks of steel, pressed brass or cast brass.

Suites or sets of locks are made in several different ways, three of the most important being:—

1. All to pass, *i.e.*, all keys and locks identical.
2. All with different keys.
3. All to differ and yet controlled by a master key. A variation of this is often employed for flats, the front doors of the flats having locks with keys all different from each other but each key opening the street door lock.

There are many methods adopted in the trade for making such suites as these, depending on the types of locks used.

The selling price of a lock varies from the cheapest padlock at 2d. each, to a lock used on a Banker's strong-room door worth perhaps £100, but the price of an average household door lock is about 3/- to 4/- each. It has been estimated that there are 50,000,000 locks produced in the world every year. (A. J. Pa.)

LOCK, in canal or dock engineering, a watertight chamber, closed by gates at each end, used as a means of transferring vessels from one level or reach of a canal or canalized river to another; or at the entrance of a dock to enable vessels to be raised from a lower to a higher level, or vice versa. The largest lock in the world is that completed in 1928 to serve as a new entrance to the North Sea–Amsterdam ship canal at Ymuiden. It is 1312 feet long and 164 feet wide internally. Entrance locks are not usually embodied in the construction of dock works unless the range of tide is considerable, exceeding 14ft. or thereabouts. An analogous principle is used in compressed air working where *air-locks* are employed for the transfer of men and materials from atmospheric to higher pressures and vice versa. (*See* CANALS AND CANALIZED RIVERS; DOCKS.) (N. G. G.)

LOCKE, JOHN (1632–1704), English philosopher, was born on Aug. 29, 1632, at Wrington, Somersetshire. His father, a small landowner and attorney, was a strict but genial Puritan and fought on the parliamentary side in the Civil War. The relations between father and son were ideal, and left their mark on Locke's educational theory. In 1646 he entered Westminster school. Probably the warnings in the *Thoughts on Education* against learning by rote and against beginning the study of languages by grammar were suggested by his own experiences at school. In 1652 he entered Christ church, Oxford, then under John Owen, the Puritan dean and vice-chancellor of the university. For some years after he entered, Oxford was ruled by the Independents, who were among the first in England to advocate religious toleration. But Locke's hereditary sympathy with the Puritans was gradually lessened by the intolerance of the Presbyterians and the fanaticism of the Independents, and he had no use for the scholastic philosophy still taught at Oxford. In 1660 he was serving as tutor of Christ Church, lecturing in Greek, rhetoric and philosophy. The works of Descartes gave him a relish for philosophy, although he often differed from them. We find him experimenting in chemistry in 1663, also in meteorology, in which he was always interested. Locke's religious disposition attracted him to theology, but as there was no place for free enquiry in the Anglican Church after the Restoration, he decided on medicine as a profession. Then began his friendship with Robert Boyle and with Sydenham. Sydenham adopted empirical methods in medicine, just as Boyle did in chemistry, and Locke, during his very short experience of medicine, frequently accompanied Sydenham on his rounds.

In 1666, soon after his return from accompanying Sir Walter Vane on his mission to the elector of Brandenburg, Locke met Lord Ashley, afterwards first earl of Shaftesbury. This was the beginning of a lasting friendship, sustained by common sympathy with liberty—civil, religious and philosophical. In 1667 he moved to Exeter House, Lord Ashley's London residence, to become his confidential secretary. Although he retained his studentship at Christ church, he found a home with Shaftesbury for 15 years.

Locke's commonplace books throw welcome light on the history of his mind in early life. A paper on the "Roman Commonwealth" which belongs to this period, expresses convictions about religious liberty and the relations of religion to the State that were modified and deepened afterwards; objections to the sacerdotal conception of Christianity appear in another article; short work is made of ecclesiastical claims to infallibility in the interpretation of Scripture in a third; a scheme of utilitarian ethics, wider than that of Hobbes, is suggested in a fourth. The most significant of those early revelations is the *Essay concerning Toleration* (1666), which anticipates conclusions more fully argued nearly 30 years later.

At Exeter House Locke held informal reunions to discuss debatable questions in science and theology. One of these, in 1670, is historically memorable. "Five or six friends," he says, were discussing "principles of morality and religion. They found themselves quickly at a stand by the difficulties that arose on every side." Locke proposed to attempt some criticism of the necessary "limits of human understanding," and fancied that "one sheet of paper" might suffice. What was thus "begun by chance, was continued by entreaty, written by incoherent parcels, and, after long intervals of neglect, resumed again as humour and occasions permitted." In 1690, the issue was given to the world as the *Essay Concerning Human Understanding*.

The fall of Shaftesbury in 1675 drove Locke from English political circles to France, where he spent three years, partly at Montpellier and partly in Paris.

In Paris he met men of science and letters—Peter Guenellon, the well-known Amsterdam physician; Ole Römer, the Danish astronomer; Thoynard, the critic; Melchisédech Thévenot, the traveller; Henri Justel, the jurist; and François Bernier, the expositor of Gassendi. But there is no mention of Malebranche, whose *Recherche de la vérité* had appeared three years before, nor of Arnauld. In 1679 Locke resumed his old relations with Shaftesbury, at Thanet House in Aldersgate, London. It was a time of plots and counterplots, and in the end Shaftesbury was committed to the Tower, tried and acquitted. More insurrectionary plots followed in 1682, after which, suspected at home, the versatile statesman escaped to Holland, and died at Amsterdam in Jan. 1683. In these two years Locke was much at Oxford and in Somerset, for the later activities of Shaftesbury did not commend themselves to him. The letters of Prideaux and of John Fell show that Locke was suspected at court. Correspondence with his Somerset friend, Edward Clarke, of Chipley, describes Locke's life in those troubled years, and reveals the opening of his intimate intercourse with the Cudworth family. The letters allude to toleration in the State and comprehension in the Church, and show an indifference to theological dogma.

In 1683, Locke retired to Holland, then the asylum of exiles in search of liberty of thought. Descartes and Spinoza had speculated there; it had been the home of Erasmus and Grotius; it was now the refuge of Bayle. Locke spent more than five years there. For a time he was in danger of arrest at the instance of the English Government. After months of concealment at Amsterdam, under the assumed name of Dr. Van der Linden he escaped; but he was deprived of his studentship at Christ Church by order of the king, and Oxford was thus closed against him. In Holland he met Limborch, the successor of Episcopius as Remonstrant professor of theology, and Le Clerc, whose *Bibliothèque universelle* was then the chief organ in Europe of men of letters. Locke contributed several articles. It was his first appearance as an author, although he was now 54 years of age. The *Essay* was finished in Holland, and a French epitome appeared in 1688 in Le Clerc's journal, the forecast of the larger work. Locke was then at Rotterdam, where he was a confidant of political exiles, including Burnet and the earl of Peterborough, and he became known to William, prince of Orange. William landed in England in Nov. 1688; Locke followed in Feb. 1689, in the ship which carried the princess Mary.

WHEN HE BECAME FAMOUS

After his return to England Locke emerged into European fame. Within a month after he reached London he had declined an offer of the embassy to Brandenburg, and accepted the modest office of commissioner of appeals. His defence of religious liberty, in the *Epistola de Tolerantia,* was published at Gouda in the spring of 1685, and translated into English in autumn by William Popple, a Unitarian merchant in London. *Two Treatises on Government,* in defence of the right of ultimate sovereignty in the people, followed a few months later. The intention of the treatises was to "establish the throne of our great restorer, the present King William, to make good his title in the consent of the people." The famous *Essay concerning Human Understanding* appeared early in 1690. He received £30 for the copyright.

The course of public affairs disappointed him, for the settlement at the Revolution fell short of his ideal of toleration and civil liberty. In spring, 1691, he went to live at Oates Manor in Essex, the country seat of Sir Francis Masham. Lady Masham was the accomplished daughter of Ralph Cudworth, and was his friend before he went to Holland. At Oates he enjoyed for 14 years as much domestic peace and literary leisure as was consistent with broken health, and sometimes anxious visits to London on public affairs. In his letters and otherwise we have pleasant pictures of its domestic life and the occasional visits of his friends, among others Lord Peterborough, Lord Shaftesbury of the *Characteristics,* Sir Isaac Newton, William Molyneux and Anthony Collins.

The *Letter on Toleration* involved him in controversy. An *Answer* by Jonas Proast of Queen's college, Oxford, had drawn forth in 1690 a *Second Letter.* A rejoinder in 1691 was followed by Locke's elaborate *Third Letter on Toleration* in the following year. In 1692 he also addressed an important letter to Sir John Somers on the *Consequences of the Lowering of Interest and Raising the Value of Money.* When he was in Holland he had written letters to his friend Clarke of Chipley about the education of his children. These letters formed the substance of the little volume *Thoughts on Education* (1693), which remains an educational classic. Nor were the "principles of revealed religion" forgotten. The subtle theological controversies of the 17th century made him anxious to show the simplicity of fundamental Christianity. In the *Reasonableness of Christianity as delivered in the Scriptures* (anon., 1695), Locke sought to separate the essence of the teaching of Jesus from later accretions. This involved him in controversies that lasted for years, and his *Vindication,* followed by a *Second Vindication* in 1697, added fuel to this fire. Above all, the great *Essay* was assailed and often misinterpreted by philosophers and divines. John Norris, the metaphysical rector of Bemerton and English disciple of Malebranche, criticized it in 1690. Locke's second winter at Oates was partly employed in *An Examination of Malebranche's Opinion of Seeing all Things in God,* and in *Remarks upon some of Mr. Norris's Books,* tracts which throw light upon his own ambiguous theory of perception through the senses. These were published after his death. A second edition of the *Essay,* with a chapter added on "Personal Identity," and numerous alterations in the chapter on "Power," appeared in 1694. The third, a reprint, was published in 1695. Wynne's well-known abridgment helped to make the book known in Oxford, and his friend, William Molyneux, introduced it in Dublin. In 1695 a revival of controversy about the currency diverted Locke's attention. Events in that year occasioned his *Observations on Silver Money* and *Further Considerations on Raising the Value of Money.*

In 1696 Locke accepted a commissionership on the Board of Trade which entailed frequent visits to London. In the autumn of that year, Stillingfleet, bishop of Worcester, in his *Vindication of the Doctrine of the Trinity,* charged Locke with disallowing mystery in human knowledge, especially in his account of the metaphysical idea of "substance." Locke replied in Jan. 1697. Stillingfleet's rejoinder appeared in May, followed by a *Second Letter* from Locke, to which the bishop replied in the following year. Locke's *Third Letter* was delayed till 1699, in which year Stillingfleet died. One of the ablest of the other critics of the *Essay* was John Sergeant, a Catholic priest, in *Solid Philosophy Asserted Against the Fancies of the Ideists* (1697). He was followed by Thomas Burnet, Dean Sherlock and others. The *Essay* itself meanwhile spread over Europe, impelled by the name of its author as the chief philosophical defender of civil and religious liberty. The fourth edition appeared in 1700, with important additional chapters on "Association of Ideas" and "Enthusiasm." What was originally meant to form another chapter appeared among Locke's posthumous writings as *The Conduct of the Understanding,* one of his most characteristic works.

In 1700 Locke resigned his commission at the Board of Trade, and devoted himself to biblical studies and religious meditation. He turned to the Epistles of St. Paul, and applied the spirit of the *Essay* and the ordinary rules of critical interpretation to a literature which he venerated as infallible. The work, *A Paraphrase and Notes on the Epistles of St. Paul, etc.,* was published in 1706 and a tract on *Miracles,* written in 1702, also appeared posthumously. His last days were occupied in beginning a *Fourth Letter on Toleration,* never finished, in reply to an attack made by Jonas Proast in 1704. Locke died on Oct. 28, 1704, and was buried by the parish church of High Laver.

LOCKE'S WORKS

Locke's writings have made his intellectual and moral features familiar. Large, "round-about" common sense, intellectual strength directed by a virtuous purpose, not subtle or daring speculation, sustained by an idealizing faculty, is what we find in Locke. Defect in speculative imagination appears when he encounters the vast and complex final problem of the universe in its organic unity. He initiated criticism of human knowledge, and diffused the spirit of free enquiry and universal toleration which has since profoundly affected the civilized world. He has not bequeathed an imposing system, hardly even a striking discovery in metaphysics, but he is a signal example of the love of attainable truth for the sake of truth and goodness.

Social Economy.—Locke's works on social polity were written at a time when the principles of democracy and toleration were struggling with that of the divine right of kings, and when "the popular assertors of public liberty were the greatest engrossers of it too." "The state" with Locke was the outcome of free contract rather than a natural growth. He maintained that natural rights, among which he includes property and personal freedom, were in no way abrogated by the change from a state of nature to society. That the people, in the exercise of their sovereignty, have the right to govern themselves in the way they judge to be for the common good; and that civil government, whatever form it assumes, has no right to interfere with religious beliefs that are not inconsistent with civil society, is at the foundation of his political philosophy. He rested this sovereignty on virtual mutual contract on the part of the people themselves to be so governed. But the terms of the contract might be modified by the sovereign people themselves in accommodation to changing circumstances. He recommended harmonious co-operation with the civil magistrate in all matters of worship and government that were not expressly determined by Scripture. In the *Second Treatise on Government,* he maintained that civil rulers hold their power not absolutely but conditionally, government being essentially a moral trust, forfeited if the conditions are not fulfilled by the trustees. His *Treatises on Government* were meant to vindicate the Convention parliament and the English revolution, as well as to refute the ideas of absolute monarchy held by Hobbes and Filmer. They are classics in the library of English constitutional law and polity, and framed the principles afterwards embodied in the American War of Independence and the French Revolution.

Religious Views.—Locke's philosophical defence of religious liberty in the four *Letters of Toleration* show that a constant sense of the limits of human understanding was at the bottom of his arguments. He had no objection to a national establishment of religion, provided that it was comprehensive, and was organized to promote goodness; not to protect the metaphysical subtleties of sectarian theologians. The recall of the national religion to the simplicity of the Gospels would, he hoped, make toleration of Nonconformists unnecessary, as few would then remain. To the atheist Locke refuses full toleration, on the ground that social obligation can have no hold over him, for "the taking away of God dissolves all." He argued, too, against full toleration of the Roman Catholic Church in England, on the ground of its allegiance to a foreign sovereign. Belief is legitimately formed only by discernment of sufficient evidence; a man cannot determine arbitrarily what his neighbours must believe. Thus Locke's pleas rest upon his philosophical view of the foundation and limits of human knowledge.

Locke believed that he had established, philosophically, the existence of God and "natural" religion. Personally he added a sincere belief in revelation, and a profound reverence for Holy Writ. He sought for the original simplicity of Christianity and held that those who practically acknowledge the supremacy of Jesus as Messiah accept all that is essential. His own Christian belief, sincere and earnest, was more the outcome of the common sense which, largely through him, moulded the prudential theology of England in the 18th century, than of the nobler elements present in More, Cudworth and others of the preceding age.

Education.—Locke has his place among classic writers on education. In the *Thoughts on Education* imaginative sentiment is never allowed to weigh against utility; information is subordinate to the formation of useful character; the part which habit plays in individuals is always kept in view; the dependence of intelligence and character, which it is the purpose of education to improve, upon health of body is steadily inculcated; to make children happy in undergoing education is a favourite precept; accumulating facts without exercising thought, and without accustoming the youthful mind to look for evidence, is referred to as a cardinal vice. Wisdom more than much learning is what he requires in the teacher. The infinity of real existence, in contrast with the necessary finitude of human understanding and experience, is always in his thoughts. In his *Conduct of the Understanding* (posthumously published 1706) the pupil is invited to occupy the point at which "a full view of all that relates to a question" is to be had, and at which alone a rational discernment of truth is possible. The uneducated mass of mankind, he complains, either "seldom reason at all," or "put passion in the place of reason," or "direct their minds only to one part of the evidence." Hasty judgment, bias, absence of an *a priori* "indifference" to what the evidence may in the end require us to conclude, undue regard for authority, excessive love for custom and antiquity, indolence and sceptical despair are among the states of mind marked by him as most apt to interfere with the formation of beliefs in harmony with the Universal Reason that is active in the universe.

PHILOSOPHY

The well-known *Essay Concerning Human Understanding* embodies Locke's philosophy. It was the first extensive attempt to estimate critically the certainty and the adequacy of human knowledge when confronted with God and the universe. Excluding from his enquiry "the physical consideration of the mind," he sought to make a faithful report, based on an introspective study of consciousness, as to how far a human understanding of the universe can reach.

Locke saw that the ultimate questions about our knowledge and its extent *presuppose* questions about ideas. Without ideas knowledge is impossible. He uses the word *idea* in a peculiar way —"the term which, I think, stands best for whatsoever is the object of the understanding when a man thinks" or "whatever it is which the mind can be employed about." But ideas themselves are, he reminds us, "neither true nor false, being nothing but bare appearances," phenomena as we might call them. Truth and falsehood belong only to assertions or denials concerning ideas. That none of our ideas are "innate" is contended in book i. of the *Essay*. This means that the human mind, before any ideas are present to it, is a *tabula rasa*. This famous argument has been criticized as if it was a speculative controversy between empiricism and intellectualism, and for this, Locke himself is partly to blame; the phrase *tabula rasa* was misleading and seems to have been used to refute the Cambridge Platonists and Lord Herbert of Cherbury. What Locke really objects to is, that any of our supposed knowledge, even of the existence of God, or fundamental principles of morality, should claim immunity from free criticism. He believed that in attacking "innate principles" he was pleading for universal reasonableness instead of blind reliance on authority, and was thus, as he says, not "pulling up the foundations of knowledge," but "laying those foundations surer." When men heard that there were propositions that could not be doubted, it was a short and easy way to assume that what are only arbitrary prejudices are "innate" certainties.

Book ii. proposes that all human ideas, even the most complex and abstract and sublime, ultimately depend upon "experience." They come, either from the five senses or from reflective consciousness. He proposes to show that even those concerned with the Infinite depend at last on one or other of these two sources. To prove this, our thoughts of space, time, infinity, power, substance, personal identity, causality and others which "seem most remote from the supposed original" are shown to depend either on perception of things external, through the five senses, or on reflection upon operations of the mind within. Reflection, "though it be not sense, as having nothing to do with external objects," is yet, he says, "very like it, and might properly enough be called internal sense." But the suggestion that "sense" might designate *both* the springs of experience is misleading, when we find in the sequel how much Locke tacitly credits "reflection" with. The mind, in becoming gradually stored with its "simple ideas" is able to elaborate them in numberless modes; although it cannot invent or frame any new simple idea.

Qualities of Matter.—Chapter 8 of book ii. on "things and their qualities" looks like an interpolation in an analysis of mere "ideas." Locke here treats simple ideas of the five senses as qualities of outward things. And the sense data are, he finds, partly (*a*) revelations of external things themselves in their mathematical relations, and partly (*b*) sensations, boundless in variety, which are somehow awakened in us through contact with things relatively to their mathematical relations. Locke calls the former sort "primary, original or essential qualities of matter," and the others "secondary or derived qualities." The primary, which are quantities rather than qualities, are inseparable from matter, and virtually identical with the ideas we have of them. On the other hand, there is nothing perceived in the mathematical relations of bodies which in the least resembles their secondary qualities. If there were no sentient beings, the secondary qualities would cease to exist, "except perhaps as unknown modes of the primary, or, if not, as something still more obscure." On the other hand, "solidity, extension, figure and motion would," he assumes, "be really in the world as they are, whether there were any sensible being to perceive them or not." Thus Locke teaches that matter is something capable of being expressed in terms of mathematical quantity, and also in terms of our own sensations. A further step was to suggest the ultimate dependence of the secondary qualities of bodies upon "the bulk, figures, number, situation and motions of the solid parts of which the bodies consist," these mathematical or primary qualities "existing as we think of them whether or not they are perceived."

Chapters 13–28 of bk. ii. concern what may be called "crucial instances" in verification of its fundamental hypothesis of the dependence of human knowledge upon the simple ideas presented in our dual experience. Space, he says, appears when we use our senses of sight and touch; succession he finds "suggested" by all the changing phenomena of sense, and by "what passes in our minds"; number is "suggested by every object of our senses, and every thought of our minds, by everything that either doth exist or can be imagined." The modifications of which these are susceptible he reports to be "inexhaustible and truly infinite, extension alone affording a boundless field to the mathematicians." But the mystery latent in our ideas of space and time is, that "something in the mind" irresistibly hinders us from allowing the possibility of any limit to either. Thus Locke seems by implication to acknowledge something added by the mind to the original "simple ideas" of extension and succession; though he finds that what is added is not positively conceivable.

Substance and Causality.—Locke is too faithful to facts to overlook the ultimate mysteries in human experience. This is illustrated in his acknowledgment of the inconceivable that is at the root of our idea of Substance which he admits cannot be resolved into a mere succession of phenomena. The phenomena must be attributed to something, but he was perplexed by this "confused negative" idea. So for him the word substance means "only an uncertain supposition of we know not what." Our only positive idea is of an aggregate of phenomena.

Locke's thoughts about Causality and Active Power are especially noteworthy, for he rests our knowledge of God and of the external universe on those ultimate ideas. He is content to trace the idea of "cause and effect," to our "constant observation" that "qualities and finite substances begin to exist, and receive their existence from other beings which produce them." We find that this connection is what gives intelligibility to ceaseless and what seemed chaotic changes. Locke seems hardly to realize all that is implied in scientific prevision or expectation of change. Anything, as far as "constant observation" tells us, might *a priori* have been the natural cause of anything; and no finite number of "observed" sequences, *per se,* can guarantee universality and necessity. The idea of power, or *active* causation, on the other hand, "is got," he acknowledges, not through the senses, but "through our consciousness of our own voluntary agency, and therefore through reflection" (bk. ii. ch. 21). In bodies we observe no active agency, only a sustained natural order in the succession of passive sensuous phenomena. The true source of change in the material world must be analogous to what we are conscious of when we exert volition. Locke here unconsciously approaches the spiritual view of active power in the physical universe afterwards taken by Berkeley.

Ideas and Words.—The third book is concerned with Words, or the sensible signs of ideas. Here he analyses "abstract ideas," and instructively illustrates the confusion apt to be produced in them by the inevitable imperfection of words. He unfolds the relations between verbal signs and the several sorts of ideas; words being the means for enabling us to treat ideas as typical, abstract and general.

Fourfold Classification of Knowledge.—Bk. iv. on Knowledge proper and Probability describes knowledge as perception of relations among ideas; it is expressed in our affirmations and negations; and real knowledge is discernment of the relations of ideas to what is real. Here he is concerned with intuitive "judgment" and demonstrative "reasoning," also with judgments and reasonings about matters of fact and the narrow extent of knowledge. Knowledge is concerned either with (*a*) relations of identity and difference among ideas, as when we say that "blue is not yellow"; or (*b*) with mathematical relations, as that "two triangles upon equal bases between two parallels must be equal"; or (*c*) in assertions that one quality does or does not coexist with another in the same substance, as that "iron is susceptible of magnetical impressions, or that ice is not hot"; or (*d*) with ontological reality, independent of our perceptions, as that "God exists" or "I exist" or "the universe exists." The first sort is analytical; mathematical and ethical knowledge represents the second; physical science forms the third; real knowledge of self, God and the world constitutes the fourth.

Of these four knowable relations, which are strictly known either by mathematical demonstration or by intuition, the first is the only one in which our knowledge is coextensive with our ideas; we cannot be conscious at all without distinguishing, and every affirmation necessarily implies negation. The second sort of knowable relation is sometimes intuitively and sometimes demonstrably discernible. Morality, Locke thinks, as well as mathematical quantity, is capable of being demonstrated. Turning to concrete relations of coexistence and succession among phenomena—the third set of knowable relations—Locke finds the light of pure reason disappear; although these relations form "the greatest and most important part of what we desire to know." Man cannot attain perfect and infallible science of bodies. For natural science depends on knowledge of the relations between their secondary qualities on the one hand, and the mathematical qualities of their atoms on the other, or else "on something yet more remote from our comprehension." Now, as perception of these atoms and their relations is beyond us, we must be satisfied with inductive presumptions, for which "experimental verification" affords, after all, only conclusions that wider experience may prove inadequate.

Our knowledge under Locke's fourth category of relations—real existence—includes (*a*) intuitive perceptions of our own existence; (*b*) demonstrable certainty of the existence of God; and (*c*) actual perception of the existence of surrounding things, as long as, but only as long as the things are present to sense. "If I doubt all other things, that very doubt makes me perceive my own existence" (iv. 9. 3). Faith in the existence of God is virtually with Locke an expression of faith in the principle of active causality in its ultimate universality. Each person knows that he now exists, and is convinced that he had a beginning; with not less intuitive certainty he knows that "*nothing* can no more produce any real being than it can be equal to two right angles." His final conclusion is that there must be eternally "a most powerful and most knowing Being, in which, as the origin of all, must be contained all the perfections that can ever after exist," and out of which can come only what it has already in itself; so that as the cause of my mind, it must be Mind. There is thus causal necessity for Eternal Mind, or what we call "God." But the immanence of God in the universe is a conception foreign to Locke, whose habitual conception was of an extra-mundane deity. For Locke, nearly all that one can affirm or deny about "things external" is not knowledge but venture or presumptive trust. We have, strictly speaking, no "knowledge" of real beings beyond our own self-conscious existence, the existence of God, and the existence of objects of sense as long as they are actually present to sense. Accordingly, purely rational science of external Nature is, according to Locke, impossible. All our "interpretations of nature" are inadequate; only reasonable probabilities, not final rational certainties.

It was Locke's distinction to present to the modern world, in his own "historical plain method," perhaps the largest assortment ever made by any individual of facts characteristic of human understanding. Criticism of the presuppositions implied in those facts—by Kant and his successors, and in Britain more unpretentiously by Reid, all under the stimulus of Hume's sceptical criticism—has employed philosophers since Locke in the *Essay Concerning Human Understanding* collected materials that raised deeper philosophical problems than he tried to solve. Locke's mission was to initiate modern criticism of the foundation and limits of our knowledge. Hume negatively, and the German and Scottish schools constructively, continued what it was Locke's glory to have begun.

Bibliography.—There are numerous editions of Locke's collective works. The *Essay Concerning Human Understanding* has passed through some 40 editions (including that of A. C. Fraser, 2 vols., Oxford, 1894), besides being often translated and abridged, notably by A. S. Pringle-Pattison (1924). The two treatises *On Civil Government* were published in Everyman's Library (1924), and *The Educational Writings* were edited by J. W. Adamson (1912; 2nd ed., 1922). H. Ollion has published *Lettres Inédites de J. Locke à Nicholas Thoynard, Philip van Limborch et Edward Clarke* (1912), and B. Rand has edited *The Correspondence of Locke and Edward Clarke,* with a good biographical study (1927).

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LOCKE, MATTHEW (*c.* 1630–1677), English musician, perhaps the earliest English writer for the stage, was born at Exeter, where he became a chorister in the cathedral. His music, written with Christopher Gibbons (son of Orlando Gibbons), for Shirley's masque *Cupid and Death,* was performed in London in 1653. He wrote some music for Davenant's *Siege of Rhodes* in 1656; and in 1661 was appointed composer in ordinary to Charles II. During the following years he wrote a number of anthems for the Chapel Royal, and excited some criticism on the score of novelty, to which he replied with considerable heat (*Modern Church Music; pre-accused, censured and obstructed in its Performance before His Majesty, April 1st, 1666, etc.;* copies in the Fitzwilliam Museum, Cambridge, and the Royal College of Music). A good deal of music for the theatre followed, the most important being for Davenant's productions of *The Tempest* (1667) and of *Macbeth* (1672), but some doubt as to this latter has arisen, Purcell Eccles or Leveridge, being also credited with it. He also composed various songs and instrumental pieces, and published some curious works on musical theory. He died in August 1677, an elegy being written by Purcell.

LOCKE, WILLIAM JOHN (1863–1930), English novelist and playwright, born on March 20, 1863 in Georgetown, Demerara, was educated at Trinidad and St. John's, Cambridge. He died at Paris on May 15, 1930.

He wrote *The Morals of Marcus Ordeyne* (1905); *The Beloved Vagabond* (1906, dramatized 1908); *Stella Maris* (1913); *The Wonderful Year* (1916); *The Rough Road* (1918); *The House of Baltazar* (1920); *The Mountebank* (1921); *The Coming of Amos* (1924); *The Great Pandolfo* (1925); *The Old Bridge* (1926); *Ancestor Jorico* (1929). His original plays include *Mr. Cynic* (1899); *The Lost Legion* (1900); and *The Man from the Sea* (1910).

LOCKERBIE, a small burgh, Dumfriesshire, Scotland, district of Annandale, 14½ mi. E.N.E. of Dumfries by the L.M.S.R. Pop. (1938) 2,640. Area, .7 sq.mi. It is famous for its sheep sales, particularly for the great August lamb fair. It contains an ancient tower, once the stronghold of the Johnstones, long the ruling family under whose protection the town grew up. At Dryfe Sands, about 2 mi. W., the Maxwells were almost exterminated by the Johnstones in 1593, hence "Lockerbie Lick" became a proverbial expression, signifying an overwhelming defeat.

LOCKER-LAMPSON, FREDERICK (1821–95), English man of letters, was born on May 29, 1821, at Greenwich hospital, son of Edward Hawke Locker, the civil commissioner of the hospital. He became deputy-reader and *précis* writer at the admiralty. In 1850 he married Lady Charlotte Bruce, daughter of Lord Elgin. After his marriage he left the Civil Service, in consequence of ill-health. He published *London Lyrics* (1857); *Lyra Elegantiarum* (1867), an anthology of light and familiar verse; and *Patchwork* (1879), a book of extracts. In 1872 Lady Charlotte Locker died. Two years later Locker married Hannah Jane Lampson, and in 1885 took his wife's surname. At Rowfant he died on May 30, 1895. Locker delighted a wide circle of friends by his gifts as a host and *raconteur*. His books are catalogued in the volume called the *Rowfant Library* (1886), to which an appendix (1900) was added by his eldest son.

See his *My Confidences* (1896), edited by his son-in-law, Augustine Birrell.

LOCKHART, GEORGE (1673–1731), of Carnwath, Scottish writer and politician, son of Sir G. Lockhart (d. 1689), lord president of the court of session, was member for the city of Edinburgh in the Scottish parliament and was appointed a commissioner for arranging the union with England in 1705. After the union he continued to represent Edinburgh, and later the Wigton burghs. His sympathies were with the Jacobites, whom he kept informed of all the negotiations for the union; in 1713 he took part in an abortive movement aiming at the repeal of the union. He was deeply implicated in the rising of 1715, the preparations for which he assisted at Carnwath and at Dryden, his Edinburgh residence. He was imprisoned in Edinburgh castle, but probably, through the favour of the duke of Argyll, he was released without being brought to trial; but his brother Philip was taken prisoner at the battle of Preston and condemned to be shot, the sentence being executed on Dec. 2, 1715. After his liberation Lockhart became a secret agent of the Pretender; but his correspondence with the prince fell into the hands of the government in 1727, compelling him to go into concealment at Durham until he was able to escape abroad. Argyll's influence was again exerted in Lockhart's behalf, and in 1728 he was permitted to return to Scotland. On Dec. 17, 1731, he was killed in a duel.

Lockhart was the author of *Memoirs of the Affairs of Scotland*, dealing with the reign of Queen Anne till the union with England, first published in 1714. These *Memoirs*, together with Lockhart's correspondence with the Pretender, and one or two papers of minor importance, were published in two volumes in 1817, forming the well-known "Lockhart Papers," a valuable authority for the history of the Jacobites.

See *The Lockhart Papers* (2 vols., 1817); Andrew Lang, *History of Scotland* (4 vols., 1900). For Sir Simon Lockhart's adventures with the heart of the Bruce, *see* Sir Walter Scott, *The Talisman*.

LOCKHART, JOHN GIBSON (1794–1854), Scottish writer and editor, was born on July 14, 1794, in the manse of Cambusnethan in Lanarkshire. At 12 he moved from the Glasgow high school to the university, and at 14 entered Balliol college, Oxford. He read French, Italian, German and Spanish, was interested in classical and British antiquities, and became versed in heraldic and genealogical lore. In 1813 he took a first class in classics in the final schools. For two years after leaving Oxford he lived chiefly in Glasgow before settling to the study of Scottish law in Edinburgh, where he was called to the bar in 1816. A tour on the Continent in 1817, when he visited Goethe at Weimar, was made possible by Blackwood, who advanced money for a promised translation of Schlegel's *Lectures on the History of Literature* (1838). In 1817 the Scottish Tories founded *Blackwood's Magazine*. After a somewhat hum-drum opening, *Blackwood* suddenly electrified the Edinburgh world by an outburst of brilliant criticism. John Wilson (Christopher North) and Lockhart had joined its staff in 1817. Lockhart no doubt took his share in the caustic and aggressive articles which marked the early years of *Blackwood;* but he was not responsible for the virulent articles on Coleridge and on "The Cockney School of Poetry," *i.e.*, on Leigh Hunt, Keats and their friends. He has been persistently accused of the later *Blackwood* article (Aug. 1818) on Keats, but he showed at any rate a real appreciation of Coleridge and Wordsworth. He contributed to *Blackwood* many spirited translations of Spanish ballads, which in 1823 were published separately. In 1818 he met Sir Walter Scott, and the acquaintance soon ripened into an intimacy which resulted in a marriage between Lockhart and Scott's eldest daughter Sophia, in April 1820. The Lockharts spent the winters in Edinburgh and the summers at a cottage at Chiefswood, near Abbotsford. In 1820 John Scott, the editor of the *London Magazine,* wrote a series of articles attacking the conduct of *Blackwood's Magazine,* and making Lockhart chiefly responsible for its extravagances. A correspondence followed, in which a meeting between Lockhart and John Scott was proposed, with Jonathan Henry Christie and Horace Smith as seconds. After complicated negotiations, a duel was fought in 1821 between Christie and Scott, in which Scott was killed.

Between 1818 and 1825 Lockhart worked indefatigably. In 1819 *Peter's Letters to his Kinsfolk* appeared, and in 1822 he edited Peter Motteux's edition of *Don Quixote,* to which he prefixed a life of Cervantes. Four novels followed, the best of which is *Adam Blair* (1822). In 1825 Lockhart became editor of the *Quarterly Review*. He contributed largely himself. He showed the old railing spirit in an amusing but violent article in the *Quarterly* on Tennyson's *Poems* of 1833, in which he failed to discover the mark of genius. He continued to write for *Blackwood;* he produced for *Constable's Miscellany* in 1828 what remains the most charming of the biographies of Burns; also he superintended *Murray's Family Library,* the opening volume being his *History of Napoleon* (1829).

But his *magnum opus* was the *Life of Sir Walter Scott* (7 vols., 1837–38; 2nd ed., 10 vols., 1839). Lockhart was taxed in some quarters with ungenerous exposure of his subject, but to most minds the impression conveyed by the biography was, and is, quite the opposite. Carlyle did justice to many of its excellencies in a criticism contributed to the *London and Westminster Review* (1837). Lockhart's account of the transactions between Scott and the Ballantynes and Constable caused great outcry; and in the discussion that followed he showed unfortunate bitterness by his pamphlet, "The Ballantyne Humbug handled." The *Life of Scott* has been called, after Boswell's *Johnson,* the most admirable biography in the English language. Lockhart resigned its proceeds for the benefit of Scott's creditors.

The close of Lockhart's life was saddened by family bereavement, resulting in his own breakdown in health and spirits. His eldest boy (the suffering "Hugh Littlejohn" of Scott's *Tales of a Grandfather*) died in 1831; Scott himself in 1832; Mrs. Lockhart in 1837; and the surviving son, Walter Lockhart, in 1852. Resigning the editorship of the *Quarterly Review* in 1853, he wintered in Rome, and being taken to Abbotsford by his daughter Charlotte (Mrs. James Robert Hope-Scott), he died there on Nov. 25, 1854. He was buried near Scott, in Dryburgh Abbey.

Lockhart's *Life* (2 vols., 1897) was written by Andrew Lang. A. W. Pollard's edition of the *Life of Scott* (1900) is the best.

LOCKHART, SIR WILLIAM, of Lee (1621–1675), eldest son of Sir James Lockhart of Lee (afterwards Lord Lee) (d.

1674), after fighting on the king's side in the Civil War attached himself to Cromwell, whose niece he married. He was appointed commissioner for the administration of Justice in Scotland in 1652, and ambassador to France in 1656.

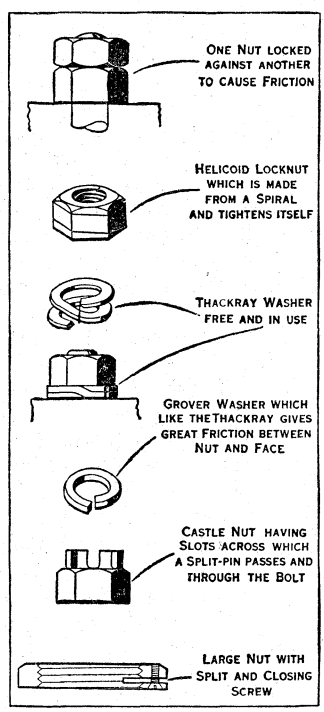
LOCKHART, SIR WILLIAM STEPHEN ALEXANDER (1841–1900), British general, was born in Scotland on Sept. 2, 1841, his father being a Lanarkshire clergyman. He entered the Indian army in 1858, in the Bengal native infantry. He served in the Indian Mutiny, the Bhutan campaign (1864–66), the Abyssinian expedition (1867–68), the Hazara Black Mountain expedition (1868–69). From 1869 to 1879 he acted as deputy-assistant and assistant quartermaster-general in Bengal. In 1877 he was military attaché with the Dutch army in Acheen. He served in the Afghan War of 1878–80, and commanded a brigade in the Third Burmese War (1886–87). An attack of fever brought him to England, where he was employed as assistant military secretary for Indian affairs; but in 1890 he returned to India to take command of the Punjab frontier force, and for five years was engaged in various campaigns including the Waziristan campaign in 1894–95. He became full general in 1896, and in 1897 he conducted the difficult Tirah campaign. In 1898 he was commander-in-chief in India. Lockhart had a great gift for dealing with the tribesmen, who called him Amir Sahib. He died on March 18, 1900.

LOCK HAVEN, a city of central Pennsylvania, U.S.A., on the west branch of the Susquehanna river, 70m. N.N.W. of Harrisburg; the county seat of Clinton county. It is on Federal highways 105, 120 and 220, and is served by the New York Central and the Pennsylvania railways. The population was 8,557 in 1920, 9,668 in 1930 and 10,810 in 1940 by the federal census. The city is surrounded by fertile cultivated valleys and beautiful mountain scenery. It is the seat of a state teachers college (opened 1877). Fireclay, shale and coal abound in the vicinity. The principal industry is the manufacture of paper for the Curtis Publishing company of Philadelphia. Other products of importance are brick, leather, silk, lumber and furniture. A town was founded there in 1833, and the name was suggested by the locks of the Pennsylvania canal (completed to this point in 1834) and the harbour, or haven, for rafts in the river. It was incorporated as a borough in 1840 and chartered as a city in 1870. It has adopted the commission form of government.

LOCKJAW: *see* TETANUS.

LOCKLAND, a city of Hamilton county, Ohio, U.S.A., 12 mi. N. of Cincinnati. It is served by the Baltimore and Ohio, the Big Four and the Erie railways. The population was 5,703 in 1930; 5,601 in 1940. Lockland has a number of manufacturing plants, making cotton goods, paper, asbestos products, steel and composition roofing. It was settled about 1800.

LOCK-NUT. Whenever a nut on a bolt or stud or shaft is subjected to vibration it is likely to work loose; therefore, in the majority of prime movers and power-driven machinery, lock-nuts are to be found. These either give a frictional grip sufficient to withstand jarring loose, or a positive lock. An expensive or delicate type is not admissible, hence the standard devices are limited in number, notwithstanding that patents for nuts are being taken out constantly. The familiar double nut device gives great friction of one face against the other and of the threads. The helicoid nut is used alone, and is made as a spiral spring, slightly small in the threaded hole. When run down with a wrench or spanner (British term) the coil is slightly sprung apart, and on touching the face of the object becomes powerfully compressed. The Dardelet creates friction between bolt and nut by a taper incorporated in the thread form. The Thackray washer gives friction under the nut, by its compression. The Grover washer has one coil. For fastenings where there must be no possible risk, either a split-pin is passed through a hole drilled through nut and bolt, or in the portion of bolt standing above the nut. Or a slotted nut is employed, giving the choice of different distances up and down the bolt, the split-pin passing through the bolt always at one place. The castle nut has the slots cut in a projecting portion above the nut proper. Other devices include a plate with corner turned up to catch against a flat of the nut and prevent rotation, a piece of wire hooked in a hole in the nut and its end caught in a slot in the bolt, or a loop sprung around into a groove in the nut and then into a hole in the bolt. Many large nuts are locked with a lateral screw passed through to press on the bolt, while another way is to partly saw through the nut and tighten the split with a screw, so causing friction of the threads on the bolt.



STANDARD LOCKNUTS USED ON MACHINERY SUBJECT TO VIBRATION

LOCKOUT: *see* STRIKES AND LOCK-OUTS.

LOCKPORT, a city of Will county, Illinois, U.S.A., 33 mi. S.W. of Chicago, on the Des Plaines river, at the end of the Chicago Sanitary and Ship canal, which has its controlling works and a hydroelectric plant there. Pop. in 1940 was 3,475. It is in a picturesque farming region, and has various manufactures. A settlement was made there about 1827. In 1837 it was chosen for the headquarters of the Illinois and Michigan canal, and a village was laid out. In 1892 work was begun on the Chicago Drainage (later renamed Sanitary and Ship) canal, which was opened in 1900. The city was incorporated in 1904.

LOCKPORT, city, western New York, U.S.A., 25 mi. N. by E. of Buffalo, on the State Barge (formerly the Erie) canal; the county seat of Niagara county. It is served by the Erie and the New York Central railways. The population was 21,308 in 1920 (84% native white) and was 24,379 in 1940 by the federal census. The city owes its name to the five double locks of the canal, which overcome the difference (66 ft.) between the level of Lake Erie and that of the Genesee river. It has abundant water power, and electric energy from Niagara. The manufactures, valued at $50,000,000, include flour, pulp and paper, wallboard, plastics, textiles, brooms, glass, steel, automobile radiators and parts and machinery; there are limestone quarries; and the district is noted for its apples, peaches and grain. The site of Lockport was in the tract bought by the Holland company (1792–93). Most of it was sold about 1816 to Esek Brown, the proprietor of a local tavern, and 14 others, but there were few settlers until after 1820. In 1822 the town was made the county seat, and in 1823 it became the temporary headquarters for construction on the Erie canal. It was incorporated as a village in 1829 and as a city in 1865.

LOCKROY, EDOUARD (1840–1913), French politician, son of Joseph Philippe Simon (1803–91), an actor and dramatist, who took the name of Lockroy, was born in Paris on July 18, 1838, and died on Nov. 22, 1913. In 1860 he enlisted as a volunteer under Garibaldi. The next three years were spent in Syria as secretary to Ernest Renan, and on his return to Paris he embarked in militant journalism against the Second empire in the *Figaro,* the *Diable à quatre,* and eventually in the *Rappel.* He commanded a battalion during the siege of Paris, and in Feb. 1871 was elected deputy to the National Assembly, where he sat on the extreme left. In March he signed the proclamation for the election of the Commune, and resigned his seat as deputy. He sat in the Chamber for various constituencies from 1873 onwards and from 1885 to 1887 he was minister of commerce. For the first ten years of his parliamentary life he voted consistently with the extreme left, but then adopted a more opportunist policy, and gave his unreserved support to the Brisson ministry of 1885. In the new Freycinet cabinet formed in January he held the portfolio of commerce and industry, which he retained in the Goblet ministry of 1886–87. In 1885 he had been returned at the head of the poll for Paris, and his inclusion in the Freycinet ministry was taken to indicate a prospect of reconciliation between Parisian Radicalism and official Republicanism. Lockroy made the preliminary arrangements for the exposition of 1889, and in a witty letter defended the erection of the Tour Eiffel against artistic Paris. After the Panama and Boulangist scandals he became one of the leading politicians of the Radical party. He was minister of marine in successive cabinets, and was a persistent and successful advocate of a strong naval policy, in defence of which he published *La Marine de Guerre* (1890), *La Défense navale* (1900) and other works. He also wrote *M. de Moltke, ses mémoires et la guerre future* (1891), *Journal d'une bourgeoise pendant la Révolution* (1881) and his reminiscences, *Au hasard de vie* (1912).

LOCKWOOD, WILTON (1861–1914), American painter, born at Wilton, Conn., on Sept. 12, 1861. He was a pupil and an assistant of John La Farge, and also studied in Paris, becoming a well-known portrait and flower painter. He became a member of the Society of American Artists (1898) and of the Copley Society, Boston, and in 1912 was elected to the National Academy of Design. He died at Brookline, Mass., on March 20, 1914.

LOCKYER, SIR JOSEPH NORMAN (1836–1920), English astronomer, was born at Rugby on May 17, 1836. After completing his education on the Continent of Europe, he obtained a clerkship in the War Office in 1857. His leisure was devoted to the study of astronomy, and he was appointed in 1870 secretary to the duke of Devonshire's royal commission on science. In 1875 he was transferred to the Science and Art Department at South Kensington, and on the foundation of the Royal College of Science he became director of the solar physics observatory and professor of astronomical physics. Eight British Government expeditions for observing total solar eclipses were conducted by him between 1870 and 1905, accounts of them being given in his *Recent and Coming Eclipses* (1897 and 1900) He was a pioneer in the application of the spectroscope to the sun and stars. He initiated in 1866 the spectroscopic observation of sunspots; announced in 1868 that the prominences were upheavals in a layer round the sun which he called the chromosphere; applied Doppler's principle to the sun in 1869; and successfully investigated the chemistry of the sun from 1872 onward. In 1868 Lockyer and Janssen, working independently, discovered a spectroscopic method whereby the solar prominences could be observed in daylight, whereas previously they could be observed only at a total eclipse. To commemorate this discovery a medal bearing the names of both astronomers was struck by the French Government in 1872. With the co-operation of Lady Lockyer he had built an observatory at Sidmouth and carried on there his photographic and spectroscopic work. After Lockyer's death this observatory was named the "Norman Lockyer Observatory." He was an enthusiast, inaugurating *Nature* in 1869, which he edited until his death on Aug. 14, 1920. He was made a F.R.S. in 1869, received the Rumford medal in 1874, and was vice-president of the Society 1892–93. He was president of the British Association in 1903, and contributed papers to the Royal Society and Royal Astronomical Society. Also, he wrote: *The Chemistry of the Sun* (1887); *The Sun's place in Nature* (1897); *The Dawn of Astronomy* (1894); *Stonehenge and other British Stone Monuments astronomically considered* (1906); *Inorganic Evolution* (1900).

See T. M. and W. L. Lockyer, *Life and Work of Sir Norman Lockyer* (1928).

LOCLE, LE, a town in the Swiss canton of Neuchâtel, 24 m. by rail W.N.W. of Neuchâtel, 5 m. S.W. of La Chaux de Fonds, and with a narrow gauge railway to Les Brenets. It is built (3,035 ft. above the sea-level) on the Bied stream in a valley of the Jura, and is about 1 m. from the French frontier. In 1681 Daniel Jean Richard introduced watch-making here, which soon drove out all other industries, and there is also a school of watch-making. In 1930 the population was 12,001, mainly Protestants and French-speaking. The church tower dates from 1521, but the old town was destroyed by fire in 1833. The valley in which the town is situated used to be subject to inundations, but in 1805 a tunnel was constructed by means of which the surplus waters of the Bied are carried into the Doubs

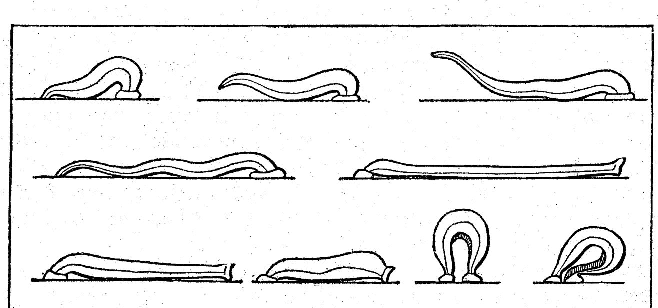
LOCMARIAQUER, a village of western France, on the west shore of the Gulf of Morbihan, in the department of Morbihan, 8½ mi. S. of Auray by road. Pop. (1936) 602. Locmariaquer has a small port, and oyster culture is carried on close to it. Roman remains are to be seen, but the place owes its fame to the very large megalithic monuments in the vicinity. A great menhir, broken into four pieces by lightning in the 18th century, measured about 67ft. in height, and from 9 to 13ft. in thickness.

LOCOMOTION OF ANIMALS. It is characteristic of animals that they can move about in search of food, foothold and mates, or away from enemies and hurtful influences; this locomotion is effected in a great variety of ways. Among multicellular animals there are four chief methods, which, following F. W. Gamble, may be illustrated by picturing a man in a boat.

Pulling.—The man may reach forward with a boathook, fasten it to some prominence like a tree-root, and pull the boat forwards. This is the pulling method, and is well illustrated by leeches and starfishes. When looping along, the leech exhibits (*see* fig.) the following order: Fixing its mouth and loosening the posterior sucker, it pulls its body forward, contracting its longitudinal muscles. At the end of this process the posterior sucker has been brought forward almost to touch the margin of the mouth, and the body is arched upwards like a croquet hoop. Then the posterior sucker being fixed, the mouth is freed, and the body is protruded forwards to a new position of oral attachment. This protrusion is effected by a contraction of circular and diagonal muscles, which squeeze the body forward. The mouth is re-attached, the posterior sucker is loosened, and the sequence re-begins.

Punting.—The man may stand up in the boat and use a pole as a lever, pressing it against the floor of the stream. This "punting" is one of the commonest modes of animal locomotion, being exhibited by all the diverse types that have firm appendages useable as levers against a base. A beetle hurrying across the roadway, a crab walking over a rock, a frog jumping among the grass, an ostrich sprinting at full speed, a man walking—all are using levers which propel the body forwards by pressing against a hard substratum. Sometimes there are complications, which do not essentially affect the principle of the method employed. Thus the freshwater mussel may make its flabby "foot" tense with blood, close a sphincter muscle which prevents backflow, and then pull the ploughshare-like organ backwards against the sand, thus pushing its body forwards. The foot has to be protracted before the next step is taken. This method approaches pulling.

The movements of snakes are somewhat intricate. A rapid dart forward may be effected by a sudden straightening of one or more of the bays of the sinuous body, but let us take the ordinary



FROM HESSE, "TIERBAU UND TIERLEBEN" (TUEBNER)

DRAWINGS SHOWING THE MOVEMENTS OF A LEECH

smoothly continuous progression. Except in burrowing snakes the ventral surface is covered by a single series of large scales, which can be raised and lowered. The posterior margins of these scales are sharp, strong and imbricating. When raised, which is effected by special muscles, they catch on roughnesses on the ground. Into the sides of these large ventral scales the lower ends of the ribs are attached by minute ligaments, and the upper ends are connected to the vertebrae by articulations which allow them ready movement forwards and backwards. Several ribs are drawn forwards by muscles and move the associated scales a minute distance headwards, a whole series of ribs and scales working simultaneously in the same direction. Then these ribs are drawn backwards, and the pressure of the raised scales against the hard ground pushes the body forwards. While one series of ribs is being drawn backwards, another series is being drawn forwards, and thus a continuous flowing movement is brought about. This case is perhaps intermediate between "punting" and "rowing."

Sculling.—The man in the boat may stand in the stern and "scull," using a single oar to displace masses of water alternately to right and left. This is a common method among swimming animals, such as fishes and whales. In most fishes the swimming organ is the post-anal body, which consists almost entirely of strong W-shaped blocks of muscle, dovetailed into one another, and centred in the flexible backbone. By alternately bending and straightening the posterior body, masses of water are displaced, and thus the fish is propelled forwards. In cetaceans locomotion is similar, but a complication is introduced by the adaptive shape of the tail-flukes. In true seals (Phocidae) the hind-limbs are permanently turned backwards and bound up with the short tail, forming a unified functional propeller. The principle is the same in cases like sea-snakes and swimming leeches, where the gripping of the water and the using of it as a resistant mass, against which to contract, extend over the whole length of the body.

Rowing.—Fourthly, the man in the boat may row, the principle being the simultaneous exertion of pressure on each side. Thus the platypus rows in the water with its webbed fore-feet, and the turtle with its paddles. Rowing in the air is the essence of flight in birds, bats and insects, though here part of the energy must be expended in keeping the body from sinking. Brittle stars or ophiuroids sometimes strike the sand with their posterior arms and may be said to row along the solid substratum, and in the mole's rapid turning in the ground the fore-limbs are used like oars as if the animal was rowing in the ground. The insect known as the water boatman (*Notonecta*) swims back-downward in the pool, using its long third pair of legs as oars. In many of the auk family the wings are used as well as the feet in swimming under water.

Other Methods.—The analogy of the man in the boat becomes somewhat forced when applied to out-of-the-way modes of animal locomotion, of which a few examples may be given. A jellyfish swims by alternately expanding and contracting the disc-like or bell-like body. The rapid contraction drives the water out from the mouth of the bell, and the medusa is propelled in the opposite direction. Cuttlefishes expand their mantle cavity, and having filled it with water proceed to close it by a hook-and-eye contrivance, so that the water cannot leave by the way it entered, but is forced, as the cavity contracts, through a narrow funnel. As the jet comes out with considerable strength, the body is driven rapidly through the water, with the head and tentacles in the wash. The same method of propulsion by a posterior outgush of water is seen in larval dragon-flies. Somewhat unusual, again, is the way in which lobsters jerk themselves tail-foremost in the water by suddenly flexing the posterior body (abdomen) forwards and downwards. This displaces a mass of water towards the head. On occasion the common scallop (*Pecten*) can jerk itself off the sea-floor with an energetic snap of its shell-valves, and continue swimming thus for some time.

In some ways the strangest mode of animal locomotion is exhibited by the common sea-urchin (*Echinus*) on a firm flat surface. This animal habitually moves by means of its tube-feet, and also utilizes its spines, which are swayed on ball-and-socket joints by basal muscles. But *Echinus* is also able to tumble along on the tips of the five teeth of Aristotle's lantern which project out of the mouth. The lantern can be swayed from side to side by powerful muscles, and the locomotion is a stumbling along on the tips of the teeth. The track shows at short intervals the indentations of the teeth, and marks of spines in between.

Mechanism of Locomotion.—The movements of most multicellular animals are effected by muscles, and there is an important distinction between the unstriped or smooth muscle of sluggish animals, such as tapeworms, and the striped or striated muscle of ordinary active animals (*see* MUSCULAR SYSTEM, ANATOMY OF). Unstriped muscle consists of homogeneous spindle-shaped cells, closely fitting, each with a single nucleus. Ordinary striped muscle is composed of elongated cross-striped cells, usually with many nuclei, which are sometimes situated peripherally, as in man; sometimes embedded in the muscle-substance, as in the frog. A striped muscle-cell is usually a single cell; but in some cases it seems to be due to longitudinal fusion of several cells. The most important general fact is that unstriped muscles contract slowly, and are therefore found in sluggish animals, and in the slowly moving parts of active animals, as the walls of the food-canal and arteries. Apart from these and similar exceptions, the muscle-fibres in active animals are cross-striped and quickly contracting. Some of the lower animals such as turbellarian and nemertean worms are aided greatly by superficial cilia. The last occurrence of these superficial cilia as locomotor structures is in newly hatched tadpoles.

Among unicellular organisms locomotion is effected by flagella, by cilia, by myonemes and in an amoeboid fashion. Each flagellum or cilium is a thread of protoplasm, sometimes with an axial filament. It is alternately flexed and straightened, as one might bend one's arm at the elbow and elongate it again. It is interesting to notice that among multicellular animals cilia are very common, from the lowest to the highest, except in nematodes and arthropods, where the abundant chitin apparently precludes their development. As has been mentioned, the turbellarian and nemertean worms are covered with cilia, which assist in locomotion; but above the level of these two classes, cilia cease to be locomotor except in larval forms, like the trochospheres of marine annelids and molluscs. Starfishes and some other echinoderms are richly provided with external cilia, but these are used for wafting food-particles, not for locomotion. Above nemerteans cilia become of great internal importance, for they may line a windpipe, an excretory tube, a female genital duct and so forth. Myonemes are contractile plasmic threads, anticipations of muscle-fibres, but intracellular. An instance of their occurrence is the axial filament inside the non-contractile sheath of the stalk of the bell-animalcule (*Vorticella*).

Amoeboid movement, probably the most primitive mode of animal locomotion, has been much studied; but it is difficult to form a clear picture of what happens. An ordinary *Amoeba*, a naked blob of living matter, protrudes blunt finger-like processes and draws others in, continually altering its shape but not its volume. It glides along at the rate of about ¾ in. an hour. It is probably in some way gripping the substratum by a very delicate external plasma-membrane, which is continually giving way anteriorly, and being re-instated posteriorly. This film is the seat of surface-tension effects, and the tension seems to increase anteriorly and decrease posteriorly. But attentive scrutiny shows that the *Amoeba* is rather rolling than gliding. For a definitely recognizable particle may be seen moving along the upper surface of the cell, in the direction in which the *Amoeba* is moving, then disappearing over the front, and, after a while, re-appearing at the posterior end; and so *da capo,* as if there were a "caterpillar-wheel"-like movement. Moreover, there is a deeper protoplasmic streaming, connected with intricate physical and chemical changes. There are indications of rapid changes of the protoplasm from "sol" to "gel" states and back again. It is very interesting to notice that this most primitive mode of locomotion is retained in varied expression even in higher animals, *e.g.,* in the outgrowing tip of embryonic nerve-cells and in the excursions of phagocytes.

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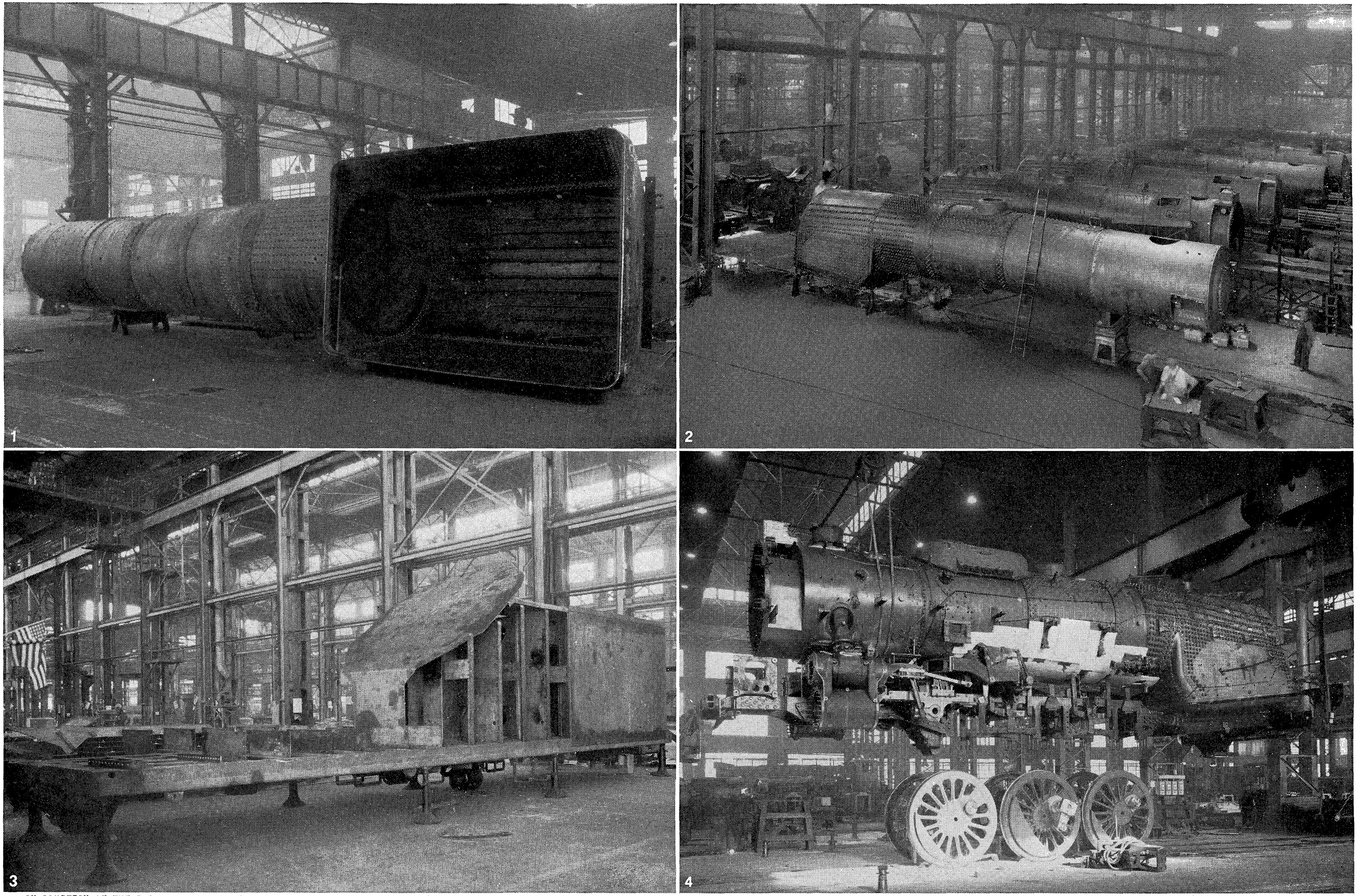
(J. A. TH.)

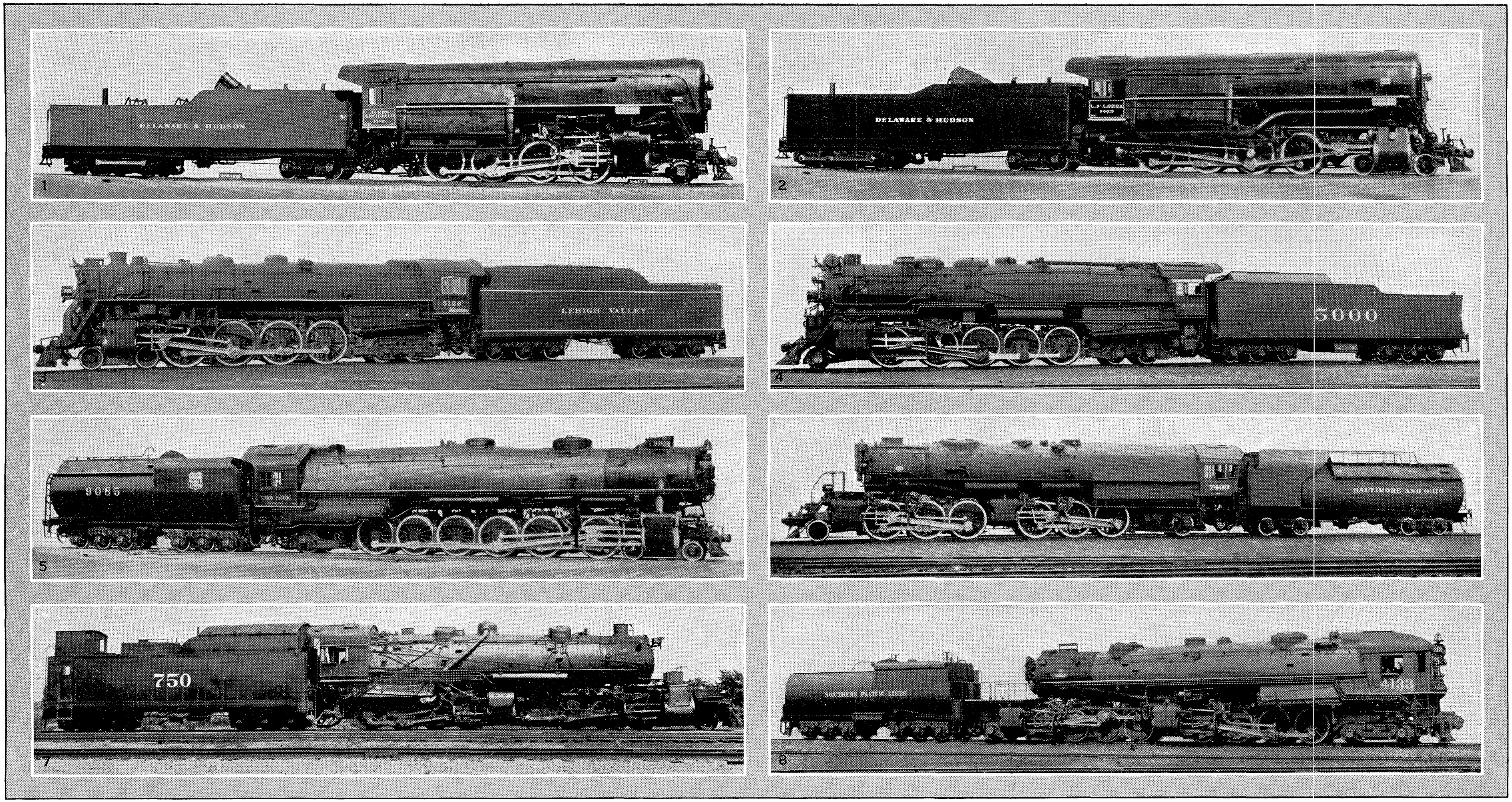
LOCOMOTIVE. This article deals with the three types of locomotives used in railway transportation: (1) self-contained, and self-propelled high pressure steam, (2) internal combustion and (3) electric locomotives dependent upon an outside source of power. *See* also BOILERS; STEAM GENERATION; RAILWAYS; ELECTRIC TRACTION and various other articles under specific headings.



BY COURTESY OF THE BALDWIN LOCOMOTIVE WORKS

ERECTING A LOCOMOTIVE

1. Outer shell of a locomotive boiler and firebox
2. General view of the erecting shop of a modern locomotive works, showing a row of boilers and fireboxes before the cylinders and frame assembly have been attached
3. A locomotive tender tank under construction
4. Lowering a locomotive boiler and frame assembly onto the driving wheels



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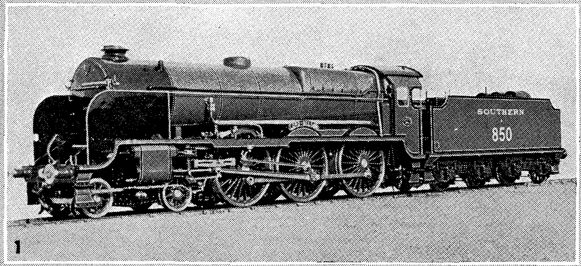
AMERICAN STEAM LOCOMOTIVES—HEAVY FREIGHT TYPES

1. Consolidation, 2-8-0 type. Fast heavy freight service; fuel, anthracite and bituminous coal mixed; tractive effort, simple 84,300 lbs.; compound 70,300 lbs.; additional for tender truck booster 18,000 lbs.; boiler pressure 500 lbs.; cylinders, 2 multiple expansion, 1 high-pressure, 1 low-pressure; drivers 63″; weight on drivers 300,000 lbs.; total weight engine ex. tender 356,000 lbs.
2. Twelve-wheel 4-8-0 type. Fast heavy freight service; fuel, anthracite and bituminous coal mixed; tractive effort, simple 90,000 lbs.; triple expansion 75,000 lbs.; additional for tender truck booster 18,000 lbs.; boiler pressure 500 lbs.; cylinders, 4 triple expansion, 1 high-pressure, 1 intermediate pressure, 2 low-pressure; poppet valves and outside cam valve gear; drivers 63″; weight on drivers 313,000 lbs.; total weight engine ex. tender 382,000 lbs.
3. Sixteen-wheel 4-8-4 type. Passenger and fast freight service; fuel, bituminous coal; tractive effort 66,500 lbs.; boiler pressure 275 lbs.; cylinders, 2 single expansion; drivers 77″; weight on drivers 272,200 lbs.; total weight engine ex. tender 435,000 lbs.
4. Sixteen-wheel 2-10-4 type. Freight service; fuel, bituminous coal; tractive effort 93,000 lbs.; boiler pressure 300 lbs.; cylinders, 2 single expansion; drivers 69″; weight on drivers 349,910 lbs.; total weight engine ex. tender 502,260 lbs.
5. Eighteen-wheel 4-12-2 type. Freight service; fuel, bituminous coal; tractive effort 96,650 lbs.; boiler pressure 220 lbs.; cylinders, 3 single expansion; drivers 67″; weight on drivers 372,000 lbs.; total weight engine ex. tender 515,000 lbs.
6. Sixteen-wheel Mallet 2-6-6-2 type. Freight service; fuel, bituminous coal; tractive effort 90,000 lbs.; boiler pressure 250 lbs.; cylinders, 4 single expansion; drivers 70″; weight on drivers 372,000 lbs.; total weight engine ex. tender 465,000 lbs.
7. Eighteen-Wheel Mallet 2-8-8-0 type. Heavy freight service; fuel, powdered bituminous coal and lignite, and fuel oil; tractive effort, simple 147,220 lbs., compound 122,683 lbs.; boiler pressure 250 lbs.; firebox type superheater; cylinders, multiple expansion, 2 high-pressure, 2 low-pressure; drivers 57″; weight on drivers 466,000 lbs.; total weight engine ex. tender 495,000 lbs.
8. Twenty-two wheel 4-8-8-2 type. Passenger and freight service; fuel, fuel oil; tractive effort 123,400 lbs.; boiler pressure 250 lbs.; cylinders, 4 single expansion; drivers 63½″; weight on drivers 517,000 lbs.; total weight engine ex. tender 639,500 lbs.



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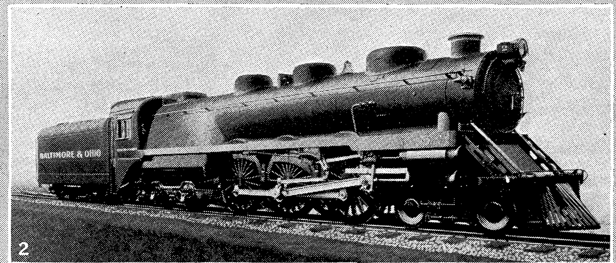

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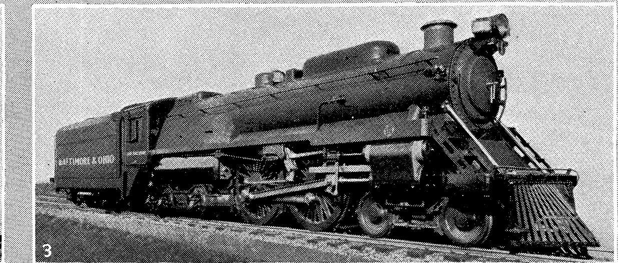

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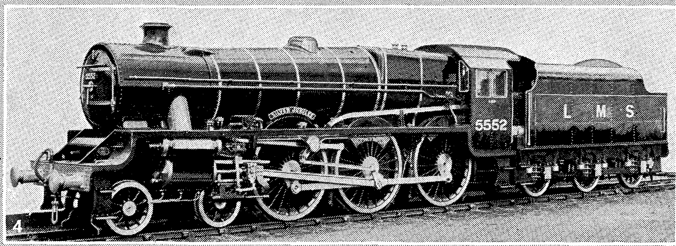

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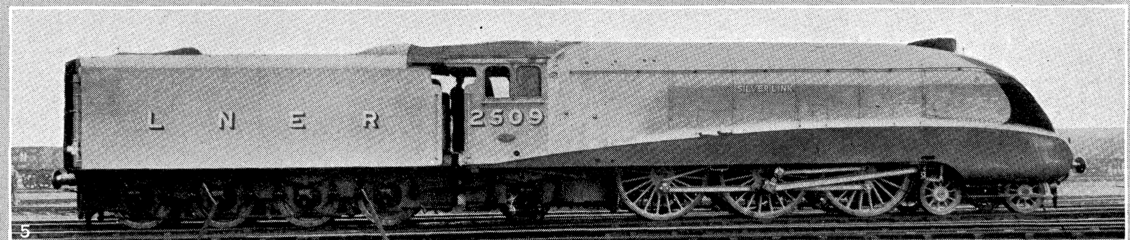

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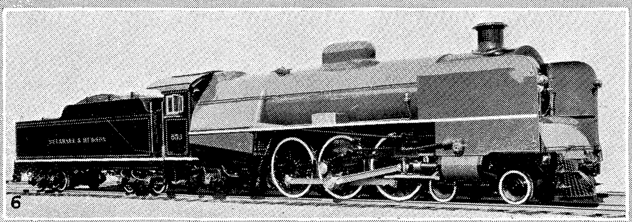
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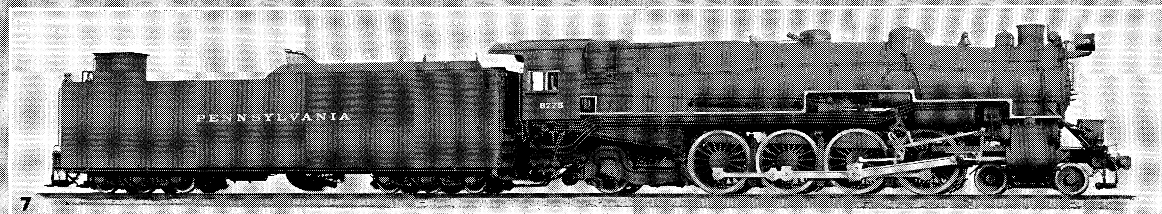

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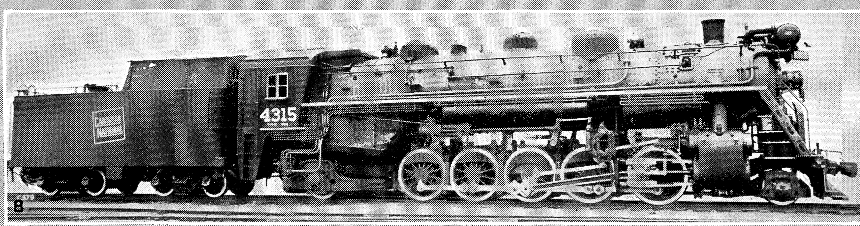

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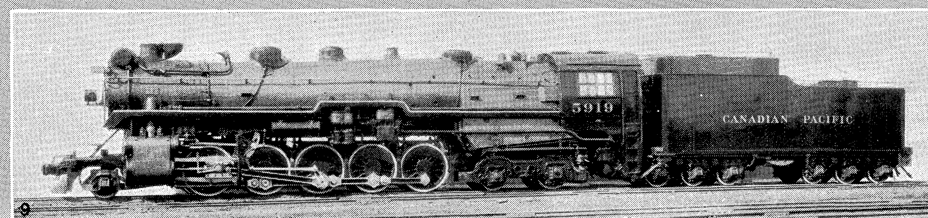

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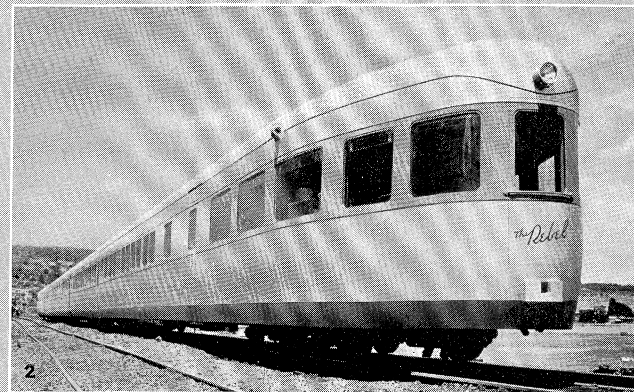
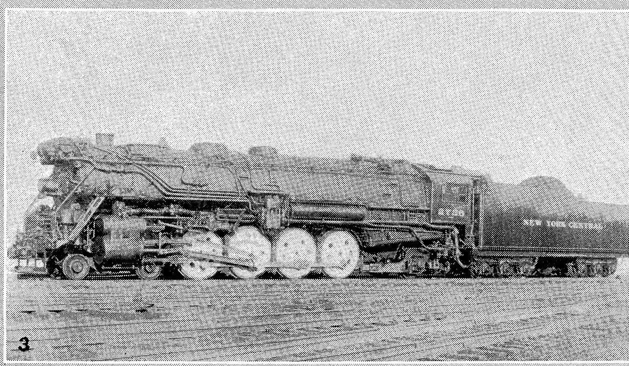
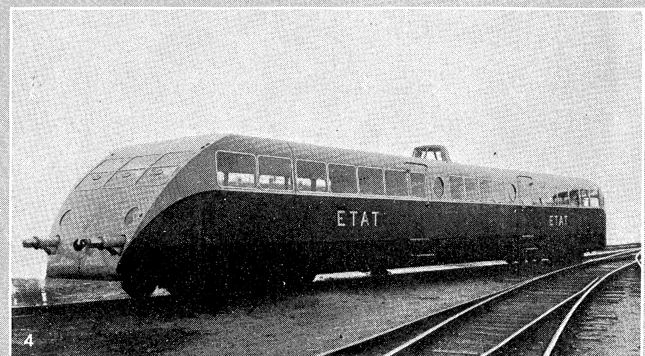
BRITISH AND AMERICAN TYPES OF STEAM LOCOMOTIVES FOR PASSENGER AND FREIGHT SERVICE

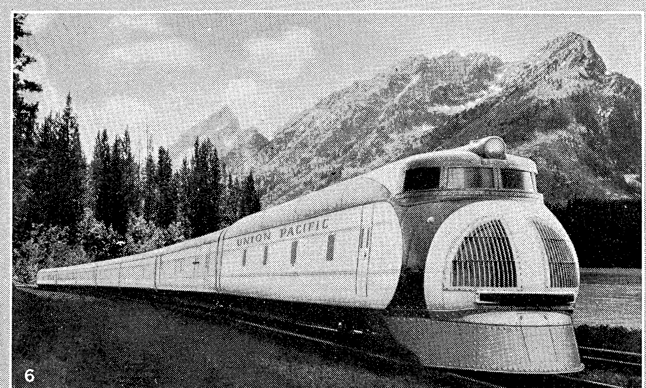
1. Lord Nelson 4-6-0 type. Four-cylinder express passenger locomotive; total weight of engine and tender in working order, 140 tons, 4 cwt.; tractive effort at 85% boiler pressure 33,500 lbs. 2. Lord Baltimore, Pacific 4-6-4 type. Fast passenger service; fuel, soft coal; tractive effort 34,000 lbs.; boiler pressure, 350 lbs.; cylinders 19 in. diameter, 28 in. stroke; drivers 84″; weight on drivers 156,000 lbs.; total weight engine ex. tender 294,000 lbs. 3. Lady Baltimore, Atlantic 4-4-4 type. Fast passenger service; fuel, soft coal; tractive effort 28,000 lbs.; boiler pressure, 350 lbs.; cylinder 17½ in. diameter, 28 in. stroke; drivers 84″; weight on drivers 99,800 lbs.; total weight engine ex. tender 217,800 lbs. 4. Silver Jubilee 4-6-0 type. Fuel, bituminous coal; boiler working pressure 225 lbs. per sq. in.; three cylinders 17″ dia. x 26″ stroke; tractive effort at 85% B.P. 26,610 lbs.; weight ex. tender (light) 168,784 lbs. 5. Silver Link 4-6-2 three-cylinder engine, type A.4. Fuel, coal; boiler pressure 250 lbs.; cylinders, 18½ in. diam., 26 in. stroke; driving wheel 6 ft. 8 in.; tractive power at 85% boiler pressure 35,455 lbs.; weight of engine and tender 165 tons, 7 cwt. 6. Pacific 4-6-2 type. Fast passenger service; fuel, anthracite and bituminous coal mixed; tractive effort 59,500 lbs.; boiler pressure 325 lbs.; cylinders, 2 single expansion; poppet valves and outside rotary cam valve gear; drivers 73″; weight on drivers 191,000 lbs.; total weight of engine ex. tender 296,500 lbs. 7. Fourteen-wheel 4-8-2 type. Fast freight and passenger service; fuel, bituminous coal; tractive effort 64,550 lbs.; boiler pressure 250 lbs.; cylinders, 2 single expansion; drivers 72″; weight on drivers, 271,000 lbs.; total weight engine ex. tender 390,000 lbs. 8. Fourteen-wheel 2-10-2 type. Heavy freight service; fuel, bituminous coal; tractive effort 61,600 lbs.; boiler pressure 275 lbs.; cylinders, 2 single expansion; drivers 57″; weight on drivers 261,040 lbs.; total weight engine ex. tender, 344,170 lbs. 9. Sixteen-wheel, 2-10-4 type. Heavy freight service; fuel, bituminous coal; tractive effort 77,200 lbs.; boiler pressure 275 lbs.; cylinders, 2 single expansion; drivers 63″; weight on drivers 312,800 lbs.; total weight engine ex. tender 452,000 lbs.

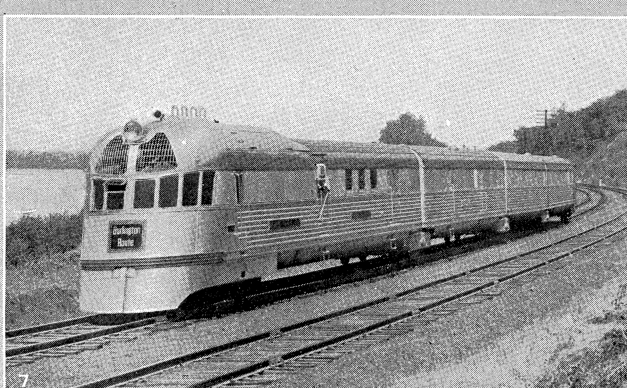
LOCOMOTIVE

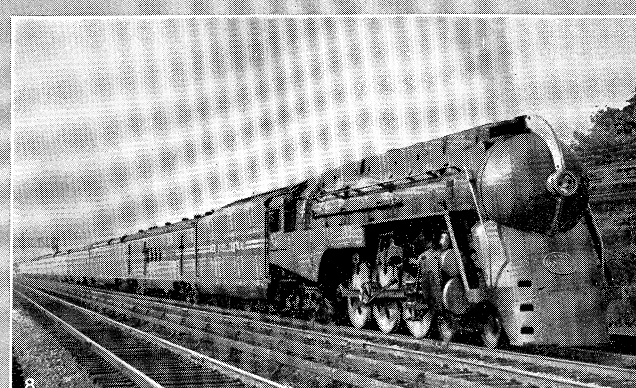












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MODERN LOCOMOTIVES AND TRAINS

1. "The Rebel," streamlined train designed and built by American Car and Foundry Co. for Gulf, Mobile and Northern Railroad. 2. Rear view showing observation end of "The Rebel," first streamlined train for the South. 3. Freight locomotive with new type disc driving wheels. 4. Streamlined unit of the "Bugatti" type, operated on the French State Railways. 5. "The Hiawatha" in service between Chicago, Milwaukee, St. Paul and Minneapolis. 6. "The City of Portland," Union Pacific streamliner. 7. First streamlined "Zephyr" of the Chicago, Burlington & Quincy. 8. "The Twentieth Century Limited," drawn by a Hudson type steam locomotive with 4700 horse power, in operation between New York city and Chicago

STEAM LOCOMOTIVE DEVELOPMENT

Although there were numerous predictions and suggestions of steam-propelled carriages, notably those of Sir Isaac Newton, in 1680, Cugnot's steam-driven road wagon in 1769 and Murdock's in 1784, there is little authentic information as to when actual locomotion by steam power first occurred, but there is definite record of the first success in heavy haulage, obtained on a prepared track, in England, when Richard Trevithick, a Cornish mine captain had his first locomotive built in 1801. Trevithick's next locomotive (1803), had four wheels, all drivers, 4 ft. 6 in. diameter, and the boiler was 6 ft. long and had a return flue, bringing the stack over the fire door. There was only one cylinder, which was 8 in. diameter, by 54 in. long. Trevithick found that smooth tread wheels had sufficient adhesion, and that the exhaust steam, when turned back in the stack, could be effectively utilized to promote combustion in the fire-box.

The Rocket.—Between Trevithick's steam engine of 1803, and the "Rocket" (1829), came the Blenkinsop colliery locomotive, built by Fenton, Murray and Wood of Leeds in 1812, Hedley with his "Puffing Billy" in 1813, Stephenson's "Blucher" in 1814 and various other developments. After George Stephenson produced his first locomotive his energies were devoted to the improvement of the steam locomotive by the various stages which led up to the "Rocket." The Stockton and Darlington Railway Company, the first public railway, was opened in 1825, and Stephenson was the engineer of the "Locomotive," which was built by him in that year. Several other locomotives were built, but none were entirely satisfactory. In 1829, the directors of the Liverpool and Manchester railroad offered a prize of £500 for the best locomotive engine. There were originally ten competitors, but the number was reduced on the morning of the trials to five: "The Novelty," "Sans Pareil," the "Rocket," the "Cycloped" and the "Perseverance." The trials lasted seven days, after which on Oct. 26, 1829, Stephenson's "Rocket" which was the only engine that fulfilled the conditions of the competition, was awarded the prize. When drawing a load equivalent to three times its own weight, the "Rocket" travelled at the rate of 12½ m. per hour; and with a carriage and passengers at the rate of 24 m. an hour, with the cost per mile for fuel about 3 pence. Its success was due to the combination of the tubular boiler, suggested by Henry Booth, and a suitably proportioned blast pipe, first used by Richard Trevithick, and a simple power transmission mechanism in the direct drive between the cylinder piston and the driving wheels. The principal characteristics of the "Rocket" were: boiler pressure 50 lb.; cylinders 8 by 16½ in.; one pair drivers, 3 ft. 8½ in. diameter; boiler, 3 ft. 4 in. diameter, by 6 ft. long; fire-box, 3 by 2 ft.; boiler tubes, 23 ft. 3 in.; fire-box heating surface, 63 sq.ft.; boiler tube heating surface, 7 sq.ft.; total heating surface, 138 sq.ft.; weight of engine, about 9,500 pounds.

Other Early Developments.—The early canal, quarry and coal mining engineers in the United States favoured the building of railroads as the result of their investigations in England at about the time that public opinion was being influenced in that direction there. About 1800 the American people began to realize the need of highway and other inter-communication as a means for developing the extensive unsettled districts of the country. The difficulty of constructing artificial waterways, the slowness of canal boats and the freezing of transportation channels for a considerable part of each year, gave impetus to the movement. In 1828, John B. Jervis, chief engineer of the Delaware and Hudson Canal Company, convinced of the feasibility of rail motive power, presented a plan to the management, with the result that Horatio Allen, assistant engineer, was sent to England, to study railroad operation and to contract for rails and locomotives. Jervis planned to bring the anthracite coal of the Susquehanna valley, by rail, into the valleys of the Delaware and the Hudson rivers, and on to the ocean. Allen in 1828 contracted for four locomotives. The locomotive "America," furnished by Robert Stephenson and Company, arrived in New York on Jan. 15, 1829. It was transported up the Hudson river and through the canal from Rondout and cleared Eddyville on July 16, 1829. There its record is lost, and so far as is known, it was never operated in America. The other three locomotives built by Foster, Rastrick and Company, of Stourbridge, England, were the "Stourbridge Lion," "Delaware" and "Hudson." The "Stourbridge Lion" reached New York on May 13, 1829. It was transported up the Hudson to Rondout, and by canal to Honesdale, Pa. It was set up and made a trial trip on Aug. 8, 1829, this being the first operation of a locomotive in the Western Hemisphere. The second and third locomotives from Foster, Rastrick and Company arrived in New York on Aug. 9 and Sept. 17, 1829, respectively. Their subsequent history is obscure. The "Peter Cooper," the first locomotive built in the United States, was successfully operated on the Baltimore and Ohio railroad, as early as Aug. 28, 1830. A speed of from 5 to 18 m. per hour was attained with a car and 23 persons, and the average tractive force developed represented about 1·43 h.p. or more than three times as much as the "Rocket" developed. This improvement was due to the higher pressure steam used by the "Peter Cooper."

On Jan. 4, 1831, the Baltimore and Ohio offered $4,000 for the best American engine of 3½ tons, to pull 15 tons, on level track at a speed of 15 m. an hour. Phineas Davis won the prize with the "York," a vertical engine with four 30 in. wheels. In 1832 the "Ironsides"—Matthew Baldwin's first engine—was put into service in the United States. After a trial and some imperfections had been remedied, it was put into regular service and did duty on the Philadelphia, Germantown and Norristown railroad and others for over 20 years. The Baltimore and Ohio Railroad Company was a pioneer in the United States, it having been chartered by the State of Maryland on Feb. 27, 1827, and incorporated on April 24 of the same year. Its centenary pageant and exhibit held near Baltimore, Md., during 1927, gave a graphic exhibition of transport since the first settlement of the nation. For this exhibit the "Tom Thumb," built by Peter Cooper, of New York in 1829–30, to prove the practicability of steam operation, was reproduced and operated. The original "Tom Thumb" ran successfully on the rails of the Baltimore and Ohio and was followed by the "Thomas Jefferson," 1834; "Winans Camel Back," 1848; "William Mason," 1856, and the "J. C. Davis," 1875, first passenger engine of the Mogul type used by the Baltimore and Ohio. The first Mallet type locomotive built in the United States in 1903–04, Baltimore and Ohio No. 2,400, named "John E. Muhlfeld," was exhibited, as well as numerous later steam and electric locomotive designs. The "King George V.," No. 6,000, the most powerful locomotive in Great Britain, was also sent over for the pageant. This locomotive, on its trial trip, ran from Paddington to Plymouth, a distance of 226¾ m. in 4 hours and 2 minutes, at the rate of 61·7 m. an hour, with a load of 410 tons. It is of the ten-wheel type, with four cylinders, 16¼ by 28 in.; the inside cylinders are connected to the forward pair of drivers, and the outside cylinders to the second pair of drivers. The boiler pressure is 250 lb., drivers, 78 in. diameter, weight on drivers, 151,200 pounds.

With the "King George V." was sent the "North Star," one of the first engines on the Great Western Railway of England, designed by Sir Daniel Gooch, of that company, and built by Robert Stephenson and Company. The "North Star" as well as others of the "Star" class of locomotives, of the 2-2-2 type, as designed and built by Sir Daniel Gooch, at the Swindon works of the Great Western about 1846, for fast passenger service, was adapted to a 7 ft. gauge of track; cylinders, 18 by 24 in.; one pair of driving wheels, 96 in.; heating surface, 1,952 sq.ft.; boiler tubes, 300; and was equipped with the Gooch fixed link valve motion. This locomotive had a maximum speed of 78 m. per hour, and when evaporating about 1,500 gal. of water per hour, the fuel consumption averaged about 2·5 lb. of coal per horse-power hour, which compares most favourably with present performance. The Delaware and Hudson Company high-pressure freight locomotive, No. 1,401, the "John B. Jervis," was also exhibited. The outstanding feature of this locomotive is the water tube—fire flue type of boiler carrying 400 lb. boiler pressure; one high-pressure cylinder, 22¼ in. and one low-pressure cylinder, 38½ in. diameter, by 30 in. stroke; the weight on four pairs of drivers, 295,000 lb.; driving wheels, 57 in. diameter; and the tractive power of

85,000 lb. in simple gear, 70,800 lb. in compound gear and 18,000 lb. additional tractive power in the tender truck booster for starting and accelerating trains.

Locomotive Classification.—Prior to the locomotive classification system developed by F. M. Whyte, mechanical engineer of the New York Central and Hudson River Railroad Company, the designation was by name only, as Ten-Wheel, Mogul, Consolidation and the like. Whyte's classification, which has been generally adopted, is by numerals. It consists of three divisions, the first to designate the total number of leading truck wheels; the second, the total number of coupled driving wheels and the last, the total number of trailing wheels. In some cases, the number of leading and trailing truck wheels in the tender is also added.

Capacity and Efficiency.—The capacity of a locomotive is rated in terms of—

1—Its starting tractive force and

2—The horsepower developed at speed. The latter determines the available tractive force at various speeds. The starting tractive force on the other hand is limited by the available adhesion at the driving wheels. For this reason, the starting or rated tractive force should not exceed approximately one-quarter the weight on drivers.

The tractive force is effected by the action of the steam against the pistons in the cylinders and the connecting rod mechanism, resulting in a torque applied to the driving wheels. This is resisted by the moment of the tractive force at the rim of the wheels. Friction in the mechanism, however, reduces the effective torque applied to the driving wheels, and friction in the main journal bearings further reduces the moment of the tractive force at the rail. This total friction loss reduces the actual tractive force developed at the rail and which propels the train, to a certain percentage of the cylinder tractive force. The ratio of the actual tractive force to the cylinder tractive force (*i.e.*, the tractive force developed by the cylinders without friction) is termed the machine efficiency. At low speeds, where the torque and traction force is large, the machine efficiency is relatively high, whereas at the higher speeds, it is considerably lowered and the corresponding losses materially limit the output of the locomotive. If it were not for the resistance of the locomotive and tender idle axles, the drawbar pull and tractive force at the drivers would be identical in value. Actually, the train resistance of the locomotive as a vehicle, reduces the drawbar pull below the tractive force developed at the drivers. Obviously, during acceleration, the difference may be considerable, due to inertia resistance of the locomotive.

The performance of a locomotive at speed, in fact from 50 R.P.M. or 250 ft. piston speed, and above, is dependent upon the horsepower characteristics of the locomotive as a power plant. The horsepower rating of a locomotive is essentially dependent upon the boiler evaporation rate per hour and the cylinder steam consumption rate per horsepower hour. At the lower speeds, the steam consumption of the cylinders increases over that at the higher speeds due to the inherently longer cut-offs, together with a somewhat reduced evaporation rate of the boiler. For this reason, the horsepower developed varies with the speed, increasing to a maximum value at the operating speed wherein economical cut-offs are possible.

The horsepower rating of road locomotives is, therefore, usually stated at an arbitrary piston speed at from 1000 to 1200 ft. per min. or a corresponding rotational speed of the drivers at from 200 to 750 R.P.M. In this speed range maximum horsepower is reached. It is then dependent upon the normal maximum boiler evaporation rates and the normal minimum cylinder steam consumption rate.

In heavy freight drag service, it is desirable to improve the operating efficiency in the low speed range. In this case, more economical cylinder steam consumption is obtained by early cut-offs in the low speed range. Such locomotives are frequently termed "limited cut-off" locomotives.

To increase the Rankine efficiency, high pressure locomotives have been introduced, using compound cylinders. Aside from the increased economy, the compound cylinder, properly proportioned, gives a much wider speed range for economical fuel consumption and low water rates.

To improve cylinder performance and reduce cylinder condensation, superheated steam is supplied to the cylinders by superheating the steam through superheater units in the boiler.

The thermal efficiency is the ratio of the work developed at the drivers to the heat value of the fuel, as fired, to produce its hauling capacity at the rear engine or tender drawbar. In the average steam locomotive the thermal efficiency, based on the fuel as fired during road service, will vary from 4 to 9% where high steam pressures and temperatures, multiple expansion, feed-heating and the like are utilized.

A pound of average United States coal, as used by the railways, will run about 13,500 B.T.U. as fired, and with proper combustion in the fire-box of a steam locomotive, will enable from 50 to 80% of its heat value to flow across the boiler and the superheater heating surfaces, to the water and the steam, most of the remainder of the heat passing out of the stack in the form of cinders, escaping gases with the ash, and by radiation. The steam pressure and temperature produced, in consequence of this heat transference from the furnace gas to the water and the steam, when they reach the cylinders, transform from 8 to 9% of the total heat in the steam into mechanical energy, in the conventional single expansion cylinder locomotives, the remainder passing away through the stack with the exhaust steam. By the use of feed-heating, a certain percentage of this heat in the exhaust steam may be recovered and returned to the boiler in the form of heat in the feed-water. Likewise, the waste heat in the cinders and gases passing through the smoke-box, and out of the stack, may be partially recovered, by utilization in an economizer for further heating of the boiler feed.

Locomotive Design.—The problems involved in the design, material and construction of the modern locomotive are many and complex. Of first consideration is the roadway and structures over which the locomotive is to be operated, which involves the permissible truck and driving wheel loading, both static and dynamic, on the road bed and the bridges; then the width and height of clearances as established by tunnels, overhead crossings, station platforms and other limitations; the gradient and curvature to be negotiated; the required speed; character of the local fuel and water supply; length of turn-tables and engine-houses; engine-house and shop facilities; location and general arrangement of fuel and water supply stations; length of runs between division or intermediate terminals, and other similar factors. After the design has been prepared to conform to the foregoing requirements, then the general wheel arrangement and boiler and cylinder capacities must be determined upon to best meet the gradient, curvature and train loading requirements for the different districts over which the locomotives are to operate. In these calculations, the size and capacity of the boiler and superheater, with special regard for the steam pressure and temperature, grate area, fire-box volume and fire-box and boiler evaporation surfaces are important; also the locomotive bed or frame and driving or truck wheel arrangement; the kind and size of the cylinders and the valve gear, after which the auxiliary devices and appliances to make up the assembly, as a whole, must be decided upon.

With respect to the weight and clearance limitations, the European and other foreign designers have been considerably handicapped due to the restrictions which, in the United States and Canada, have been less limited, and for which reason the American practice has reached a stage, so far as size and capacity are concerned, far in advance of other countries, and which has enabled the development of heavier motive power for the handling of longer and heavier trains. However, instead of resorting to improved combustion of fuel, maximum utilization of radiant heat, high rate of heat transfer, efficient convection, higher steam pressures and temperatures and the more economical use of the heat in the steam, the general trend, particularly during the past 20 years, has been to more extravagant methods of stoking and use of fuel, lower steam pressures in boilers and cylinders and the ejection of a greater percentage of heat from the exhaust nozzle and stack. The special appliances that have been introduced are for fuel handling, firing, combustion, superheating, boiler circulation, feed water heating and feeding, steam distribution and utilization, lubrication, insulation, lighting, heating, safety, comfort and labour saving. Those auxiliary appliances, such as trailer and tender truck auxiliary engines, stack blowers, air brake pumps, mechanical stokers, fuel oil heaters and atomizers, power reverse gears, fire door openers, feed water pumps, injectors, grate shakers, coal pushers, ashpan slide pushers, ashpan blowers, water scoops, drifting valves, electric generators, automatic train control devices, steam heat equipment, cab heaters, lubricators, wheel flange oilers, bell ringers, rail sanders, cylinder cocks, steam whistles, safety valves, blow-off cocks, snow flanges and like accessories all require live steam or heat from the boiler of the locomotive for their operation, which the boiler and firebox must generate, in addition to the steam which is actually used for overcoming heat losses.

The steam locomotive, therefore, must not only produce superheated steam for the development of draw-bar pull, but it must also supply saturated and superheated steam to various auxiliaries and for train operation. In the case of a passenger locomotive, even greater demands for power are required in connection with the train lighting, heating, air-conditioning and ventilating equipment; hot and cold water and refrigeration systems and other devices. The most modern conventional type will produce at its best, from 6 to 8% thermal efficiency at the tender drawbar in terms of the heat value in the fuel fired. In average road service this percentage will be reduced to from 4 to 6% and is being obtained in the basic design by the use of from 200 to 250 lb. boiler pressure, in combination with an average amount of superheat in from two to four single expansion cylinders, or in duplex multiple expansion types of cylinders. In the handling of heavy freight tonnage, the question of locomotives of great power as opposed to grade reduction involves, as a primary consideration, the operating cost per train mile, the train load and the resulting cost per ton mile for various kinds and capacities of locomotives on different gradients. For secondary consideration there are the factors of maintenance of way and structures and of the mechanical facilities required for the handling and upkeep. (*See* RAILWAYS for a discussion of problem.) Speed, curvature and grade are factors that largely control the loading of locomotives, as well as the cost for their operation. In view of engine and train crew wages and fuel being the governing factors in train operating expenses, it is believed that on the basis of an eight-hour day, per 100 m. run, freight train running speeds of 15, 20 and 25 m. per hour are more economical, from a transportation standpoint, than speeds of 10, 30 and 35 m. per hour. In general, freight locomotives handling low class tonnage should be loaded to haul trains at an average schedule speed between terminals, including road delays, of from 12 to 15 m. per hour on low grade, and of from 10 to 12 m. per hour on high grade lines, which is as fast as economy will allow.

During the past ten (10) years, in order for the railroads to meet the intensive competition of the highway trucks and buses, freight train speeds have been materially increased for the purpose of moving higher class freight on shorter schedules. This has made necessary a substantial increase in the sustained hauling capacity of steam locomotives, with the result that boiler capacities have been increased by greater evaporation surface, boiler water storage and higher steam pressures, in conjunction with increased total temperature of the steam admitted to the valve chests and cylinders by a combination of the higher pressure and higher superheat. (Where from 200 to 250 lb. steam pressure was formerly used, from 275 to 325 lb., is now provided in the conventional designs of locomotive boilers, and from 350 to 500 lb. in the cylindrical-drum water-tube type firebox boilers, in combination with superheated steam total temperatures of as high as 750° F., and poppet valves actuated by outside rotary cam type of valve gear.)

Boiler Pressures.—Until 1895, steam locomotive boiler pressures were generally limited to 150 or 160 lb. gauge pressure. Then there was an advance to 200 lb. and in 1903–05 the Baltimore and Ohio went to 235 lb. in its first Mallet articulated compound locomotive, Baltimore and Ohio No. 2,400; and in 1905, to 225 lb. in its first 35 Pacific type passenger locomotives. During the next 20 years there was practically no increase, the general tendency being to use 200 lb. as a maximum, due largely to the adherence to the conventional type of locomotive boiler with its flat and radial sheet stay-bolts, water-legs and other non-self-supporting surfaces. During the past five years, on account of the public service central power station boilers being installed with pressures ranging from 350 to 650 lb., and marine boiler pressures going to 350 and 400 lb., there has been a tendency to raise the locomotive steam pressures and temperatures on account of the ability to increase locomotive capacity within the established clearance and weight limitations and the possible fuel and water savings. The conventional radial and flat sheet stayed water-leg type of fire-box is in some cases now being superseded by self-sustaining cylindrical-drum water-tube type of fire-boxes. A conventional type of boiler is now carrying steam pressures as high as 325 lb., but for higher pressures, as in the case of the Delaware and Hudson Railroad 350 to 500 lb. pressure, multiple expansion, and the Baltimore and Ohio Railroad 350 lb. pressure, single expansion locomotives, the cylindrical-drum water-tube type of fire-box is being substituted.

The "Horatio Allen" (named after the engineer who ran the first locomotive in the Western Hemisphere), high-powered locomotive No. 1,400 completed in 1924, was an epochal event in steam locomotive development. It has a total loaded weight of engine and tender in working order of 273 tons, was designed by the Delaware and Hudson Company and built at the Schenectady works of the American Locomotive Company. Instead of having the usual water-leg fire-box with its undesirable flat sheets and staybolts and the sluggish circulation of water around these sheets, the fire-box is built up of self-supporting cylindrical structures in the form of drums and tubes disposed horizontally and vertically, requiring no stays, and are directly exposed to the radiant heat of combustion and split the boiler water into small streams to provide for its rapid circulation, quick absorption of heat and release of the steam bubbles. The "Horatio Allen," when operating on a 0·5% ascending grade in tonnage freight service, with 3,217 actual gross tons in the train, at an average speed of 16·5 m. per hour, with coal of about 13,500 B.T.U., can produce an equivalent evaporation of 11·35 lb. of water per pound of coal at an average high-pressure cylinder cut-off of 64%; on the basis of indicated horse-power per hour, including auxiliaries, the dry coal consumption was 2·15 lb., and the steam consumption was 17·5 lb.; on the basis of draw-bar pull, the dry coal consumption was 2·14 pounds. During this performance the efficiency of the boiler was 80·6%, the machine efficiency was 93·86%, the thermal efficiency at the tender in terms of the heat value of the coal was 8·72%. An important advantage of the higher steam pressure on the "Horatio Allen" and the "John B. Jervis" locomotives has been found to be in the ability to increase the capacity of a locomotive within the same roadway clearance and weight limitations.

The success of the "Horatio Allen" and "John B. Jervis" higher steam pressure locomotives resulted in the Delaware and Hudson Railroad building the "James Archbald," as illustrated in Plate II, Figure 1, and the "L. F. Loree" as illustrated in Plate II, Figure 2, each carrying 500 lb. boiler pressure; the first mentioned being equipped with combined cylinders, and the last mentioned being equipped with triple expansion cylinders, giving road service thermal efficiencies ranging from 10·5 to 12·5 per cent.

In Europe, the Schmidt high-pressure experimental ten-wheel passenger locomotive on the German State railways, which makes use of 855 lb. boiler pressure, is outstanding as an example of high efficiency. From the results, to date, of this locomotive, and its use of multiple pressure, super-heating and re-superheating, multiple expansion and feed-water heating and purification, it has been proven conclusively that high pressures are safe in operation, great fuel savings are effected, that the first are little more than the conventional pressure locomotive, and that the high pressure machine can be easily handled by competent locomotive engineers and engine-house and shop organizations. The German State railways built a second locomotive which makes use of

1,700 lb. steam pressure. These are, however, exceptional cases, and it is still debatable as to whether the increased weight and first cost necessary to steam pressures beyond 500 or 600 lb., in locomotive design, will be justified by the greater economy over what has already been obtained from the 350 and 400 lb. pressures in combination with multiple expansion. In 1928, for a locomotive having four pairs of coupled driving wheels, the Delaware and Hudson Company's Consolidation No. 1,401, "John B. Jervis," is the most powerful. For starting and acceleration up to 8 m. per hour, it develops a tractive power of 103,000 lb., above which speed it is reduced to about 85,000 lb., up to 10 or 12 m. per hour, when it is still further reduced to between 65,000 and 70,000 pounds.

The largest and most powerful steam locomotives in the United States are represented by the Mallet types. On the Kansas City Southern railway, Mallet articulated compounds of the 2-8-8-0 type, carrying 250 lb. boiler pressure, have a tractive power in simple gear of 147,500 lb., and in compound gear of 122,500 pounds. When the tender truck booster is cut in, this produces an additional tractive power of about 13,000 lb. for starting and acceleration, thereby bringing the total up to about 160,000 pounds. The Virginian railway has in its service some of the largest steam locomotives in the United States. These are of the Mallet articulated compound 2-10-10-2 type, having a maximum tractive power of 176,000 lb. in simple gear, 147,200 lb. in compound gear and 108,000 lb. at a speed of 15 m. per hour. The modern American steam locomotive is quite deficient in superheating, as the conventional type of superheater brings the last pass of the superheated steam before it reaches the branch pipes to the steam chests, through the coldest part, or front end, of the boiler and the smoke-box, where the prevailing temperatures are usually less than that of the superheated steam. The possibility of preventing this waste and increasing the total temperature of the steam will make it advisable to use a different type of superheater in the future. The possibilities of utilizing the waste heat in the exhaust steam from the main engines and from the auxiliaries, such as the air brake pump, turbo-generator, booster engines and other appliances, and from the smoke-box gases, offer another probability for substantial increase in capacity and reduction in fuel. Various types of open and enclosed feed-water heaters and economizers, now being used on passenger and freight locomotives in the European countries and in the United States and Canada, have demonstrated that savings of from 6% to as high as 18% in fuel can be brought about in this manner. The development of a mechanically driven pump, whereby the operating power can be obtained from the main cylinders and which will reduce the steam requirements for pumping from about 80 lb. of live steam per horse-power hour to from 16 to 20 lb., offers possibilities in this direction. The exhaust steam type of injector, as now developed, also enables substantial fuel savings, although these can be depended upon for operation with the exhaust steam only when the locomotive is running at a uniform speed of 6 m. per hour and more; when the boiler pressure does not exceed 250 lb. and when the temperature of the feed-water does not exceed about 80° F. The burning of coal and lignite in powdered form, in suspension, the same as oil or gas, has come prominently to the front during the past ten years. There were, in 1928, in the United States and Canada, in central power station and industrial use, about 650 stationary boilers, representing about 8,500 nominal boiler horse-power, that are making use of powdered coal. Boiler capacities are being obtained of from 400 to 450% of the nominal ratings, and with combined boiler, furnace, superheater and economizer efficiencies of as high as from 90 to 92%, in terms of the heat value in the coal as fired, at between 125 and 275% of boiler rating. Progress is being made in marine service through the use of powdered coal, as well as on steam locomotives in America and Europe. One great advantage on railway systems using both coal and fuel oil is that when locomotives are transferred from the coal to the oil burning districts, and vice versa, it is not necessary to change the furnace and tender equipment to adapt them to the two fuels, and the method for firing the powdered coal or lignite is practically the same. The locomotive will have as great, if not more, an evaporative and superheating capacity with the solid as with the liquid fuel. (*See* Coal and Coal Mining; Pulverized Fuel.)

Steam Cylinders.—In Europe, the use of poppet valves as a substitute for piston valves is being brought forward, particularly in Austria, France and England. A few locomotives have also been equipped in the United States, but the applications are of an experimental nature, and the use of the piston valve in com-

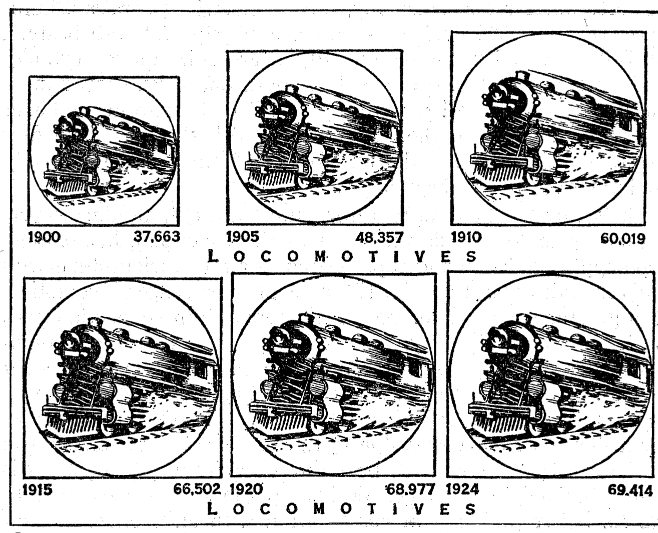
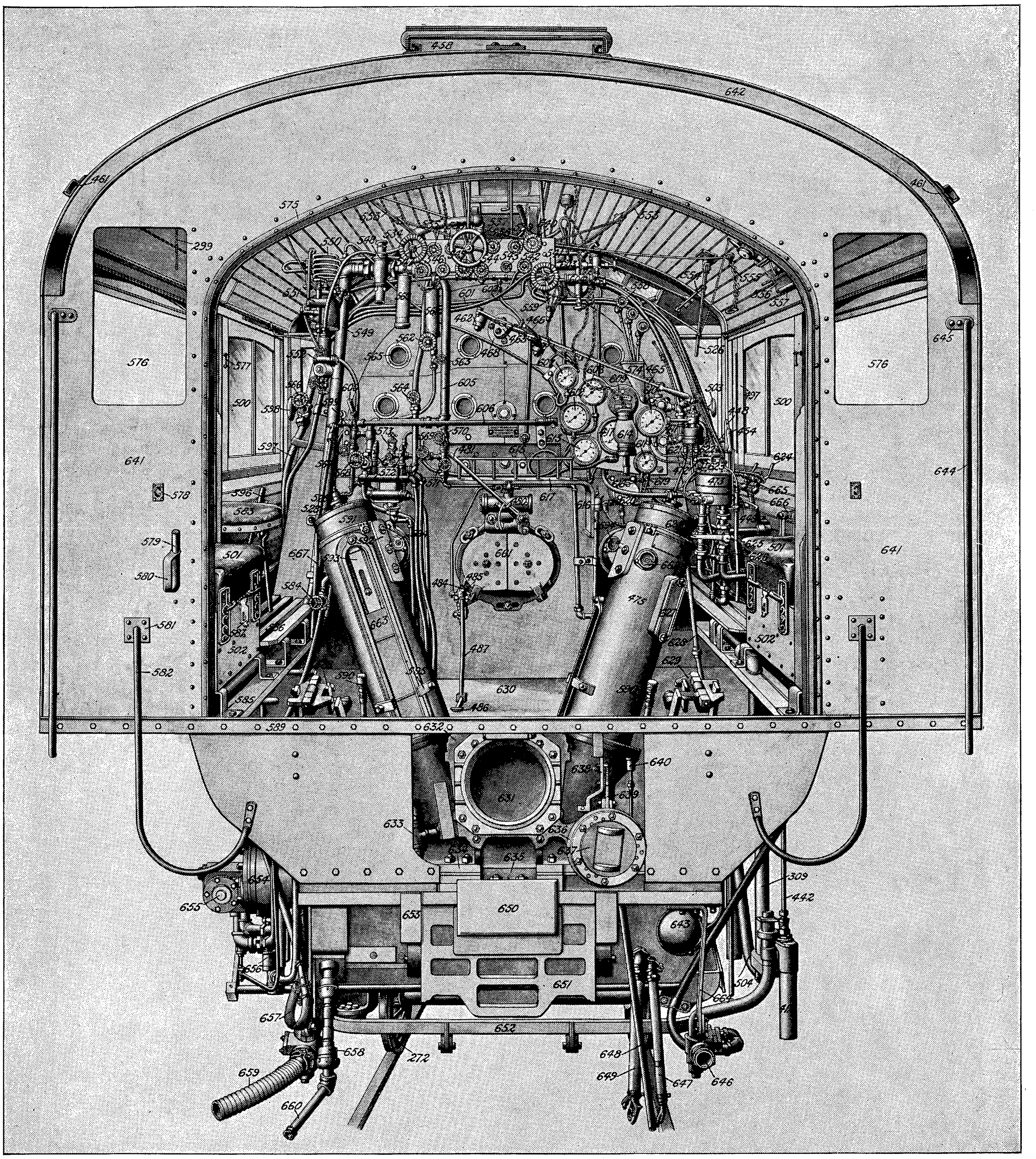


CHART SHOWING GROWTH OF LOCOMOTIVES IN SERVICE FROM 1900 TO 1924

bination with a Walschaerts or some similar outside valve gear, even in combination with pressures as high as 500 lb., will no doubt be continued until the poppet valve in combination with an angular motion gear has conclusively demonstrated its advantages, both from an operating and maintenance standpoint as compared with the linear movement. In the use of steam, the general practice in the United States and foreign countries is single expansion cylinders. Recently, by limiting the maximum cut-off in these cylinders to from 50 to 75%, an effort has been made to increase the expansion of the steam, reduce the loss of heat and produce greater economy through the use of a shorter cut-off. Reduction in the loss of heat is accomplished by the compound, triple and quadruple expansion engine by expanding the steam in several stages, which reduces the range of temperature in each cylinder and the condensation, when saturated steam is used, or waste of superheat, when superheated steam is used, but these multiple expansion engines have greatly increased the steam contacting cylinder and piston areas, and must be operated at relatively long cut-off. Furthermore, the counterflow use of the steam causes a great waste in heat. Therefore, the uniflow cylinder offers special inducements in locomotive practice. It has advantages over compounding in that the same results can be accomplished with shorter cut-off, and by the peculiarities of the flow of the steam in the cylinder. After entering the cylinder the steam does not retrace its steps, but continues to go forward from the point of entrance until it passes out, and in this way the steam in exhausting does not sweep the heat from the inlet port surfaces, nor from the cylinder heads. This method greatly reduces the cut-off, condensation and expulsion of heat with the exhaust, and enables the single cylinder non-condensing engine to excel in economy to a substantial degree the compound or any similar multiple expansion non-condensing engine.

Future Development.—The trend of the steam locomotive development is toward a wheel and running gear arrangement that will provide the maximum ratio of main engine coupled adhesive to total engine weight, and of main engine power to such adhesive weight; 500 lb. steam pressure; 850° F total temperature of the steam; a uniflow boiler, superheater and two or four outside cylinder arrangement; piston valves and outside valve gear; a 100% furnace volume, evaporation surface and



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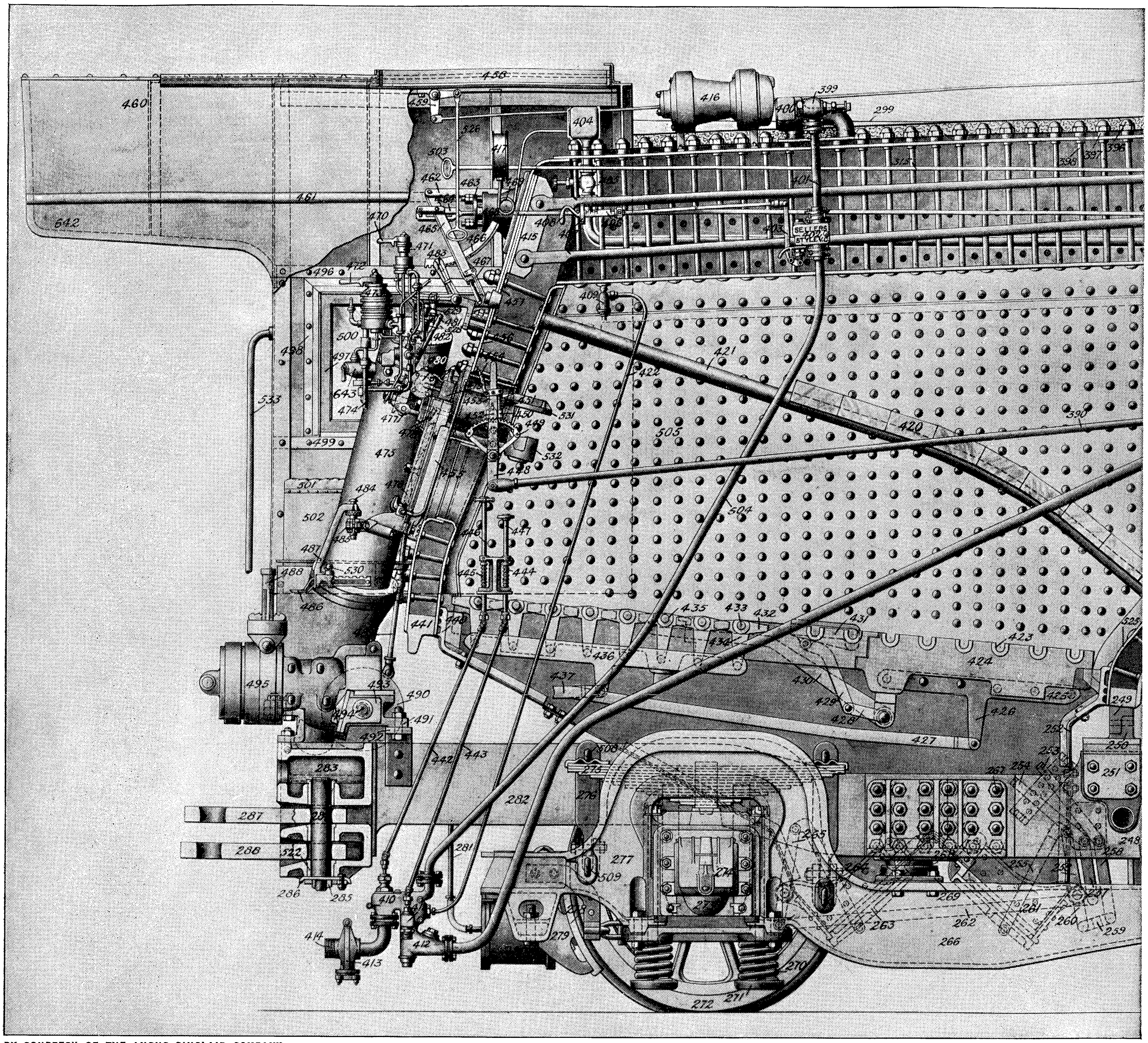
PACIFIC OR 4-6-2 TYPE LOCOMOTIVE—FORWARD VIEW

272. Trailing truck details. **299.** Bell lever and bell cord. **309.** Delivery pipe. **412.** Sellers U.S. standard non-lifting injector line check. **417.** Steam gauge. **442.** Sellers U.S. standard non-lifting injector details. **448–449** Ragonnet power reverse gear details. **454.** Ragonnet power reverse gear details. **458.** Cab ventilator. **461.** Cab eaves trough. **463.** Throttle stem stuffing box gland. **465.** Throttle lever. **471.** Westinghouse independent brake valve body. **472.** Westinghouse engineer's valve handle. **473.** Westinghouse engineer's valve top case. **475.** Duplex stoker elevator casing. **481.** Franklin fire door opener hand lever. **484.** Franklin fire door opener hanger bolt. **485.** Franklin fire door opener tread hanger adjusting gear. **486–487.** Franklin fire door opener tread and hanger. **497.** Cab window, sash, frame and guides. **500.** Cab window, sash, frame and guides. **501–502.** Cab seat and box. **503.** Sand rod handle. **504.** Steam pipe to injector. **505.** Side sheet of fire box. **526.** Whistle lever rod. **534.** Left injector steam valve handle. **535.** Flange lubricator steam valve handle. **536.** Car heating valve handle. **537.** Main fountain valve handle. **538.** Coal pusher valve handle at turret. **539.** Ragonnet reverse gear valve handle. **540.** Right injector steam valve handle. **541.** Main steam valve handle from turret to stoker. **542.** Air pump steam valve handle. **543.** Head-light turbine steam valve handle. **544.** Main lubricator steam valve handle. **545.** Cab heater turret steam valve handle. **546.** Grate shaker steam valve handle. **547.** Main blower valve handle. **548.** Reducing valve for steam heat. **549.** Car heat steam pipe. **550.** Steam coil for flange lubricator. **551.** Sight feed flange lubricator. **552.** Sight feed stoker lubricator. **553.** Cab brace. **554–555.** Whistle rod and cord. **556–557.** Pyle National head-light switch and dimmer. **558.** Gauge cock. **559.** Lubricator light. **560.** Water glass lamp. **561.** Water glass. **562–563.** Water glass shut off valve and drip pipe valve. **564.** Main steam pipe valve to grate shaker. **565.** Washout plug for crown sheet. **566.** Left blower valve. **567.** Cab heater valve. **568.** Stoker valve. **569.** Coal passer valve. **570–571.** Coal pusher pipe valve and pusher valve. **572.** Grate shaker handles. **573.** Grate shaker oil cup. **574.** Water gauge funnel. **575.** Cab opening stiffening angle. **576.** Back cab window opening. **577–578.** Cab window hook and gangway chain hook. **579.** Bar for cab handhold. **580–582.** Cab handhold and grabiron. **583.** Cab drop seat. **584.** Sprinkling hose valve. **585–586.** Seat-step and foot-rest. **587.** Seat box hasp. **588.** Grate shaker lever. **589.** Bottom cab stiffening angle. **590.** Oil pipe to duplex stoker driving rack. **591–595.** Duplex mechanical stoker details. **596.** Blow-off cock lever. **597.** Blower pipe. **598.** Injector starting valve lever. **599–600.** Duplex stoker operating rod bearing and handles. **601.** Lubricator pipe to steam cylinder. **602.** Lubricator pipe to steam cylinder of air pump. **603.** Steam valve Pyle National head-light turbine. **604.** Steam valve for Ragonnet reverse gear. **605.** Coal pusher steam pipe. **606.** Duplex stoker operating rod. **607.** Steam gauge Pyle National head-light turbine. **608.** Steam gauge for flange lubricator. **609.** Pyrometer gauge. **610–611.** Large and small duplex air gauges. **612–613.** Car and cab heater gauges. **614.** Steam gauge lamp. **615.** Oil can rack. **616.** Duplex stoker conveyor oil cup. **617.** Oil can shelf. **618.** Train line gauge pipe. **619.** Brake cylinder gauge pipe. **620.** Release valve for brakes. **621.** Brake application pipe. **622.** Distributing valve release pipe. **623.** Main reservoir pipe. **624.** Sander valve handle. **624a.** Train line pipe cut-out cock handle. **625.** Train line pipe cut-out cock. **626.** Equalizing reservoir pipe. **627.** Duplex stoker elevator casing door. **628.** Drain pipe for gauge cock funnel. **629.** Grate shaker. **630.** Footplate. **631–640.** Duplex mechanical stoker details. **641–642.** Cab wall and hood. **643.** Double-heading cock. **643a.** Equalizing reservoir. **644.** Cab handhold. **645.** Cab handhold crowfoot. **646.** Feed water suction pipe valve. **647.** Air signal hose. **648.** Gauge cock drip pipe. **649.** Air brake hose. **650.** Back buffer plate. **651.** Unit safety bar casting. **652.** End piece of trailing truck. **653.** Engine frame. **654–655.** Duplex stoker cylinder and steam chest. **656.** Left injector. **657.** Blow-off pipe. **658.** McLaughlin flexible conduit. **659.** Suction hose. **660.** Steam-heater pipe. **661.** Franklin fire door. **662.** Duplex stoker peep hole. **663.** Duplex stoker elevator casing slide guide. **664.** Feed water suction pipe valve bracket. **665.** Sander valve. **666.** Driver brake cylinder cut-out cock. **667.** Duplex stoker reach rod

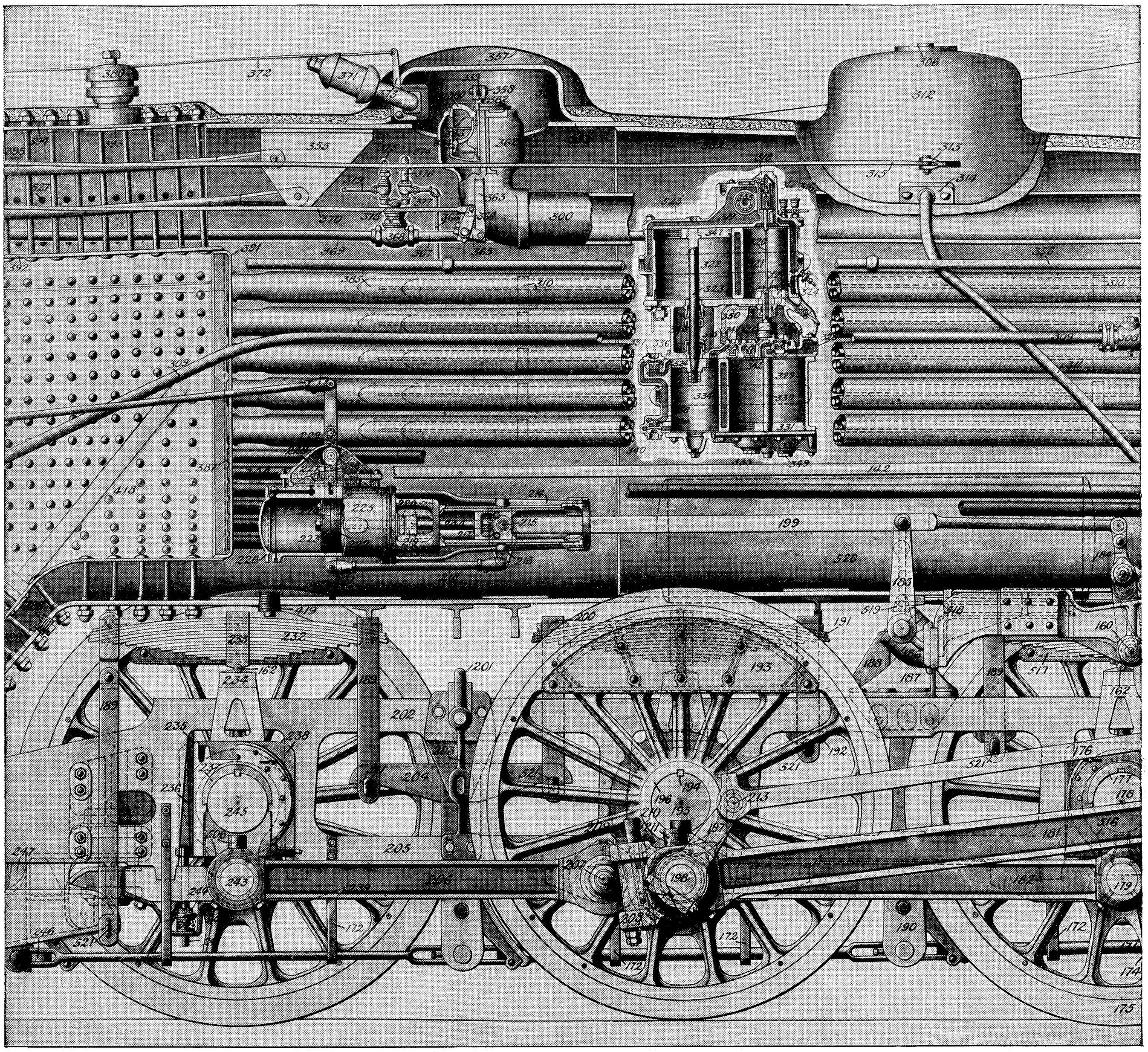
LOCOMOTIVE



BY COURTESY OF THE ANGUS SINCLAIR COMPANY

PACIFIC OR 4–6–2 TYPE LOCOMOTIVE—CAB AND FIREBOX DETAILS

248. Driver brake lever. 249–250. Foundation ring bearing shoe and support. 251. Expansion plate. 252. Ashpan casing. 253. Operating lever for ashpan door of front hopper. 254. Operating lever for ashpan door of rear hopper. 255. Lifting bar front hopper ashpan door. 256. Swinging lever front hopper ashpan door. 257. Bell crank arm for rear hopper ashpan door. 258. Bell crank arm for front hopper ashpan door. 259. Connecting link front ashpan hopper door rigging. 260. Lower arm swinging lever ashpan hopper door. 261. Front hopper casting for ashpan. 262. Connecting link rear ashpan hopper door rigging. 263. Rear hopper ashpan door. 264. Lifting bar rear ashpan hopper door. 265. Swinging lever rear hopper ashpan door. 266. Trailing truck and driving equalizer. 267. Rear frame section bolts. 268. Equalizer fulcrum ball. 269. Equalizer fulcrum socket bracket. 270–277. Trailing truck details. 278–279. Trailing truck brakeshoe and brake-head. 280–281. Trailing truck brake cylinder and air pipe. 282. Rear section of engine frame. 283. Footplate. 284. Drawbar pin. 285–287. Keeper key, keeper and drawbar. 288. Unit safety bar. 299. Bell lever and bell cord. 315. Sand box rod. 390. Ragonnet reverse gear reach rod. 396–397. Tate flexible stay bolt cap and sleeve. 398. Tate flexible stay bolt. 399–400. Sellers fountain valve and fountain. 401. Injector steam pipe. 402–403. Sellers U.S. standard non-lifting injector details. 404–405. Steam turret and valve. 406. Sellers U.S. standard non-lifting injector hand pull. 407. Boiler bracket for injector hand pull. 408. Sellers U.S. standard non-lifting injector hand pull handle. 409. Sellers injector indicator. 410. Sellers U.S. standard non-lifting injector. 411. Sellers U.S. standard non-lifting injector overflow. 412. Sellers U.S. standard non-lifting injector line check. 413. Sellers feed water strainer. 414. Hose nut thread for feed water suction pipe. 415. Rear Anchor for back head brace. 416. Pyle National head-light turbine. 417. Steam gauge. 420. Security sectional brick arch. 421. Arch tube. 422. Copper pipe for injector indicator. 423. Grate trunnion bearing. 424. Grade side frame. 425–427. Front gate shaking bar, arm and connection. 428–429. Dumping grate crank arm and connecting bar. 430. Dumping grate lever. 431. Dumping grate. 432–433. Grate finger and grate trunnion. 434–435. Grate arm and grate trunnion boss. 436. Back grate shaking bar. 437. Grate shaking rod. 440. Ashpan frame. 441. Foundation ring. 442–447. Sellers U.S. standard non-lifting injector details. 448–454. Ragonnet power reverse gear details. 455. Door opening. 456. Back boiler head. 457. Stiffening plate for boiler brace. 458. Cab ventilator. 459. Whistle bell crank. 460. Cab roof. 461. Cab eaves trough. 462. Throttle fulcrum. 463. Throttle stem stuffing box gland. 464. Throttle stem. 465. Throttle lever. 466–467. Throttle lever quadrant and latch handle. 468. Throttle stem stuffing box. 469. Steam gauge siphon coil. 470. Westinghouse independent brake valve handle. 471. Westinghouse independent brake valve body. 472. Westinghouse engineer's valve handle. 473. Westinghouse engineer's valve top case. 474. Brake pipe. 475. Duplex stoker elevator casing. 476. Franklin butterfly fire door. 477. Franklin fire door latch bracket. 478. Duplex stoker steam jet nozzle. 479–480. Franklin fire door opener gear casing and cylinder. 481. Franklin fire door opener hand lever. 482. Duplex stoker elevator drive and reverse casing. 483. Duplex stoker operating handle. 484. Franklin fire door opener hanger bolt. 485. Franklin fire door opener tread hanger adjusting gear. 486–487. Franklin fire door opener tread and hanger. 488. Duplex stoker conveyor drive and reverse gear. 489. Duplex stoker steam valve rod to engine. 490–491. Duplex stoker engine cylinder head and frame. 492. Duplex stoker supporting leg or cradle casting. 493. Duplex stoker rack housing. 494. Duplex stoker lubricator hole in rack housing. 495. Duplex stoker conveyor drive and reverse unit. 496–500. Cab window, sash, frame and guides. 501–502. Cab seat and box. 503. Sand rod handle. 504. Steam pipe to injector. 505. Side sheet of fire box. 508–509. Top and bottom trailing truck spring hanger keys. 522. Drawbar pin bushing. 525. Inside throat sheet. 526. Whistle lever rod. 528–529. Duplex stoker elevator shifter and shaft. 530. Franklin fire door opener tread weight. 531. Duplex stoker distributor tube. 532. Duplex stoker deflecting ribs of distributor tube. 533. Cab handhold or grab-iron. 641–642. Cab hood. 643. Double-heading cock

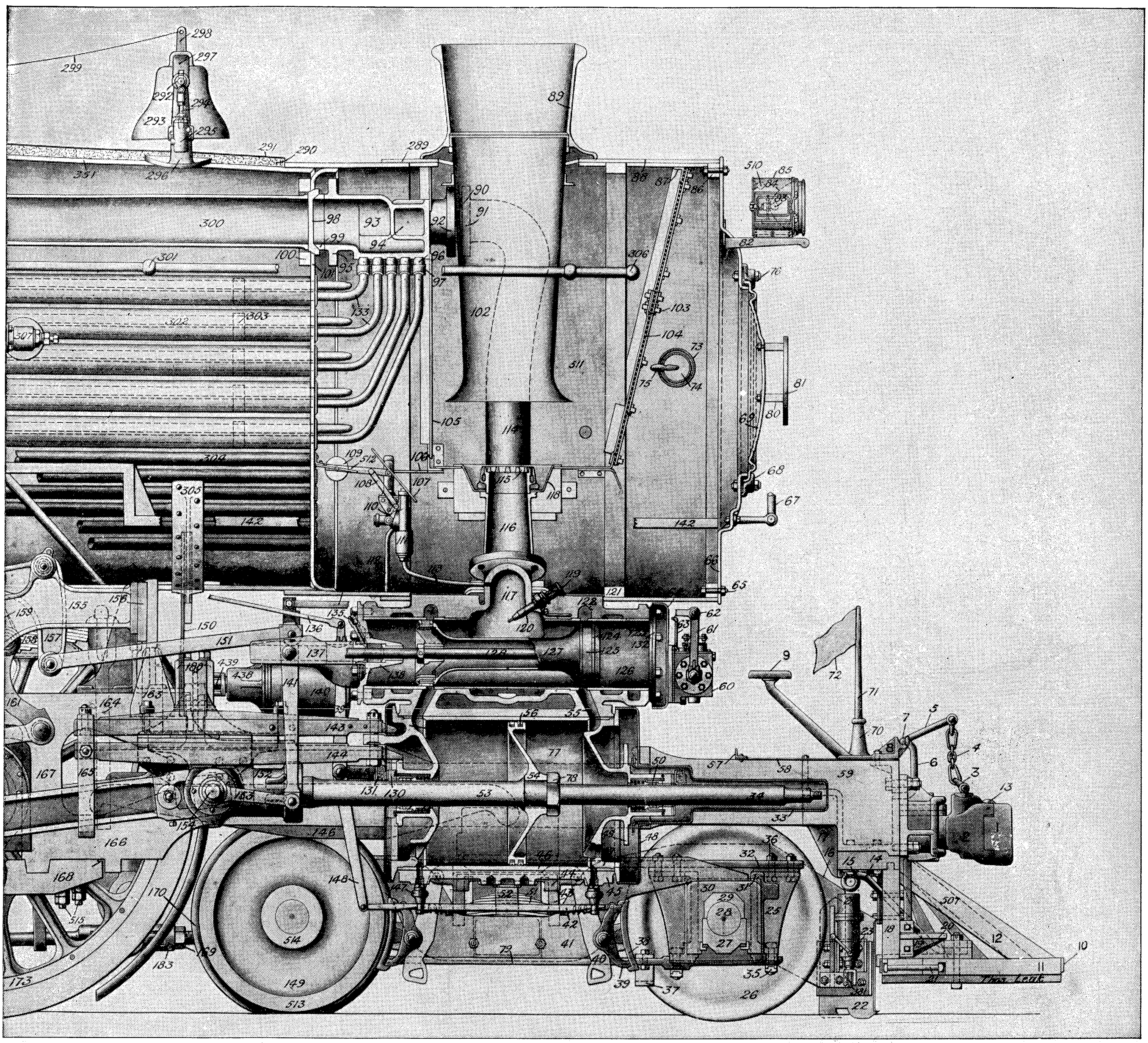


BY COURTESY OF THE ANGUS SINCLAIR COMPANY

PACIFIC OR 4-6-2 TYPE LOCOMOTIVE—BOILER AND DRIVE WHEEL DETAILS

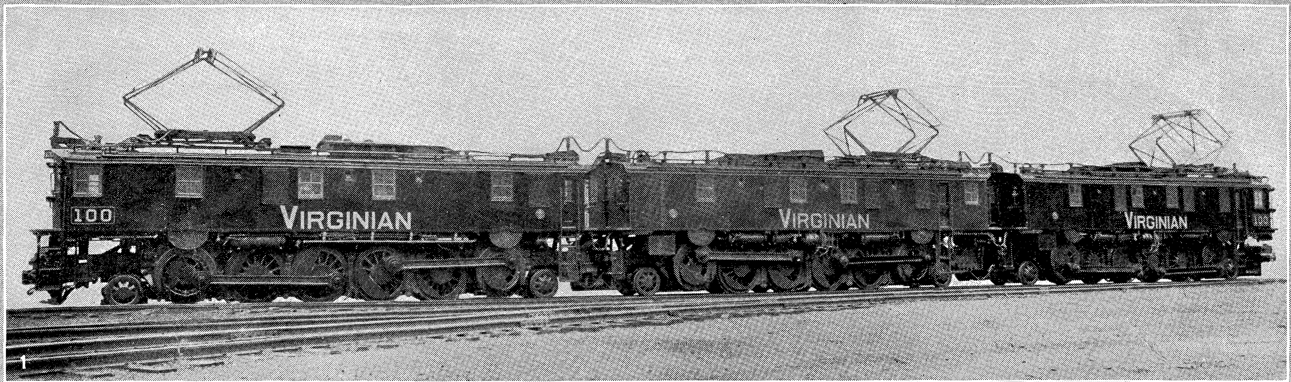
142. Running board. 160. Baker valve gear reverse yoke pivot pin. 161. Baker valve gear (*see* Plate IX.). 162. Driver spring stirrup. 171–172. Driver brake pull rod and hangar. 174. Driving wheel spoke. 175. Driving wheel tyre. 176. Baker valve gear eccentric rod. 177. Front driving axle journal bearing. 178. Front driving axle. 181. Connecting or main rod. 182. Front section of side or parallel rod. 184. Baker valve gear reverse yoke. 185. Reach rod carrying arm. 186. Valve gear counterbalance spring case. 187. Baker gear frame bracket. 188. Frame brace. 189. Driver spring hanger. 190. Driver brake lever. 191. Main driver spring. 192. Driver spring hanger step. 193. Main driver counterbalance. 194. Driving wheel and axle key. 195. Main driving axle. 196. Main driving wheel hub. 197. Baker valve gear eccentric crank. 198. Main crank pin. 199. Reach rod. 200. Main driver spring hanger seat. 201. Frame brace. 202. Top rail of main frame. 203. Equalizer bracket. 204. Driver equalizer. 205. Lower rail of main frame. 206. Rear section of side of parallel rod. 207. Knuckle pin or side rod. 208. Connecting rod fork. 209. Connecting rod cotter for brasses. 210. Connecting rod key for brasses. 211. Connecting rod oil cup. 212. Eccentric crank clamp. 213. Eccentric rod crank pin. 214–231. Ragonnet power reverse gear details. 232. Rear driving axle spring. 233–234. Driving axle spring band and stirrup. 235. Franklin automatic driving box. 236. Franklin automatic driving box adjusting wedge. 237. Rear driving axle journal bearing. 238. Rear driving axle journal box. 239. Rear side rod flange. 240–242. Franklin automatic adjustable driving box wedge spring bracket, bolt and spring. 243. Rear driving wheel crank pin. 244. Franklin automatic adjustable driving box wedge spring cap. 245. Rear driving axle. 246–247. Driver brake beam, brakeshoe and lever. 249–250. Foundation ring bearing shoe and support. 251. (*see* Plate VII.) 300. Dry pipe—runs from steam to cylinders (*see* Plate IX.) 306. Sand box cap. 308. Sellers injector check. 309. Delivery pipe. 310. Superheater unit support. 311–312. Sand pipe and sand box. 313–314. Sand lever and sand pipe connection. 315. Sand box rod. 316. Westinghouse air pump low pressure air cylinder lubricator. 317. Westinghouse air pump high pressure air cylinder lubricator. 318–350. Westinghouse air pump details. 352. Second course of boiler shell. 353. Dome reinforcing plate. 354. Dome. 355. Front anchor for back head brace. 356. Hand rail. 357. Dome casing. 358–365. Chamber throttle valve. 366. Air pipe from duplex compressor governor to main reservoir. 367. Steam pipe from duplex compressor governor to compressor. 368. Steam valve body of duplex compressor governor. 369. Steam pipe to air compressor. 370. Chamber throttle valve throttle rod. 371–373. Whistle, whistle rod and whistle lever. 374. Check unit from maximum compressor head of duplex compressor governor. 375. Check unit for excess pressure head of duplex compressor governor. 376. Spring box for maximum pressure head of duplex compressor governor. 377. Diaphragm body for duplex compressor governor. 378. Siamese fitting for duplex compressor governor. 379. Pipe from excess pressure head of duplex compressor governor to automatic brake valve. 380. Safety valve. 382–384. Chambers throttle valve balance valve, piston and packing ring. 385. Superheater forged return bend. 386. Ragonnet reverse gear valve chest gland. 387. Beading on tubes. 388. Arch tube wash-out plug. 389. Outside throat sheet. 391. Back tube sheet. 392. Crown sheet. 393. Stiffening plate for safety valve opening. 394. Outside or roof sheet of fire box. 395. Boiler brace. 418. Combustion chamber. 419. Wash-out plug. 506. Side rod oil cup. 516. Front driving wheel crank. 517. Front driving wheel counter balance. 518–519. Baker valve gear counter balance rod and arm. 520. Main reservoir. 521. Driver spring hanger key. 523. Westinghouse compound air pump. 524. Westinghouse air pump high pressure air piston. 527. Belpaire cross stay

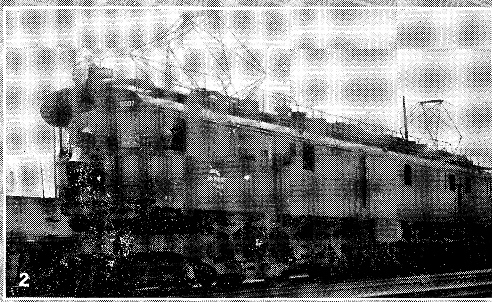
LOCOMOTIVE

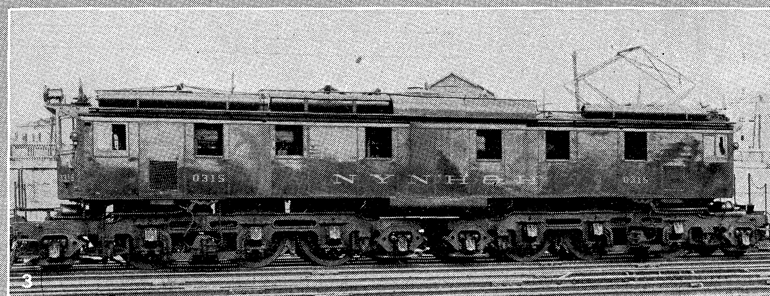


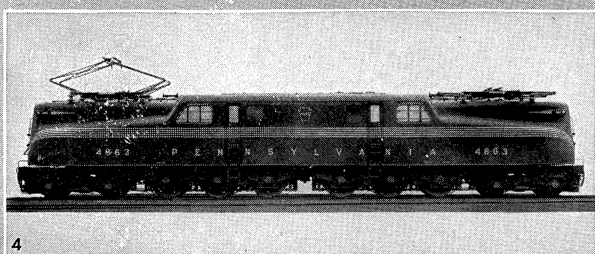
PACIFIC OR 4–6–2 TYPE LOCOMOTIVE—CYLINDER AND SMOKEBOX DETAILS

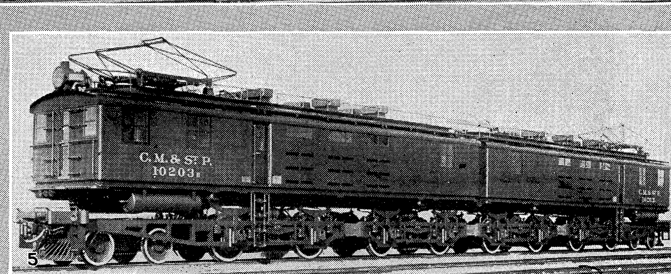
1–9. Coupler and uncoupling lever details. 9. Front end step. 10–12. Pilot nosing, base and bar. 13. Coupler knuckle pin. 14. Pilot brace. 15. Safety chain eye. 16. Snow flanger equalizer (Ray type). 17. Pilot and buffer angle. 18. Back vertical of pilot. 19–20. Pilot step bracket trend. 21. Pilot base tie bolt. 22–24. Snow flanger details (Ray type). 25. Truck pedestal. 26. Truck wheel. 27. Truck axle box cellar. 28. Truck axle. 29. Truck axle journal bearing. 30. Truck journal box. 31. Truck pedestal rib. 32. Truck frame. 33–34. Extension piston rod casing and rod. 35. Pedestal tiebar bolt. 36. Truck pedestal bolt. 37. Truck pedestal tiebar cross tie. 38. Truck brakeshoe. 39. Truck brakehead. 40. Truck brake lever. 41. Front truck equalizer. 42. Cylinder cock slide rod. 43–44. Truck spring hanger and bracket. 45. Cylinder shell. 46. Cylinder bushing. 47. Front cylinder head. 48–49. Front cylinder head casing and flange. 50. Extension piston rod packing. 51–52. Front truck semi-elliptic spring and band. 53–54. Piston rod and piston. 55. Steam port. 56. Piston packing ring. 57–58. Front plate stiffening angle and front plate. 59. Front buffer beam. 60–63. Lubricator details (Schlacks system). 64. Front steam chest casing. 65. Boiler front bolt. 66. Boiler front. 67. Boiler front hand rail. 68–69. Smoke-box door clamp and door. 70–72. Flagstaff fixture, flagstaff and signal flag. 73–75. Spark cleaning hole cap ring, cap and handle. 76. Smoke-box door clamp bolt. 77. Cylinder. 78. Piston nut. 79. Truck pedestal tiebar. 80–81. Number plate stud and number plate. 82–85. Head-light bracket, lamp, reflector and casing (Pyle National). 86. Front smoke-box ring. 87. Netting frame. 88. Smoke-box shell. 89. Smokestack. 90–91. Steam-pipe ring and flange. 92. Superheater steam-pipe connection. 93. Saturated steam passage. 94. Superheater steam passage. 95. Superheater header (type A). 96. Superheater unit ball end. 97. Superheater unit clamp. 98. Dry pipe flange. 99. Superheater header ring. 100. Dry pipe stiffening ring. 101. Front tube sheet. 102. Smokestack lift pipe. 103–104. Netting stud and netting. 105. Diaphragm. 106–113. Superheater damper details. 114. Steam pipe. 115. Muffled exhaust nozzle. 116–117. Exhaust pipe and passage. 118. Horizontal diaphragm pocket. 119. Lubricator diaphragm terminal check valve (Schlacks system). 120. Lubricator terminal check valve steam pipe extension (Schlacks system). 121. Intermediate smoke-box ring. 122–123. Steam chest casting and bushing. 124–125. Piston valve packing and bull ring. 126. Steam chest. 127–128. Piston valve and valve stem. 129. Back cylinder head. 130. Piston rod packing (Q. ana C. type). 131. Piston rod lubricator (Q. and C. type). 132. Front steam chest head. 133. Superheater unit pipe. 134. Lubricator lever link (Schlacks system). 135. Valve stem lubricator. 136. Cylinder cock reach rod. 137. Valve stem cross head guide. 138. Back steam chest head. 139. Back steam chest head stud. 140. Driving brake cylinder. 141. Baker valve gear combination lever. 143–144. Top and bottom guides. 145. Cylinder cock shaft. 146. Driver and truck equalizer. 147. Cylinder cock. 148. Cylinder cock shaft arm. 149. Truck wheel web. 150. Buckle plate. 151. Baker gear valve rod. 152. Cross head. 153. Baker valve gear union rod. 154. Wrist or cross-head pin. 155–157. Baker valve gear frame, cross tie and bell crank. 158. Front driver spring. 159. Baker valve gear radius bar. 163. Guide yoke. 164. Front driving spring hanger. 165. Guide strap. 166. Engine frame. 167. Front pedestal leg. 168. Pedestal tie. 169. Brake pull rod adjusting nut. 170. Truck wheel flange. 173. Driver tire retaining ring. 180. Guide yoke. 183. Brake pull rod turn buckle. 289. Smokestack base reinforcing plate. 290–291. Boiler lagging and boiler jacket. 292. Hammett bell-ringer crank. 293. Bell. 294–295. Hammett bell-ringer piston rod and bell-ringer cylinder. 296–297. Bell stand and bell yoke. 298–299. Bell lever and bell cord. 300. Dry pipe. 301. Handrail bracket. 302. Superheater tube. 303. Superheater unit band. 304. Boiler tube or flue. 305. Boiler belly brace. 307. Sellers injector stop valve. 351. Front course of boiler shell. 381. Snow flanger cross tie brace (Ray type). 438–439. Driving brake cylinder head and piston rod. 507. Pilot. 510. Pyle National head-light side-light bulb. 511. Smokebox. 512. Superheater damper counter weight arm. 513. Truck wheel rim. 514. Truck wheel hub. 515. Pedestal tie bolts

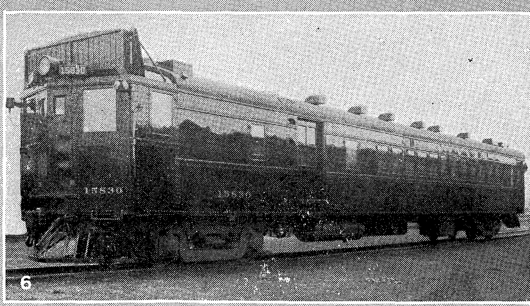


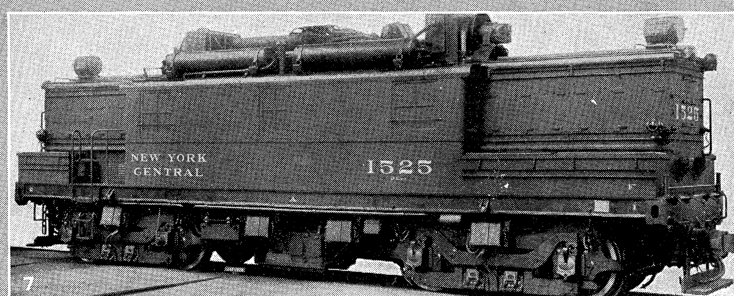








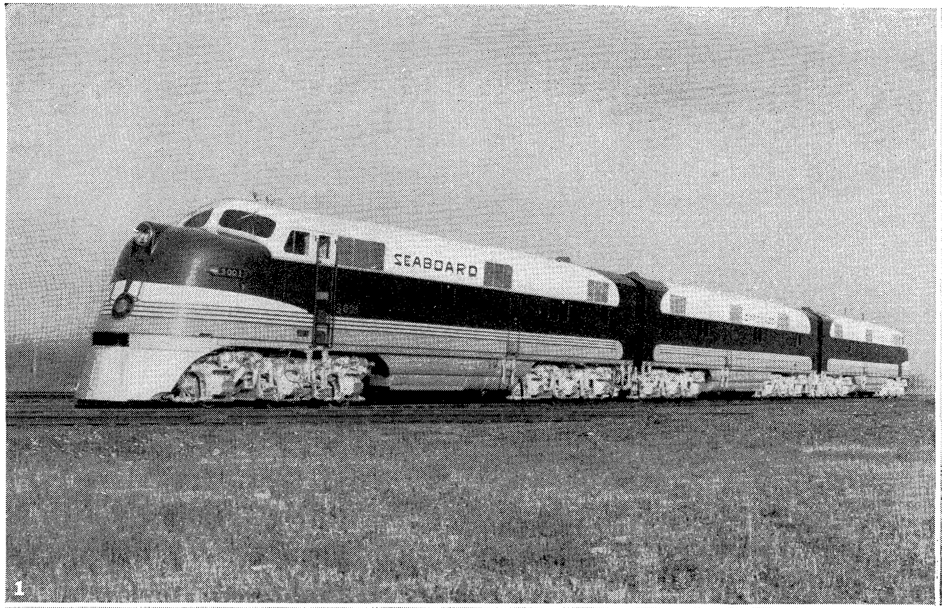


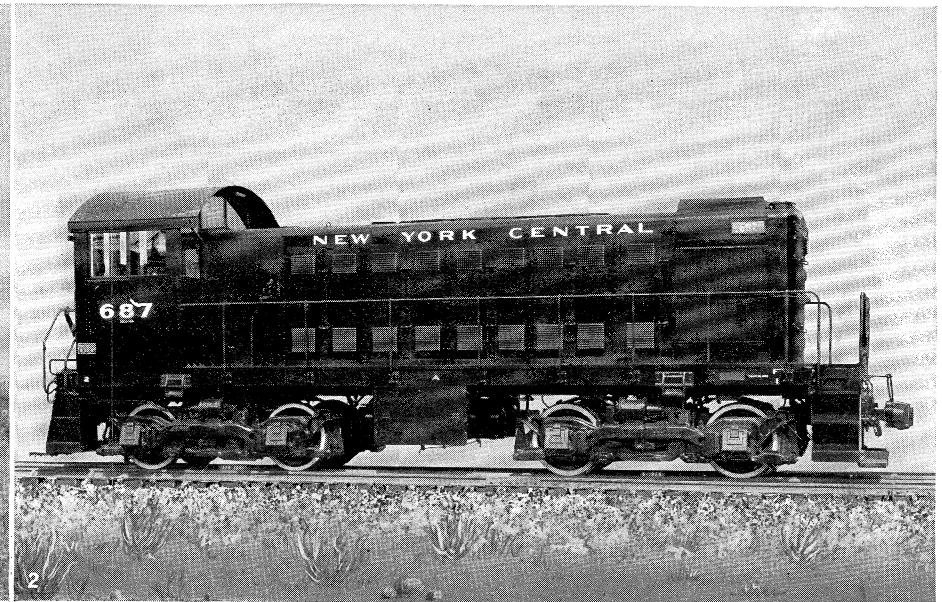


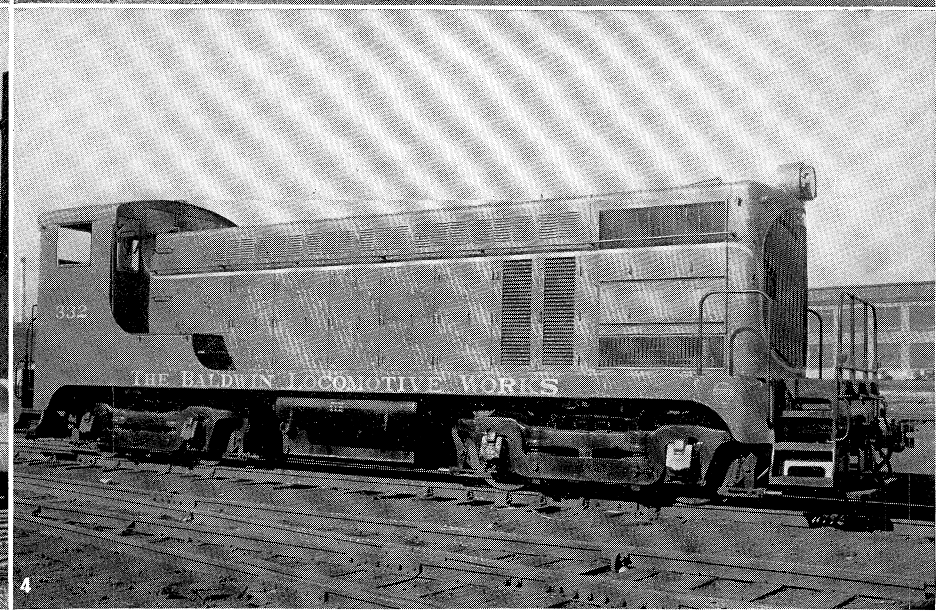
BY COURTESY OF (1-3) THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, (4) THE PENNSYLVANIA RAILROAD, (5) THE GENERAL ELECTRIC COMPANY, (6) THE CANADIAN NATIONAL RAILWAYS, (7) THE ELECTRIC STORAGE BATTERY COMPANY

ELECTRIC PASSENGER AND FREIGHT LOCOMOTIVES IN USE ON AMERICAN RAILROADS

1. Virginian Railway. Three 2-8-2 units, AAR Classification 3 (1-D-1), built by American Loco. Co., & Westinghouse Elec. and Mfg. Co.; 11,000 or 22,000 volts A.C. Total wt. 1,282,380 lb.; wt. on drivers 922,580 lb.; wt. on guiding trucks 359,800 lb.; capacity at one hr. rating 6,090 h.p. at 14.1 m.p.h.; 7,125 h.p. at 28.3 m.p.h. Starting tractive effort 277,500 lb. at 30.07% adhesion; tractive effort, hourly rating, 162,000 lb. at 14.1 m.p.h., 94,500 lb. at 28.3 m.p.h.; tractive effort continuous rating, 135,000 lb. at 14.2 m.p.h.
2. Chicago, Milwaukee, St. Paul & Pacific Railroad. One 4-6-2 and one 2-6-4 articulated units, built by Westinghouse Elec. & Mfg. Co.; 300 tons cap.; 3,000 volts D.C. Total wt. of locomotive 600,000 lb.; wt. on drivers 378,000 lb.; wt. on idle trucks 222,000 lb.; capacity at one hr. rating 4,680 h.p. Starting tractive effort 94,500 lb.; tractive effort, hourly rating, 66,000 lb.; tractive effort, continuous rating, 40,800 lb.
3. New York, New Haven & Hartford Railroad. Two 2-6-2 articulated units, built by Westinghouse Elec. & Mfg. Co.; 11,000 volts A.C. Total wt. of locomotive 356,000 lb., wt. on drivers 240,000 lb., wt. on idle trucks 116,000 lb.; capacity at one hr. rating 2,508 h.p. Starting tractive effort 52,500 lb.; tractive effort, hourly rating, 19,260 lb., continuous rating, 13,080 lb.
4. Pennsylvania Railroad. One articulated unit (4-6-0+0-6-4). Class GG1. Built by the Pennsylvania Railroad. 11,000 volt A.C. Total weight of locomotive 460,000 lb.; weight on drivers 300,000 lb.; weight on idle trucks 160,000 lb.; capacity at continuous rating 4,620 h.p. Starting tractive effort 72,800 lb.; tractive effort, continuous rating (90 miles per hour) 19,140 lb.
5. Chicago, Milwaukee, St. Paul & Pacific Railroad. Two 4-8-0 articulated units, built by General Elec. Co.; 3,000 volt D.C. Total wt. of locomotive 564,000 lb.; wt. on drivers 448,000 lb.; wt. on idle trucks 116,000 lb. Starting tractive effort 112,000 lb.; tractive effort, hourly rating, 71,000 lb.
6. Canadian National Railways. Two 4-wheel-truck type oil-electric passenger and baggage motor car, built at Point Charles Works, Montreal. Length of car body 73 ft. 9 in. over end sills; total wt. on rails 133,000 lb. Beardmore six-cylinder oil engine, 300 h.p. at 750 r.p.m. Westinghouse 198 K.W. D.C. gen.; two 600 volt 200 h.p. motors
7. New York Central Railroad. Two 4-wheel-truck type, built by Elec. Storage Battery Co. Combination battery and oil-electric; 218-cell storage battery, capacity 294 Kwh. Four motors, total rated 1,580 h.p.; motor gear ratio 4.24; driving wheels 44 in. diam. Tractive effort, max. 60,000 lb. Total wt. on drivers 257,000 lb.; 300 h.p.







BY COURTESY OF (1) ELECTRO-MOTIVE CORPORATION, (2) AMERICAN LOCOMOTIVE COMPANY AND GENERAL ELECTRIC COMPANY, (3) CHICAGO AND NORTH WESTERN LINE, (4) THE BALDWIN LOCOMOTIVE WORKS

OIL-ELECTRIC LOCOMOTIVES FOR PASSENGER AND FREIGHT SERVICE

1. Three-unit diesel-electric locomotive for passenger train service. This streamlined locomotive develops a total of 6,000 horse-power
2. Alco G.E. diesel-electric 660-h.p. switching locomotive
3. Diesel-electric locomotive of two units that draws a streamlined passenger train, "The 400," between Chicago and Minneapolis
4. Diesel-electric switching locomotive, 1,000 h.p.; economy, safety and cleanliness are its advantages

gas area water tube fire-box—fire flue and tube boiler; a fire-box header—fire flue superheater; main throttle valve and steam delivery and branch pipes to be placed outside of boiler and smoke-box; a turbo-fan stack-draft blower; insulation and jacketing to have an efficiency of 98%; a mechanically driven feed pump; an open de-aërating feed-water heater; a smoke-box economizer, a unit system for automatically burning solid or liquid fuel in suspension; the use of high-elastic limit, tough, ductile, high manganese-low carbon steel castings, forgings and plates; and the utilization of engine and tender leading and trailing uncoupled truck wheel weight, for necessary starting, acceleration and light power use, by means of independently operated four-wheel coupled, reversible and relatively high speed and economical steam auxiliaries. High pressure-temperature non-condensing steam locomotives can be designed and constructed at a reasonable cost, to operate safely, reliably and efficiently, at speeds as high as 110 m. per hour under roadway, track and signal conditions suitable for such train speed, and permissible improvements will greatly reduce the existing smoke and noise nuisances. In terms of the heat value of the fuel used, the thermal efficiency at the tender draw-bar can be increased from what we now ordinarily obtain in road service—4 to 6%—to from 13 to 15%. In relation to the unit of work produced, *i.e.*, gross ton miles or draw-bar horse-power hour, this shows the enormous possibilities remaining in the way of increasing steam locomotive boiler, engine and machine efficiency. Pressures will be limited for the time being in locomotive construction to around 500 pounds. The wheel loads to be encountered in 1929 by a locomotive boiler pressure higher than 500 lb. may not increase the efficiency sufficiently to compensate for the added total locomotive weight.

Higher passenger train speeds have brought up the factor of head end air resistance, and numerous designs of streamlining developed and still under advisement are for the purpose of reducing air and train resistance when trains are operated at speeds of over 75 m. per hour. However, as it is the track curvature, super-elevation and the track and transportation conditions in general that govern maximum train speeds, it is probable that streamlining will be more a factor of "styling" than of efficiency.

The use of the self-contained high-pressure-temperature steam locomotive, in combination with an improved steam distribution gear, will no doubt be continued indefinitely where heavy trains and traffic must be expeditiously and economically hauled for long distances under all sorts of profile and weather operating conditions. Where they cannot be made suitable Diesel engines or electricity may be substituted. (J. E. Mu.)

ELECTRIC LOCOMOTIVES

The electric locomotive, as commonly defined, is a motive power unit which receives its power from an overhead trolley or a third rail contact system. Certain other classifications might also rightfully be considered as electric locomotives, such as the diesel-electric, the gasoline-electric, the turbine-electric and the storage battery type.

While these units generate or furnish their own basic power, they employ electric drive quite similar to that of the straight electric locomotive. Some combination locomotives using two or three sources of power have been built.

Electric locomotives have been applied for every type of transportation service including mining, industrial plants, interurban railroads and, most conspicuously, to supersede steam service on main line railroads. For these varied services, locomotives have been constructed in a multitude of sizes and types, ranging from the so-called midget of 1½ tons for industrial service to the heavy duty, main line freight locomotives of the Virginian railway, weighing over 600 tons, rating 6,000 continuous horse-power and developing 277,500lb. tractive effort. Electric operation of different roads extends from minor installations of a few miles to that of the Pennsylvania railroad, the most extensive in the world, which connects New York, Philadelphia, Washington and Harrisburg with over 2,000mi. of electrified track.

STRAIGHT ELECTRIC LOCOMOTIVES

Types of Locomotives.—Electric locomotives are of the alternating current type or the direct current type depending upon the kind of power furnished over the trolley or third rail system. For all installations of minor extent the direct current system is invariably employed. For main line operation, both systems are used, and so far their use has been about equal in extent. From the purely technical standpoint, each system has certain advantages for any particular application, and thus the decision as to system should be dictated by local conditions. However, for uniformity and interchangeability, many countries have seen fit to standardize not only on the system, but also on the trolley voltage. The extent to which each system is employed may be seen from the tabulation which follows, showing the prevailing standards in those countries where electrification has been extensively employed:

Country or Region	*System*
United States	600, 1,500, 3,000 volts d.c. 11,000 volts, 25 cycles a.c.
South America	3,000 volts d.c.
British Empire	600, 1,500, 3,000 volts d.c.
Belgium	3,000 volts d.c.
Italy	3,000 volts d.c.
Poland	3,000 volts d.c.
Russia	3,000 volts d.c.
France	1,500 volts d.c.
Japan	1,500 volts d.c.
Holland	1,500 volts d.c.
Germany	15,000 volts, 16⅔ cycles a.c.
Switzerland	15,000 volts, 16⅔ cycles a.c.
Sweden	16,000 volts, 16⅔ cycles a.c.

All alternating current systems listed are single phase. The complications which arise in the trolley construction have placed the three phase system in the discard.

Locomotive Mechanical Design.—The mechanical parts include those portions of the locomotive which make it suitable as a vehicle, *i.e.*, the running gear, and the cab or superstructure which houses the operator and the electrical apparatus.

In contrast with the steam locomotive, the designer of an electric locomotive is offered the possibility for an infinite variety of running gear arrangements as each axle can be driven by its own motor when preferred. As a result of this potential flexibility, an almost endless number of running gear designs have been produced. Fortunately, recent progress in the art is leading to the abandonment of the more fantastic types and to greater standardization on proven designs.

Any electric locomotive mechanical design can be classified by one of the three following general types:

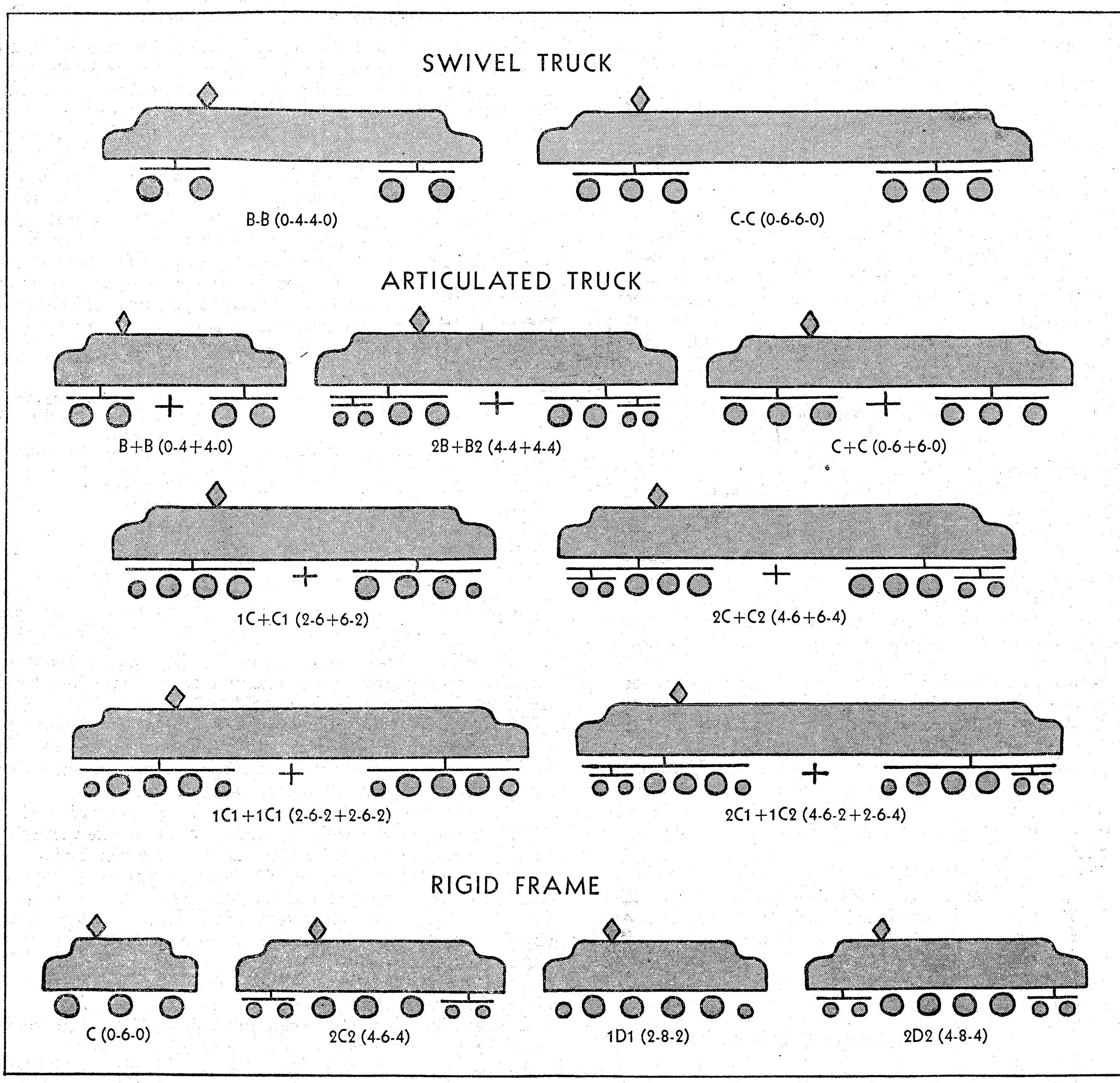
1. The swivel truck type where two independent swivel trucks carry the cab superstructure on centre pins.
2. The articulated truck type where the trucks are interconnected by joints or hinges which permit the entire draw-bar pull to be carried through the trucks themselves and none through the cab superstructure.
3. The rigid frame type where the driving axles are carried by the main locomotive frame in a rigid wheel base.

The two latter types, when applied for operation at the higher speeds, incorporate guiding trucks at the outer ends of the locomotive to improve its riding characteristics.

The types more commonly in vogue today are illustrated by the diagrams on page 284. (In this tabulation the + sign indicates that the trucks are connected at this point by a joint or hinge to form the articulation.)

Swivel truck locomotives are commonly applied to switching and transfer service where speeds are relatively low and where the flexible truck arrangement permitted by this type of locomotive ideally fits it for the sharp curves found in yard tracks. Furthermore, the swivel truck type usually offers the minimum first cost for this service.

For heavy duty service either the articulated truck or the rigid frame type is employed. While the rigid frame type generally offers a more simplified design with a lower cost, certain limitations are imposed upon its application as it is often impractical



TYPES OF ELECTRIC LOCOMOTIVE MECHANICAL DESIGN

to meet normal curve restrictions with more than four driving axles in the rigid wheel base. Thus, where large capacities are required, this type is restricted to those railroads which will permit relatively heavy axle loadings.

The articulated type has the widest possible field of application. Since it is practical to provide six to eight driving axles, this type offers the designer a wide variety of choices to meet any particular requirements.

The design of the guiding trucks is influenced largely by the prevailing speeds at which the locomotive will be called upon to operate. Single axle trucks are generally preferred for medium speeds, but above 60 m.p.h., two-axle trucks predominate. To perform effectively their function in guiding, the weight carried by each guiding axle must be from 50% to 80% of the weight carried by each driving axle. The design of the guiding trucks is a most important feature for very high speed operation. By proper design of its mechanical parts, the electric locomotive can be made safe for operation at any speeds permitted by the roadbed.

Drive.—One feature of the electric locomotive which has received much attention is the "drive," or the arrangement by which the motor torque is transmitted to the driving wheels. All locomotive drives may be classified into two general types: (*a*) the individual axle drive where each axle is driven by its own motor or motors, and (*b*) the collective drive where two or more axles are driven from one motor or group of motors. While the collective drive is somewhat the outgrowth of steam practice, both types have been widely used, although more recently, especially in America, the individual axle drive has greatly predominated as it eliminates side rods and heavy rotating parts.

The simplest form of individual axle drive is the direct geared, axle hung motor. Here the motor is mounted within the truck and geared directly to the axle to be driven. The motor is supported on one side by bearings on the axle, and on the opposite side by a nose support which rests on some portion of the truck. The field of application of this drive is somewhat restricted by space limitations, but for those cases where it is suitable it is widely used because of low cost and low maintenance expense.

When the service to which the locomotive is to be applied calls for large capacity motors operating at high speeds, experience has proven the desirability of carrying the motors on the spring-borne parts of the running gear to relieve the track from excessive unsprung weight. When this mounting is used, there must be relative movement between the spring-borne motor and the driving wheels, necessitating some form of flexible drive. There are several forms of individual axle drive which provide this flexibility, principal among which are the Buchli link drive and the centre axle drive (both extensively used in Europe), and the quill cup or quill spring drives (used extensively in America and Europe). In all of these drives, the motors are mounted above the axle with intermediate gears provided to reduce motor speed to axle speed, so that their principal differences lie in the connections between gear and axle which will permit the necessary relative movement between the two. These drives have been so perfected that satisfactory performance is obtained under the most severe present-day requirements.

Collective axle drives invariably employ side rods when used on large locomotives. One or more motors are usually geared to a jack shaft which in turn is connected to the drivers by side rods. These drives, of which there are many variations, have reached their greatest development in Europe, while in America they are being rapidly superseded by the individual axle type. The vogue which the collective drive originally enjoyed was the result, to a certain extent, of limitations in the electrical equipment which could not be overcome otherwise, but recent developments no longer make them so necessary.

Electrical Apparatus.—Locomotive designers, whether steam or electric, continually face the problem of producing units of increased capacity. In America, since about 1910, the average capacity of electric locomotives has increased from 1,000 h.p. to 5,000 h.p., or fivefold. However, the weight and clearance restrictions imposed by the roadway have shown little or no change, making it necessary to provide the larger capacity within the same limits of space and weight. These restrictions and demands are so severe that today (1940) electrical apparatus on locomotives is designed for higher speeds and higher operating temperatures than those generally found throughout the electrical industry.

The four principal types of locomotives used today, as classified according to the kind of propulsion motors, are briefly described below.

The first electric locomotive used d.c. equipment. Roughly 50% of all main line locomotives are of this type, and practically all locomotives for installations requiring units smaller than main line requirements.

The electrical apparatus for all d.c. locomotives follows the same general pattern. The series motor is universally used as its inherent characteristics are ideally suited for traction purposes. The speed of d.c. locomotives is controlled by one or more of the following methods: (*a*) by inserting in the motor circuits resistance which can be varied in value; (*b*) by series and series-parallel or parallel connection of the motors, and (*c*) by field control whereby the motor series field winding is shunted or tapped to give reduced field strength. When locomotives operate on trolley voltages under 750 volts, the traction motors are wound for full trolley voltage, but for higher voltages the motors are wound for one-half to one-quarter of trolley voltage. In the latter case, two or more armatures are permanently connected in series, and each such circuit handled in the control as if it were a single motor.

Alternating current locomotives employ several fundamental types of electrical apparatus depending upon the service to be operated. Where the prevailing speeds range from 25 to 100 m.p.h., the a.c. series commutator motor is the preferred type, and the vast majority of a.c. locomotives are equipped with this motor. The a.c. series motor is similar in its characteristic performance to the d.c. motor, but its construction involves special features to assure satisfactory commutation when operated from an a.c. trolley. As this motor has been used on many of the major electrifications it has probably reached a higher stage of development than any other type.

Speed control of the a.c. series motor driven locomotive is obtained through a multi-tap transformer located within the cab which reduces the trolley voltage to the required motor voltage. The possible wide range of voltage afforded by transformer control makes the a.c. series motor locomotive the most flexible of all types of motive power from the operating standpoint.

In the U.S.A. two other types of a.c. locomotives have been applied for heavy drag, slow speed operation in mountain grade territory. The first of these used was the phase converter or split-phase type. On this locomotive the single phase trolley supply is converted to polyphase by a phase converter located within the cab. The propulsion motors are of the three phase, wound rotor induction type. Two or more continuous running speeds are provided by reconnection of the motor windings for various pole combinations or by cascade connection of the motors. The great advantage of the phase converter locomotive is its ability to withstand abuse at starting due to the absence of all motor commutators.

The second heavy duty a.c. locomotive used in America is the motor generator type where single phase trolley power is converted by a motor generator set to direct current to drive direct current traction motors. This type combines the advantages of the d.c. motor for slow speed service with that of the a.c. high voltage trolley supply.

Except in special cases, all major apparatus on electric locomotives is highly ventilated, often by special blowers. Ventilation imposes the problems of dirt, snow and rain, but space restrictions require cooling air so that often special devices are used to assure clean air. In large locomotives, the air requirements may exceed 50,000 cu.ft. per minute.

While small locomotives may use the conventional wheel trolley, all main line units are equipped with the pantograph type of trolley. These are normally spring raised and air lowered. Current collection at extremely high speeds requires a most careful design of both the pantograph and of the contact system.

The air brake system is similar to that of the conventional steam locomotive except that the compressors are driven by electric motors. All types of electric locomotives can be arranged to give regenerative braking. In this system the motors act as generators on descending grades, convert the momentum of the train into electric energy which is returned to the trolley system, and control the train speed without the use of air brakes. The power regenerated may be from 10 to 25% of that required for traction.

When electric locomotives haul passenger trains, the trains are heated by oil fired steam boilers within the locomotive. As the cars normally operate in both electrified and non-electrified territory, the heating system must be uniform for both services.

Locomotive Performance.—More capacity per ton of locomotive can be placed in the electric locomotive than in any other type of motive power. Hence the potential capacity of electrified operation to handle heavy trains at high speeds cannot be matched by any other type of power.

The weights, dimensions and capacities of electric locomotives vary over a wide range. These variations have been caused by many factors, some of which are the operating conditions to be met, the weight and space limitations imposed by different railroads, and the speeds which the particular roads will allow. However, as a general rule, most designs will fall within the following limits which show the range to which single cab locomotives can or have been built with electrical apparatus now developed:

Mechanical Design	Total Loco. Weight Tons	Driver Axle Loading Pounds	Cont. h.p.	Max. Short Time h.p.
Swivel Truck .	40–125	20,000–63,000	500–2,000	750–3,000
Articulated Truck .	80–300	30,000–70,000	2,000–7,500	3,000–12,000
Rigid Frame	65–230	40,000–75,000	2,000–5,000	3,000– 8,000

SELF-PROPELLED LOCOMOTIVES

In this classification fall the diesel-electric, the gasoline-electric, the turbo-electric and the storage battery types. Except for the prime mover and control, the equipment in any of these types is essentially the same as that of the conventional direct current locomotive.

The diesel-electric is receiving great favour as a switching locomotive, and to a lesser extent for passenger service. In road freight service its application has been nil. Most units so far constructed have not exceeded 2,000 engine h.p. per cab, but for passenger service as many as three of these cabs are placed on the train, providing a three-cab 6,000 h.p. locomotive. Designs are being made for locomotives of 4,000–6,000 h.p. in a single cab, but none have yet (1940) been placed in service.

It can reasonably be expected that the diesel locomotive will be more widely used in the future. It is yet too early in the development to foresee its final field in the railroad picture, but the trend to date is for a wide use in switching service, a field in ultra high speed passenger service and a limited use in road freight service. The gasoline-electric is used on the smaller units and where the locomotive is in service a relatively small proportion of the time. Its fuel cost is higher than that of the diesel, but its first cost is lower, hence its application is one of relative economy.

The storage battery locomotive has been most widely used in those locations were it is impractical to construct a trolley, or where the use of a diesel or gasoline engine is prohibitive. In some cases, diesel or trolley locomotives are equipped with auxiliary storage batteries to serve during those periods when they are required to operate in restricted territory.

A development has been the steam-turbine electric locomotive. Only one of these locomotives has been built (1940), this one being a two cab affair with a rating of 5,000 turbine horsepower. The locomotive has a high pressure flash boiler, burning oil, which supplies steam for the turbo-generator set. The electrical propulsion equipment is of conventional design. About one-third of the locomotive space is consumed by the condensers for the turbine. The two cabs weigh in excess of 500 tons in working order. The use of electric locomotives throughout the world is gradually being extended. While accurate statistics are not available, the total of main line locomotives is about 5,000 as of the year 1940. (C. K.)

LOCOMOTIVE COALING, the three industrial enterprises which consume most coal are railways, gas works and power stations. Of these three, gas-works engineers were the foremost to realize the need of handling their coal mechanically; those in power stations followed, and employed conveyors practically from their inception, basing their plant on the experience gained in gas works during the previous decade. The railway companies, who probably use more coal than either of the other two undertakings, continued, with one or two minor exceptions, to handle their locomotive fuel entirely by manual labour, until 1913; in the meantime American and Continental railways were leading in the adoption of machine coaling. While England has some of the finest locomotive coaling plants to be found anywhere, they are not as widely used as elsewhere. Since the coal consumed annually by locomotives amounts to many millions of tons, such devices should be provided for all important coaling yards. Large engine sheds may use as much as 600 to 700 tons of coal per day for their tenders and tank engines, while even small ones will require 200 to 300 tons.

Manual Coaling.—To load coal by transferring it manually from the truck to the tender necessitates the employment in a yard of about 30 "coal men," who do nothing else. Moreover, the time taken varies from 15 to 45 minutes for coaling a tender; this delays the engine and wastes the driver's time in the sheds. By modern mechanical means the largest locomotive can be provided with its quota of coal in three minutes by the services of a maximum number of four men; *i.e.*, one on each 8-hr. shift of the day, to operate the coal valves, and one during the first shift for filling the bunker and for assisting in the shunting of the coal wagons. It has been realized that if 100 locomotives per day have to be coaled, it is an economical proposition to do so entirely by mechanical means.

Modern methods, by which coal can be handled from the mineral truck to the locomotive tender, are very numerous. Some are quite inexpensive, while others are elaborate and costly. The determining factor is not solely the amount of coal to be handled, but the area, and more particularly the shape of the available site, which have both to be taken into consideration when deciding on the type of plant to be adopted.

The subject may be conveniently divided into three classes: locomotive coaling plant which provides for storage of coal in wagons; locomotive coaling plant in which the coal is held in suspension in overhead bunkers; locomotive coaling plant with ground storage "bings."

Installations of the first kind can only serve one tender at a time, whereas the others can serve several simultaneously. For a plant of the first class a long and narrow strip of land is required and a relatively simple mechanical device is employed, while the rest of the space is utilized for standing room for the full trucks. The disadvantage of such simple plants is that the operators must always be in attendance during the three shifts of the day.

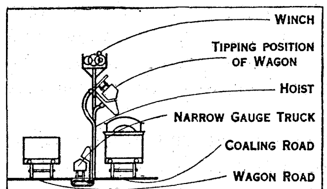


FIG. 1.—LOCOMOTIVE COALING PLANT USED BY THE LONDON, MIDLAND AND SCOTTISH RAILWAY COMPANY AT COAL YARD, KING'S CROSS, LONDON

With all locomotive coaling plants, except those where self-discharging hopper wagons are in use, the coal tippler which transfers the contents of the wagon to the rest of the handling machinery, plays a most important part and generally constitutes the most expensive item of cost. Such devices are fully dealt with under the heading WAGON TIPPLERS.

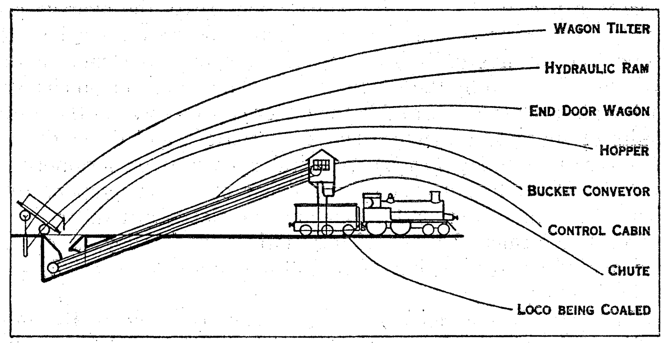


FIG. 2.—MECHANICALLY OPERATED LOCOMOTIVE COALING PLANT USED BY THE LONDON, MIDLAND AND SCOTTISH RAILWAY AT CAMDEN TOWN, LONDON, AND AT CARLISLE

The simplest type of fully mechanized locomotive coaling plant in Great Britain is that of the L.M. & S. Rly., at Kings Cross, London, which is shown in diagram, fig. 1. Here the coal is transferred from the wagons into narrow gauge trucks, which are hoisted up and emptied on the tenders. Diagram fig. 2 shows the type of mechanically operated device, as used by the L. M. & S. Rly., at Camden Town and also at Carlisle. In this an end wagon tippler unloads a truck in an under-rail hopper, thence on to a bucket conveyor which raises the coal to a point from which it can be shot on to a tender. The buckets of the conveyor are of such a size that 20 to 25 of them hold sufficient coal to charge one tender, so that the conveyor is run intermittently for each locomotive. Such an installation will coal over 100 locomotives per day, three minutes only being required to fill a large tender, with two men operating the device. In fig. 3 an installation on a different principle is shown, also used by the L.M. & S. Rly. Here the coal is taken from a rotary wagon tippler and thence, via a skip hoist and small hopper, on to a locomotive. This is in use at the Willesden coal yard, London. It is of particular interest because it is, more or less, an intermediate type. These three installations were built by the Mitchell Conveyor & Transporter Co. Ltd. For convenience of comparison figs. 1 to 6 are all drawn to the same scale.

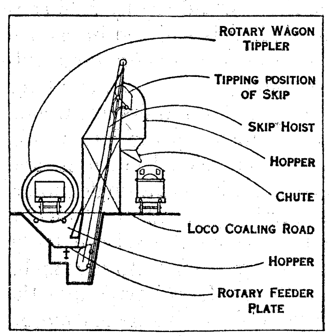


FIG. 3.—COALING PLANT USED AT THE COAL YARD, WILLESDEN, LONDON, BY THE LONDON, MIDLAND AND SCOTTISH RAILWAY

Coal in Overhead Bunkers.—With this plant a wagon tippler is used, and several methods are employed for raising the coal to the bunkers; viz., inclined hand conveyors, bucket conveyors and skip hoists. (*See* MECHANICAL HANDLING.) The latter are not, however, used in this country so much as they might be, though in America they are most usually employed.

Since such coaling installations have also to include a device for unloading the coal from the truck before it can be fed on to

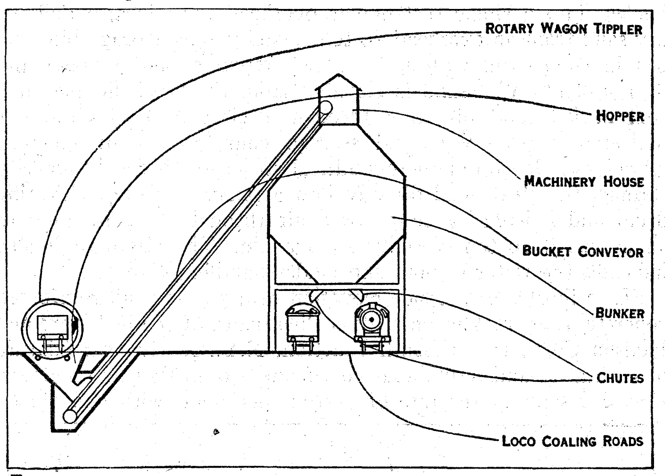


FIG. 4.—LOCOMOTIVE COALING PLANT USED AT NORTH CREWE, ALSO AT DAIRYCOTES, HULL

a conveyor or skip hoist, a system has been evolved for use where large capacities are concerned, in which a wagon tippler is so modified that a full coal truck can be lifted bodily off the rails to a level well above the bunkers, tipped and returned empty to the rails, thereby dispensing with conveyors. Such devices are, as a matter of fact, modifications of a type of wagon tippler.

In the following examples handling methods as enumerated in the foregoing are employed.

The locomotive coaling plant of the L.N.E.R. Rly. at Stratford, is the only installation of the kind in this country where a band conveyor is employed. It consists of a wagon tippler which discharges into an under-rail hopper which, in turn, feeds a band conveyor 277 ft. long, disposed at an incline of about 20°, which delivers the load at a height of 64 ft. above the rails into an overhead bunker of reinforced concrete, 120 ft. long and 45 ft. wide, which has a capacity of 800 tons. It is provided with 16 shoots, eight for each road, one on either side. These provide fuel for 400 locomotives per day, at the rate of 600 to 700 tons of coal. Less than two minutes is taken to coal one locomotive. The plant was installed by Messrs. Fraser & Chalmers, of Erith.

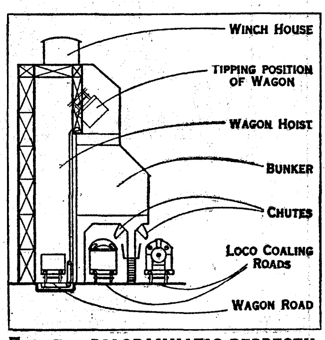


FIG. 5.—DIAGRAMMATIC REPRESENTATION OF COALING PLANT USED AT SOUTH CREWE, CHESHIRE, BY THE LONDON AND NORTH EASTERN RAILWAY

In fig. 4 is shown a diagrammatic representation of the type of locomotive coaling installation employed at North Crewe and at Dairycotes, Hull. In this a bucket conveyor is used for raising coal to the bunker. The manufacturers of this are Messrs. Spencer (Melksham) Ltd., Melksham, Wilts.

All the latest coaling plant in Great Britain is of the type in which a modification of side discharging wagon tipplers are employed (*see* fig. 5), which represents the plant at South Crewe, where the wagons are lifted vertically, while fig. 6 is a diagrammatic representation of the Nine Elms plant, in which the path of the rising wagons is steeply inclined. These installations were both built by The Mitchell Conveyor & Transporter Co. Ltd.

A coaling plant which is unique on account of its simplicity and efficiency is that used by the L.M.S. Rly Co. at their Edgehill depot. Topographical conditions being favourable, no conveyors are needed to fill the bunkers, the coal being handled by gravity with the exception of the use of a few capstans for the purpose of marshalling the wagons in position for unloading into the bunkers. Full wagons are brought along an overhead ramp and subsequently transferred to a spur track with two lines, one for the full, the other for the empty trucks; these traverse the length

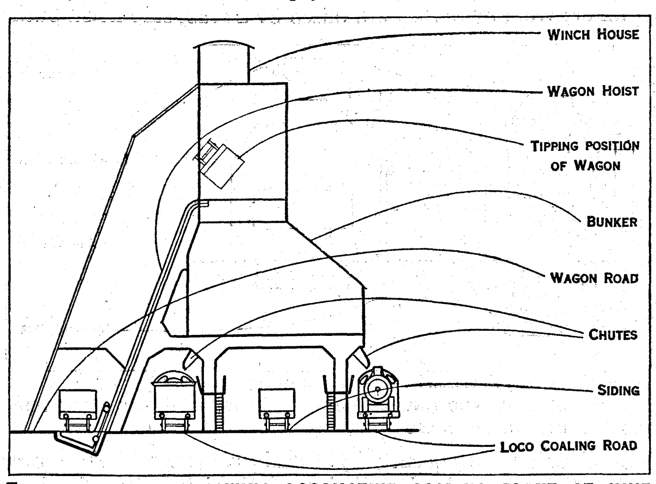
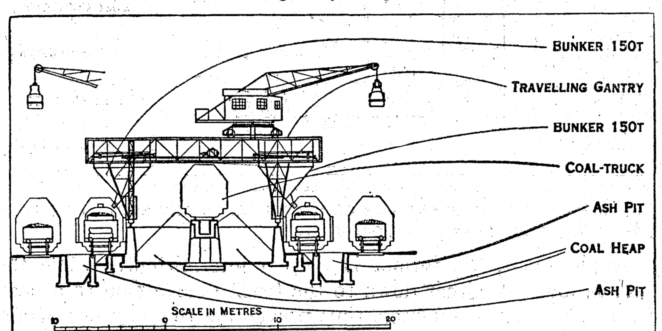


FIG. 6.—DIAGRAM SHOWING LOCOMOTIVE COALING PLANT AT NINE ELMS, LONDON

of a set of three concrete bunkers, into which the wagons are unloaded and over which the lines terminate. The empties are returned on a track with a gradient of 1:50. Each of the three bunkers holds 40 tons, with a maximum of 45. Each bunker has two outlets at a sufficient level above the engines and provided with feeding spouts, thus serving two lines, one on each side of the staging. The coal is transferred through a measuring shoot which doles it out in half-ton charges, merely by the manipulation of two levers.

Ground Storage "Bings."—The advantage of this type is that the wagons are not kept idle while they serve as storage receptacles. It is much used in Germany in conjunction with a crane and grab installation, for the purpose of coaling tenders. Such a system is shown diagrammatically in fig. 7. A travelling bridge gantry straddles a coal bing; on this the travelling crane is mounted so that it can reach both extreme positions over two rail roads, the inner ones for the locomotive and the two outer ones for the coal trucks. The bing can be accumulated by the crane from trucks on the outer roads, or from the trucks on a raised central track. The gantry is provided with two bunkers

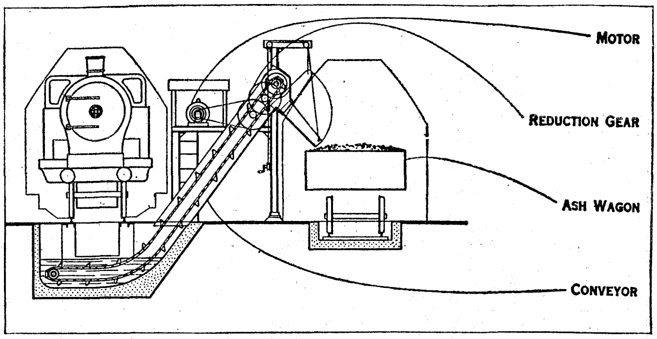


BY COURTESY OF THE ZEITSCHRIFT DES VEREINS DEUTSCHE INGENIEURE

FIG. 7.—GERMAN TYPE OF LOCOMOTIVE COALING INSTALLATION

holding 150 tons each; these are kept full by the crane and the tender is coaled merely by lowering the bunker outlet. Pits between the outer and inner tracks (*see* fig. 7) are provided for the reception of ashes and clinkers, which are raked out during the coaling process and are likewise disposed of by the crane combination at intervals. The only drawback to this otherwise efficient installation is the grab. As a matter of fact grabs are not really suitable for discharging railway wagons. If large they are apt to damage the wagons, and in any case, much hand trimming is necessary.

In order to omit nothing appertaining to the subject, it should be mentioned that, during the time occupied in coaling locomotives, particularly in large yards, it is sometimes essential to provide appliances for the removal of ashes and soot, and the provision of dry sand. In such cases the ashes are generally raked out and dropped into a pit beneath the rails, which contains quenching water; from there they are raised by a grab, skip hoist, bucket

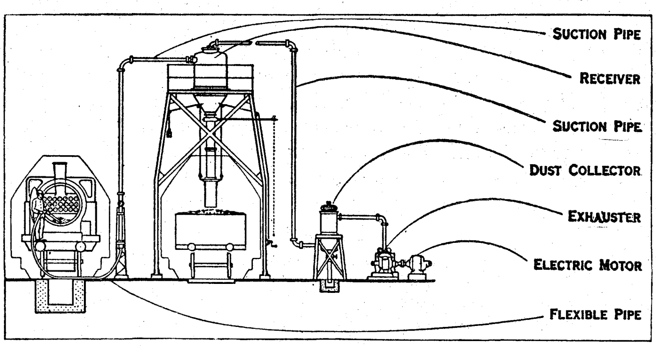


BY COURTESY OF THE ZEITSCHRIFT DES VEREINS DEUTSCHE INGENIEURE

FIG. 8.—DIAGRAM SHOWING METHOD OF DISPOSING OF THE ASHES DURING THE COALING PROCESS

elevator, or more frequently by a chain conveyor of the scraper or drag-link type. An installation of the latter type is shown in fig. 8, which is self-explanatory. The motor is housed in a small structure between the two tracks and the speed reduction gear is in this case mounted beneath the top terminal of the conveyor.

In Germany a small pneumatic plant has been introduced (*see* fig. 9) for clearing soot from the smokebox and flues. The electro-motor is shown on the extreme right, it is direct-coupled to a rotary exhauster; a partial vacuum is produced in the receiver which is located in the central position over a rail track, for the removal of the soot. A partly flexible tube which terminates in a nozzle, is led from the receiver to the locomotive. Between the receiver and the exhauster is a dust collector, partly filled with water, which prevents the entry of gritty substances. Unlike more elaborate pneumatic plant (*q.v.*), a receiver is not here provided with an "air trap," but is, instead, fitted with a sliding gate and



BY COURTESY OF THE ZEITSCHRIFT DES VEREINS DEUTSCHE INGENIEURE

FIG. 9.—PNEUMATIC PLANT FOR REMOVING ASHES AND SOOT FROM THE SMOKE-BOX AND FLUES OF A LOCOMOTIVE

telescopic shoot, the former is opened intermittently while the latter is lowered, either down to the truck floor, or on to a heap of soot already accumulated, thus preventing the entrance of air.

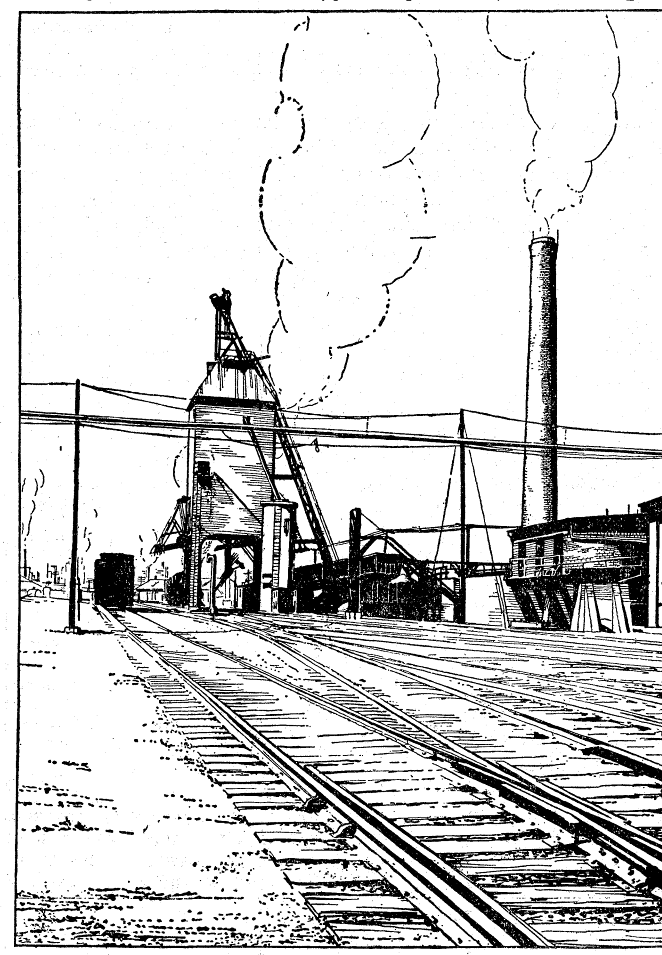
(G. F. Z.)

UNITED STATES

Owing to the tendency to eliminate fuel and water stops, the tenders of the more modern locomotives have a capacity of from 16 to 30 tons of coal, some of the coal spaces being over 26 ft. in length. To avoid making more than one stop for the purpose of supplying these tenders with fuel, provision must be made at the coal loading plants for two, instead of one, set of grates and aprons, or otherwise a swivel chute arrangement, in order to necessitate only one positioning or "spotting" of the engine under the loads. As about 10,000 American steam locomotives are now equipped with mechanical stokers, provision must also be made for the special preparation of the coal to obtain sizes other than mine-run in order not to clog the stoker operation. While such preparation is generally done at the mine, considerable equipment for this purpose must be provided at the coaling plants.

Fig. 1 shows a side elevation of a 500 ton capacity, three-track, all reinforced concrete, locomotive coaling plant, of the Lehigh Valley railroad, at Oak Island yard, Newark, N.J., receiving coal on a single track unloading hopper, 20 ft. long, elevating same at the rate of 60 tons per hour, with one 2 ton bucket, into a single rectangular overhead bin. It also delivers dry sand from an overhead 10 ton capacity sand storage bin, and has in connection with it a gravity circular sand storage and drying plant. Wet sand is elevated from the track hopper in a coal bucket, and diverting through a circular steel chute, as indicated, to the wet sand storage compartment of 50 tons capacity at the top of the cylindrical structure; is fed by gravity through the steam coil directly into a pneumatic sand elevating drum and hoisted by compressed air through a $2\frac{1}{2}$ in. pipe to an overhead 10 ton capacity storage bin. The photograph also indicates the water column and cinder handling plant.

Fig. 2 illustrates the side elevation of a 500 ton, all reinforced concrete, four-track locomotive coaling plant, of the Delaware and Hudson Company, at South Junction, N.Y., receiving a mixture of anthracite and bituminous coal from two 28 ft. track hoppers, elevating same at the rate of 75 tons per hour, with one $2\frac{1}{2}$ ton



BY COURTESY OF THE CHIEF ENGINEER, THE LEHIGH VALLEY RAILROAD

FIG. 1.—COALING PLANT OF THE LEHIGH VALLEY RAILROAD, AT OAK ISLAND YARD, NEWARK, N. J.

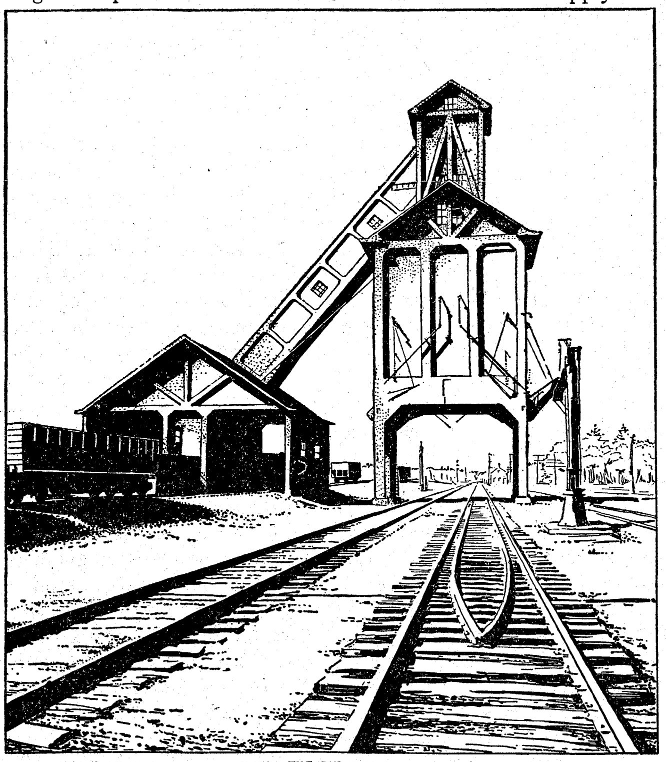
bucket, crushing to 4 in. cubes in a rotary type double-roll crusher, and depositing into either of two 250 ton pockets for delivery by gravity to locomotives on tracks below. The coal can be mixed in proportions ranging from 65% bituminous and 35% anthracite, to 25% bituminous and 75% anthracite. It also delivers dry sand through pipes and sand valves from a 10 ton overhead bin to locomotives on the coaling tracks.

Fig. 3 shows the side elevation of a 2,400 ton, all reinforced concrete, five-track locomotive coaling plant of the New York, New Haven and Hartford railroad, Cedar Hill yard, New Haven, Conn., receiving one kind of coal on a double track receiving hopper 20 ft. long, elevating same at the rate of 150 tons per hour, in two $2\frac{1}{2}$ ton buckets, and depositing without crushing into a single circular overhead storage bin, which is 55 ft. in diameter, to tracks below. It also delivers dry sand through pipes from a 15-ton bin at the top.

Fuel-oil stations consist in general of large steel storage reservoirs, elevated supply tanks, sump tanks, unloading pits, pumping plants and cranes. The unloading pits are steel or concrete boxes built between the track rails, the tank cars being "spotted" over these boxes and the fuel oil unloaded by gravity through pipes into the sump tank, where the oil is picked up by pumps and discharged into storage reservoirs or into the elevated supply tank. When cars are not being unloaded the pumps take oil from the storage reservoirs and discharge it into the elevated supply tank, from which the locomotives are supplied by gravity through track cranes. To salvage the fuel oil that is wasted, a suitable catch basin and skimming plant are provided.

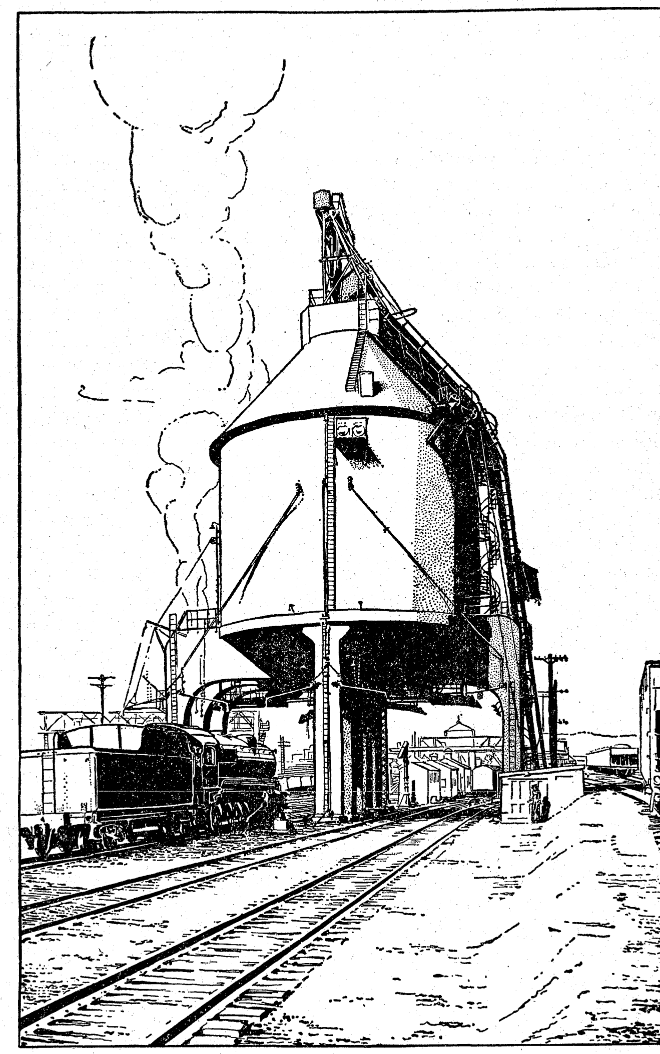
The practice of providing an accurate check on the amount of fuel supplied to the tenders is becoming more prevalent. In the case of coal, weighing devices are being installed in the form of hopper scales. Experiments are also being made in combination with certain types of stokers of a volumetric measuring device. Where fuel oil is used, the amount supplied is readily determined by gauging.

At terminals, and at the larger wayside or intermediate stations, the general practice is to combine the sand and water supply with



BY COURTESY OF THE CHIEF ENGINEER, THE DELAWARE AND HUDSON RAILROAD
FIG. 2.—COALING PLANT OF THE DELAWARE AND HUDSON RAILROAD AT SOUTH JUNCTION, NEW YORK

the fueling facilities; for example, a locomotive coal or fuel oil and water and sand plant, so that all of these supplies can be disbursed to the locomotive at one "spotting." Both coal and oil burning locomotives require dry sand supply for sanding the rail; and oil burners, in addition, require the dry sand for "sanding out" the boiler fire flues and tubes. The sand supply facilities consist of the wet sand storage, drying and handling equipment. There are three general types of sand handling facilities: (1) the small unit type, with open wet sand storage, from which the sand is wheeled to the drying stove and hoisted to the engine sand box by buckets or blown to an overhead dry storage receptacle by compressed air and then delivered to the engine sand box by gravity, (2) the independent supply plant, with drying apparatus located underneath, to which the wet sand is fed by gravity, after which it is blown by compressed air to an overhead dry sand storage bin, (3) wherein the wet sand is unloaded into a track hopper and hoisted by a conveyor to an overhead wet sand storage,



BY COURTESY OF THE CHIEF ENGINEER, THE NEW YORK, NEW HAVEN AND HARTFORD RAILROAD
FIG. 3.—COALING PLANT OF THE NEW YORK, NEW HAVEN AND HARTFORD RAILROAD, CEDAR HILL YARD, NEW HAVEN, CONN.

from where it is fed by gravity to driers, to dry sand bins and to sand boxes on the engines. The latter type has the advantage of reducing the cost for handling to the minimum. The two general methods for drying sand consist of either a stove, surrounded by a hopper containing the wet sand, or of steam heated pipe coils, conforming to a hopper, into which the wet sand is placed. (J. E. MU.)

LOCOMOTOR ATAXIA (synonyms, *Tabes dorsalis, posterior spinal sclerosis*), a progressive degeneration of the nervous system, involving the posterior columns of the spinal cord with other structures and causing muscular inco-ordination and disorder of gait and station. The essential symptoms—stamping gait, and swaying with the eyes shut, the occurrence of blindness and of small fixed pupils—were recognized by Romberg (1851), but it was the clinical genius of Duchenne and his masterly description of the symptoms which led to its acceptance as a definite disease (1858), and he named it locomotor ataxia after its most striking symptom. In 1869 Argyll Robertson discovered that the eye-pupil is inactive to light but acts upon accommodation in the great majority of cases. This most important sign is named the "Argyll Robertson pupil." With an ever-increasing knowledge of the widespread character of this disease and its manifold variations in the complex of symptoms, the tendency among neurologists is to revert to the term employed by Romberg—*tabes dorsalis*. "Locomotor ataxia," although it expresses a very characteristic feature of the disease, has this objection: it is a symptom which does not occur in the first (preataxic) stage of the disease; indeed many years may elapse before ataxy comes on, and sometimes the patient, after suffering long from the disease, may die from an intercurrent complication, without being ataxic.

It is generally recognized by neurologists that persons who are not the subjects of acquired or hereditary syphilis do not suffer from this disease; and the average time of onset after infection is ten years. (*See* NEUROPATHOLOGY.) There are three stages: (1) The preataxic, (2) the ataxic, (3) the bed-ridden paralytic. The duration of the first stage may be from one or two years, up to 20 years or even longer. In this stage various symptoms may arise. The patient usually complains of shooting, lightning-like pains in the legs, which he may attribute to rheumatism. If a physician examines him he will almost certainly find the knee-jerks absent and Argyll Robertson pupils present; probably on enquiry he will ascertain that the patient has had some difficulty in starting urination, or that he is unable to retain his water or to empty his bladder completely. In other cases, temporary or permanent paralysis of one or more muscles of the eyeball (which causes squint and double vision), a failure of sight ending in blindness, attacks of vomiting (or gastric crises), painless spontaneous fractures of bones and dislocations of joints, failing sexual power and impotence, may lead the patient to consult a physician, when this disease will be diagnosed, although the patient may not as yet have had locomotor ataxy. All cases, however, if they live long enough, pass into the second ataxic stage. The sufferer complains now of difficulty of walking in the dark; he sways with his eyes shut and feels as if he would fall (Romberg's symptom); he has the sensation of walking on wool, numbness and formication of the skin, and many sensory disturbances in the form of partial or complete loss of sensibility to pain, touch and temperature. These disturbances affect especially the feet and legs, and around the trunk at the level of the fourth to the seventh ribs, giving rise to a "girdle sensation." There may be a numbed feeling on the inner side of the arm, and muscular inco-ordination may affect the upper limb as well as the lower, although there is no wasting or any electrical change. The ataxic gait is very characteristic, owing to the loss of reflex tonus in the muscles, and the absence of guiding sensations from all the deep structures of the limbs, muscles, joints, bones, tendons and ligaments, as well as from the skin of the soles of the feet; therefore the sufferer has to be guided by vision as to where and how to place his feet. This necessitates the bending forward of the body, extension of the knees and broadening of the basis of support; he generally uses a walking stick or even two, and he jerks the leg forward as if he were on wires, bringing the sole of the foot down on the ground with a wide stamping action. If the arm be affected, he is unable to touch the tip of his nose with the eyes shut. Sooner or later he passes into the *third,* bed-ridden, stage, with muscles wasted and their tonus so much lost that he is perfectly helpless.

The complications which may arise are intercurrent affections due to septic conditions of the bladder, bed-sores, pneumonia, vascular and heart affections. About 10% of the cases, at least, develop general paralysis of the insane. This is not surprising seeing that it is due to the same cause, and the etiology of the two diseases is such as to lead many neurologists to consider them one and the same disease affecting different parts of the nervous system. *Tabes dorsalis* occurs with much greater frequency in men than in women. (*See* NEUROPATHOLOGY.)

The avoidance of all stress of the nervous system, whether physical, emotional or intellectual, is indicated, and a simple regular life, without stimulants or indulgence of the sexual passion, is the best means of delaying the progress of the disease. Great attention should be paid to micturition, so as to avoid retention and infection of the bladder. Drugs, even antisyphilitic remedies, appear to have but little influence upon the course of the disease.

LOCO-WEEDS, various North American plants of the pea family (Leguminosae), chiefly species of *Astragalus* (*q.v.*) and *Oxytropis,* which produce a disease in cattle known as "loco-disease." The name is apparently taken from the Spanish *loco,* mad. The disease affects the nervous system of the animal eating the plants, and is accompanied by exhaustion and wasting. The toxic properties of some species of *Astragalus* are due to the presence of selenium absorbed from the soil in which they grow.

LOCRI, a people of ancient Greece (Gr. *Λοκροί*), inhabiting two distinct districts, one extending from the northeast of Parnassus to the northern half of the Euboean channel, between Boeotia and Malis, the other southwest of Parnassus, on the north shore of the Corinthian gulf, between Phocis and Aetolia. The former were divided into the northern Locri Epicnemidii, situated on the spurs of Mt. Cnemis, and the southern Locri Opuntii, so named from their chief town Opus. Homer mentions only these eastern Locrians; their national hero in the Trojan War is Ajax Oileus, who often appears afterwards on Locrian coins. The Opuntians were thought by some to be of "Lelegian" origin (*see* LELEGES), but they were Hellenized early (though matriarchal customs survived among them). The westerly Locri "in Ozolae" on the Corinthian gulf, a rude and barbarous people, make no appearance in Greek history till the Peloponnesian War. The Locrian dialect resembles that of Elis. A colony of Locrians settled, about the end of the 8th century B.C., at the southwest extremity of Italy. They are often called Locri Epizephyrii from Cape Zephyrion 15 mi. S. of the city. Their founder was Euanthes. *See* LOCRI below.

LOCRI, an ancient city of Magna Graecia, Italy. The original inhabitants were, it has recently been ascertained, of Sicilian race (MacIver, *Iron Age,* 210). They occupied the Zephyrian promontory (Capo Bruzzano some 12 m. N. of Capo Spartivento), and though after three or four years they moved 12 m. north, still near the coast, 2 m. south of Gerace Marina below the modern Gerace, they still retained the name of Locri Epizephyrii, *Λοκροὶ οἱ ἐπιζεφύριοι,* to distinguish them from the Ozolian and Opuntian Locri of Greece itself. The foundation of Locri goes back to about 683 B.C. It was the first Greek community to have a written code of laws given by Zaleucus in 664 B.C. From Locri were founded the colonies of Meisma and Hipponium. It repelled the attacks of Croton and found support in Syracuse against Rhegium: it was thus an active adversary of Athenian aggrandisement. Pindar extolls it in the 10th and 11th Olympian Odes. Stesichorus (*q.v.*) was indeed of Locrian origin. Dionysius I. of Syracuse selected his wife from Locri: its territory was then increased, and the circuit of its walls was doubled, but it lost its freedom. In 356 B.C. it was ruled by Dionysius II. From the battle of Heraclea to the year 205 (when it was captured by P. Cornelius Scipio Africanus Maior, and placed under the control of his legate Q. Pleminius), Locri was continually changing allegiance between Rome and her enemies; but it remained an ally. In later Roman times it was of no great importance. It was destroyed by the Saracens in 915.

Excavations in 1889–90 discovered an Ionic temple (the Doric style being usual in Magna Graecia) at the north-west angle of the town—originally a cella with two naves, a closed pronaos on the east and an adytum at the west, later converted into a hexastyle peripteral temple with 34 painted terra-cotta columns. This was destroyed about 400 B.C. and a new temple built on the ruins, heptastyle peripteral, with no intermediate columns in the cella and opisthodomos, and with 44 columns in all. The figures from the pediment of the twin Dioscuri, who according to the legend assisted Locri against Crotona, are in the Naples museum. The environs yielded many archaic terra-cottas, and large trenches, covered with tiles, contained some 14,000 scyphoi arranged in rows. A Doric temple was also cleared under the house called Casa Marafioti: the fine equestrian group in terra cotta from the western gable is, with other objects from Locri, in the museum at Syracuse. There was also a sanctuary of Persephone from which came numerous votive tablets of the 5th century B.C. Much work has also been done in cemeteries, most of the tombs belonging to the 5th and 4th centuries, though the earliest are pre-Hellenic (9th–7th centuries.) The city walls, the length of which was nearly 5 m., consisted of three parts—the fortified castles (*φρούρα*) with large towers, on three different hills, the city proper, and the lower town—the latter enclosed by long walls running down to the sea. Under Rome, the city was restricted to the plain near the sea.

Prehistoric objects confirm the accounts of Thucydides and Polybius that the Greek settlers were preceded by Siculi.

See Orsi in *Notizie degli Scavi,* 1901–1917. (T. A.)

LÖCSE: *see* LEVOČA.

LOCUS, a term used in geometry with the meaning suggested by the Latin *locus,* place. In plane geometry it is the curve (including a straight line) which contains all points in the plane that satisfy a given condition, and which contains no points that do not satisfy the given condition; *e.g.,* in a plane the locus of a point at a given distance from a fixed point is the circle of which the fixed point is the centre and the given distance is the length of the radius. The term is also applied to figures in space of three dimensions, the locus corresponding to the circle being a sphere (considered as a surface). The locus is then a curve surface. The finding of the locus of an equation, or inversely, is a basic problem of analytic geometry (*q.v.*). Among the loci there considered are the conic sections (*q.v.*). The term is readily extended to higher dimensions.

LOCUST, any of certain insects of the family Acrididae (*see* ORTHOPTERA) which at times multiply greatly and migrate long distances in destructive swarms. In Europe, the term "locust" connotes large size; smaller acridids are called grasshoppers (*q.v.*). In North America "locust" and "grasshopper" are used for any acridid. Unfortunately cicadas (order Hemiptera) are also called locusts or harvest locusts; the 17-year locust is the periodical cicada.

The Phases of Locusts.—In 1921 B. P. Uvarov satisfactorily explained for the first time the sporadic coming of locust swarms and the apparent disappearance of the insects between times by the phase theory, later substantiated and elaborated by many workers. Each plague species exists in two phases, solitary and gregarious, connected by transitional forms. The extreme phases differ in coloration, form, physiology and behaviour. Solitary phase nymphs vary in colour and pattern, adjust their colour to

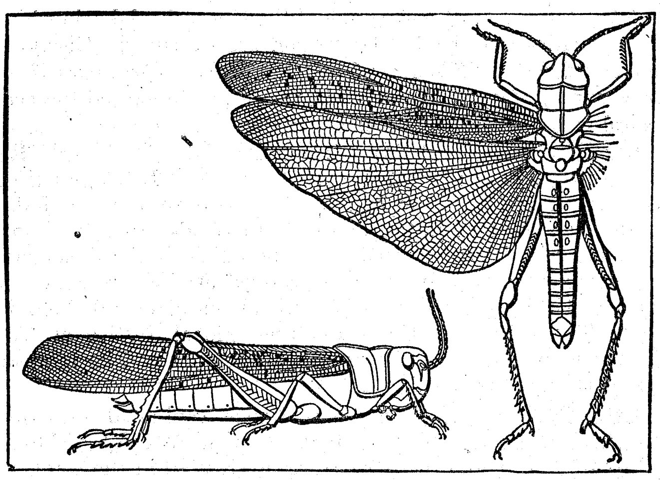


FIG. 1.—LOCUSTA MIGRATORIA IN ITS MIGRATORY PHASE

This insect is one of the chief locusts of the old world and in this phase causes great destruction to crops and other vegetation

match that of their surroundings, do not congregate, have low metabolic and oxygen-intake rates and are sluggish. Gregarious phase nymphs have a black and yellow (orange) coloration of fixed pattern, are gregarious, have high metabolic and oxygen-intake rates, and are active and nervous; their temperature is higher because their dark pigments absorb more radiation. Adults differ less in colour, but often notably in form. The solitary phase has shorter wings, longer legs, narrower pronotum with higher crest and larger head; the gregarious phase has a more saddle-shaped pronotum with broader shoulders and long, ample wings.

Progeny of the solitary phase, reared in crowds, change toward the gregarious type; and if the crowding is of sufficient degree and duration, the extreme of the gregarious migratory phase is produced. Progeny of the gregarious phase, reared in isolation, revert to the solitary phase. By rearing single nymphs in constantly agitated cages J. C. Faure (1932) showed that the effects of crowding result from the unceasing activity it induces. The solitary phase is the normal state of the species, while the gregarious phase is a physiological response to violent fluctuations in the environment. Within the territory of each species its solitary phase exists at all times and in a wide variety of oecological conditions. Swarms do not form in the regions most favourable to the species, but in marginal areas where suitable habitats are restricted and climatic balance is delicate. Here a succession of

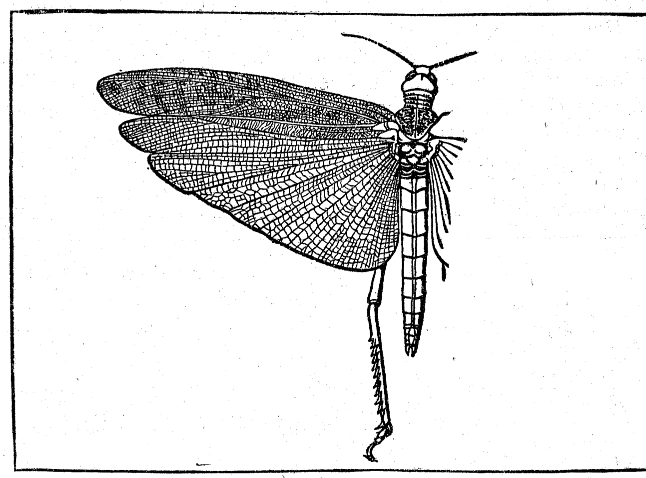


FIG. 2.—OLD WORLD LOCUST (SCHISTOCERCA GREGARIA)

favourable seasons enables the restricted populations to expand into adjoining areas, but return of unfavourable conditions forces the enlarged populations back into the small permanently habitable areas and crowding results. The exact circumstances vary with the species and region. Thus the outbreak areas of *Locusta migratoria* are of four oecological types: (1) deltas of rivers entering the Caspian and Aral seas and Lake Balkash (and similar situations in China and Africa), surrounded by arid sandy tracts; here the extent of the grassland habitat of the locust changes greatly due to irregularities of floods; (2) grassland areas adjoining deserts, subject to extreme fluctuations in precipitation with corresponding changes in extent of habitable area; (3) "islands" of dry warm soil in central Russia, a region generally too cold and wet for the species; here overcrowding occurs after several exceptionally warm dry years; (4) grasslands produced by periodic burning in the unfavourable, humid, tropical forest lands of the Philippines; their extent varies greatly, leading to frequent overcrowding and production of the gregarious phase.

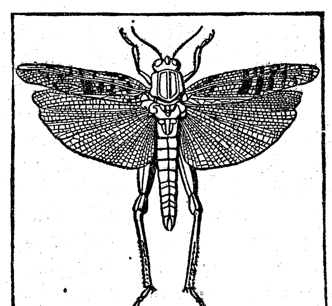


FIG. 3.—CALLIPTAMUS ITALICUS, COMMON IN SOUTHERN EUROPE

Locusts of the gregarious phase are restless and irritable; the bands of nymphs wander, and adult swarms take flight spontaneously on warm dry days when their body temperature is high. The muscular activity of flight further raises their temperature, and a swarm can therefore cease flying only when conditions change. Rain, a drop in temperature, or nightfall will usually stop a flight. The distances travelled may be great; swarms have been seen 1,200 mi. at sea, and *Schistocerca gregaria* reached England in 1869, probably from west Africa. The flights are not purposive and often end in destruction of the swarm. Some swarms are very large; a flight of the desert locust across the Red sea in 1889 was estimated as 2,000 sq.mi. in extent. The gregarious instinct is strong, and swarms remain compact even when reduced to small size by high mortality; they are dispersed, with resultant transformation into the solitary phase, only by storms and other external factors.

Important Species.—The migratory locust (*Locusta migratoria,* with its races *rossica, migratoria, migratorioides, capito* and *manilensis*) has a wider range than any other acridid. It is found in grasslands throughout Africa, most of Eurasia south of the Taiga forest, the East Indies, tropical Australia, and New Zealand. The desert locust (*Schistocerca gregaria*) inhabits dry grasslands and deserts from Africa to the Punjab. Its swarms arrive during the summer monsoons in India; in autumn they migrate to Iran and Arabia with others from Africa, and thence spread to soviet Asia, Syria, Palestine and Egypt. In late fall some return to India and East Africa, where breeding occurs during the next monsoon rains. The smaller Italian and Moroccan locusts (*Calliptamus italicus* and *Dociostaurus maroccanus*) do much injury in the Mediterranean area; the second is found discontinuously east to Turkestan. In South Africa the brown and red locusts (*Locustana pardalina* and *Nomadacris septemfasciata*) are both very destructive. In Central and South America the chief migratory species is the South American locust (*Schistocerca paranensis*), of which the nonmigratory *S. americana* of the United States may possibly be the solitary phase. The Rocky mountain locust or lesser migra-

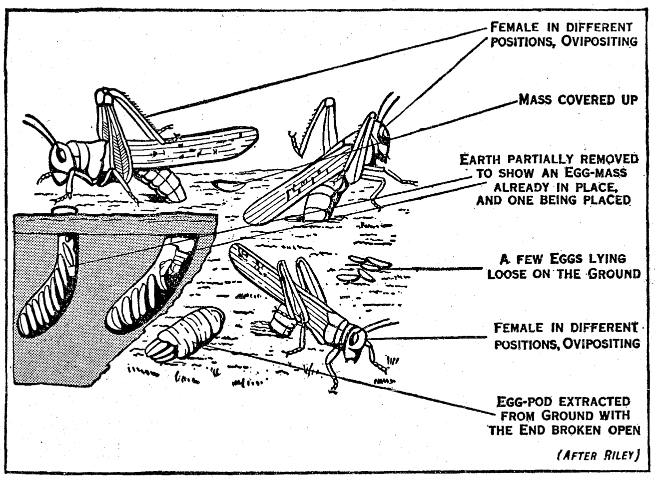


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FIG. 4.—ROCKY MOUNTAIN LOCUST (MELANOPLUS SPRETUS)

tory grasshopper (*Melanoplus mexicanus* phase *spretus*) wreaked havoc on the prairie farms of Canada and the United States in the 1870s, but later disappeared; it is probably the gregarious phase of the common and widespread *M. mexicanus* (*atlanis*), which is, with the clear-winged grasshopper (*Camnula pellucida*), a major crop pest in North America. Many other species of Acrididae in different regions occasionally increase to plague proportions, but few of them compare in economic importance with those named above.

Control Measures.—Once well started, a locust plague is almost impossible to check, and only palliative measures can be taken. These have included destruction of egg-masses laid by invading swarms (1,300 tons were destroyed in Cyprus in 1881), trenches to trap the nymphs, hopperdozers (wheeled screens, upon striking which locusts fall into troughs containing water and kerosene), poison baits and aeroplane dusting of swarms and breeding grounds with insecticides. The control problem is made difficult by the great extent of the territory affected, with many invasions beginning in sparsely populated, undeveloped regions. Permanent control requires both national and international action. It is possible because locust swarms do not arise simultaneously over wide regions, but in a few localized outbreak areas, many of which are known. From 1930–38 five International Locust conferences were held. In 1932 the Anti-Locust Research centre was set up in London; it directed international surveys and field studies and, during World War II, large-scale campaigns in Africa and Asia against the desert locust. Warnings were given of incipient outbreaks and swarm movements, and control measures were planned and supervised. Ultimately many outbreak areas may be made oecologically unsuitable for production of the gregarious phase, when the oecology and behaviour of each plague species are better known.

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LOCUST-TREE or **CAROB-TREE** (*Ceratonia siliqua*), a member of the tribe *Cassieae* of the family Leguminosae, the sole species of its genus, and widely diffused spontaneously and by cultivation from Spain to the eastern Mediterranean regions. The flowers have no petals and are polygamous or dioecious (male, female and hermaphrodite flowers occur). The seed-pod is compressed, often curved, indehiscent and coriaceous, but with sweet pulpy divisions between the seeds, which, as in other genera of the *Cassieae*, are albuminous. The pods are eaten by men and animals, and in Sicily a spirit and a syrup are made from them. These husks, being often used for swine, are called swine's bread, and are probably referred to in the parable of the Prodigal Son. They are also called St. John's bread, from a misunderstanding of Matt. iii, 4. Gerard (*Herball*, p. 1241) cultivated them in 1597. They were introduced in 1570.

LÓCZY, LÁJOS DE LÓCZ (1849–1920), Hungarian geologist, was born at Pressburg (Bratislava) on Nov. 2, 1849. He studied at the Zurich Polytechnic, obtaining his engineer's diploma in 1874, and from 1877–80 travelled through India and China as geologist to the expedition of Count Bela Szechenyi. In 1886 he became professor of geology at the University of Budapest, and in 1908 director of the Hungarian Geological institute. He completed geological researches in China, in Hungary and, during World War I in Serbia. His principal work, *The Scientific Results of the Expedition of Count Bela Szechenyi to Eastern Asia* (1890), comprises the first scientific description of the mountains which connect the Kuen Lun chains with the northeast Indian chains behind the red basin of Szechwan. His researches concerning the steppe-formations of the Gobi and the northern Hwang Ho territory are also of great importance. His other important work, *The Results of the Scientific Research of the Balaton*, forms a great monograph of the Hungarian lake, in which the formations of the Balaton region are explained. His posthumous works are: *The New Geological Map of (pre-War) Hungary*, and *Geology of West-Serbia*, which revolutionised the geological map of Serbia. He died at Balatonaracs May 13, 1920.

LODER, BERNARD CORNELIUS JOHANNES (1849–1935), Dutch jurist. From 1873 to 1908 Loder practised as a lawyer in Rotterdam and from 1908 to 1921 was a judge of the high court of justice of the Netherlands. In 1905, 1909, 1910 and 1922 he represented the Netherlands at the diplomatic Sea conferences at Brussels. He presided at the conference of the Scandinavian kingdoms, Switzerland and Holland, held in 1920. The Permanent Court of International Justice at The Hague appointed him its first president in 1922 and he retained this position until early in 1925.

LODÈVE, a town of southern France, capital of an arrondissement of the department of Hérault, 36 mi. W.N.W. of Montpellier by rail. Pop. (1936) 5,631. It is situated in the southern Cévennes at the point where the Soulondres joins the Lergue, a tributary of the Hérault. Two bridges over the Lergue connect the town with Carmes and two others over the Soulondres lead to the ruins of the château de Montbrun (13th century). Lodève (Luteva) existed before the invasion of the Romans, who for some time called it *Forum Neronis*. It was Christianized by St. Flour, first bishop of the city, *c.* 323. It became in the 9th century a separate countship and afterward the domain of its bishops until the revolution. During the religious wars it was sacked in 1573.

The old fortified cathedral of St. Fulcran, founded by him in 950, dates as it is now from the 13th, 14th and 16th centuries. Near the town stands the 12th century monastery of St. Michel de Grammont, now used as farm buildings. In the neighbourhood are three dolmens. The manufacture of woollens for army clothing is the chief industry.

LODGE, EDMUND (1756–1839), English writer on heraldry, was born in London on June 13, 1756, son of Edmund Lodge, rector of Carshalton, Surrey. He held a cornet's commission in the army, from which he resigned in 1773. In 1782 he became Bluemantle pursuivant-at-arms in the College of Arms. He subsequently became Lancaster herald, Norroy king-at-arms, Clarencieux king-at-arms, and, in 1832, knight of the order of the Guelphs of Hanover. He died in London on Jan. 16, 1839. He contributed the literary matter to *Portraits of Illustrious Personages of Great Britain* (1814, etc.), known familiarly as "Lodge's Portraits." His chief work on heraldry was *The Genealogy of the existing British Peerage . . .* (1832; enlarged ed., 1859).

LODGE, HENRY CABOT (1850–1924), American statesman and author, was born in Boston, Mass., on May 12, 1850. He graduated at Harvard college in 1871 and at the Harvard Law school in 1875; was admitted to the Suffolk (Mass.) bar in 1876; and in 1876–79 was instructor in American history at Harvard. He was a member of the Massachusetts house of representatives in 1880–81, and of the national House of Representatives in 1887–93. In 1893 he succeeded Henry L. Dawes as U.S. senator from Massachusetts, a place he continued to hold for nearly 32 years.

His continuous service in the Senate brought recognition during the closing years of the Roosevelt Administration and under Taft as one of the most prominent of the Republican leaders. He was a member of the Alaskan Boundary Commission of 1903, and of the U.S. Immigration Commission of 1907. He served as permanent chairman of the Republican National conventions of 1900, 1908 and 1920. During the Republican-Progressive split which led to the election of Woodrow Wilson in 1912, Lodge maintained his personal friendship with Roosevelt, while he held true to his long-established principles of party regularity by supporting Taft, the Republican nominee.

In 1914 Lodge supported Wilson's demand for the repeal of the Panama tolls exemption, but lost confidence in him as a result of the President's handling of the Mexican problem in 1914, and thereafter became one of his principal critics. He opposed Wilson's Caribbean policy and Colombia Treaty, and desired the entrance of his country into the World War after the sinking of the "Lusitania." In Jan. 1916 he offered a resolution calling for armed intervention in Mexico.

With the entrance of the United States into the World War, Lodge called for united support of the President in all policies that might increase the war effort of the United States, although he opposed the Overman Act, designed to organize war-making agencies. Wilson's peace policies Lodge neither understood nor approved. In 1915 and 1916 he himself had advocated a league of nations and the principle of compulsory arbitration, but he later confessed that he changed his mind and saw in Wilson's proposals more danger than advantage. In Aug. 1918 Lodge was elected Republican floor leader of the Senate, and becoming chairman of the Senate foreign relations committee, he was the leader of the opposition to Wilsonian peace policies. On Dec. 21, 1918, Lodge inaugurated a successful campaign against the Wilson peace plan when he insisted on the need of separating the League of Nations from the Versailles Treaty. On March 4 following Lodge with 38 Republican senators issued a declaration disapproving of the Covenant as it was and its inclusion in the treaty. He did not hope to defeat the treaty by a straight vote of disapproval; the popular demand for peace was too compelling. He did succeed, however, in attaching 15 reservations to the treaty which attracted the support of the die-hard enemies of Wilson. Wilson refused to accept the reservations, and Lodge was able to hold his group firm in refusing to pass the treaty without reservations. His tactical success was unquestionable when on March 19, 1920, the treaty, which had been reintroduced, having previously been defeated both with and without reservations, failed by seven votes, to secure the necessary two-thirds vote of the Senate, the Democratic senators voting against it at the wish of the President.

As the successful leader of the opposition to Wilson, Lodge's prestige was increased. He served as one of the four U.S. delegates at the Washington Conference on the Limitation of Armaments in 1921. His influence waned after he opposed Harding's proposal for joining the World Court, but he was re-elected to the Senate in 1922 by a narrow margin. He died at Nahant (Mass.), on Nov. 9, 1924, at the age of 74.

Senator Lodge was one of the chief congressional figures of the last decade of the 19th and the first two decades of the 20th centuries. Reputed cold and distant in manner, he enjoyed the prestige indicated by his popular appellation, the "scholar in politics," and held the respect of his colleagues on both sides of the Senate.

His literary production started early and continued until the close of his life. In 1874–76 he edited the *North American Review* with Henry Adams; and in 1879–82, with John T. Morse, Jr., he edited the *International Review*. In 1884–90 he was an overseer of Harvard college. His doctoral thesis at Harvard was published with essays by Henry Adams, J. L. Laughlin and Ernest Young, under the title *Essays on Anglo-Saxon Land Law* (1876). He wrote: *Life and Letters of George Cabot* (1877); *Alexander Hamilton* (1882), *Daniel Webster* (1883) and *George Washington* (2 vol., 1889), in the "American Statesmen" series; *A Short History of the English Colonies in America* (1881); *Studies in History* (1884); *Boston* (1891), in the "Historic Towns" series; *Historical and Political Essays* (1892); with Theodore Roosevelt, *Hero Tales from American History* (1895); *Certain Accepted Heroes* (1897); *The Story of the American Revolution* (2 vol., 1898); *The War with Spain* (1899); *A Fighting Frigate* (1902); *A Frontier Town* (1906); with J. W. Garner, *A History of the United States* (4 vol., 1906). He edited *The Works of Alexander Hamilton* (9 vol., 1885–86); *The Federalist* (1891); *André's Journal* (1903); and *Education of Henry Adams* (1918).

William Lawrence's *Henry Cabot Lodge* (1925) is the only complete biography of Lodge, though short sketches appear in a number of magazines. *Speeches and Addresses* (1909); *One Hundred Years of Peace* (1913); *Early Memories* (1913); *The Democracy of the Constitution* (1915); *War Addresses, 1915–1917* (1917); *Theodore Roosevelt* (1919); *The Senate of the United States, and Other Essays* (1921); and *The Senate and the League of Nations* (1925).

His son, GEORGE CABOT LODGE (1873–1909), also became known as an author, with *The Song of the Wave* (1898), *Poems, 1899–1902* (1902), *The Great Adventure* (1905), *Cain: a Drama* (1904), *Herakles* (1908) and other verse. (C. SEY.)

LODGE, SIR OLIVER JOSEPH (1851–1940), English physicist, was born at Penkhull, Staffordshire, on June 12, 1851. He was intended for a business career, but being attracted to science he entered University College, London, in 1872. In 1875 he was appointed reader in natural philosophy at Bedford College for Women, and in 1879 he became assistant professor of applied mathematics at University College, London. Two years later he was called to the chair of physics in University College, Liverpool, where he remained till in 1900 he was chosen first principal of the new Birmingham University. He was knighted in 1902. His original work includes investigations on lightning, the seat of the electromotive force in the voltaic cell, the phenomena of electrolysis and the speed of the ion, electromagnetic waves and wireless telegraphy, the motion of the ether near the earth, and the application of electricity to the dispersal of fog and smoke. In addition to numerous scientific memoirs he wrote, among other works, *Lightning Conductors and Lightning Guards, Signalling without Wires, Modern Views of Electricity, Electrons* and *The Ether of Space*.

After 1910 Sir Oliver Lodge became increasingly prominent as a leader of psychical research and a strong believer in the possibility of communicating with the dead, and he interested himself in a serious endeavour to reconcile science and religion. Among his publications dealing with this subject are *The Survival of Man* (1909); *Reason and Belief*, 3rd ed. (1911); *The War and After* (1915); *Raymond, or Life and Death* (1916), a memoir of his son killed in the World War, with an account of communications believed to have been received from him since; *Christopher: a Study in Human Personality* (1918). Early in 1920 he made an extensive lecturing tour of the United States, having just previously retired from his post as principal of Birmingham University. Among his later publications are *The Making of Man* (1924), *Ether and Reality* (1925), *Relativity* (1925), *Science and Human Progress* (1927), *The Reality of a Spiritual World* (1930), and *My Philosophy, containing final views on the Ether of Space,* (1933). In 1919 he received the Albert Medal of the Royal

Society of Arts for his pioneer work in wireless telegraphy. He acted as president of the British Association, of the Physical Society, of the Society for Psychical Research, of the Radio Society and of the Röntgen Society; he became an F.R.S. in 1902.

LODGE, THOMAS (*c.* 1558–1625), English dramatist and miscellaneous writer, was born about 1558 at West Ham. He was the second son of Sir Thomas Lodge, who was lord mayor of London in 1562–63. He was educated at Merchant Taylor's school and Trinity college, Oxford; taking his B.A. degree in 1577 and that of M.A. in 1581. In 1578 he entered Lincoln's Inn. When the penitent Stephen Gosson had (in 1579) published his *Schoole of Abuse,* Lodge took up the glove in his *Defence of Poetry, Music and Stage Plays* (1579 or 1580; reprinted for the Shakespeare Society, 1853), which shows a certain restraint, though neither deficient in force of invective nor backward in display of erudition. The pamphlet was prohibited, but appears to have been circulated privately. It was answered by Gosson in his *Playes Confuted in Five Actions;* and Lodge retorted with his *Alarum Against Usurers* (1584, reprinted *ib.*)—a "tract for the times" which no doubt was in some measure indebted to the author's personal experience. He was called before the Privy Council in 1581 to answer for certain matters brought against him.

In 1583 he produced *The Delectable History of Forbonius and Prisceria,* both published and reprinted with the *Alarum.* In his tales he follows the lead of Greene and Lyly.

Having, in the spirit of his age, "tried the waves" with Captain Clarke in his expedition to Terceira and the Canaries, Lodge in 1591 made a voyage with Thomas Cavendish to Brazil and the Straits of Magellan, returning home by 1593. During the Canaries expedition, to beguile the tedium of his voyage, he composed his prose tale of *Rosalynde, Euphues Golden Legacie,* which, printed in 1590, afterwards furnished the story of Shakespeare's *As You Like It.* The novel, which in its turn owes some debt to the mediaeval *Tale of Gamelyn,* is written in the euphuistic manner. It has been frequently reprinted. Before starting on his second expedition he had published an historical romance, *The History of Robert, Second Duke of Normandy, surnamed Robert the Divell;* and he left behind him for publication *Catharos, Diogenes in his Singularity,* a discourse on the immorality of Athens (London). Both appeared in 1591.

Another romance in the manner of Lyly, *Euphues Shadow, the Battaile of the Sences* (1592), appeared while Lodge was still on his travels. His second historical romance, the *Life and Death of William Longbeard* (1593), was more successful than the first. Lodge also brought back with him from the new world *A Margarite of America* (published 1596), a romance of the same description interspersed with many lyrics. Already in 1589 Lodge had given to the world a volume of poems bearing the title of the chief among them, *Scillaes Metamorphosis, Enterlaced with the Unfortunate Love of Glaucus,* more briefly known as *Glaucus and Scilla* (reprinted with preface by S. W. Singer in 1819). To this tale Shakespeare was possibly indebted for the idea of *Venus and Adonis.* Some readers would perhaps be prepared to give up this and much else of Lodge's sugared verse, fine though much of it is in quality, largely borrowed from other writers, French and Italian in particular, in exchange for the lost *Sailor's Kalendar,* in which he must in one way or another have recounted his sea adventures. If Lodge, as has been supposed, was the Alcon in *Colin Clout's come Home Again,* it may have been the influence of Spenser which led to the composition of *Phillis,* a volume of sonnets, published with the narrative poem, *The Complaynte of Elstred,* in 1593. *A Fig for Momus,* on the strength of which he has been called the earliest English satirist, and which contains eclogues addressed to Daniel and others, an epistle addressed to Drayton, and other pieces, appeared in 1595.

Lodge's ascertained dramatic work is small in quantity. In conjunction with Greene he, probably in 1590, produced in a popular vein the odd but far from feeble play of *A Looking Glasse for London and England* (printed in 1594). He had already written *The Wounds of Civile War. Lively set forth in the Tragedies of Marius and Scilla* (produced perhaps as early as 1587, and published in 1594), a good second-rate piece in the half-chronicle fashion of its age. Various critics have assigned to Lodge a share in *Mucedorus and Amadine,* played by the Queen's Men about 1588, in *George a Greene, the Pinner of Wakefield,* in Shakespeare's 2nd part of *Henry VI.,* and in *The Troublesome Raigne of John, King of England* (*c.* 1588).

In the latter part of his life—possibly about 1596, when he published his *Wits Miserie* and the *World's Madnesse,* which is dated from Low Leyton in Essex, and the religious tract *Prosopopeia* (if, as seems probable, it was his), in which he repents him of his "lewd lines" of other days—he became a Catholic and engaged in the practice of medicine, for which Wood says he qualified himself by a degree at Avignon in 1600. Two years afterwards he received the degree of M.D. from Oxford university. His works henceforth have a sober cast, comprising translations of Josephus (1602), of Seneca (1614), a *Learned Summary* of Du Bartas's *Divine Sepmaine* (1625 and 1637), besides a *Treatise of the Plague* (1603), and a popular manual, which remained unpublished, on *Domestic Medicine.* He was abroad on private affairs in 1616. From this time to his death in 1625 nothing further concerning him remains to be noted.

Lodge's works, with the exception of his translations, were edited for the Hunterian club by Edmund Gosse. The preface was reprinted in Gosse's *Seventeenth Century Studies* (1883). Of *Rosalynde* there are numerous modern editions. *See* also J. J. Jusserand, *English Novel in the Time of Shakespeare* (Eng. trans., 1890); F. G. Fleay, *Biographical Chronicle of the English Drama* (vol. ii., 1891); E. K. Chambers, *Elizabethan Stage* (1923, etc.), vol. iii. (A. W. WA.)

LODGER AND LODGINGS. The term "lodger" is used in English law in several slightly different senses. It is applied (i.) most frequently and properly to a person who takes furnished rooms in a house, the landlord also residing on the premises, and supplying him with attendance; (ii.) sometimes to a person who takes unfurnished rooms in a house finding his own attendance; (iii.) to a boarder in a boarding house (*q.v.*). It is with (i.) and (ii.) alone that this article is concerned.

Where furnished apartments are let for immediate use, the law implies an undertaking on the part of the landlord that they are fit for habitation, and, if this condition is broken, the tenant may refuse to occupy the premises or to pay any rent. But there is no implied contract that the apartments shall *continue* fit for habitation; and the rule has no application in the case of unfurnished lodgings. There is no implied warranty that the incoming tenant is a fit and proper person to occupy the lodgings and is not, *e.g.,* suffering from any infectious disease (*Humphreys v. Miller* [1917] 2 K.B. 122). In the absence of express agreement to the contrary, a lodger has a right to the use of everything necessary to the enjoyment of the premises, such as the door bell and knocker and the skylight of a staircase. Whether the rent of apartments can be distrained for by the immediate landlord where he resides on the premises and supplies attendance is a question the answer to which is involved in some uncertainty. The weight of authority seems to support the negative view (*see* Foa, *Landlord and Tenant,* 3rd ed. p. 434). As to distress on a lodger's goods for rent due by an immediate to a superior landlord *see* RENT. As to the termination of short tenancies, as of apartments, *see* LANDLORD AND TENANT. The landlord has no lien on the goods of the lodger for rent or charges. It has been held in England that keepers of lodging-houses do not come within the category of those persons (*see* also CARRIER; INNS AND INNKEEPERS) who hold themselves out to the public generally as trustworthy in certain employments; but that they are under an obligation to take reasonable care for the safety of their lodgers' goods (see *Scarborough v. Cosgrove* [1905] 2 K.B. 805). As to Scots Law *see* Bell's *Prin.* s. 236 (4).

In the United States, the English doctrine of an implied warranty of fitness for habitation on a letting of furnished apartments has only met with partial acceptance; it was repudiated, *e.g.,* in the District of Columbia, but has been accepted in Massachusetts. In the French *Code Civil* there are some special rules with regard to furnished apartments. The letting is reputed to be made for a year, a month or a day, according as the rent is so much per year, per month or per day; if that test is inapplicable, the letting is deemed to be made according to the custom of the place (art. 1,758). There are similar provisions in the Civil Codes of Belgium (art. 1,758), Holland (art. 1,622) and Spain (art. 1,581).

See also the articles, BOARDING-HOUSE, COMMON LODGING-HOUSE and FLAT; and the bibliographies to FLAT and LANDLORD AND TENANT.

(A. W. R.)

LODI, town and episcopal see of Lombardy, Italy, province of Milan, 20½ mi. by rail S.E. of Milan, on a hill above the right bank of the Adda, 230 ft. above sea-level. Pop. (1936) 23,305 (town); 30,636 (commune). The city is on an eminence rising very gradually from a very rich dairy district. The cathedral (1158), with Gothic façade and 16th-century lateral tower, has a restored interior. The church of the Incoronata, erected by Battaggio (1487 onwards) in Bramantesque style, is an elegant octagonal domed structure, decorated with frescoes by the Piazza family, natives of the town, and four large altar pieces by Calisto Piazza. The 13th-century Gothic church of San Francesco has 14th-century paintings. The Palazzo Modegnani has a fine gateway in the style of Bramante, and the hospital a cloistered quadrangle. Besides an extensive trade in cheese (Lodi producing more Parmesan than Parma itself) and other dairy produce, there are manufactures of hemp ropes, linen, silk, majolica and chemicals.

The ancient Laus Pompeia lay 3½ mi. W. and the site is still occupied by a considerable village, Lodi Vecchio, with the old cathedral of S. Bassiano. In the middle ages Lodi was second to Milan in northern Italy. A dispute with the archbishop of Milan about the investiture of the bishop of Lodi (1024) began a long feud. In 1111 and again in 1158 the Milanese laid the whole place in ruins. A number of the Lodigians had settled on Colle Eghezzone; and their village soon grew up under the patronage of Frederick Barbarossa into a new city of Lodi (1162). Lodi was before long compelled to enter the Lombard League, and in 1198 it formed an offensive and defensive alliance with Milan, on which after 1416 it became dependent. The duke of Brunswick captured it in 1625 in the interests of Spain; and it was occupied by the French (1701), by the Austrians (1706), by the king of Sardinia (1733), by the Austrians (1736), by the Spaniards (1745), and again by the Austrians (1746). On May 10, 1796, was fought the battle of Lodi between the Austrians and Napoleon, which made the latter master of Lombardy.

LODI, a city of San Joaquin county, Calif., U.S.A., in the central part of the state, 34 mi. S. of Sacramento. It is on federal highway 99, and is served by the Southern Pacific, Santa Fe and Western Pacific railways. The population was 6,788 in 1930 by the federal census and was 11,079 in 1940. It is the largest grape and wine producing community in the United States, and also produces small fruits, walnuts, almonds, celery, asparagus, grain and forage crops. The city was incorporated in 1906.

LODI, a growing borough of Bergen county, New Jersey, U.S.A., off the Passaic river, adjoining Hackensack on the southwest. It is served by the Erie Railroad company. The population was 11,549 in 1930 and was 11,552 in 1940. It has important manufactures, including dyes and chemicals. Between 1900 and 1920 the population increased more than fourfold.

LODZ, a province in the west of Poland, bounded on the north-east by the province of Warsaw, on the north-west by Poznan, and on the south by the province of Kielce. Area 19,034 sq.km.; pop. (1931) 2,632,434. The province was occupied by Germany in World War II. The southern part of the province is a continuation of the plateau of Kielce, the northern part consists of lowlands washed by the Warta and its tributary, the Prosna. It was formerly covered by forests and lakes and formed the lesser principalities of Kalisz, Sieradz and Łęczyca. The forests have been mostly destroyed and agriculture and cattle-breeding are extensively carried on, the crops principally raised being rye, wheat, oats, barley and potatoes. But the importance of the area has been increased in the last century by the rapid rise of the textile industry in Lodz, Pabjanice, Tomaszów, Zgierz and other towns. Cotton spinning and weaving is the most important industry, but woollens, linens, silks and other fabrics are also manufactured, while the embroideries of Kalisz are of importance. The whole area suffered almost complete destruction during World War I, and had to face new economic problems after the restoration of the factories. Previously designed to supply the Russian and oriental markets, the textile industry of Lodz specialized in coarse materials and neglected the finer fabrics. After 1918, however, the greatly enlarged home market and the markets of western Europe demanded finer materials, and great changes were made to meet the new situation. The revival of the industry was amazing, in spite of the relative lack of new capital.

Lodz again suffered heavily from war during the German invasion of Sept. 1939. It was immediately overrun by German forces under Gen. Blaskowitz, and Berlin announced the capture of Lodz, the chief city, on Sept. 9. By a decree signed in Berlin Oct. 8, 1939 and effective after Nov. 1, the whole province was incorporated into Germany proper. The chief towns of the province, which is the most thickly-populated area of Poland after Silesia, are Lodz (pop. 1938, 665,200); Kalisz (68,300); Piotrków (51,300); Pabjanice, Tomaszów, Zgierz, Łęczyca and Sieradz.

ŁODZ (*Łódz;* also pronounced *Woodsh*), a town of Poland, in the province of Lodz, 82 mi. by rail S.W. of Warsaw. It is situated on the Lodz plateau, which at the beginning of the 19th century was covered with impenetrable forests. Now it is the centre of a group of industrial towns—Zgierz, Łęczyca and Pabjanice. Chiefly owing to a considerable immigration of German capitalists and workers, Lodz grew rapidly. The city is built about one main street, 7 mi. long, and manufactures cottons, woollens and mixed stuffs, chemicals, beer, machinery and silk. The population, which was only 50,000 in 1872, reached 672,000 by 1939. In 1921 60% were Poles and some 180,000 Jews. It is the seat of a Roman Catholic bishop. Lodz fell to the German invaders in Sept. 1939 and Hitler by decree incorporated it into the German reich.

ŁODZ, BATTLE OF, Nov. 11–25, 1914. The repulse at the end of Oct. 1914 of their first offensive in Poland (*see* VISTULA-SAN) placed the Germans in a perilous position on the Eastern Front. The Austrian armies were again in retreat, and were rapidly becoming demoralised; the Germans themselves, on the northern part of the Eastern Front, were greatly outnumbered and could expect no considerable reinforcement till the Ypres battle in the west had been decided. The evident intention of the Russian Commander-in-Chief, the Grand Duke Nicholas, was to advance on the great industrial region of Silesia. In their retreat from Warsaw and Poland the Germans had done their best by elaborate destruction of communications to impose as slow a rate as possible on this advance; but their numbers were insufficient to stem the oncoming tide of Russia's hordes by a direct defence. Invasion of German territory might be slow, but it seemed inevitable.

Ludendorff's Plan.—The German High Command solved their portion of the problem by placing Hindenburg, commander of the IX. Army, in charge of all German forces on the Eastern Front (VIII. and IX. Armies and Woyrsch's detachment) and instructing him to do his best without immediate reinforcement. Hindenburg kept Ludendorff as his chief of staff, and the latter at once proposed a characteristically bold solution. This was to withdraw the IX. Army from Central and southern Poland and, taking advantage of the excellent railway system, to transfer it north to a base between Posen and Torún (Thorn), from which to strike a blow at the Grand Duke's communications as he advanced southwest on Silesia. The plan was an audacious one. In the first place it left the direct route to the enemy's objective, the province of Silesia, barred only by the unreliable Austrians and by weak German elements. Ludendorff trusted to the destroyed communications and to the customary Russian sluggishness of manoeuvre for time sufficient to carry out the contemplated counterstroke. Secondly, East Prussia, again threatened by invasion, would be further denuded of defenders, for Ludendorff proposed to call on the VIII. Army to furnish a quota to his striking force. Lastly, the manoeuvre involved thrusting a body of between five and six corps within reach of Russian forces twice that size, and the greater the success of the blow, the deeper

the penetration into the Russian rear, the heavier would be the weight of the enemy masses concentrated on it. But the result of the battle of Tannenberg had been to persuade Hindenburg and Ludendorff that disparity in numbers could be largely discounted with the Russians as foes.

Disposition of the Russian Forces.—On the Russian side, the first fortnight of Nov. 1914 saw the high-water mark of that onward sweep towards Germany of Russia's exhaustless masses, on which the Allies had built such high hopes. There were at this time eight Russian armies deployed. The X. Army, which had replaced the defeated I. Army on the eastern frontier of East Prussia, had begun to move forward. The I. and II. Armies, to the northwest and west of Warsaw, protected the flank of the main advance by the V., IV. and IX. Armies; on the south, the III. and VIII. Armies covered the left flank by pressure on the Austrian main forces in the direction of Cracow. But progress was slow, hampered by difficulties of supply; and already the Russians were beginning to feel that shortage of munitions and of trained drafts which was to lead to their disasters of 1915. Their armies were strung out in linear formation and no central reserves were available.

The point of attack chosen by Ludendorff for the IX. Army under Mackensen, which now comprised 5½ corps and two cavalry divisions, was the junction between the I. and II. Russian Armies. The Vistula and Warta rivers, to east and west, would protect the flanks of the German advance. To prevent any transfer of Russian forces from north of the Vistula, a detachment, mainly of fortress troops, was to advance on Mława, while another pushed up the right bank of the river towards Płock.

The Russian I. Army was spread over a wide front with three corps north of the Vistula between Mława and Płock and two corps south of the river—the V. Siberian at Włocławek and the II. Corps (lately transferred from the II. Army) between Kutno and Łęczyca. The II. Army was on the Warta, west of Lodz directed on Kalisz. The V. Army was on the left of the II. and was approaching the upper Warta.

First Battle of Łodz.—Mackensen began his advance on Nov. 11. On the 12th the isolated Siberian V. Corps at Włocławek was overwhelmed and driven back on Płock. Two days later the II Corps acting as a link between the I and II Armies about Kutno, and the XXIII, the right corps of the II Army, were defeated by greatly superior numbers and driven south. Scheidemann, commander of the Russian II Army, now tried to wheel his corps from their line on the Warta to a position northeast of Lodz, the chief manufacturing town of Poland. But the German movements were too sure and rapid for the ponderous Russian counter-march. The columns of the II Army were attacked in turn as they came up and were thrown back on Lodz.

Meanwhile the two defeated corps of the I Army, now joined by the Siberian VI Corps from north of the Vistula, were forced back towards Warsaw and away from Lodz. Into the gap between the two Russian armies Mackensen thrust three divisions, the two of the XXV Res. Corps and the 3rd Guard Div. and his two cavalry divisions, with instructions to pass round the right flank of the II Army and encircle Lodz from the south. A corps formed from the Breslau garrison, which had now come up from the west, was to turn the left wing of the Russian II Army, pinned in front by the attacks of the German XI, XVII and XX Corps. Ludendorff was aiming at a second Tannenberg, in which Scheidemann's army was to fill the same role as had the unfortunate Samsonov's. The I Reserve Corps meanwhile was by attack to prevent the I Army from intervening.

By Nov. 18 the position of the Russian II Army seemed well-nigh desperate. It was being driven into a narrow semicircle round Lodz with both flanks turned, and was becoming exhausted and dispirited. But help from the V Army was now close at hand. Plehve, its commander, on receiving orders to turn back to the assistance of the II Army, acted promptly and with resolution. He attempted to rail one division north to Skierniewice but only one regiment got through before Mackensen's cavalry cut the line. The rest of the division came into action on Nov. 19, south of Lodz against the turning movement of the German XXV Res. Corps. The whole of the remainder of the V Army marched north on the 18th, the gap it left on the IV Army's right being filled with cavalry. The same night the Siberian I Corps relieved the pressure on Scheidemann's left by a successful attack on the German XI Corps. Next day the XIX Corps routed the Breslau troops. This restored the situation on the west side of Lodz, but to the east and south of the town Schaffer's XXV Res. Corps and 3rd Guard Div. were still advancing. By the evening of Nov. 20 they had completely turned the right of the Russian II Army and were attacking Lodz from the south.

During Nov. 21 Ludendorff persisted in a last effort to accomplish the destruction of the Russian II Army, but the attacks definitely failed. By the 22nd the tables had been turned, and Schaffer's force was itself completely surrounded. While part of Plehve's army, after rescuing the left of the II Army, turned to attack Schaffer's group south of Lodz, Rennenkampf, the commander of the I Army, had been ordered to dispatch forces from Lowicz and Skierniewice to gain touch with the II Army and close the German line of retreat to the north. The Lowicz force which consisted of $3\frac{1}{2}$ divisions, started on Nov. 20 and by the evening of the 22nd, in spite of three changes of command and indifferent staff work, had captured Stryków and Brzeziny, and had apparently sealed the gap between the Russian I and II Armies. The Russians actually ordered up 18 trains to remove the anticipated harvest of prisoners. The Skierniewice column of a division and a regiment accomplished nothing.

Escape of Schaffer's Force.—In the evening of the 22nd, Schaffer, heavily engaged with part of Plehve's army, south of Lodz, received a wireless order from Mackensen to cut his way out by Brzeziny. During the night of Nov. 22, in intense cold, he succeeded in slipping from the grasp of the enemy opposing him and concentrating his weary divisions to make the bid for release. Unknown to him, the Russians had already opened a breach. The centre columns of the Lowicz force had marched on to Lodz, leaving the left column, the Siberian 6th Div., isolated west of Koluszki on the Warsaw-Lodz railway. This division fought gallantly during Nov. 23 and repulsed all efforts of the XXV Res. Corps to escape. Farther west, however, the 3rd Guard Div. moving through the Galkówek forests, found the gap in the Russian net and captured Brzeziny in the early hours of Nov. 24. Encouraged by this success, the XXV Corps renewed its efforts against the hapless Siberian 6th Div., whose appeals for help were disregarded by other Russian formations within easy reach of the battlefield. Finally, the division, with both flanks turned and overborne by weight of numbers, broke and left the way open for the XXV Res. Corps to rejoin the 3rd Guard Div. at Brzeziny. Schaffer's line of retreat was now clear, and on the 25th his whole force, moving by Stryków, rejoined Mackensen. He brought with him several thousands of prisoners and a number of captured guns.

Effect of the Battle.—Ludendorff's bold stroke had stopped the grand duke's intended invasion of Silesia as effectively as Sir John Moore, by a similar move, had halted Napoleon's incursion into Spain a little more than 100 years before. Never again during the War were the Russians in a position to threaten German territory. The campaign shows well the value of mobility as a strategical weapon. On Oct. 26 the IX Army was engaged opposite Warsaw during Hindenburg's first offensive. During the next fortnight it retired 120 mi. destroying the communications as it went; reorganized and repaired its losses; was transferred by railway across the enemy front; and deployed in complete fighting trim for its new offensive on Nov. 11. This shows German organization and efficiency at its highest. The quality of German leadership was also well displayed, and was in strong contrast with the irresolution and inertia shown by some of the Russian commanders.

Schaffer's exploit was a masterly one; within a few hours of receiving his orders to retire, he had succeeded in breaking off action and setting his columns in motion to seek a way to safety, which his determination and the fine fighting spirit of his troops was to win. This compares with the inaction of many of the Russian commanders, particularly the failure of the numerous bodies within reach to come to the rescue of the Siberian 6th Div. on Nov. 23. Ludendorff had owed much to Rennenkampf's passivity for his victory at Tannenberg; here again Rennenkampf's inefficiency and lack of the will to victory saved him from the loss of Schaffer's force which his rashness and obstinancy had exposed. Yet Rennenkampf had been accounted a dashing leader of men before the War. The Grand Duke himself, Ruzski (the commander of the Northwest Front), and Plehve, who hid an iron will in a weak and wizened frame, all acted promptly and with determination to take advantage of the opportunity.

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LOEB, JACQUES (1859–1924), German biologist, was born in Germany, April 7, 1859. Graduating at Ascanisches Gymnasium, Berlin, he studied medicine in Munich and Strasbourg (M.D., 1885). He was assistant in physiology at the universities of Würzburg (1886–88) and Strasbourg (1888–90), working also at the Naples biological station from 1889 to 1891. He went to the United States in 1891 and taught biology at Bryn Mawr for a year. He became assistant professor of physiology and experimental biology at the University of Chicago in 1892, being appointed associate professor in 1895 and professor in 1900. In 1902 he became professor of physiology at the University of California. From 1910 to the date of his death he was head of the division of general physiology at the Rockefeller Institute for Medical Research. He died at Hamilton, Bermuda, Feb. 11, 1924. Dr. Loeb's work was chiefly directed to a pursuit of the real distinction between living and dead matter, the thesis upon which he worked being that all living things are chemical machines and that their workings are open to the same mechanistic explanation as are those of any machines made of inert matter. His most important researches concern the effects of electrolytic, thermant and radiant energy upon living matter, regeneration, the process of fertilization in the egg and artificial parthenogenesis. In 1899 he was able to produce larvae from the unfertilized ova of the sea-urchin, and in 1915 tadpoles from the similar ova of frogs.

Among his published works are: *The Heliotropism of Animals and Its Identity with the Heliotropism of Plants* (1890); *Physiological Morphology* (1891–92); *Comparative Physiology of the Brain and Comparative Psychology* (1900); *Studies in General Physiology* (1905); *The Dynamics of Living Matter* (1906); *The Mechanistic Conception of Life* (1912); *Artificial Parthenogenesis and Fertilisation* (1913); *The Organism as a Whole* (1916); *Forced Movements: Tropisms and Animal Conduct* (1918); *Proteins and the Theory of Colloidal Behaviour* (1922); and *Regeneration from a Physico-chemical Viewpoint* (1924).

LOEB, JAMES (1867–1933), American banker and philanthropist, was born in New York city Aug. 6, 1867. Graduating from Harvard College in 1888, Loeb became a member of the firm of Kuhn, Loeb and company, bankers, New York city, retiring from business in 1901. In 1905 he founded and endowed the Institute of Musical Art in New York city. He was the founder of the Loeb Classical Library of Latin and Greek authors, works which give text and translation on facing pages. The first volume appeared in 1912. He was instrumental in founding the Deutsche Forschungsanstalt für Psychiatrie, an institution in Munich for the systematic study of the causes of mental diseases.

LOEFFLER, CHARLES MARTIN TORNOV (1861–1935), composer, was born at Mühlhausen, Alsace, Jan. 30, 1861. Part of his childhood was spent in Russia near Kiev, but he was educated in Switzerland. He studied the violin under Leonard and Massart at the Paris Conservatoire and under Joachim at the Berlin Hochschule, taking composition in Paris under Guiraud and in Berlin under Kiel. In 1881 he went to the United States, and played violin in the Boston Symphony Orchestra, but resigned in 1903 to devote himself to composition. Among his significant works after 1903 were: *A Pagan Poem* for orchestra and piano; *Memories of My Childhood,* another symphonic poem; and *Canticle of the Sun,* commissioned by Mrs. Elizabeth Sprague Coolidge, with Mme. Povla Frijsh as soloist, for the opening of the Chamber Music Hall, Library of Congress, Oct. 1925, outstanding in that first memorable chamber music festival in the capital of the United States. Other compositions were *Quartet in A Minor; Les Veillées de l'Ukraine;* and *Divertimento in A Minor,* both for orchestra and violin; *The Death of Tintagiles* for orchestra and viola d'amore; *Deux Rhapsodies* for oboe, viola and piano; *Divertissement Espagñol* for orchestra and saxophone; *By the Waters of Babylon,* a setting of Psalm 137, for female chorus; *For One Who Fell in Battle,* eight-part chorus; *Hora Mystica,* symphony; music for four strings to the memory of Victor Chapman; two symphonic poems, *La Bonne Chanson* and *La Villanelle du Diable; Three Movements; Fantastic Concerto* for orchestra and violoncello; and several songs.

LOESS, in geology, a variety of loam. Typical loess is a soft, porous rock, pale yellowish or buff in colour; one characteristic property is its capacity to retain vertical or even over-hanging walls in the banks of streams. These vertical walls have been well described by von Richthofen (*Führer für Forschungsreisende* Berlin, 1886) as they exist in China, where they stand in some places 500ft. high and contain innumerable cave dwellings; ancient roads, too, have worn their way vertically downwards deep into the deposit, forming trench-like ways. This character in the loess of the Mississippi region gave rise to the name "bluff formation." A coarse columnar structure is often exhibited on the vertical weathered faces of the rock. Another characteristic is the presence throughout the rock of small capillary tubules, which appear to have been occupied by rootlets; these are often lined with calcite. Typical loess is usually calcareous; some geologists regard this as an essential property, and when the rock has become decalcified, as it frequently is on the surface by weathering, they call it "loess-loam" (*lösslehm*). In the lower portions of a loess deposit the calcium carbonate tends to form concretions, which on account of their mimetic forms have received such names as *lösskindchen, lösspuppen, poupées du loess,* "loess dolls." Bedding is absent from typical loess. The mineral composition of loess varies somewhat in different regions, but the particles are always small; they consist of angular grains of quartz, fine particles of hydrated silicates of alumina, mica scales and undecomposed fragments of felspar, hornblende and other rock-forming silicates.

In Europe and America loess deposits are associated with the margins of the great ice sheets of the glacial period; thus in Europe they stretch irregularly through the centre eastwards from the north-west of France, and are not found north of the 57th parallel. Most geologists are agreed that the true loess is an aeolian or wind-borne rock, formed most probably during periods of tundra or steppe conditions. But it seems clear that certain deposits classed as loess in western Europe do not really belong to this category, being of alluvial origin and related to the brick-earths of south-eastern England.

LOEWE, JOHANN KARL GOTTFRIED (1796–1869), German composer, was born at Löbejün, near Halle, on Nov. 30, died at Kiel, on April 20, 1869. He wrote five operas, of which only one, *Die drei Wünsche,* was performed at Berlin in 1834, without much success; and many choral and chamber works. His best work was done in the solo ballad with pianoforte accompaniment.

See H. Bulthaupt, *Karl Loewe* (1898) in Riemann's *Berühmte Meister.*

LÖFFLER, FRIEDRICH (1852–1915), German bacteriologist, was born at Frankfort on the Oder, and after being army surgeon, became professor of hygiene at Greifswald in 1888. Together with Koch he was able to cultivate the organism of diphtheria which is known as the Klebs-Löffler bacillus. He also discovered the bacteria of erysipelas in pigs in 1882, and in 1898 inoculated successfully against the foot-and-mouth disease, the cause of which he showed to be a filterable virus. He left an unfinished history of bacteriology.

LOFFT, CAPEL (1751–1824), English miscellaneous writer, was born in London on Nov. 14, 1751. He was educated at Eton, and Peterhouse, Cambridge, which he left to become a member of Lincoln's Inn. He became the patron of Robert Bloomfield, the author of *The Farmer's Boy,* and secured for him the very successful publication of that work. Byron, in a note to his *English Bards and Scotch Reviewers,* ridiculed Lofft as "the Maecenas of shoemakers and preface-writer general to distressed versemen; a kind of gratis *accoucheur* to those who wish to be delivered of rhyme, but do not know how to bring forth." He died at Montcalieri, near Turin, on May 26, 1824.

LOFOTEN AND VESTERAALEN, a group of islands off the N.W. coast of Norway, between 67° 30′ and 69° 20′ N., and between 12° and 16° 35′ E., part of the Norwegian *amt* (county) of Nordland. The extreme length of the group from Andenaes, at the north of Andö, to Röst, is about 150 mi.; the aggregate area about 1,560 square miles. It is separated from the mainland by the Vestfjord, Tjaeldsund and Vaagsfjord, and is divided into two sections by the Raftsund between Hindö and Öst-Vaagö. To the west and south of the Raftsund lie the Lofoten islands proper, of which the most important are Öst-Vaagö, Vest-Vaagö and Moskenaesö; east and north of the Raftsund are the islands of Vesteraalen, the chief being Hindö, Langö and Andö. The islands, which are of granite or gneiss, are a partially submerged mountain range, and are lofty and rugged. The highest points are found on Öst-Vaagö, near the Raftsund and Troldfjord, and the greatest height is Higrafstind (3,811 ft.).

The long line of jagged peaks seen from the Vestfjord forms one of the most striking prospects on the Norwegian coast. The channels which separate the islands are narrow and tortuous, and generally of great depth; they have remarkably strong tidal currents, particularly the Raftsund and the famous Maelström or Moskenström near Moskenaes. Though situated within the Arctic circle, the climate of the Lofoten and Vesteraalen group is not rigorous and the coast is never frozen. The isothermal line which marks a mean January temperature of 32° F runs south from the Lofotens, passing east of Bergen onward to Gothenburg and Copenhagen. The prevailing winds are from the south-west and west, the mean temperature is 38·5° F, and the annual rainfall is 43·34 in. In summer the hills have only patches of snow. Much of the interior is bleak cranberry moor. Cattle are reared, but the growth of cereals (chiefly barley) is insignificant.

The characteristic industry is the cod fishery carried on along the east coast of the Lofotens in the Vestfjord in spring. This employs many thousands during the season from all parts of Norway. The fish, dried on the cliffs during early summer, ordinarily is exported from Bergen to Spain, Holland, Great Britain, Belgium, etc., and the fish heads are used as cattle food. Industries arising out of the fishery are the manufacture of cod-liver oil and of artificial manure in factories at Skolvaer, Henningvaer, Kabelvaag, etc. The summer cod fisheries and the lobster fishery are also valuable.

The herring is taken in large quantities off the west coasts of Vesteraalen. Skolvaer built on rocky islands off Öst-Vaagö is the "capital" and chief port and trading centre, and Kabelvaag is another fishing port. Lödingen also, at the head of the Vestfjord on Hindö, is a port of call. A church existed at Vaagen (Kabelvaag) in the 12th century, and Hans Egede, the missionary of Greenland, was pastor. Steamers trade between Hamburg or Oslo and Hammerfest, and communication locally is chiefly by small boats for there are few roads. The largest island in the group, and indeed in Norway, is Hindö, with an area of 860 square miles. On Andö there is a bed of coal at the mouth of the Ramsaa.

Lofoten became well known in World War II as the scene of British "Commando" raids against the Germans.

LOFTUS, ADAM (*c.* 1533–1605), archbishop of Armagh and Dublin, and lord chancellor of Ireland, was educated at Cambridge. He accompanied the earl of Sussex to Ireland as his chaplain in 1560, and three years later was consecrated archbishop of Armagh by Hugh Curwen, archbishop of Dublin. In 1567 he was translated to the archbishopric of Dublin, where the queen looked to him to carry out reforms in the Church. On several occasions he temporarily executed the functions of lord keeper, and in August 1581 he was appointed lord chancellor of Ireland. It was largely through his influence that the corporation of Dublin granted the lands of the priory of All Hallows as a beginning of the endowment of Trinity college, of which he was named first provost in the charter creating the foundation in 1591. Loftus died in Dublin on April 5, 1605.

See J. R. O'Flanagan, *Lives of the Lord Chancellors of Ireland* (1870).

LOG, MARITIME, an appliance for measuring the speed of a ship through the water. The oldest form of log of a practical nature was that known as the "common log." The outfit consisted of a log-ship or log-chip, log-reel, log-line and log-glass. The log-ship was a wooden quadrant about $\frac{1}{2}$ inch thick with a radius of about 5 or 6 inches, its circumference being weighted with lead to keep it upright in the sea and to retard its passage through the water. One end of a short length of thin line was passed through a hole at one of the lower corners of the log-ship and secured by a knot on the opposite side. To the other end was spliced another short length terminating in a hard wooden peg which could be inserted in a similar hole in the opposite corner. The holes were so placed that the log-ship would hang square from the span thus formed.

The log-line led from this span inboard to the ship. The first length between the log-ship when floating in the sea and the ship was known as the "stray line." It varied from 10 to 20 fathoms according to the distance necessary to veer the log-ship clear of the disturbance of the ship's wake before starting observations. The place where its inboard end joined the remainder of the log-line was marked by a piece of bunting, and the line from here towards the end in the ship was marked and measured in "knots" composed of pieces of cord worked in between the strands. The distances between the knots bore the same relation to a nautical mile (6,080 ft.) as 28 sec. to an hour (3,600 sec.); *i.e.*, they were placed 47 ft. 3 in. apart. The end of the first interval, counting from the bunting, was marked with a piece of leather, the second by a cord with two knots, the third by one with three knots, and so on. Half-way between each length was a cord with one knot. It followed, therefore, that if, say, five knots of the line ran out in 28 sec. by the sand glass, the ship had gone $5 \times 47\frac{1}{4}$ ft. in that time, *i.e.*, was moving at a rate of five knots (five nautical miles per hour). For speeds over 6 knots, a 14-second glass was employed and the speed indicated by the log-line was doubled. The form of marking adopted enabled the log to be read when taking readings at night.

The actual process of "heaving the log" was as follows: The log-line was prepared by well soaking and stretching it before marking. It was then wound evenly on the log-reel, to which its inner end was securely attached. One man held the log-reel over his head, the officer (in the navy, usually the midshipman of the watch) placed the peg in the log-ship which he then threw overboard clear and to windward of the ship, allowing the line to run out freely. When the bunting at the end of the stray line passed his hand, he called to his assistant to turn the sand-glass. When all the sand had run out, the assistant called "stop," when the log-line was quickly nipped and the knots counted, any extra portion intermediate between two markings being estimated. The strain brought on the little span next the log-ship caused the peg to be withdrawn from its hole, when the log-ship turned edge on, thus facilitating hauling it in. Normally the log was hove every hour, and under favourable conditions the common log gave very fairly accurate results. It has, however, been almost entirely superseded by automatic or "continuous" logs registering inboard on dials.

One of the earliest of these logs was invented by Edward Massey in 1802; this log was in general use in 1836 and continued so until 1861. An improved log was produced by Alexander Bain in 1846, and in 1861 Thomas Walker's "harpoon" or frictionless log was introduced. In all these the dials registering the distance travelled were close to the screw which actuated the log, *i.e.*, they towed overboard and the instrument had to be hauled in before it could be read. This inconvenience was overcome by Walker, when in 1878, he introduced his "cherub" log. Walker's "cherub" consisted of a dial secured to the taffrail of the ship, a specially plaited line of 40 to 60 fathoms in length and a screw-like rotator. To regulate the rate of spin, a brass fly-wheel, known as a "governor," was added in the later patterns. The "cherub" log gave excellent results up to a speed of about 14 knots; above that the rotator was inclined to jump out of the water, and to overcome this defect the "trident" log was introduced. This log was generally similar in appearance to the "cherub," but the line was 65 fathoms, and certain improvements were made in the mechanical parts of the counter to enable it to bear the strain of higher speeds. A further development was an electrical arrangement transmitting the readings of the counter to a dial in the chart-house.

Forbes' Log and Speed Indicator.—This apparatus records (1) the distance travelled by the ship through the water, and (2) an indication of the speed in knots at which the ship is moving through the water at any given moment. It has the advantage over the trailing form of log that it does not get fouled by seaweed or damaged by being towed astern, while it will give the speed of the ship when turning, a useful piece of information for gunnery purposes. On the other hand, it is sometimes affected by the stream line of the ship.

The transmitting apparatus consists essentially of a tube projecting through the bottom of the ship and turned so as to face forward. Water is forced through this tube by the forward movement of the ship; the flow operates a small propeller which actuates the transmitting mechanism. The water flows out through another opening facing aft. The small propeller operates a commutator which transmits electric signals to the distant recorders. It also drives a magnetic generator which generates currents of a voltage proportional to the speed. The commutator operates the dial indicating the distance travelled, while the generator excites a voltmeter graduated in knots. Arrangements are made to adjust the mechanism to suit and record accurately for an individual ship. (E. A.)

LOGAN, JOHN, also known as TAHGAHJUTE (*c.* 1725–1780), American Indian leader, by birth a Cayuga, the son of Shikellamy, a white man who had been captured when a child by the Indians, had been reared among them and had become a chief. John Logan lived for some time near Reedsville, Pa., and removed to the banks of the Ohio river about 1770. He was not technically a chief but acquired great influence among the Shawnees, into which tribe he married. He was on good terms with the whites until April 1774, when, friction having arisen between the Indians and the whites, a band of marauders, led by one Greathouse, attacked and murdered several Indians, including Logan's sister and other relatives. Believing that Capt. Michael Cresap was responsible for this murder, Logan sent him a declaration of hostilities, the result of which was the bloody conflict known as Lord Dunmore's war. Logan refused to join the Shawnee chief, Cornstalk, in meeting Gov. Dunmore in a peace council after the battle of Point Pleasant, but sent him a message now famous as an example of Indian eloquence. Logan took to drink and in 1780 was killed near Lake Erie by his nephew, whom he had attacked.

See Brantz Mayer's *Tah-gah-jute or Logan the Indian and Captain Michael Cresap* (Baltimore, 1851; 2nd ed. Albany, 1867) and F. B. Sawvel, *Logan the Mingo* (1921).

LOGAN, JOHN (1748–1788), Scottish poet, was born at Soutra, Midlothian, in 1748. In 1771 he was presented to the charge of South Leith, but was not ordained till two years later. In 1770 he published *Poems on Several Occasions by Michael Bruce*. In 1781 he published his own *Poems*. Logan was accused of having appropriated in his *Poems* (1781) verses written by Michael Bruce (*q.v.*). The statements of John Birrell and David Pearson on behalf of Bruce were included in Dr. Anderson's *Life of Logan*. The charge of plagiarism has been revived from time to time.

LOGAN, JOHN ALEXANDER (1826–1886), American soldier and political leader, was born in what is now Murphysborough, Ill., on Feb. 9, 1826. He had no schooling until he was 14; he then studied for three years in Shiloh college, served in the Mexican War as a lieutenant of volunteers, graduated from the law department of Louisville university in 1851 and practised law with success. He entered politics as a Douglas Democrat. In 1858 and 1860 he was elected to the national house of representatives. Though unattached and unenlisted, he fought at Bull Run, and then returned to Washington, resigned his seat and entered the Union army as colonel of a regiment of volunteers, which he organized. He was regarded as one of the ablest officers who entered the army from civil life. In Grant's campaigns terminating in the capture of Vicksburg he rose to the rank of major-general of volunteers; in 1863 he was placed in command of an army corps, and after the death of McPherson he was in command of the army of the Tennessee at the battle of Atlanta. When the war closed, Logan resumed his political career as a Republican and was a member of the national house of representatives from 1867 to 1871, and of the U.S. senate from 1871 until 1877 and again from 1879 until his death. He was always a violent partisan and was identified with the radical wing of the Republican party. His war record and his large personal following, especially in the Grand Army of the Republic, contributed to his nomination for vice-president in 1884 on the ticket with James G. Blaine, but he was not elected. His impetuous oratory, popular on the platform, was less adapted to the halls of legislation. When commander-in-chief of the Grand Army of the Republic in 1868–71, he successfully urged the observance of Memorial or Decoration day, an idea which probably originated with him. He died at Washington, D.C., Dec. 26, 1886. He was the author of *The Great Conspiracy: Its Origin and History* (1886), and of *The Volunteer Soldier of America* (1887). There is a fine statue of him by Saint-Gaudens in Chicago.

LOGAN, SIR WILLIAM EDMOND (1798–1875), British geologist, was born in Montreal on April 20, 1798, of Scottish parents. He was educated partly in Montreal and at the high school and University of Edinburgh, where Robert Jameson excited his interest in geology. In 1831 he took charge of a colliery and copper-smelting works in Swansea. In 1840 Logan brought before the Geological society of London his paper "On the character of the beds of clay lying immediately below the coal-seams of South Wales, and on the occurrence of coal-boulders in the Pennant Grit of that district." He pointed out that each coal-seam rests on an under-clay with rootlets of *Stigmaria,* and expressed his opinion that the under-clay was the old soil in which grew the plants from which the coal was formed. To confirm this observation he visited America in 1841 and examined the coal-fields of Pennsylvania and Nova Scotia, where he found the under-clay almost invariably present beneath the seams of coal. In 1842 he took charge of the newly established geological survey in Canada, and continued as director until 1869. Logan was elected F.R.S. in 1851. He died at Castle Malgwyn, Pembrokeshire, on June 22, 1875.

LOGAN, a city of southern Ohio, U.S.A., on the Hocking river, 48 mi. S.E. of Columbus; the county seat of Hocking county. It is served by the Chesapeake and Ohio railway. The population was 6,080 in 1930 and 6,177 in 1940. Logan is in a rich farming region, with coal, oil and natural gas near by. It has railroad shops and machine shops, and its manufactures include oil-well tools and supplies, furniture, iron and steel, brick, shoes, flour and earthenware. The village was settled about 1816, incorporated in 1839 and became a city in 1922.

LOGAN, fourth city of Utah, U.S.A., on the Logan river, 80 mi. N. of Salt Lake City; the county seat of Cache county. It is on federal highways 91 and 89, and is served by the Oregon Short Line and the Utah-Idaho Central (electric) railways. The population was 9,979 in 1930, and 11,868 in 1940. It lies at the entrance to the picturesque Logan canyon, 4,500 ft. above sea level, and commands magnificent views of the Wasatch mountains and the fertile Cache valley. Logan is the business centre of the valley, which is devoted largely to raising sugar beets, alfalfa, grain, peas and beans and to dairying and which also has several beet-sugar factories, milk condensers, grain elevators, flour mills and a pea- and bean-canning plant. There are also knitting factories and bottling works. The Utah state agricultural college (founded in 1888) is there. Logan was settled in 1859 by the Mormons from the Great Salt Lake valley and was incorporated in 1866.

LOGANBERRY or **LOGAN BLACKBERRY.** This well-known fruit is supposed to be a hybrid between the wild blackberry (*Rubus ursinus*) of the Pacific coast and the red raspberry, but this view is disputed. The fruit was raised from seed in 1881 in the garden of Judge J. H. Logan at Santa Cruz, Calif. It is grown commercially in large quantities, especially in Oregon and Washington and in England and Tasmania. The Logan is a vigorous, nearly trailing, blackberry-like plant with 3- to 5-foliate leaves, prickly canes and deep wine-red, tart, high-flavoured berries that separate from the stem as do the blackberries. The Phenomenal, originated by Luther Burbank, is very similar to the Logan, but bears slightly larger fruit. The Young (Youngberry), Boysen (Boysenberry), Pacific and Cascade are related berries that have the high aroma and flavour of the Logan and of the native blackberry. Research by Crane and Thomas in England indicates that the Logan might have originated as a hybrid of an octoploid blackberry fertilized with diploid pollen of a red raspberry. A hybrid of this kind was reported by them as similar in appearance to the Logan. Confirmation of this by others has not yet been obtained. Bailey has proposed the species name *R. loganobaccus* for this cultivated blackberry.

LOGANIACEAE, a family of dicotyledonous plants including herbs, vines, shrubs and trees, chiefly tropical but with some representatives in temperate regions. About 33 genera and 700 species are recognized. The largest and most important genus is *Strychnos* in the tropics of both hemispheres, the seeds of various species, but especially those of *S. nux vomica,* yielding the important drug strychnine (*q.v.*). Many species of *Buddleia* and one of *Gelsemium,* the yellow jessamine of the southeastern United States, are cultivated for ornamental purposes. (E. D. Ml.)

LOGANSPORT, a city of Indiana, U.S.A., on the Wabash river, at the mouth of the Eel, 67 mi. N.W. of Indianapolis; the county seat of Cass county. It is on federal highways 24 and 35 and is served by the Pennsylvania, the Wabash and five motorbus lines. The population was 18,508 in 1930 and 20,177 in 1940 (97% native white) by the federal census. The city has an area of 5.7 sq.mi. and an altitude of 600 ft. It is an important shipping point for grain, lumber, pork and other products of the rich farming region round about. There are approximately 30 important manufacturing industries with approximately 1,590 employes. Among the products are fire-fighting apparatus, heating systems, steel springs, wearing apparel, electrical equipment, machine parts, fishing tackle, bicycle tires and oxygen. A state hospital for the insane is situated there.

Title to the land in and about Logansport was acquired by the United States from the Miami and the Pottawatomie Indians by treaty in Oct. 1826. The town was laid out in 1828 and was named after a Shawnee chief, Capt. Logan (d. 1812), who was a faithful friend of the whites. It was incorporated as a town in 1831 and as a city in 1838.

LOGAR, a river and valley of Afghanistan. The Logar river drains a wide tract of country, rising in the southern slopes of the Sanglakh range and receiving affluents from the Kharwar hills, north-east of Ghazni. It joins the Kabul river a few miles below the city of Kabul. The Logar valley, which is watered by its southern affluents, is rich and beautiful, about 40 m. long by 12 wide, and highly irrigated throughout. Lying in the vicinity of the capital, the district contributes largely to its food-supply.

LOGARITHMIC DECREMENT is the measure of the rate of decay of any exponentially damped oscillatory phenomenon, usually mechanical or electrical. It is the Naperian logarithm of the ratio of the first to the second of two successive current amplitudes in the same direction. The logarithmic decrement can also be considered as a constant of a simple radio circuit, being π times the product of the resistance by the square root of the ratio of the capacity to the inductance of the circuit. Measurement of logarithmic decrement is of great importance since it makes possible the determination of the equivalent resistance of the circuits under consideration, and also gives information concerning the lengths of the wave trains. The value of the sum of the decrements of two circuits may be obtained from their resonance curve.

LOGARITHMS. By shortening processes of computation, logarithms have doubled the working speed of astronomers and engineers. The explanation of this highly practical branch of mathematics begins most conveniently with the exponential expression b^l which represents some number n, so that we may write $n=b^l$. In the elementary theory we assume b, n, l to be real numbers, b and n positive, and b greater than unity. If we know b and the exponent l, we may compute n. For example, if $b=10$, $l=3$, then $n=1{,}000$. If any two of the three numbers b, l, n are given, the third may be computed. To develop the elementary theory of logarithms we assume the number n and the base b to be given, then the exponent l may be found. For the case under consideration (when b and n are both positive and b is greater than unity), the actual existence of one and only one real value l can be established by the modern theories of irrational numbers, such as that of Dedekind. For, if we make a "cut" of all ordered real numbers by placing in one class every number α for which $b^\alpha \leqq n$, and in the other class every number β for which $b^\beta > n$, then if N is the number defined by the "cut," we must have $b^N=n$, for the reason that every other assumption leads to an evident contradiction. That is, if we assume that $b^N<n$, then another number b^{N_1} exists which lies between b^N and n, and there are numbers in the first class greater than N, which is contrary to assumption. A similar result is reached if we assume that $b^N>n$.

The number l is called the "*logarithm* of the number n to the base b"; in which case n is sometimes called the *antilogarithm* of l. From a knowledge of the properties of the expression b^l it becomes evident that certain values of the base b are more convenient than others. Thus, b is selected to be positive, because a negative b would produce undesired fluctuations in the signs of n, when l takes successively the values $1, 2, 3, 4, \cdots$, while for $l=\frac{1}{2}$, $\frac{1}{4}, \cdots$ the n would be an imaginary number. It is evident also that $b=1$ would place limitations upon the possible values of n corresponding to the real exponents l, since $1^l=1$. Accordingly, when the base is unity, 1 is the only real number having a real logarithm. If b lies between 0 and 1, then l decreases as n increases, a relation that is workable in practice, though not particularly desirable. Hence we assume, as was done above, that b is positive and greater than 1.

Of all possible values greater than 1 which might be chosen as the base, two have been selected, which yield two systems of logarithms. One value is $b=10$, used in the *common logarithms*, chosen because of certain practical advantages that accrue from a base which is the same as the scale of our number system. Common logarithms have also been called *Briggian* logarithms. The other value taken for the base is $2{\cdot}718\cdots$: it is usually represented by the letter e, and belongs to a type of irrational numbers called "transcendental numbers." The logarithms having the base e are called *natural logarithms*, or sometimes less appropriately *hyperbolic* or *Naperian logarithms*. The base 10 yields logarithms that are most convenient for the purposes of computation; the base $2{\cdot}718\cdots$ yields logarithms which lead to simpler formulas in higher analysis than other systems, and are therefore the most "natural" ones to use.

According to the definition of logarithms given above, logarithms are really exponents and therefore are endowed with the properties of exponents, viz.,

$$b^{l+l_1}=b^l\cdot b^{l_1},\quad b^{l-l_1}=b^l/b^{l_1},\quad b^{ll_1}=(b^l)^{l_1}, \tag{1}$$

where l and l_1 may be positive or negative, rational or irrational real numbers. In the theory of logarithms, if $b^l=n$, we use the notation $l=\log_b n$, and we read this, "l is the logarithm of n to the base b." As $b^0=1$ and $b^1=b$, it is evident that no matter what value different from zero the base may have, the logarithm of 1 is zero, and the logarithm of the base itself is unity. Writing $b^l=n$ and $b^{l_1}=n_1$, the three exponential formulas (1) translated into the notation of logarithms, become

$$l+l_1=\log_b nn_1,\quad l-l_1=\log_b n/n_1,\quad ll_1=\log_b (n)^{l_1}, \tag{2}$$

Substituting $\log_b n$ for l, $\log_b n_1$ for l_1, we have

$$\log_b n+\log_b n_1=\log_b nn_1,\quad \log_b n-\log_b n_1=\log_b n/n_1,$$
$$p.\ \log_b n=\log_b (n^p). \tag{3}$$

Stated in words: (1) The logarithm of a product is equal to the sum of the logarithms of the factors. (2) The logarithm of a quotient is equal to the logarithm of the dividend minus the logarithm of the divisor. (3) The logarithm of a power of a number is equal to the product of the exponent and the logarithm of the number itself.

Common Logarithms.—Since $10^0=1$ and $10^1=10$, the logarithm of 1 is zero and the logarithm of 10 is unity. Any number between 1 and 10 has a common logarithm which lies between 0 and 1. Similarly, since $10^2=100$, any number between 10 and 100 has a common logarithm which lies between 1 and 2; and since $10^3=1{,}000$, any number between 100 and 1,000 has a common logarithm which lies between 2 and 3; and so on. Thus the logarithm of 75 is nearly $1{\cdot}87506$. The integral part of the logarithm is called the *characteristic*, the decimal part is called the *mantissa*. From the relations just given we obtain the general statement that *the characteristic of the common logarithm of a number greater than* 1 *is one less than the number of integral figures*. Thus, $3768{\cdot}5$ has four integral figures, hence its logarithm has the characteristic 3. From the relations $10^0=1$, $10^{-1}={\cdot}1$, $10^{-2}={\cdot}01$, $10^{-3}={\cdot}001$, etc., we obtain a corresponding rule for decimal fractions less than unity, and also the provision that the mantissa shall be positive; namely the rule that the *characteristic of the common logarithm of a decimal fraction less than unity is negative and is numerically one more than the number of zeros immediately following the decimal point*. Thus, $0{\cdot}000107$ has three zeros immediately following the decimal point and the characteristic of its logarithm is -4. The minus sign is sometimes written above the characteristic, thus $\bar{4}$, to serve as a reminder that it applies only to the characteristic and not to the mantissa. It is simply for convenience that the mantissa, when different from zero, is always taken to be positive. This is accomplished by framing the rules for finding the characteristic, as was done above, so that, when the mantissa is not zero, the characteristic is always the integer immediately below the true value of the logarithm, and the fractional value (the mantissa) must be added to the characteristic to secure the true value of the logarithm. Thus, the logarithm of ${\cdot}07$ lies between -1 and -2; it might be taken to be -1 and a minus mantissa or -2 and a positive mantissa. The latter course is chosen, for the reason that the computation involving mantissas is simplified by taking them always positive.

The great advantage of the common system of logarithms lies in the fact that the mantissa of the same sequence of figures is the same, no matter where the decimal point is placed. Thus, 3·7568 and 375·68 have different characteristics but the same mantissa. This fact is evident from the relation

$$3{\cdot}7568 \times 100 = 375{\cdot}68,$$

which indicates that the logarithm of 3·7568 is less than of 375·68 by exactly 2, which is the logarithm of 100. This property of the mantissa and the simple rules for finding the characteristic make it possible to prepare tables of common logarithms in very much more compact form than for other systems. Characteristics are omitted altogether from the tables and are supplied by the computer.

Natural Logarithms.—To show how natural logarithms arise in analysis, we find the derivative of $y=\log_b x$, where b is any positive constant greater than 1. We obtain $y+h=\log_b(x+k)$, $h=\log_b(x+k)-\log_b x = \log_b\frac{x+k}{x} = \log_b\left(1+\frac{k}{x}\right)$, and

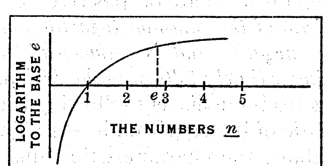
$$\frac{h}{k} = \frac{1}{x}\cdot\frac{x}{k}\cdot\log_b\left(1+\frac{k}{x}\right) = \frac{1}{x}\cdot\log_b\left(1+\frac{k}{x}\right)^{\frac{x}{k}}.$$

The derivative $\frac{dy}{dx}$ is the limit of $\frac{h}{k}$, as $k\rightarrow 0$. Thus we are led to consider the limit of $\left(1+\frac{1}{n}\right)^n$, where $n=\frac{x}{k}$. This limit can be shown to exist, but the proof, when n may assume any real values, rational or irrational, is somewhat long. It is one of the fundamental limits in mathematics. Expanding $\left(1+\frac{1}{n}\right)^n$ by the Binomial Theorem and letting $n\rightarrow\infty$, we obtain the rapidly convergent series,

$$e=1+1+\frac{1}{2!}+\frac{1}{3!}+\cdots+\frac{1}{n!}+\cdots=2{\cdot}718281828459\cdots.$$

We thus obtain $\frac{dy}{dx} = \frac{1}{x}\log_b e$. If we take the base $b=e$, so that $\log_e e=1$, this expression reduces to the simpler form $\frac{dy}{dx} = \frac{1}{x}$.

From the graph here shown it is evident to the eye that positive numbers less than 1 have negative logarithms. Numbers very close to 0 have negative logarithms whose numerical values are very large. The vertical axis is an asymptote to the curve. These statements are true also for the graphs of common logarithms and of logarithms to any base $b>1$. It is a curious special property of the graph for natural logarithms that only one of its points has co-ordinates both of which are rational numbers, namely the point (1, 0). In other words, the equation $l=\log_e n$, or $e^l=n$, can be satisfied by only one set of numbers l and n, of which both are real and rational, namely $n=1$ and $l=0$. This unexpected and curious property is rendered even more subtle by the additional fact that in all other sets of values for n and l, at least one of the two numbers is a very special type of irrational, called *transcendental*. As already stated, the base e is itself a transcendental number. A number is called transcendental when it is not algebraic; *i.e.*, when it cannot be the root of an algebraic equation, $x^m+ax^{m-1}+bx^{m-2}+\cdots+fx+g=0$, where m is any positive integer and the coefficients $a, b, \cdots, f, g$ are all integers, or zero, except that g cannot be zero since that would change the degree of the equation. Algebraic numbers include all integers and rational fractions, and also all irrational numbers which are roots of algebraic equations of the kind here described. The proof that e is transcendental was a notable achievement of the French mathematician Charles Hermite, in 1873 (*Comptes Rendus*, vol. 77, p. 285). The proof as ordinarily given is to substitute in the above equation e for x and to show that this leads to an absurdity; since the left member of the equation, after being multiplied by a suitable constant C, may be broken up into two parts, one an integral part which is not zero, and the other part having a fractional value which can be made as small as we please. Evidently the sum of an integer different from zero and a proper fraction cannot equal zero. Hence e cannot be a root of the equation.



If in the figure we imagine all algebraic numbers marked on the n-axis and also on the l-axes, the points so marked are "dense" on each axis; *i.e.*, between any two algebraic numbers, no matter how close they are to each other, there exists at least one other algebraic number, *e.g.*, the arithmetic mean of the two. If in the nl-plane we imagine all points marked which have an algebraic abscissa n and also an algebraic ordinate l, then the entire plane is "densely" covered by these algebraic points. In spite of this fact, the logarithmic curve possesses the extraordinary property of not containing any of these algebraic points, except only $n=1$ and $l=0$. With this exception, all points of the curve must have at least one co-ordinate which is an irrational of the transcendental type; the curve finds its way through this complicated maze of points without hitting more than once a point whose co-ordinates are both algebraic. "How would Pythagoras celebrate such a discovery," exclaims Felix Klein, "if the ordinary irrational seemed to him worthy of a hecatomb!"

Change of Base.—The change of logarithms from one base to another is effected by a formula obtained as follows:

If $$n=b^l=b_1^{l_1},$$

then taking the logarithm to the base b gives

$$l\cdot\log_b b=l_1\cdot\log_b b_1.$$

Since $\log_b b=1$ we have $l=l_1\cdot\log_b b_1$ or

$$\log_b n=\log_{b_1} n\cdot\log_b b_1.$$

If we take $b=10$ and $b_1=e$, we obtain

$$\log_{10} n = \log_e n\cdot\log_{10} e,\quad\text{where}\quad \log_{10} e = 0{\cdot}434294481903 25\cdots$$

is a constant factor sometimes called the *modulus* of the common system of logarithms. For the special case when $n=b$, we obtain $1=\log_c{}^b\cdot\log_b{}^c$. Suppose that we know the common logarithm of 200 and we wish to compute the natural logarithm of 200. We have from the above

$$\log_e 200=\log_{10}200\div\log_{10}e=2{\cdot}30103\cdots\div 0{\cdot}43429\cdots = 5{\cdot}2983\cdots,$$

the natural logarithm of 200.

Logarithms of Complex Numbers.—If, in the equation $b^l=n$, b is a positive real number and l is either positive or negative, but real, then n must necessarily be positive, for a positive number raised to a power that is real, though either positive or negative, always yields a positive result as its principal value. Under these restrictions a negative number has no logarithm. This limitation causes no embarrassment in computation with logarithms, for we proceed as if all factors were positive. If the number of negative factors is odd, we mark the final result as negative. From the standpoint of theory, however, the failure of the elementary exposition to include the logarithm of negative numbers indicates a lack of generality. It is found that, as soon as we drop the limitation that l shall be real, and permit l to become imaginary or complex, any number n, whether positive or negative, or even complex, has not only one logarithm, but an infinite set of them. To establish this fact we make use of two well-known theorems in trigonometry. One theorem states that the periodicity of the sine and cosine functions is $2m\pi$, where m is any integer. The other theorem, due to Cotes and Euler, is expressed by the formula

$$e^{i\theta}=\cos\theta+i\sin\theta \tag{4}$$

where $i=\sqrt{-1}$ and θ is any angle measured in radians. Accordingly we obtain,

$$e^{i\theta}=\cos\theta+i\sin\theta=\cos(\theta+2m\pi)+i\sin(\theta+2m\pi)=e^{i\theta+2im\pi}.$$

Suppose now that $n=p+iq$, and $l=c+id$, where p, q, c, d are real numbers; then, taking for simplicity e as the base of the system of logarithms, we obtain

$$p+iq=e^{c+id}=e^c \cdot e^{id}=e^c(\cos d+i\sin d). \tag{5}$$

Equating the real numbers and also the imaginary numbers we obtain the numerical relations

$$p=e^c \cdot \cos d, \qquad q=e^c \cdot \sin d.$$

Allowing for periodicity, we obtain from (5) the more general equation

$$p+iq=e^c[\cos(d+2m\pi)+i\sin(d+2m\pi)]=e^{c+i(d+2m\pi)}, \tag{6}$$

and
$$\log_e(p+iq)=c+i(d+2m\pi). \tag{7}$$

If we write $z=p+iq$ and $\rho=\sqrt{(p^2+q^2)}$, then $\log\rho=c$ and we obtain formula (7) in the form

$$\log_e z=\log_e\rho+i(d+2m\pi). \tag{8}$$

As formula (7) is a general expression which is true for every integral value of m, we see that the number of logarithms of $z=p+iq$ is infinite. Let us consider some special cases. To find the logarithm of a negative number, say -1, we take $n=-1$, $p=-1$, $q=0$, and obtain from formula (6) $c=0$, and

$$\cos(d+2m\pi)=-1,$$

therefore $d=\pi$, and finally from formula (7),

$$\log_e(-1)=i\pi(1+2m)=i\pi,\ 3i\pi,\ 5i\pi, \text{ etc.}$$

That is, the natural logarithm of -1 has, in this more general theory, an infinite number of logarithms, all imaginary. In the case of i, we find

$$\log_e i=i\left(\frac{\pi}{2}+2m\pi\right)=\frac{i\pi}{2},\ \frac{5i\pi}{2},\ \frac{9i\pi}{2}, \text{ etc.}$$

Similarly, for the logarithm of e, we obtain

$$\log_e e=1+2im\pi=1,\ 1+2i\pi,\ 1+4i\pi, \text{ etc.}$$

That is, e has one real logarithm, namely 1, all the others are imaginary. Note that the integer m may take also negative values.

The conclusion reached is that in this more general treatment of logarithmic theory, every number has an infinite set of logarithms which are all imaginary except when the number n is positive, in which case there is one real logarithm to the base e which is the same as the natural logarithm obtained by the more restricted theory.

"Gaussian" Logarithms.—When $\log_{10}a$ and $\log_{10}b$ are known, there is often great need of a process for finding $\log_{10}(a+b)$ and $\log_{10}(a-b)$, without making it necessary to pass from $\log a$ and $\log b$ to a and b. To achieve this expeditiously the Italian physicist Zecchini Leonelli in 1803 suggested a new type of tables. A five-place table of this type was published in 1812 by Karl Friedrich Gauss; hence the name "Gaussian logarithms." Six-place tables of this kind are due to Karl Bremiker, to Siegmund Gundelfinger and to George W. Jones. A seven-place table was brought out by T. Wittstein. Leonelli and Gauss used a table consisting of three columns of figures, which Gauss marked by the letters A, B, C. Gauss lets $A=\log x$, $B=\log\left(1+\frac{1}{x}\right)$, $C=\log(1+x)$, where x is a number greater than 1. It is seen that $A+B=C$. The table is arranged according to positive values of A, increasing from 0 up to a point where B vanishes within the desired degree of approximation. If now $\log(a+b)$ is to be determined from $\log a$ and $\log b$, observe that, when $a>b$ and $\frac{a}{b}=x$,

$$\log(a+b)=\log a\left(1+\frac{b}{a}\right)=\log a\left(1+\frac{1}{\frac{a}{b}}\right)=\log a+B. \tag{9}$$

The computation proceeds as follows: Find A from the equation $\log a-\log b=A$; in the table find the B which corresponds to A; add B to $\log a$.

If $a<b$, simply interchange a and b, and take

$$\log(a+b)=\log b+B.$$

To find $\log(a-b)$ from $\log a$ and $\log b$, use column B or C, according as $\log a-\log b$ is greater or less than $\log 2$. If it is greater, take $\log a-\log b=B$; here $\frac{a}{b}=1+\frac{1}{x}$, $\frac{1}{x}=\frac{a}{b}-1$; hence

$$\log(a-b)=\log b\left(\frac{a}{b}-1\right)=\log b-A. \tag{10}$$

In computing, find the A which in the table corresponds to B; subtract A from $\log b$.

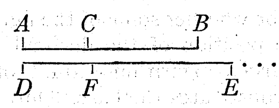
When $\log a-\log b$ is less than $\log 2$, put $\log a-\log b=C$; then $\frac{a}{b}=1+x$, $x=\frac{a}{b}-1$, and

$$\log(a-b)=\log b\left(\frac{a}{b}-1\right)=\log b+A. \tag{11}$$

In the table find the A which corresponds to C; add A to $\log b$.

Since the time of Gauss, logarithmic addition and subtraction tables have been rearranged in several different ways, by Zech and others. Some writers increase the number of columns while others reduce the number of columns to two. No agreement has yet been reached as to what arrangement is the best.

History of Logarithms.—Logarithms were invented independently by John Napier, a Scotsman, and by Joost Bürgi, a Swiss. The logarithms which they invented differed from each other and from the common and natural logarithms now in use. Napier's logarithms were published at Edinburgh in 1614 under the title, *Mirifici logarithmorum canonis descriptio.* When, in 1620, Bürgi's logarithms appeared at Prague under the title *Arithmetische und Geometrische Progresstabulen*, Napier's logarithms were already known and admired quite generally throughout Europe. To modern readers Napier's logarithms are a great curiosity, because of their singular properties and their strange mode of derivation. His theory and mode of computation are fully set forth in a second book, his *Mirifici logarithmorum canonis constructio*, which appeared in 1619, two years after his death. This book was translated into English in 1889 by W. R. Macdonald. Napier invoked kinematic notions in the development of his theory. One point moves along the line segment AB with a velocity decreasing so that when at any point C,



its velocity is proportional to the remaining distance CB. A second point starts at the same time and with the same initial velocity, moving on the unlimited line DE with uniform velocity. Then, by definition, if C and F are simultaneous positions of the two points, *DF is the logarithm of CB.* The successive distances DF, taken at equal intervals of time, yield an arithmetical series whose terms are increasing; the corresponding distances CB yield a geometric series whose terms are decreasing. In the translation of these kinematic concepts into numbers Napier begins by taking the distance $AB=10^7$, and the distance AC passed over during the first small time-interval equal to 1. Clever devices are employed for the computation of the two series. His object was to simplify trigonometric computation. Hence his book of 1614 is not what is ordinarily called a table of logarithms of numbers, but a table of logarithmic sines which can be used also as a table of the other trigonometric functions. Since $\sin 90°$ is of frequent occurrence in computation, he thought it most convenient to take its logarithm to be zero. But $\sin 90°$ is equal to the radius of the circle which he assumed to be 10^7. Hence the logarithm of 10^7 was taken to be zero.

It is of interest to develop a formula expressing the relation between Napier's logarithms of 1614 and the modern natural logarithms. If $AB=a=10^7$, $DF=x$ and $CB=y$, then $AC=a-y$. The velocity of the point C at any moment is $\frac{d(a-y)}{dt}=y.$

Integrating, we obtain $-\log_e y=t+c$, where c is a constant of integration. To determine this constant, assume the initial conditions of motion to be $t=0$ and $y=a$; substituting these values, $c=-\log_e a$. The uniform motion of the point F on the second line yields $\frac{dx}{dt}=a$ as its velocity. Consequently $x=at$, the constant of integration being zero in this case. Substituting for t and c their values, $-\log_e y=\frac{x}{a}-\log_e a$, observing that $a=10^7$ and $-\log y=\log\frac{1}{y}$, and remembering that, by Napier's definition of a logarithm, $x=\text{Nap.}\log y$, we have

$$\text{Nap.}\log y=10^7\log_e\frac{10^7}{y}\cdot \qquad (12)$$

Assuming the properties of natural logarithms, the various properties of the logarithms of Napier may be deduced from this compact formula. We see that Napier's logarithms increase as the numbers y decrease, that $y=10^7$ has the logarithm 0, and that a number y larger than 10^7 has a negative logarithm. We see also that, in Napier's system, the logarithm of a product xy of two numbers is not equal to the sum of the logarithms of the numbers x and y. How is it possible to use such numbers in computation? The answer is that according to the custom of the time, trigonometric computation was carried on by the aid of proportions, such as $\sin A:\sin C=a:c$. An unknown term $\sin A$, is found by two operations, one a multiplication and the other a division. For these two operations combined, Napier's logarithms give correct results. In other words, in his system the relation holds, $\log\sin A-\log\sin C=\log a-\log c$. Since Napier in 1614 did not take the logarithm of 1 to be 0, his logarithms, unmodified, *do not admit of a base, i.e.*, the relation of a number to its logarithm cannot be expressed by the equation $b^l=n$.

Bürgi's Logarithms.—Bürgi's publication of 1620 is in arrangement a table of antilogarithms. The logarithms are printed in red and the numbers in black. His explanation of his logarithms, under the title of the "gründliche Unterricht" was intended to be published with the tables but was finally omitted, probably to reduce the cost of publication; it was not printed until 1856 (*Archiv für Mathematik und Physik*, vol. 26, 1856, p. 316–334). Doubt has existed whether the numbers in his tables were intended to be integers or whether some of the figures form decimal fractions. Upon the position of the decimal point hinges the question whether Bürgi's logarithms admit of a base and, if they do, what value constitutes the base. Only recently has this question been cleared up. In the "gründliche Unterricht" (*loc. cit.* p. 322) Bürgi states that he takes 0 to be the logarithm of 1, but is indefinite on some other points. From his tables we copy the following pairs of corresponding numbers:

Red	0	10	20	...
Black	100000000	100010000	100020001	...

The upper line is an arithmetic series, the lower a geometric series having the ratio 1·0001. Since 0 is the logarithm of 1, it is evident that the last eight figures of the numbers in black must be looked upon as decimals. This raises the question, Is this the case also with the numbers in red integers? In the Danzig copy of the *Progresstabulen* there is on the title page a red number marked $23027\overset{\circ}{0}022$ and below it is the black number 1000000000. The little circle placed over one of the zeros in the red number is Bürgi's decimal separatrix, so that this number means in our notation 230270·022. But the Danzig title page contains certain figures clearly entered later by hand and at first it was thought that this little circle was also hand written. Against this interpretation goes the fact that the shape of this circle is very regular, such as probably would not be the case if drawn by hand. Later the Munich copy of the *Progresstabulen*, which is the only other copy known, was examined. It shows the same little circle, regular in shape, but none of the hand entries found in the Danzig copy. It is clear, therefore, that we have here a number in red with the decimal place carefully marked by a printed symbol. The conclusion is then, as pointed out by Dr. O. Mautz of Basle, that 230270·022 is the logarithm of 1000000000 divided by 100000000; *i.e.*, the logarithm of 10. A little computation reveals that this statement is equivalent to making 10 the logarithm of 1·0001. Hence the red numbers 10, 20, ··· which we quoted from Bürgi's tables are integers. The two series, one arithmetic, the other geometric, upon which Bürgi based his system are therefore as follows:

Red	0	10	20	...
Black	1·00000000	1·00010000	1·00020001	...

If 10 is the logarithm of 1·0001, it follows at once that the base of Bürgi's logarithms is $\sqrt[10]{(1\cdot0001)}=1\cdot000009999\cdots$.

But Bürgi did not have the concept of a logarithmic base any more than had Napier. Neither of them started out from the relation $b^l=n$. The possibility of defining logarithms as exponents was recognized by John Wallis in 1685 and by Johann Bernoulli in 1694, but not until 1742 do we find a systematic exposition of logarithms, based on this idea. It is given in the introduction to Gardiner's *Tables of Logarithms* and is due to William Jones. Bürgi started out with the comparison of arithmetic and geometric series, which indicates clearly that when inventing his logarithms he adopted the point of view taken before him by Michael Stifel and other algebraists for the purpose of illustrating the addition of exponents in multiplication, and the subtraction of exponents in division.

Invention of Common Logarithms.—The invention of the common system of logarithms is due to the combined effort of Napier and Henry Briggs. The share taken by each is described by Briggs in his *Arithmetica logarithmica*, 1624: "I myself, when expounding this doctrine publicly in London to my auditors in Gresham college, remarked that it would be much more convenient that zero should be kept for the logarithm of the whole sine (as in the *Canon mirificus*) but that the logarithm of the tenth part of the same whole sine, that is to say, 5 degrees 44 minutes and 21 seconds should be 10000000000. And concerning that matter I wrote immediately to the author himself; and as soon as the season of the year and the vacation of my public duties of instruction permitted I journeyed to Edinburgh, where, being most hospitably received by him, I lingered for a whole month. But as we talked over the change in the logarithms he said that he had for some time been of the same opinion and had wished to accomplish it; he had however published those he had already prepared until he could construct more convenient ones, if his affairs and his health would admit of it. But he was of the opinion that the change should be effected in this manner, that 0 should be the logarithm of unity and 10000000000 that of the whole sine; which I could not but admit was by far the most convenient. So, rejecting those which I had previously prepared, I began at his exhortation to meditate seriously about the calculation of these logarithms." This statement contains all the information that has been handed down on the part taken by the two mathematicians in the invention of common logarithms. Briggs's and Napier's suggestions, described in this passage, do not quite yield the common logarithms. If R is the radius, Briggs's suggestion was that $\log R=0$ and $\log\frac{R}{10}=10^{10}$. Napier's improved suggestion was $\log 1=0$ and $\log R=10^{10}$. It was a later change, nowhere specifically described, which replaced $\log R=10^{10}$ by $\log 10=1$. Briggs began his computing of tables by extracting the square root of 10 fifty-four times in succession and at each step dividing the logarithm by 2. Thus $\log\sqrt{10}=\log 3\cdot162\cdots=0\cdot5$; $\log\sqrt[4]{10}=\log 1\cdot778\cdots=0\cdot25$; etc. His publication of 1624 contained the logarithms to 14 places of the numbers 1 to 20,000 and from 90,000 to 100,000. The gap 20,000 to 90,000 was filled up by Adrian Vlacq, a Dutch bookseller then residing in London, who in 1628 published tables from 1 to 100,000. Tables of common logarithms of trigonometric functions were first published by Edmund Gunter in 1620; more extensive ones, computed in part by Briggs and completed by Henry Gellibrand, were published by Vlacq at his own expense. The word "characteristic" as used in the theory of logarithms first occurs in

Briggs's tables of 1624; the word "mantissa" was introduced by John Wallis in his *Algebra* of 1693 (p. 41).

Origin of Natural Logarithms.—Natural logarithms first arose as more or less accidental variations of Napier's original logarithms. Their real significance in analysis was not recognized until later. The earliest natural logarithms occur in the 1618 edition of Edward Wright's translation into English of Napier's *Descriptio*, where in an anonymous appendix, very probably written by William Oughtred, there is a small table containing logarithms of 72 sines, used in a process of interpolation. The latter are natural logarithms with the decimal point omitted. Thus, log 10 is given as 230254. where the natural logarithm of 10 is 2·30254. In the 1622 edition of John Speidell's *New Logarithms* there is included a table of logarithms of the numbers 1–1,000; except for the omission of the decimal point, these are natural logarithms. The earliest table to appear after the importance of natural logarithms in analysis was generally understood was published more than a century later, in 1770, by Johann Heinrich Lambert, an Alsatian. He included a seven-place table of natural logarithms of the numbers 1–100 in his *Zusätze zu den Logarithmischen und Trigonometrischen Tabellen.* The most elaborate natural logarithmic tables are those of the Dutch lieutenant of artillery, Wolfram, which give natural logarithms of practically all numbers from 1 to 10,000, to 48 decimal places. They were published in 1778 in J. C. Schulze's *Sammlung*.

Controversies About Logarithms of Complex Numbers.—The history of this subject affords an interesting example of how able intellects may for a long time grope hopelessly in the dark but through persistent effort may finally reach general, consistent, and elegant results. In 1712 and 1713 G. W. Leibniz and Johann Bernoulli discussed in their correspondence the question whether negative numbers have logarithms. Leibniz contended that since a positive logarithm corresponds to a number larger than unity and a negative logarithm to a positive number less than unity, the logarithm of -1 was not really true, but imaginary (non-existent); hence the ratio $-1 \div 1$, having no logarithm, is itself imaginary. Bernoulli maintained that -1 has a logarithm, since $dx : x = -dx : -x$, and, integrating, $\log x = \log(-x)$. Thus x and $-x$ have the same logarithm. A second discussion of this question took place in a correspondence between Johann Bernoulli and Leonhard Euler in the years 1727–31. Euler uncovered the inconsistencies of Bernoulli's conclusion that $\log x = \log(-x)$ and also of views which he himself had entertained. Somewhat later, Euler exchanged letters with D'Alembert on this topic and disproved the latter's contention that $\log(-1) = 0$. About 1747 Euler succeeded in creating a consistent theory of logarithms of negative and complex numbers, but D'Alembert advanced arguments against it, metaphysical, analytical, and geometrical in nature, which shrouded the subject in a dense haze and helped to prolong the controversy to the beginning of the 19th century. Euler published in 1749 an article *De la controverse entre Mrs. Leibnitz et Bernoulli sur les logarithmes, négatifs et imaginaires* which gives the modern results that $\log n$ has an infinite number of values, which are all imaginary, except when n is a positive number, in which case one logarithm out of this infinite number is real. These conclusions were so novel and the theory of imaginary numbers in algebra was so little understood that in his day Euler's theory was not understood, nor generally accepted as valid. In the early part of the 19th century the general theory of logarithms was elaborated, and Euler's results were confirmed by Martin Ohm, John Graves, John Warren, A. J. H. Vincent, Augustus De Morgan, William R. Hamilton and others.

Methods of Computing Logarithmic Tables.—For the computation of logarithms numerous processes were devised by Napier, Briggs, James Gregory, Abraham Sharp and others. Nicolas Mercator in 1668 derived the infinite series

$$\log(1+x) = x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \cdots$$

which though convergent for $-1 < x \overline{\gtrless} 1$, is worthless for practical computation on account of its slow convergence. John Wallis in 1695 deduced from it the rapidly convergent series

$$\tfrac{1}{2}\log\frac{1+z}{1-z} = z + \tfrac{1}{3}z^3 + \tfrac{1}{5}z^5 + \cdots$$

and G. F. Vega in his *Thesaurus* of 1794 let $z = 1/(2y^2 - 1)$ and obtained expressions converging rapidly.

Bibliography.—For details on the modern technique of logarithmic computation and for lists of leading publications of logarithmic tables, *see* the *Napier Tercentenary Memorial Volume* (1915), the *Encyclopédie des sciences mathématiques*, I. (1908) 23, "Tables de logarithmes"; D'Ocagne, *Le Calcul simplifié* (1905). For a bibliography of logarithmic tables consult J. W. L. Glaisher, report of the committee on mathematical tables, published in the *Report of the British Association for the Advancement of Science for 1873*, pp. 1–175. Among recent noted publications of logarithmic tables are the following: A 10-place table of logarithms of numbers to 100,000, in 1910; also an 8-place table to 200,000, and trigonometric tables to every sexagesimal second, by J. Bauschinger and J. Peters; a 14-place table of logarithms of sines and tangents to every 10 sexagesimal seconds, in 1911, by H. Andoyer of Paris. On the history of logarithms consult recent histories of mathematics, also *The Napier Tercentenary Memorial Volume*, edited by C. G. Knott (1915). (F. Ca.)

LOGAU, FRIEDRICH, Freiherr von (1604–1655), German epigrammatist, was born at Brockut, near Nimptsch, in Silesia, in June 1604. He entered the service of the duke of Brieg, and in 1644 was made "ducal councillor." He died at Liegnitz on July 24, 1655. Logau's epigrams, which appeared in two collections under the pseudonym "Salomon von Golaw" (an anagram of his real name) in 1638 (*Erstes Hundert Teutscher Reimensprüche*) and in 1654 (*Deutscher Sinngedichte drei Tausend*), show great range and variety of expression. He satirized the court life, the useless bloodshed of the Thirty Years' War, the lack of national pride in the German people, and their slavish imitation of the French in customs, dress and speech. He belonged to the *Fruchtbringende Gesellschaft* under the name *Der Verkleinernde*, and regarded himself as a follower of Martin Opitz; but he did not allow such ties to influence his independence.

Logau's *Sinngedichte* were edited in 1759 by G. E. Lessing and K. W. Ramler, who first drew attention to their merits. A critical edition by G. Eitner (1872), who also edited a selection of Logau's epigrams for the *Deutsche Dichter des XVII. Jahrhunderts* (vol. iii., 1870). *See* H. Denker, *Beiträge zur literarischen Würdigung Logaus* (1889); W. Heuschkel, *Untersuchungen über Ramlers und Lessings Bearbeitung Logauscher Sinngedichte* (1901); P. Hempel, *Die Kunst Friedrichs von Logau*, Berlin (1917).

LOGGERHEAD (*Caretta caretta*), a carnivorous marine turtle, inhabiting tropical seas. (*See* Turtle.)

LOGGIA, a room, gallery or hall open to the air on one or more sides.

LOGIA, a title used to describe a collection of the sayings of Jesus Christ (λόγια Ἰησοῦ) and therefore generally applied to the "Sayings of Jesus" discovered in Egypt by B. P. Grenfell and A. S. Hunt. There is some question as to whether the term is rightly used for this purpose. It does not occur in the Papyri in this sense. Each "saying" is introduced by the phrase "Jesus says" (λέγει) and the collection is described in the introductory words of the 1903 series as λόγοι not as λόγια. Some justification for the employment of the term is found in early Christian literature. Several writers speak of the λόγια τοῦ κυρίου or τὰ κυριακὰ λόγια, *i.e.*, oracles of (or concerning) the Lord. Polycarp, for instance, speaks of "those who pervert the oracles of the Lord" (Philipp. 7), and Papias, as Eusebius tells us, wrote a work with the title "Expositions of the Oracles of the Lord." The expression has been variously interpreted. It need mean no more than narratives of (or concerning) the Lord; on the other hand, the phrase is capable of a much more definite meaning, and there are many scholars who hold that it refers to a document which contained a collection of the sayings of Jesus, and which is believed to be the source or the principal source of the teachings of Jesus found in Matthew and Luke but not in Mark.

"The Sayings."—These fragments, to which the term Logia is also applied, consist of (*a*) a papyrus leaf containing seven or eight sayings of Jesus discovered in 1897, (*b*) a second leaf containing five more sayings discovered in 1903, (*c*) two fragments of unknown Gospels, the former published in 1903, the latter in 1907. All these were found amongst the great mass of papyri acquired by the Egyptian Exploration Fund from the ruins of Oxyrhynchus, one of the chief early Christian centres in Egypt, situated some 120 m. S. of Cairo. The 8 sayings discovered in 1897 may be translated as follows:—

1. ". . . and then shalt thou see clearly to cast out the mote that is in thy brother's eye."

2. "Jesus saith, Except ye fast to the world, ye shall in no wise find the kingdom of God; and except ye make the sabbath a real sabbath, ye shall not see the Father."

3. "Jesus saith, I stood in the midst of the world and in the flesh was I seen of them, and I found all men drunken, and none found I athirst among them, and my soul grieveth over the sons of men, because they are blind in their heart, and see not. . . ."

4. ". . . poverty . . . ."

5. "Jesus saith, Wherever there are two, they are not without God, and wherever there is one alone, I say, I am with him. Raise the stone and there thou shalt find me, cleave the wood and there am I."

6. "Jesus saith, A prophet is not acceptable in his own country, neither doth a physician work cures upon them that know him."

7. "Jesus saith, A city built upon the top of a high hill and stablished can neither fall nor be hid."

8. "Jesus saith, Thou hearest with one ear [but the other ear hast thou closed]."

The "sayings" of 1903 are as follows:—

1. "Jesus saith, Let not him who seeks . . cease until he finds and when he finds he shall be astonished; astonished he shall reach the kingdom and having reached the kingdom he shall rest."

2. "Jesus saith (ye ask? who are those) that draw us (to the kingdom if) the kingdom is in Heaven? . . . the fowls of the air and all beasts that are under the earth or upon the earth and the fishes of the sea (these are they which draw) you and the kingdom of Heaven is within you and whosoever shall know himself shall find it. (Strive therefore?) to know yourselves and ye shall be aware that ye are the sons of the (Almighty?) Father; (and?) ye shall know that ye are in (the city of God?) and ye are (the city?)."

3. "Jesus saith, A man shall not hesitate . . . to ask concerning his place (in the kingdom. Ye shall know) that many that are first shall be last and the last first and (they shall have eternal life?)."

4. "Jesus saith, Everything that is not before thy face and that which is hidden from thee shall be revealed to thee. For there is nothing hidden which shall not be made manifest nor buried which shall not be raised."

5. "His disciples question him and say, How shall we fast and how shall we (pray?) . . . and what (commandment) shall we keep . . . Jesus saith . . . do not . . . of truth . . . blessed is he . . . ."

First Gospel Fragment.—The fragment of a lost Gospel which was discovered in 1903 contained originally about fifty lines, but many of them have perished and others are undecipherable. The translation, as far as it can be made out, is as follows:—

1–7. "(Take no thought) from morning until even nor from evening until morning either for your food what ye shall eat or for your raiment what ye shall put on. 7–13. Ye are far better than the lilies which grow but spin not. Having one garment what do ye (lack)? . . . 13–15. Who could add to your stature? 15–16. He himself will give you your garment. 17–23. His disciples say unto him, When wilt thou be manifest unto us and when shall we see thee? He saith, When ye shall be stripped and not be ashamed . . . 41–46. He said, The key of knowledge ye hid: ye entered not in yourselves, and to them that were entering in, ye opened not."

Second Gospel Fragment.—The second Gospel fragment discovered in 1907 "consists of a single vellum leaf, practically complete except at one of the lower corners and here most of the lacunae admit of a satisfactory solution." The translation is as follows:—

. . . before he does wrong makes all manner of subtle excuse. But give heed lest ye also suffer the same things as they: for the evil doers among men receive their reward not among the living only, but also await punishment and much torment. And he took them and brought them into the very place of purification and was walking in the temple. And a certain Pharisee, a chief priest, whose name was Levi, met them and said to the Saviour, Who gave thee leave to walk in this place of purification, and to see these holy vessels when thou hast not washed nor yet have thy disciples bathed their feet? But defiled thou hast walked in this temple, which is a pure place, wherein no other man walks except he has washed himself and changed his garments, neither does he venture to see these holy vessels. And the Saviour straightway stood still with his disciples and answered him, Art thou then, being here in the temple, clean? He saith unto him, I am clean; for I washed in the pool of David and having descended by one staircase, I ascended by another and I put on white and clean garments, and then I came and looked upon these holy vessels. The Saviour answered and said unto him, Woe ye blind, who see not. Thou hast washed in these running waters wherein dogs and swine have been cast night and day and hast cleansed and wiped the outside skin which also the harlots and flute-girls anoint and wash and wipe and beautify for the lust of men; but within they are full of scorpions and all wickedness. But I and my disciples who thou sayest have not bathed have been dipped in the waters of eternal life which come from . . . . But woe unto the . . . .

Probable Date of the "Sayings."—These documents have naturally excited considerable interest and raised many questions. The papyri of the "sayings" date from the 3rd century and most scholars agree that the "sayings" themselves go back to the 2nd. The year A.D. 140 is generally assigned as the *terminus ad quem.* There is a considerable diversity of judgment, however, with regard to the value of the collection. (*a*) Some scholars maintain that the collection goes back to the 1st century and represents one of the earliest attempts to construct an account of the teaching of Jesus. They are therefore disposed to admit to a greater or less extent and with widely varying degrees of confidence the presence of genuine elements in the new matter. (*b*) Sanday and many others regard the sayings as originating early in the 2nd century and think that, though not "directly dependent on the Canonical Gospels," they have "their origin under conditions of thought which these Gospels had created." The "sayings" must be regarded as expansions of the true tradition, and little value is therefore to be attached to the new material.

With the knowledge at our disposal, it is impossible to reach an assured conclusion between these two views. The real problem, to which at present no solution has been found, is to account for the new material in the "sayings." There seems to be no motive sufficient to explain the additions that have been made to the text of the Gospels. It cannot be proved that the expansions have been made in the interests of any sect or heresy. Unless new discoveries provide the clue, or some reasonable explanation can otherwise be found, there seems to be no reason why we should not regard the "sayings" as containing material which ought to be taken into account in the critical study of the teaching of Jesus.

Date of the Gospel Fragments.—The 1903 Gospel fragment is so mutilated in many of its parts that it is difficult to decide upon its character and value. It appears to be earlier than 150, and to be taken from a Gospel which followed more or less closely the version of the teaching of Jesus given by Matthew and Luke. The second Gospel fragment (1907) seems to be of later origin than the documents already mentioned. Grenfell and Hunt date the Gospel, from which it is an excerpt, about 200. There is considerable difficulty with regard to some of the details. The statement that an ordinary Jew was required to wash and change his clothes before visiting the inner court of the temple is quite unsupported by any other evidence. Nothing is known about "the place of purification" nor "the pool of David." Nor does the statement that "the sacred vessels" were visible from the place where Jesus was standing seem at all probable. But if the inaccuracy of the fragment in this important respect is admitted the historical character of the whole episode breaks down and it is probably to be regarded as an apocryphal elaboration of Matt. xv. 1–20 and Mark vii. 1–23.

See the *Oxyrhynchus Papyri,* part i. (1897), part iv. (1904), part v. (1908). (H. T. A.; X.)

LOGIC is the systematic study of the general conditions of valid inference. There are other conceptions of the scope of logic. The principal rival conceptions are opposite in character. One view would limit logic to the study of what is sometimes called formal logic and sometimes deductive logic. This view finds favour among mathematically-minded writers who wish to bring logic and mathematics into intimate connection. But while there is room for a border science between the two (*see* LOGISTIC) there is no good reason for excluding from the scope of logic any of the main types of reasoning. On the contrary, there are obvious advantages in including in one systematic study a comprehensive survey of all the main types of inference. The only other view that need be considered goes to the opposite extreme and would include under logic the psychology of thinking and the theory of knowledge. The thorough study of logic certainly requires attention to both psychological and epistemological problems. But that is a different thing from fusing them all together. This is only too likely to end in confusion, and to lead to the neglect of the properly logical problems. The tendency now under consideration is natural enough when regard is had to the historical unity of philosophy, and its resistance to differentiation into separate studies. There are still philosophers of the old school who look upon this differentiation with as much disapproval as some British statesmen of the old school feel about the increasing autonomy of various parts of the British empire. But since both psychology and theory of knowledge are now recognized as well established, autonomous disciplines, it would be sheer waste of space and time to discuss their special problems all over again under the heading of logic. The scope of logic, then, as here conceived, is that indicated in the opening sentence of this article. But in order to understand that definition or description of logic, it is necessary to understand the terms employed in the opening statement. Let us begin with the term "inference," which retains in logic much of its etymological meaning.

Inference, Judgment, Proposition, Belief, Knowledge.—*Inference* is the act or process of deriving one judgment or proposition from another or from others. The judgment or proposition so derived is also called an inference; and for the most part we shall use the term inference in this more concrete sense, that is, as meaning a derived judgment or proposition. By a "proposition" is here meant a judgment expressed in words, the judgment itself being the actual thought or belief in the mind, which may or may not be expressed in a proposition, though we cannot discuss it until it is so expressed. But this needs further elucidation. All beliefs and all knowledge consist of judgments. For our present purpose the term *belief* is wider than, and includes the term *knowledge.* All knowledge is belief; but not all belief is knowledge. In ordinary usage it would probably be denied that knowledge is belief. But that is not quite correct. In ordinary usage the term "belief" is restricted to *what we do not know but still accept as true.* This identification of *belief* with what may more correctly be called *mere belief* is awkward. For, strictly speaking, if we can believe even what we do not know for certain, we most surely believe what we do know. So that all knowledge is belief, though there is also a *mere belief* of what cannot claim to be knowledge, that is, *adequately justified belief.* In the sense explained, then, judgment may be identified with belief, with all that we know for certain, or think as more or less probable, or merely believe without any evidence worth speaking about. But what exactly is judgment?

Judgment is essentially a process of intellectual orientation. Life is only possible by continuous adjustment to surroundings, and therefore requires that living beings should take their bearings so as to adapt their actions to their environment. At the lower levels of life the orientation is rather blind and merely instructive, though never merely mechanical. The method pursued is that of "trial and error," which frequently leads to improved adaptation. In this way even the lowliest organisms learn from experience. At the human level, however, a new form of orientation emerges. It is intellectual; it consists of judgments. Intellectual orientation is, to begin with, a new instrument in the struggle for existence. It is an enormous improvement on its predecessor in the extent to which it enables man to learn from past experience, not only from his own experience but also from that of others. For it is more articulate, more clear-sighted. Situations already experienced, and successful methods of dealing with them when once discovered, are retained in the form of ideas which are helpful in new situations of the same type. The connections between things and events are not merely felt vaguely, as at the lower levels of life, but are apprehended more or less closely, and are frequently articulated in general ideas or laws of interconnection. These can then be applied to imaginary as well as to real cases. So there arise purely imaginary experiments, as distinguished from actual experiments, by the method of trial and error. The biological advantage of such imaginary experiments is obvious in all cases in which actual experiments are beset with danger. In course of time intellectual interests extend beyond the pressing needs of the moment. The order and connections of natural phenomena are studied in a spirit of disinterestedness, and thereby render possible an orientation that is characterized by greater depth of insight, and an enormously increased range of foresight. And all this intellectual work consists of judgments interconnected by "why" and "wherefore," "because" and "therefore," which constitute inference or reasoning. It is the main business of logic to trace the principal types of inference and the general conditions of their validity.

Some judgments, then, namely inferences, are derived. What about those from which they are derived or inferred? They also may be inferred from others, but sooner or later, of course, we must come to judgments which are not inferred from others. How are they obtained? Well, they are immediate judgments either of perception or of intuition. That is to say, they are the outcome either of sense-perception or of that kind of intellectual intuition by which we apprehend so-called self-evident truths. It is sometimes rather difficult to say whether a given judgment is immediate or inferred. With advance in the power of analysis and discrimination it may be seen readily that many judgments which are commonly considered to be perpetual or self-evident are really inferences, at least in part. Still, the difficulties are not, as a rule, insurmountable. But what is of special interest at present is that logic is mainly concerned with inferred judgments, and with others only in so far as they furnish a basis for inference. The nature and reliability of immediate judgments as such constitute problems which belong partly to psychology and partly to the theory of knowledge. Logic is the study of inferences, not of all kinds of beliefs.

Having explained the term inference, we must next consider what is meant by *valid* inference in the definition of logic from which we started. It means, of course, the same as *accurate, correct, sound.* But it must not be treated as synonymous with *true.* An inference is *valid* when it is justified by the evidence given in support of it. It is *true* if it expresses the facts as they are. Now careful reasoners generally aim at inferences which shall be both correct and true. But an inference may be either without the other. For example, speculators sometimes make inferences which turn out to be true although they were not really valid, that is, were not justified by the available evidence. On the other hand, propositions are sometimes refuted by a mode of reasoning commonly known as "reduction to absurdity," that is, by showing that a valid inference drawn from it is untrue. Now logic is the study of *valid* inference, not *true* inference. This is not because logic is not interested in truth, for its own function is to explain the *true* conditions of valid inference. It is simply a case of that division of labour which necessity has forced upon all the sciences. The study of the conditions of *valid* inference means the study of the general relations between inferences and premises. This is a sufficiently important task by itself. The study of the conditions of *true* inference would mean, in addition, an investigation into the truth of all possible premises—an obviously impossible task.

The Main Types of Inference or Implication.—It is obvious that one judgment can be *inferred* from another or others only when the other judgment or judgments *imply* it. Inferability and implication are, in fact, only different aspects of the same rational situation, in which judgments are so interconnected that some imply others which are thus inferable from them. Inference only makes explicit what is latent in implication. Now the judgments which imply the inference or conclusion are usually called the evidence or the premises. Sometimes the evidence consists of formulated propositions; sometimes it consists of facts of observation. This distinction is not a hard and fast one, because, on the one hand, "facts" only become evidence when they give rise to judgments, which can always be expressed in propositions; and, on the other hand, all judgments are in the last resort based on facts. But the distinction is a convenient one in some ways. There are cases in which the question of objective fact, in the usual sense of the term, does not arise.

For example, every State has its laws, which are in a sense the arbitrary (though not capricious) decisions or enactments of the legislature, and so are, in many ways, different in different states. The judges who have to administer these laws have to treat them as authoritative and final for the time being. They only have to understand them and their full implications, and to apply them to relevant cases. It is not their business to check the truth of these laws in the way in which it *is* the business of a man of science to check the truth of what are currently accepted as laws of nature. So that there are cases in which inference or reasoning is mainly concerned with the meaning and implication of certain propositions or premises, and not with the facts (if any) from which they derive. Such inference or reasoning may be called *formal,* or *deductive,* in the rather wide and loose sense of these terms that has become traditional. On the other hand, inference or reasoning which sets out from facts of observation without relying in a special degree on propositions accepted either on authority, or even provisionally for the sake of argument, may be called *inductive, material* or *empirical,* again in the loose traditional sense of these terms. As the term "deductive" is needed for another purpose, the former type of inference will be described here as *formal;* and the latter type will be called *inductive,* which is the least unsatisfactory of the traditional terms. It should be noted at once, however, that whereas *formal* reasoning can often be carried far without the intervention of inductive reasoning (or simply "induction"), induction can rarely go far without the auxiliary use of formal inference at certain stages, such as the verification of tentative hypotheses, for instance. Again, inductive reasoning constitutes what is widely known as *scientific method.* As a mere matter of convenience inductive inference will be dealt with under the heading of Scientific Method, while this article will deal mainly with formal inference, and with one or two other special types of inference.

Now the study of formal inference, as already explained, is essentially a study of the implications of propositions. For this purpose it is necessary to ascertain the main types of proposition, their several meanings and implications. This part of logic is known as the study of *immediate inference.* But under certain circumstances, which will be explained in due course, two or more propositions may, between them, imply something over and above the implications which each of them has separately, something that is not even the mere sum of their several implications. The study of these implications is known as the study of *mediate inferences.* These are the two principal divisions of formal inferences, and each of them contains a number of varieties, which we shall presently describe and explain. But before doing so it will be necessary to deal first with the ultimate assumptions or postulates of logic. These are really ultimate assumptions of reason, without which there would be no such thing as reasoning, or at least no distinction between valid and invalid reasoning. It is the business of logic to formulate them explicitly.

Ultimate Postulates of Logic.—In all reasoning (as distinguished from dogmatic assertion, *e.g.*) some proposition is asserted to be justified by some other proposition or propositions, called the evidence. Dismissing those cases in which one verbal expression is substituted for another with which it is synonymous, and which do not constitute real reasoning, one proposition can only be justified or implied by another or by others in so far as the contents of the propositions are connected in some definite way—in other words, in so far as the facts to which the propositions in question refer stand in certain connections. It is the belief in, or the knowledge of, such objective connections among natural events or objects that constitutes in the last resort the basis of all reasoning or inference. Such objective connections cannot, strictly speaking, be proved, although they are commonly assumed to exist as a matter of course. But in a study like logic it is necessary to state explicitly every assumption that is necessary for its very existence. Accordingly, we may formulate as the first postulate of logic the assumption that *there are connections among the events and objects of the real world.* If the world were not, to some extent at least, an orderly cosmos, if things just happened by chance or anyhow, there could be no genuine reasoning, and consequently no logic. This assumption may be described briefly as *the postulate of cosmic connectedness.*

Another postulate is what is known as the *principle of the uniformity of nature,* which postulates that the connections among the events and objects of the world are uniform in character. In other words, phenomena of the same kind exhibit the same kind of objective connections. From the point of view of logic this postulate is of importance as the basis of what the writer has called the *principle of the uniformity of reasons,* namely, *whatever is regarded as a sufficient reason in any one case must be regarded as a sufficient reason in all cases of the same type,* or expressed negatively, *nothing can be regarded as a sufficient reason in any one case unless it can also be regarded as a sufficient reason in all cases of that kind.* This principle is of special importance in connection with inductive inference, inasmuch as it formulates the logical basis of generalization. But it is also of importance in connection with the study of formal inference, for it is the basis of our derivation of the general rules of formal inference from an inspection of the form of inference in particular cases.

Two other postulates required for formal inference are known as the *law of contradiction* and the *law of excluded middle.* The law of contradiction is to the effect that the same predicate cannot be both affirmed and denied of the same subject—*S cannot both be P and not be P.* The law of excluded middle postulates that a given predicate must be either affirmed or denied of a given subject—*S must either be P or not be P.* Since "not to be P" is the same as "to be non-P" (that is, something other than P), the two laws may also be expressed respectively in the following formulae—*S cannot be both P and* $\overline{P}$, and *S must be either P or* $\overline{P}$ (when $\overline{\mathrm{P}}$=non-P).

IMMEDIATE INFERENCE

We have now to consider *the main types of propositions,* their meanings, and their implications. It has already been stated that a proposition is the verbal expression of judgment, and that a judgment is what one thinks, believes, or knows. For purposes of formal logic it is convenient sometimes to use the term proposition not only for the expressed content of what is actually believed, but also for any suggestion that may be believed or disbelieved, or merely understood and considered. Now there are three principal types of proposition which must be considered, namely, categorical, hypothetical and disjunctive (or alternative) propositions. A *categorical proposition* is one in which something is asserted unconditionally. It has the form *S is* (or *is not*) *P.* An *hypothetical proposition* is one which expresses an antecedent (or condition) and a consequent. Its general form is *If A, then C.* A *disjunctive proposition* is one which expresses alternatives. Its general form is *either A or B.* Categorical propositions usually contain two terms, namely, a subject (*S*) and a predicate (*P*), though there are simple forms (the so-called impersonals) which consist of one term only (the predicate). Hypothetical and disjunctive propositions contain three or four terms, or even more. But it is better to think of their component propositions rather than of their component terms. In the above forms, *A,B,C,* stand for such propositions, not for terms; e.g., "*If a triangle is equilateral* (*A*), then *it is equiangular* (*C*)"; "either *a line is straight* (*A*), or *it is curved* (*B*)." By substituting symbols for actual terms we obtain the *form,* that is the *type,* of the proposition in question. That, in fact, is the simplest way of getting at the various *kinds* of propositions; but, of course, it must be borne in mind that in actual reasoning real terms are always employed, for a propositional form is not an actual proposition, just as, in algebra, x, y, z are not actual things or even numbers, but are only devices for dealing with numbers in the most general way possible.

There are important differences between the categorical, hypothetical and disjunctive types of proposition. The categorical type is that employed when we want to assert a mere brute fact without wishing to suggest that there is any inner connection between the terms of the proposition. The hypothetical type, on the other hand, is just specially designed to express the thought that there is a connection between the antecedent and the consequent. And the disjunctive type is the most suitable one for expressing alternative possibilities, one or other of which is true, though it is not known which one is true. At the same time, these differences of function need not be exaggerated, and it is usually possible to express what is essentially the same thought in any one of the three types, as the following may serve to illustrate. *Equilateral triangles are equiangular. If a triangle is equilateral, it is equiangular. Either a triangle is equiangular or it is not equilateral.* So, generally, *SM is P=if S is M it is P=either S is P or it is not M.* In view of what has just been said and illustrated, it may be remarked that all the essentials of formal inference may be learned by a close study of categorical propositions alone in the first instance. There is no difficulty in applying to hypothetical and disjunctive arguments what has been found to hold good of categorical arguments. And these are easier to get on with at first. We shall, accordingly, confine ourselves for the present to categorical propositions and inferences.

The Quality and Quantity of Categorical Propositions.—Propositions are either affirmative or negative. These are known as differences of quality. And they are either universal or particular, that is to say, they assert something either of the whole of the subject term explicitly, or of some indefinite part of it. These are known as differences of quantity. If the two kinds of distinctions are combined in one scheme, we obtain four types of categorical proposition, the forms of which are as follows:—*Every S is P* (universal affirmative); *no S is P* (universal negative); *some S*'s *are P* (particular affirmative); *some S*'s *are not P* (particular negative). The following are examples of the several types: "Every equilateral triangle is equiangular"; "no equilateral triangle is right-angled"; "some stars are self-luminous"; "some planets are not self-luminous." In this classification of propositions the class universal propositions includes singular propositions (that is, those whose subject is a singular term) like a proper noun, for example, as well as general propositions (that is, those which have a general term, like a common noun, *e.g.*, and assert something about the whole class or kind of object or event which it is the name of). The above four types of categorical proposition are commonly called *A,E, I,O,* respectively. *A* and *I* are the vowels of "affirm," the first being used for the universal, the second for the particular, affirmative; *E* and *O,* the vowels of "nego" (Latin for *I deny*), are similarly used for the universal and the particular negative. By using the corresponding small letters to express the quality and quantity of propositions, the above formulae of the four types of categoricals can be expressed respectively as follows: *SaP; SeP; SiP; SoP.* This is a convenient symbolic method which can be used for all formal inference with great advantage.

The next thing to observe in connection with these four types of proposition is what is called the *distribution of terms* in each of them. A term is said to be distributed in a proposition when reference is made explicitly to the whole range or class of objects, etc., which the term denotes; otherwise it is said to be undistributed. Thus in *SeP* (no *S* whatever is any *P* whatever) both *S* and *P* are distributed. In *SaP* (every *S* is *P* but nothing is stated about *every P*) *S* is distributed, but *P* is not. In *SiP* (some *S*'s are *P,* nothing definite is said about all *S*'s or all *P*'s) neither *S* nor *P* is distributed. In *SoP* (some *S*'s are not any *P* whatsoever) *S* is not distributed, but *P* is. Briefly, universal propositions (*A,E*) distribute their subjects and negative propositions (*E,O*) distribute their predicates.

It is a *general rule of all formal reasoning* that no term may be distributed in the conclusion unless it is distributed in the premise or premises. For, otherwise, the conclusion would go beyond the evidence. A great many cases of invalid inference are due to a breach of this rule; and some of the most important rules of valid inference are meant to be safeguards against such a breach. Hence the importance of becoming familiar with these few points about the distribution of terms in propositions. There is no objection at all to not distributing in the conclusion a term that is distributed in the premises. Just as the maxim against extravagance does not demand that people should spend the whole of their income, but only that they should keep within it, so this rule only requires that people should not go beyond the evidence; it does not require them to exhaust the whole of it when it is unnecessary.

Opposition and Eduction.—The doctrine of immediate inference, as already remarked above, is concerned with the implications of single or isolated propositions, as distinguished from the joint implications of two or more propositions taken together. It has two main parts. One part, known as the doctrine of opposition, deals with the implications of each type of proposition in relation to others having precisely the same subject and the same predicate, but differing in quality or quantity. The other part, known as the doctrine of eductions, deals with the implications of each type of proposition in relation to others having not the same subject and the same predicate but the same terms or their contradictories. In other words, "opposition" is concerned with the relations between *SaP, SeP, SiP, SoP,* whereas "eduction" is concerned with the relations between propositions of the types $S\text{-}P$, $S\text{-}\bar{P}$, $P\text{-}S$, $P\text{-}\bar{S}$, $\bar{P}\text{-}S$, $\bar{P}\text{-}\bar{S}$, $\bar{S}\text{-}P$, $\bar{S}\text{-}\bar{P}$. These relationships look more complicated than they really are, and can be determined with comparative ease with the aid of the laws of contradiction and excluded middle, and the rule relating to the distribution of terms just explained.

Opposition.—Given *SaP, SeP* and *SoP* must both be false, otherwise, all or some *S*'s would both be *P* and not be *P,* which would violate the law of contradiction; but *SiP* must be true, as the *some S*'s must be included in *"every S"* of *SaP.* Again, given *SeP, SaP* and *SiP* must be false, otherwise all or some *S*'s would both not be and be *P,* which is against the law of contradiction; the *SoP* must be true, because its *"some S*'s" are included in all the *S*'s of which *P* is denied in *SeP.* Next, *SiP* excludes *SeP,* otherwise *"some S*'s" would both be and not be *P,* in violation of the law of contradiction; but it throws no light on *SaP, SoP,* either of which (though not both at once of course) might be true or false, when *SiP* is true, without offending against any law of thought or rule of inference. Lastly, *SoP* excludes *SaP,* otherwise *"some S*'s" would both not be and be *P,* against the law of contradiction; but it has no implication in relation to *SeP* or *SiP,* either of which (though not both) might be true or false when *SoP* is true.

To complete the study of the interrelations between these propositional types, let us consider next the implications of the *rejection* of any one of them. So far we have only considered the implications of the acceptance of any one of them. To reject *SaP* is to maintain that *not every S is P,* that is, that it is wrong to say of one or more *S*'s at least that they are *P.* But if so, then by the law of excluded middle it must be right to say of the one or more *S*'s in question that they are not *P,* or *SoP.* Thus the rejection or falsity of *SaP* implies the acceptance or truth of *SoP.* On the other hand, *SiP* and *SeP* are not affected by it; either (though not both of course) might be true or false, if *SaP* be untrue. Similarly, to reject *SeP* is to maintain that it is wrong to say of every *S* that it is not *P,* that is, that there are one or more *S*'s of which it should not be said that they are not *P.* If so, then by the law of excluded middle it must be right to say of the one or more *S*'s in question that they are *P,* or *SiP.* Thus the falsity of *SeP* implies the truth of *SiP.* But it does not affect *SoP* or *SaP,* either of which (but not both) might be true or false when *SeP* is untrue. Next, to reject *SiP* is to maintain that it is incorrect to say of even one *S* that it is *P* (for *some S*'s are *P* means "one *S* at least is *P*"). If so, then by the law of excluded middle it must be right to say of every *S* that it is not *P*, or *SeP*, which, as has already been seen, implies *SoP*. Thus the falsity of *SiP* implies the truth of both *SeP* and *SoP*, each of which, as was already shown above, excludes the truth of *SaP*, by the law of contradiction. Similarly, the falsity of *SoP* implies the truth of both *SaP* and *SiP*. For to reject *SoP* is to maintain that it cannot be said of even one *S* that it is not *P*. Hence, by the law of excluded middle, it must be said of every *S* that it is *P* or *SaP*, which implies *SiP*, and each of these implies the falsity of *SeP*.

Of the foregoing relationships the most important are those known by the special names of *contrariety* and *contradiction*. Two propositions are called *contraries* when both cannot be true at the same time, but both may be false. *SaP* and *SeP* are related in this way, as the above account shows. Again two propositions are called *contradictories* when both cannot be true at the same time, but also not false at the same time, in other words, when one of them must be true and the others false. From the above account it will be seen that *SaP* and *SoP* are related in this way, also *SeP* and *SiP*. Two propositions are also contrary when they affirm contrary predicates, like "white" and "black" of the same subject; and contradictory when they affirm contradictory predicates, like "white" and "non-white," of the same subject. It should be noted that *SiP* and *SoP*, which are commonly called *sub-contraries*, are related in a manner which is the precise reverse of that between contraries, for both can be true, and one of them must be true.

Eductions.—Given a proposition having for its terms *S-P* it always implies some proposition having for its terms $S\text{-}\bar{P}$, which is called its *obverse*. Thus *SaP*, in virtue of the law of contradiction, implies $Se\bar{P}$; since *S* cannot be both *P* and $\bar{P}$, the *S*'s which are *P* are not $\bar{P}$. Similarly, *SiP* implies *SoP*. Again, *SeP* implies $Sa\bar{P}$, in virtue of the law of extended middle; since *S* must be either *P* or $\bar{P}$, the *S*'s that are not *P* must be $\bar{P}$. Similarly *SoP* implies $Si\bar{P}$. It should be noted that in each case if the obverse is obverted the original proposition is obtained. Thus $Se\bar{P}$ implies, in virtue of the law of excluded middle, *SaP*, and so with the rest. Again, given a proposition having for its terms *S-P* it sometimes (but not always) implies a proposition having for its terms *P-S*, which is called its *converse*. Thus *SeP* implies *PeS*, for it asserts the mutual exclusion of *S* and *P*, and it makes no essential difference whether, looking at the relation from the point of view of *S*, we say *SeP* or, looking at it from the point of view of *P*, we say *PeS*.

Similarly *SiP* implies *PiS*, for it expresses the fact that some things are both *S* and *P* (*SP*), and it makes no essential difference whether these things are described as some *S*'s that are *P* or as some *P*'s that are *S*'s. *SaP* likewise expresses the fact that some things are both *S* and *P*, but whereas it tells us that these include every *S* it does not say that they include every *P*. Hence it implies *PiS*, not *PaS*. To make *SaP* imply *PaS* would violate the above-mentioned rule about the distribution of terms, for *P* is not distributed in the premise *SaP*, but is distributed in *PaS*. In other words, *SaP* may be true even when *PaS* is not true, that is, when *PoS* is true (*e.g.*, "All Englishmen are British subjects" but not "All British subjects are Englishmen," for "Some British subjects are not Englishmen"). Lastly, *SoP* has no converse, for in *PoS* the term *S* would be distributed, and it is not distributed in *SoP*; in other words *PaS* may be true at the same time as *SoP* (*e.g.*, "Some British subjects are not Englishmen," yet "All Englishmen are British subjects," so that it would not be true to say that "Some Englishmen are not British subjects"). In the case of the converse, as in the case of the obverse, we get no further forward if we take the converse of the converse. It only brings us back to the original proposition or to something less. Thus the converse of *PeS* is *SeP*, of *PiS* it is *SiP*, even where the original was *SaP*.

The obverse and the converse are the fundamental types of eduction, but by combining obversion and conversion (that is by applying them alternately, beginning with obversion and going on to conversion, and so on alternately, or beginning with conversion and going on to obversion and so on alternately), certain derivation eductions are obtainable. The following table sets out all the eductions and shows how they are obtained. The arrow $\rightarrow$ means "implies," "(o)" means "by obversion," "(c)" "by conversion."

$$
\begin{array}{ll}
SaP & \nearrow \text{(o) } Se\bar{P} \rightarrow \text{(c) } \bar{P}eS \rightarrow \text{(o) } \bar{P}a\bar{S} \rightarrow \text{(c) } \bar{S}i\bar{P} \rightarrow \text{(o) } \bar{S}oP. \\
 & \searrow \text{(c) } PiS \rightarrow \text{(o) } Po\bar{S}. \\
SeP & \nearrow \text{(o) } Sa\bar{P} \rightarrow \text{(c) } \bar{P}iS \rightarrow \text{(o) } \bar{P}o\bar{S}. \\
 & \searrow \text{(c) } PeS \rightarrow \text{(o) } Pa\bar{S} \rightarrow \text{(c) } \bar{S}iP \rightarrow \text{(o) } \bar{S}o\bar{P}. \\
SiP & \nearrow \text{(o) } So\bar{P}. \\
 & \searrow \text{(c) } PiS \rightarrow \text{(o) } Po\bar{S}. \\
\multicolumn{2}{l}{SoP \rightarrow \text{(o) } Si\bar{P} \rightarrow \text{(c) } \bar{P}iS \rightarrow \text{(o) } \bar{P}o\bar{S}.}
\end{array}
$$

All the eductions have special names which may just be mentioned here. Assuming that the terms of the original proposition are *S-P*, the *obverse* has the terms $S\text{-}\bar{P}$; the *converse* has *P-S*; the *obverted converse* has $P\text{-}\bar{S}$; the *converted obverse* or *contraposition* has $\bar{P}\text{-}S$; the *obverted contraposition* has $\bar{P}\text{-}\bar{S}$; the *inverse* has $\bar{S}\text{-}P$; the *obverted inverse* $\bar{S}\text{-}\bar{P}$.

There are some other types of immediate inference of which only one need be mentioned here as it is fairly common. A proposition containing a relative term in the predicate implies a *correlative* proposition. Thus "*S* is north of *P*" implies "*P* is south of *S*"; "*S* is the parent of *P*" implies "*P* is the child of *S*." Symbolically, *S is RP* implies *P is* Я *S*, when *R* and Я represent correlative terms.

MEDIATE INFERENCE

We have to consider now what kind of conclusions can be inferred from two or more propositions jointly that could not be inferred from any of them singly. Now two or more propositions with entirely different terms cannot between them imply more than the bare sum of their several implications. When, however, two propositions have one term in common, then the common term may mediate between the two other terms, so as to establish a relationship that could not be inferred from either proposition alone. It is such mediation of a common term between two other terms that constitutes the essence of mediate inference. Given the relationship of each of two terms to the same third term, it is possible, under certain conditions, to infer their relation to one another. Symbolically, given the relation of *S* to *M* and of *P* to *M*, it may be possible to infer the relation of *S* to *P*. The common or mediating term is called the *middle term;* the term which becomes the subject of the conclusion is called the *minor term;* the term which becomes the predicate of the conclusion is called the *major term*. The proposition which contains the minor term and middle term is called the *minor premise;* the other premise, containing the major term and the middle term, is called the *major premise*. The middle term does not occur in the conclusion, only in the premises. Thus in the following schematic mediate argument, *M is P, S is M,* therefore *S is P,* the symbols *S,M,P,* represent respectively the minor, middle and major terms, *M is P* represents the major premise, *S is M* represents the minor premise, and *S is P* represents the conclusion. Mediate inferences vary greatly in complexity. We propose to begin with the simplest type, and proceed by degrees to the more complex types. In the first instance we shall confine our account to mediate inferences consisting of categorical propositions only, leaving the others for subsequent treatment.

Mediate Inferences with Singular Terms.—Let us begin with an example of the simplest type of mediate inference. The story of the following incident will serve our purpose. At an "At Home" given by a French countess, Cardinal X. was among the early callers, and in reply to a sympathetic reference made by his hostess, to his varied and anxious experiences, remarked that he had started his clerical career rather ominously, for the very first person who confessed to him had confessed a murder. Later in the afternoon, while the cardinal was at the far end of the drawing room, Count S. called, and the hostess expressed a wish to introduce him to Cardinal X. Thereupon the count said no introduction was necessary, as he had known his holiness many years already. "In fact," said the count, "I was the very first person to confess to him." The consternation of the hostess may be imagined. Here, the conclusion that Count S. had confessed a murder is obvious. It is not implied in either of the two statements separately. It could not possibly be inferred from the cardinal's statement by itself, nor from the count's statement by itself, else neither would have said what he did. But it can be inferred from the two statements when combined, for the simple reason that in the two separate statements the two terms "a person who confessed a murder" and "Count S." are each identified with the same third (or middle) term, "the very first person who confessed to Cardinal X." They must, therefore, be identical with each other, that is, they must refer to the same person, and so the inference is that "Count S. is a person who had confessed a murder." *M is P, S is M,* therefore *S is P. S* being identical with *M,* they are really different descriptions of the same thing, and so if it was possible for *S* not to be *P,* then the same thing (called indifferently *S* or *M*) would be *P* according to the first premise, and would not be *P* if the suggested conclusion were rejected; but this would be against the law of contradiction. In the above case both premises were affirmative, and the conclusion was affirmative.

Suppose, next, that one of the premises is negative and one affirmative, say, *M is not P, S is M* (or *M is P, S is not M*). So long as we are dealing with singular terms and with relations of identity, such premises will imply the negative conclusion *S is not P.* For in such cases the two premises between them say that the two terms, *S* and *P,* are related in opposed ways to the same middle term, *M,* one of them (no matter which) affirming a relationship of identity, the other denying it (and so asserting a relationship of difference). Consequently, the two terms, *S* and *P,* must be different from each other, in other words, *S is not P.* In this case, as in the previous one, the rejection of this conclusion would violate the law of contradiction. Lastly, suppose both premises are negative, *M is not P* and *S is not M.* In this case no inference can be drawn, for we are only told that *S* and *P* are both different from *M,* and their common difference from *M* is compatible with either identity or difference between *S* and *P.*

The foregoing results hold good also when the relationship between the singular terms of a mediate argument is not one of identity, but some other *transitive relation.* A transitive relationship is such that if it holds good between one term and another, and also between this other and a third, then it holds good between the first and third terms. Identity is one such relationship, equality is another, "less than," "greater than," "parallel with," "brother of," "sister of" are other transitive relationships. All such cases can be expressed in the formula *M r P, S r M,* therefore *S r P,* when *r* stands for the affirmative of a transitive relation. In all such cases, too, when both premises are negative, no inference is justified. But the cases are rather variable when one premise is affirmative and the other is negative. Some cases, such as those dealing with relations of equality or parallelism, are like those concerned with identity, and warrant a negative conclusion. It is different with other cases, and, unfortunately, no general rule can be laid down—one must use his common sense and his knowledge of the systems of relationship concerned in the cases which arise.

Besides transitive relations there are certain other relations which commonly occur in mediate inference, and which may be called *dovetail relations.* In these cases one premise asserts one kind of relationship, the other asserts a different relationship, and the conclusion asserts yet a third kind of relationship by dovetailing or integrating the other two; *e.g.,* "*M* is the wife of *P,*" "*S* is the brother of *M,*" therefore "*S* is the brother-in-law of *P*"; or again, "*M* is due south of *P,*" "*S* is due east of *M,*" therefore "*S* is south-east of *P.*" Such inferences likewise can only be made with safety if one is conversant with the system of relations involved. But the mediate character of the inferences is essentially the same in all the cases considered so far; and the system of relations most frequently concerned are such as people of ordinary intelligence are familiar with. A suitable formula for the last type of mediate inference would be $M\ r_1\ P$, $S\ r_2\ M$, therefore $S\ r_3\ P$.

Mediate Inference with General Middle Terms.—When the middle term is general instead of singular, certain complications arise which require special care. The middle term must be the same in the two premises. But the mere fact that the same general *name* occurs in two propositions does not necessarily mean that the same *things* are referred to. The things meant in the one proposition may not be the same as those referred to in the other, and in that case, although the two propositions have a common name occurring in them, they really have no middle term or mediating link. For example, the general term "British subjects" occurs in both propositions "All Englishmen are British subjects" and "All Australians are British subjects," but the "British subjects" are different in the two cases, and so the common term does not furnish a basis for mediate inference. Only when the common term is distributed in at least one of the two propositions have they really got a middle term in the strict sense. For in that case they are sure to have something in common. When the middle term is singular, it is distributed in any case; not so when it is general. Again, when the middle term is singular the conclusion can only be singular, but when it is general the conclusion may be general or only particular, according to circumstances. Here the general rule already mentioned must be applied—no term may be distributed in the conclusion unless it is distributed in its premise. And so the conclusion must not be general (only particular) unless the minor term is distributed in the minor premise. Moreover, in a negative conclusion the major term is distributed, and this, for the same reason, is only permissible when the major term is distributed in the major premise. So long as the terms are all singular they are all distributed in any case; but when they are general it is different, and these precautions must be borne in mind.

Now, the conditions of valid inference when the terms are all singular, apply also to the cases in which the terms are general, and for the same reasons. The latter cases, we have just seen, call for special precautions. As a matter of fact, however, these special precautions relating to the distribution of terms are actually satisfied (though without any special care on our part) in the case of mediate inference with singular terms. The following more comprehensive rules of mediate inference with general terms may accordingly be formulated as the *general rules of all mediate inferences:*—

1. There are three propositions, namely two premises and a conclusion.
2. There are three distinct terms, one of which (called the middle term) occurs in both premises, and the others occur one in each premise, while one of them (the minor term) is the subject of the conclusion, and the other (the major term) is the predicate of the conclusion.
3. The middle term must be distributed at least once.
4. No term may be distributed in the conclusion unless it is distributed in its premise—that is to say, the conclusion must not be general unless the minor term is distributed in the minor premise, and the conclusion must not be negative unless the major term is distributed in the major premise.
5. One premise, at least, must be affirmative; that is to say, no inference can be drawn from two irreducibly negative premises.
6. If both premises be affirmative, the conclusion (if any) can only be affirmative.
7. If one premise is negative, the conclusion (if any) can only be negative; and conversely, if there is to be a negative conclusion, one premise must be negative.

These rules are only an application of the law of contradiction and of the general rule about the distribution of terms to mediate inference, and a statement of the essential character of such inference. They can be abridged by applying directly the principles just mentioned; they can also be expanded by added corollaries deducible from them—namely, (i.) that no conclusion can be inferred from two particular premises, (ii.) that if one premise is particular, the conclusion can only be particular, and (iii.) that no conclusion can be inferred when the major premise is particular and the minor premise is negative. But in the form given above rules 3–7 are convenient and serviceable for testing the validity of most mediate inferences.

Mediate, Deductive and Syllogistic Inference.—The traditional use of these terms is confused, and it is desirable to suggest a consistent mode of applying them. The sense here associated with the term mediate inference has already been explained. The term "deductive inference" may, more or less in accordance with tradition, be defined as inference from general propositions. Syllogism is commonly conceived as inference which is at once mediate and deductive, and confined to propositions involving only the relation of substances and attributes. Yet deductive inference is somehow identified with syllogism. The result is inconsistency and confusion. There is no good reason why the inference of a singular or a particular proposition from a general proposition should not be described as deductive inference, although it is immediate inference. On the other hand, there is no reason why mediate inferences involving singular propositions only, should not be called syllogisms, although they are not deductive; in fact, the text-books do include them among syllogisms in spite of their inconsistent definitions of syllogism. Here it is proposed to use the term syllogism as synonymous with mediate inference, for that is just what syllogism literally suggests; "putting two and two together" is no far-fetched translation of the term. So understood, a syllogism need not be deductive, though it can be and often is. On the other hand, deduction need not be mediate, though it can be, and frequently is. "Syllogism" and "mediate inference" will, therefore, be used as synonymous here. As compared with "mediate inference," the term "syllogism" has the advantage of greater brevity, even if it suffers from misleading associations. In the light of what has just been said, there is no harm in calling the above-mentioned "general rules of mediate inference" also, "*general rules of the syllogism*." In what follows the term "syllogism" will be used in place of the term "mediate inference."

Figures and Moods of Syllogisms.—A syllogism, we have seen, has two premises—a major premise containing the middle and major terms (*M* and *P*), and a minor premise containing the middle and minor terms (*M* and *S*). Each premise might have either of its terms as subject and the other for its predicate—the major premise, that is to say, might be *M-P* or *P-M*, and the minor premise might be *M-S* or *S-M*. There are thus four possible arrangements of the terms in a syllogism:—

Major premise: *M-P, P-M, M-P, P-M*.
Minor premise: *S-M, S-M, M-S, M-S*.

The conclusion in each case is assumed to be *S-P*. The names of the terms and of the premises are based on this assumption. Now, these variations in the positions of the terms of a syllogism are called differences of *figure*. It will be seen that the above four arrangements of terms are the only possible ones, and they are known respectively as the *first, second, third* and *fourth figure*. The first arrangement is the most natural and most common. In it the term which becomes the subject of the conclusion is the subject of its premise, and the term which becomes the predicate of the conclusion is the predicate of its premise. In the fourth figure the arrangement of terms is just the reverse of what it is in the first. In the second figure the middle term is the predicate in both premises. In the third figure it is the subject in both premises. Each figure is obviously a kind of scheme or *schema* which might remain the same while the premises vary in quality and quantity. In considering the figures of syllogisms, we abstracted from, or ignored, differences in the quality and quantity of the component propositions and only attended to the positions of the terms. But the propositions have, of course, quality and quantity. And the differences in the quality and quantity of the propositions in a syllogism constitute what are known as the different *moods* of syllogisms. *Prima facie* each figure may have various moods. The first figure, *e.g.*, contains the moods *MaP, SaM*, therefore *SaP*, also *MeP, SaM*, therefore *SeP*, and so on. It is consequently desirable to determine how many valid moods there are in each figure. This may be done as follows:

From the point of view of their quality and quantity, there are four types of proposition, namely, *A, E, I, O*. Any one of these might conceivably be the major premise or the minor premise of a syllogism. There are, therefore, 16 conceivable combinations of premises, namely, *AA, AI, AE, AO, IA, II, IE, IO, EA, EI, EE, EO, OA, OI, OE, OO*—in these combinations the first letter represents the major, the second the minor, premise. By applying to these the general rules of the syllogism it will be seen that eight of the 16 combinations of premises cannot justify a conclusion in any figure. These eight are *EE, EO, OE, OO* (rules) *II, IO, OI, IE* (rule 3 or 4). Only the following eight are, therefore, likely to warrant a conclusion in some figure or other, namely, *AA, AI, AE, AO, IA, EA, EI, OA*. But we cannot tell what conclusion (if any) these will justify until we have examined them with reference to the scheme of each figure separately. For each symbol represents a different proposition in different figures. In Figure I., e.g., *AA* means *MaP, SaM*, and warrants conclusion *SaP;* in Figure IV. it means *PaM, MaS*, and warrants only a particular conclusion. By examining each of the eight surviving combinations of premises in the light of the schema of each of the four figures and of the general rules of the syllogism, it will be found that the valid moods in the four figures are as follows:

Valid moods in Figure I.: *AAA, AII, EAE, EIO*.
Valid moods in Figure II.: *AEE, AOO, EAE, EIO*.
Valid moods in Figure III.: *AAI, AII, IAI, EAE, EIO, OAO*.
Valid moods in Figure IV.: *AAI, AEE, IAI, EAO, EIO*.

In the above symbols the third represents the valid conclusion, the first and second represent the major premise and minor premise respectively. By comparing the valid moods in the same figure, its peculiarities may be noted. In Figure I., *e.g.*, the minor premise is always affirmative and the major is universal. In Figure II., one premise is negative (therefore also the conclusion) and the major is universal. In Figure III. the minor premise is affirmative and the conclusion is particular. Lastly, in Figure IV., when either premise is negative the major is universal; when the major premise is affirmative, the minor is universal; and when the minor premise is affirmative the conclusion is particular. These peculiarities are known as the *special rules* of each figure. The reasons for them can be discovered easily by examining the scheme of each figure in the light of the general rules of the syllogism. But let it be said at once that the validity of any syllogism can be tested by a direct application of the general rules of the syllogism, without troubling about the special rules of the several figures, and, indeed, without troubling about the figure or the mood of the argument at all.

Abridged and Concatenated Syllogisms.—Syllogisms are among the commonest, perhaps *the* commonest, types of argument. That some people do not seem to realize this fact can only be accounted for by certain misunderstandings or oversights which may now be indicated briefly. In the first place, text-books on logic generally set out the propositions of a syllogism in some uniform order. We, too, have adopted the order of major premise first, minor premise next and conclusion last. This is merely a matter of convenience—it saves the reader's time if he can recognize each proposition at a glance. In actual argument the sequence of propositions varies in all possible ways. It requires a little practice to recognize the character of the different propositions. The number of people who cannot readily distinguish between the conclusion of an argument and its premises is simply amazing. But a syllogistic argument is syllogistic, whatever the sequence of propositions may be, and whether it is known to be such or not. There are people who use syllogisms almost as commonly as the famous Frenchman used prose, but like him, without knowing it. In the second place, in actual discourse, it is a common thing to omit a proposition that is obviously implied. This habit is at once a time-saving device and a tribute due to the intelligence of our fellows. Consequently, it is uncommon for all the three propositions of a syllogism to be stated explicitly, though what is omitted is clearly assumed to be true. Lastly, it is usually impracticable to settle a problem by means of a single syllogism, though it is done sometimes. What happens mostly is that several syllogisms (each abridged) and other types of argument as well, are employed in the course of one complex argument; and it requires some training and insight to dismember such a complex argument into its various components.

We may now consider briefly the different ways in which syllogisms are abridged and linked together. An abridged syllogism is called an *enthymeme.* As there are three propositions in a syllogism, any one of which might be omitted, there are three kinds or orders of enthymeme, called enthymemes of the first, second or third order respectively, according as the major premise is omitted, or the minor premise or the conclusion. When the general truth involved has just been referred to, the major premise is usually omitted; when the facts, to which the general truth is applied, stare one in the face, the minor premise is usually left out; when the conclusion may seem offensive and a mere insinuation may suffice, the conclusion is frequently suppressed. In arguments not remarkable for their candour, that premise will be omitted which is most likely to be challenged if stated explicitly.

A chain of connected syllogisms is traditionally called a *polysyllogism* A chain of syllogisms is not a mere accumulation of separate syllogisms. The syllogisms must be linked together, each either supporting, or supported by, another. This happens when the conclusion of one syllogism is used as a premise of another. The supporting syllogism is known as the *pro-syllogism* in relation to the supported syllogism, and this is known as the *epi-syllogism* in relation to the former. If a chain of syllogisms is so arranged that the argument passes from supporting syllogism (or pro-syllogism) to supported syllogism (or epi-syllogism), the whole argument is called *epi-syllogistic,* or *progressive,* or *synthetic.* But if the sequence is in the reverse order, that is, from supported syllogism (epi-syllogism) to supporting syllogism (pro-syllogism), then the whole argument is said to be *pro-syllogistic* or *regressive* or *analytic.* Now the individual syllogisms in a chain of syllogisms are, for the most part, abridged in the way already explained above. But such a chain of abridged syllogisms is called a *sorites,* if it is progressive, or an *epicheirema,* if it is regressive. But usage in these matters is not uniform, and there is no particular virtue in these technical names. The really important thing is to be able to recognize the actual nature of a chain of syllogisms, to analyse them into the component syllogisms, and to test the validity of each of these in the light of the general rules of mediate inference. It should never be forgotten that the strength of a chain is only equal to that of its weakest link, for that holds good also of a chain of syllogisms, or of any other complex argument.

Hypothetical Syllogisms.—So far we have only considered categorical inferences, that is inferences or arguments in which all the propositions are categorical. Once these are mastered, there is no serious difficulty in applying the various lessons to arguments composed of other kinds of propositions *mutatis mutandis.* We must now devote some attention to these other kinds of arguments. We shall begin with hypothetical arguments. But in order to understand these it is necessary to have a clear grasp of the nature of hypothetical propositions, which have been already mentioned.

The objects about which we think vary enormously in respect of concreteness, or its opposite, abstractness. We may think of some particular individual, object or place; or we may think of a general law or formula. The term *concrete* (from Latin *concrescere,* to grow together), is applied to anything that is conceived as a coalescence of many qualities and relations. The term *abstract* (from Latin *abstrahere,* to withdraw, *i.e.,* for separate consideration) is, on the other hand, applied to any quality, or relation that is considered apart from the things or situations which it qualifies or connects. Now, propositions vary in many ways according as their terms are concrete or abstract. A proposition with a singular concrete term for subject cannot express as much knowledge as a general proposition can; and the most important discoveries of science are embodied in highly abstract propositions called laws. Again, one may predicate something of a subject without actually knowing in virtue of which of its qualities the predicate belongs to it—it is just an assertion of brute fact. On the other hand, there are assertions which specify the connection between one thing and another. Now assertions of brute fact are naturally expressed in the more concrete type of proposition, whereas assertions of connections are naturally expressed in the more abstract type of proposition. And, speaking broadly, the *categorical proposition* is the more concrete type suitable for the expression of concrete facts, brute facts, whereas the *hypothetical proposition* is the more abstract type suitable for the expression of general connections. The form of the hypothetical, as already stated, is *if A, then C,* when *A* represents an antecedent, or condition, and *C* represents a consequent, or result, and the proposition asserts a general connection between the antecedent and the consequent, without special reference to concrete cases.

To feel the difference between the two types one has only to compare the categorical proposition: "This triangle is equilateral and also equiangular" with the hypothetical proposition: "If a triangle is equilateral, it is equiangular." In daily use, it is true, the distinction is not always respected and hypothetical and categorical forms are often interchanged indiscriminately. Perhaps even the most abstract hypotheticals are only valued just because of their wide reference to real things, their applicability to an extensive range of facts. Still, there are such things as suppositions which, though based on facts, are merely speculative, and have no direct reference to actual instances. And such suppositions are best expressed in the hypothetical form of proposition.

The main feature, then, of the hypothetical proposition is the assertion of a connection between an antecedent (*A*) and a consequent (*C*)—*if A, then C.* But what exactly does this imply? It implies, first of all, that the antecedent (*A*) cannot be true without the consequent (*C*) being likewise true. In other words, if the consequent is not true, the antecedent cannot be true either—*if not C then not A.* It has already been pointed out above that *if A, then C* can be expressed also in the categorical form AaC, and a reference to the eductions will show that AaC implies $\bar{C}a\bar{A}$, which is the categorical equivalent of *if not C, then not A.* On the other hand, *if A, then C* does not imply *if C, then A,* for the consequent might be true even when the antecedent is not. The categorical equivalent of *if A, then C,* as just pointed out, *is* AaC, and this does *not* imply CaA, only CiA. Consequently, one may not infer the falsity of the consequent from that of the antecedent. In other words, *if A, then C* does not imply *if not A, then not C.* This also may be confirmed by reference to the eductions, which show that AaC does not imply $\bar{A}a\bar{C}$, only $\bar{A}i\bar{C}$. Briefly, then, *if A, then C* implies (1) whenever *A* is true *C* must be true, (2) whenever *C* is not true, *A* is not true. But it does *not* imply that (3) when *C* is true *A* must be true, nor that (4) when *A* is not true then *C* is not true.

Again, the antecedent and consequent of an hypothetical proposition consist of categorical propositions, and either or both may be affirmative or negative—*if A, then C=if S is M, Q is P* or *if S is not M, Q is not P,* etc. Now the main business of an hypothetical proposition is to *affirm* a connection between the antecedent and the consequent. If is, therefore, permissible to treat all hypotheticals as affirmative, which simplifies considerably the whole business of formal inferences from hypotheticals. The traditional method is to regard an hypothetical proposition as negative when the consequent is negative. There is no serious objection to this. If we follow the traditional scheme, the four kinds of hypotheticals corresponding to the four categoricals, SaP, SeP, SiP, SoP, are *if A, then C, if A, then not C, if A then sometimes C, if A, then sometimes not C.*

After the foregoing explanations there should be no serious difficulty in dealing with immediate or mediate inferences from hypothetical propositions. In either case, if it is found easier to do so, the hypothetical propositions can be restated in categorical form, and treated in the way already explained in connection with categorical inferences. It may be noted that an hypothetical syllogism is called *pure* when it consists of hypothetical propositions only, otherwise it is called *mixed.* An example of a pure hypothetical syllogism will elucidate some of the above remarks.

> "If a triangle is equiangular, it cannot be right-angled;
> If a triangle is equilateral, it is equiangular;
> ∴If a triangle is equilateral, it cannot be right-angled."

If B, then not C, *If A, then B,* *If A, then not C.*	Corresponding to the categorical syllogism.	*MeP,* *SaM,* ∴ *SeP.*

A *mixed hypothetical syllogism* has an hypothetical major premise and a categorical minor premise, and the conclusion is categorical. Considering the implications of an hypothetical proposition, as already explained above, it should be obvious that there are only two ways in which a conclusion can be inferred in this case, namely, the categorical minor must either affirm the antecedent, or deny the consequent of the major premise. In the first case the conclusion affirms the consequent, in the second case it denies the antecedent. These are the two principal types of mixed hypothetical syllogism, and are known respectively as *constructive* and *destructive.* The respective form of each is: *If A, then C, A,* ∴ *C;* and *If A, then C, not C,* ∴ *not A.*

All that has been said above about abridged and concentrated categorical syllogisms applies also to hypothetical syllogisms, and need not be repeated.

Disjunctive Syllogisms and the Dilemma.—Having dealt with categorical and hypothetical propositions and inferences, we must turn next to the disjunctive, or alternative, types. A disjunctive proposition asserts the truth of one of two or more alternatives without specifying which. Its form is *either A or B,* where *A* and *B* represent propositions, like the *A* and *C* of a hypothetical proposition. There are various circumstances which occasion the use of the disjunctive propositions; and these must be understood if we are to have an insight into the meaning and implications of the disjunctive type of proposition and argument. Sometimes they are based on a classification of certain things into classes and sub-classes, or *genera* and *species,* as these are usually called; *e.g.,* some people constitute the class known as "graduates of the University of London," which class (or *genus*) is subdivided into the species "internal" and "external." Now I may know that *S* is a graduate without knowing whether he is an internal graduate. In that case I might say that "*S* is either an internal or an external graduate of the University of London." As the *species* of the same *genus* are usually mutually exclusive, it is likely enough that in most cases of alternative propositions on classification it is intended not only that one of the alternatives shall be true but also that *only* one of them shall be true. But that is not always so. It is possible, *e.g,* for a graduate of the University of London to have taken one degree as an external candidate and another as an internal student. In any case these are instances in which the alternatives are not mutually exclusive. It is possible, for instance, to produce approximately similar results in several different ways. The volume of a gas can be reduced either by reducing its temperature or by increasing the pressure on it. When, therefore, I observe such a result I may assert that it was produced in one or other of these two ways, yet without intending to exclude the possibility of both methods having co-operated to produce the result in question. It would, therefore, be a mistake so to interpret disjunctive propositions as to make the alternatives always mutually exclusive. The term "disjunctive" rather suggests such an interpretation, and so might be replaced with advantage by the term "alternative."

It is always possible to express oneself in such a way as to employ only mutually exclusive alternatives; but this would entail a good deal of pedantry, from which logic has already suffered much too much. On the whole it is best, and most in harmony with daily usage, to say that this alternative type of proposition asserts the truth of *one* of its alternatives, but *not* necessarily of *one only.* In other words, the alternative proposition *either A or B* implies *if not A, then B,* and *if not B, then A,* but it does *not* imply *if A, then not B* nor *if B, then not A.* As no significance attaches to the order of the alternatives in a disjunctive proposition, the second statement as to what is implied and not implied by *either A or B* was really unnecessary. Disjunctive propositions are essentially affirmative. The alternatives may be negative or affirmative; but what the proposition always asserts is, that one of the alternatives is true. The propositional form *neither A nor B* (the contradictory of *either A or B*) is not disjunctive but categorical—it asserts unconditionally *A is not true* and *B is not true.* Quantitatively, alternative propositions, when correctly used, are always universal. Particular disjunctives, when used, are the result of ignorance of the remaining alternatives, and should be expressed in a number of categoricals. For example, "some triangles are either equilateral or scalene" only means "some triangles are equilateral" and "some triangles are scalene."

Now, considering the nature of disjunctive propositions it will be seen that two such propositions, even when they contain a common alternative, do not always warrant a mediate inference; *e.g., either A or B* and *either B or C* may be summed up in the statement *A or B or C;* but such a summary is not an inference—there is nothing here that mediates and disappears. The only approximation to mediate inference with two disjunctive premises is obtained when an alternative contained in one of the two premises is the contradictory of one contained in the other. The formula is, *either A or B, either not B or C,* ∴ *either A or C.* For example: "Either an article is produced on a large scale or it is expensive; and either it is in great demand or it is not produced on a large scale; therefore, either an article is in great demand or it is expensive." Apart from the minor considerations as to whether the alternatives are affirmative or negative, this is the only type of *pure disjunctive syllogisms,* or syllogisms consisting entirely of disjunctive propositions. But there is also a type of *mixed disjunctive syllogism* consisting of a disjunctive major premise, a categorical minor premise, and usually a categorical conclusion. In the light of what has already been said about the relation of the alternatives in a disjunctive proposition it will be evident that it is only possible to infer a mediate conclusion from a disjunctive major premise, by means of a categorical minor premise, when the latter denies one of the alternatives of the former. The formula accordingly is: *Either A or B; not A;* ∴ *B* (or *not B;* ∴ *A*). This is the only type of mixed disjunctive syllogism, if we ignore (as we may) the minor variations arising from differences in the sequence of the alternatives, and their quality.

The *dilemma* might be classed among mixed hypothetical syllogisms or among mixed disjunctive syllogisms, for it contains both an hypothetical premise and a disjunctive premise; but it is customary to class it by itself and to confine the names mixed hypothetical and mixed disjunctive syllogisms to those the minor premise of which is categorical. The dilemma has two hypothetical propositions for its major premise and a disjunctive proposition for its minor premise. A single hypothetical major premise would obviously afford no scope for a disjunctive minor premise. Like the mixed hypothetical syllogism, and for the same reasons, the dilemma has two main forms, namely, the *constructive* and the *destructive.* It is constructive if the minor premise posits alternatively the two antecedents of the hypothetical major premise; it is destructive if the minor premise denies alternatively the two consequents of the major premise. It is usual also to distinguish between *complex* and *simple* dilemmas, according as the major premise has two distinct antecedents and two distinct consequents, or only one consequent for both antecedents, or only one antecedent for both consequents. We therefore have four kinds of dilemma, of which the following are the symbolic schemes. *Complex constructive dilemma: If A, then B, and if C, then D; either A or C;* ∴ *either B or D. Complex destructive dilemma: if A, then B, and if C, then D; either not B or not D;* ∴ *either not A or not C. Simple constructive dilemma: If A or C, then D; either A or C;* ∴ *D. Simple destructive dilemma: If A, then both B and D; either not B or not D;* ∴ *not A.*

There is an impression abroad that the dilemma is a captious kind of argument not to be taken seriously. But that is erroneous. The dilemma is a difficult type of argument, because it is difficult to sum up a situation adequately in two alternatives; yet unless the alternatives are exhaustive the conclusion is not valid. Still, there are cases when the thing can be done, and then the dilemma is quite sound. The school habit of illustrating the dilemma by means of amusing sophistical instances, is really unjust to the dilemma, which is used also in perfectly serious and scientific arguments. When a dilemma is felt to be unsound, one should carefully scrutinize the alternatives, which in that case are sure to be incomplete, even if expressed in such an ambiguous manner as to appear to be exhaustive. This is the only satisfactory way of dealing with unsatisfactory dilemmas; the so-called *rebuttal* of a dilemma is as futile as it is pretentious.

It need only be pointed out now that what was said above about abridged and concentrated categorical syllogisms also applies to disjunctive syllogisms and to dilemmas.

Inductive and Formal Inference.—Formal inference, as has already been suggested, is such as can be carried out and tested by means of the various rules explained above, provided one understands the meaning and implications of the propositions used as premises. Not that it is merely a matter of language. Far from it. For propositions express thoughts, and thoughts have reference to reality. Life is too short and pressing to permit of long holidays from the actual. But, for reasons already given, formal inference takes its ultimate premises for granted and does not examine their origin or credentials. If, however, their origin be investigated, it will be found that some propositions derive from direct observation, some from intuition, some are inferences from other propositions, and some are inferences from observations. With the first two types of proposition logic is not concerned; the problems of the third type have now been dealt with in the main; the problems presented by the last are the special problems of induction, and are discussed fully under SCIENTIFIC METHOD, though a few words must be said here. Inductive inference can, of course, be described in general, and more or less formal, terms. And it can be shown to involve certain types of formal inference. This has led some to suppose that the so-called methods of induction are essentially syllogistic in character. But this is erroneous. Prompted by the principle of the uniformity of reasons, explained in the early part of this article, we always try to formulate the general *principle* of every type of reasoning, such as the principle that "things which are equal to the same thing are equal to one another," the *dictum de omni et nullo* (*q.v.*), and the various methods of induction (*see* SCIENTIFIC METHOD).

Such principles, however, are not premises of actual arguments of the type in question; they are only abstract formulations of the general type, and postulates of their validity. If such principles were to be treated as premises, then every actual syllogism could be shown to be a double syllogism, one as it actually is, and another with the principle for major premise, the two normal premises being combined as minor premise—and even then the general principle would still be assumed. In reality, the attempt to treat induction as merely a case of deduction, or of syllogism, is unwarranted. Inductive inference involves much more than that. It requires a familiarity with the facts investigated, and such an insight into them as cannot be formulated at all to any purpose, but which may yet prompt inferences which may be deemed sound in spite of certain shortcomings when gauged by the standards of purely formal inference. Induction is a more difficult business than syllogism or deduction, and calls for rarer gifts. It is true, of course, that when inductive inferences have been formulated and established, they place at our service new propositions which become the starting points of formal inferences whereby present and past events can be explained, or future events can be anticipated.

But the deductive application of inductions, though far from being easy or fool-proof (to judge from many coroners' inquests) is much simpler than reliable induction from observation. For one medical man who can make a new discovery there are more than ten thousand who can make none, but who may be trusted more or less to apply correctly the discoveries of others. It is not intended, of course, to underestimate the value of formal inference in general or of deduction in particular. Such inference is, as a matter of fact, very useful in connection with inductive investigations. What inductive research aims at is the discovery of propositions from which the observed phenomena under investigation might have been inferred formally. Such inferability of the facts, from the propositions established inductively, usually constitutes their explanation. That is why *induction* is frequently described as *inverse deduction* or as the *reverse of deduction*. It remains true, however, that induction is on a rather different footing from deduction, or syllogism, and cannot be dealt with satisfactorily in quite so formal a manner as formal inference can be.

Inference from Circumstantial Evidence.—There is a common kind of inference which is like inductive inference in so far as it is inference from facts of observation, rather than like formal inference from propositions, is a reverse process, and proceeds by way of hypotheses. But, unlike most inductive or scientific methods, it is not concerned with generalizations, only with a particular case at a time. It is known as *inference from circumstantial evidence*. Probably most of the criminal cases and other mysteries one reads of in the papers and in works of fiction are detected or solved by this method of inference. It is not, however, confined to such cases. Indeed, it is a common method of historical research, and it exemplifies in an especially striking manner a mode of inference which often goes hand in hand with other forms of inference, formal and inductive, without receiving due recognition for various reasons. But, first of all, what exactly is meant by *circumstantial evidence?* It means a special form of indirect evidence, as contrasted with direct evidence. It is evidence which does not seem to bear directly on the main problem, only on certain facts which may be said to *surround* the main event which needs explanation.

Let us consider, *e.g.,* the case of a crime. If the criminal is caught in the act, there is direct evidence of the most convincing character. Mostly, however, those who plan crimes take every precaution they can possibly think of not only against being caught red-handed, but against every kind of direct observation of their crime; so that direct evidence is extremely rare in such cases. However, there are in many instances, certain "circumstances" which betray the criminal. These "circumstances" are subsidiary events which are in some way connected with the principal event. What usually happens is that certain things or occurrences, suspected of having some bearing on the main event, are treated as clues, are followed up as far as possible, and are linked up hypothetically with certain other facts and events until they suggest an hypothesis about the identity of the criminal. A satisfactory hypothesis will show that many apparently disconnected objects and events are really parts of one drama. And, in the absence of sufficient counter-evidence, the hypothesis which gives the most coherent setting of the principal event under investigation will be regarded as true. Needless to say, in the case of such an hypothesis, as in the case of every other kind of hypothesis, no evidence that is unfavourable to it may be ignored. An arbitrary selection of circumstances may send innocent people to prison, or even to the gallows—as has happened more than once.

Inference from circumstantial evidence varies enormously in degrees of complexity. Some of the most familiar types of such inference are the processes of piecing together the parts of a picture puzzle, or of solving a cross-word puzzle. The solution takes the form of putting the parts together in such a way that they constitute a coherent whole or system. More elaborate instances are furnished by the innumerable attempts at historical reconstruction, which aim at so piecing together the available evidence that the events under investigation are seen as parts of a coherent political drama, etc. Such a task is much more difficult than piecing together a picture puzzle. If the two are to be compared at all, we must think of a picture puzzle of which many parts are missing, some are damaged, and some, perhaps, are faked. There is consequently far greater scope for the play of individual fancy and ingenuity.

Systematic and Linear Inference.—The most characteristic feature of inference from circumstantial evidence is its concrete systematic character. It is all concerned, in the first instance at all events, with a particular concrete system or whole. In the vast majority of cases the investigator does not seek to get beyond the reconstruction of such a particular concrete whole of events or parts. This is true not only of the investigator of crimes, but also of the historian of every kind of subject. There are cases, indeed, in which the investigator, after satisfying himself about the nature and working of one particular concrete system or organism, proceeds to generalize his discovery and to apply it to all systems or organisms of that kind; *e.g.*, Harvey, after discovering the system of the circulation of the blood by his observations and reasonings concerning one living body, rightly applied his discovery to all similar living organisms. Here the first and most important discovery was made by inference from circumstantial evidence relating to the interconnection between the various parts of the circulatory system—arteries, veins, valves, heart and lungs. The second step was an inductive generalization. Potentially any particular criminal or historical reconstruction by means of circumstantial evidence might be generalized in the same kind of way; but it would be a futile generalization because such cases are never found to repeat themselves with sufficient closeness to make such a generalization worth while. And, just as inference from circumstantial evidence may sometimes go hand in hand with inductive inference, so it may be found in conjunction with deductive or syllogistic inference. In fact, the process of inference from circumstantial evidence is commonly guided by the deductive application of certain general truths relevant to the case.

Implicitly, if not explicitly, the detective and the historian certainly make use of their previous knowledge of human nature in general, and of the habits and mentality of certain human types in particular, though all this is only secondary or auxiliary to the primary business of integrating or constructing the systematic whole. On the other hand, a great deal of deductive and inductive reasoning is carried on under the general influence of a certain system, or universe, which implicitly guides the selection of special points of attack, which might otherwise be arbitrary, and actually do appear to be arbitrary to those who are without this feeling of contact with the controlling system. It is this that helps to determine the selection of some aspects of things rather than others for inductive investigation, and the application of some general truths rather than others in deductive reasoning. But these things are very difficult to explain fruitfully in general terms, except to the initiated.

Considerations such as the foregoing have prompted some thinkers to insist that systematic inference is the only real type of inference, and that formal inference, especially syllogistic inference, which they describe as *linear,* is rather unreal. But that is a serious mistake. The fact is that inference always has both these aspects, the systematic and the linear, or, as I should prefer to call them, the concrete and the abstract; but in some cases the concrete or systematic aspect is predominant, while the abstract, linear, or general is secondary, whereas in other cases the reverse holds good. It is not always possible to draw a hard and fast line between the two varieties of reasoning, just because the difference is only one of degree. For instance, while discussing such very general types of inference as immediate inference and syllogistic inference, we found ourselves faced by the inference of correlative propositions and inference from dovetail relationships, which, just like inference from circumstantial evidence, involve a reference to certain systems, though in their case, each system could, if necessary, be described in general terms. It really depends very largely on circumstances whether an argument is confined to certain general problems, leaving the whole system of reference in the background or is extended further into the hinterland. It depends partly on the thinker's ideas about the various topics relevant to the problem under discussion, and partly on the extent to which these views of his are shared by the people to whom the argument is addressed, when it is addressed to others.

The greater the number of relevant topics on which the reasoner already entertains definite views, the simpler and more general or abstract will be the argument by which he endeavours to solve the immediate problem. Similarly, the wider the agreement about relevant topics between the parties to the argument, the simpler and more abstract or general will the argument be. On the other hand, the fewer the convictions on relevant topics, provided the thinker knows what these are, and is not simply enjoying the bliss of ignorance, the more system-building there will have to be. And the wider the differences on relevant topics between the parties to an argument, the more comprehensive and systematic must the discussion be. That is why an argument which is convincing to the members of one party or one school of thought, may seem quite unconvincing to those of another. And if the differences extend to first principles, the argument, if it is continued long enough, is liable to become metaphysical and—interminable.

Reasoning from Analogy and Probable Inference.—In order to complete our sketch of the main types of inference, it would be necessary to explain next what is known as reasoning from analogy, and probable inference. Reasoning from analogy consists in arguing or inferring that something which is known to be true of one class of phenomena is also true of a certain other class of phenomena which resemble the former in essential respects—arguing, *e.g.*, that light is transmitted by undulations of the aether just as sounds are transmitted by undulations of the air. Probable inferences are those in which conclusions are obtained which are admittedly uncertain, but are more or less likely to be true according to certain conditions. As both these types of inference are dealt with elsewhere it is not necessary to discuss them here, but to refer the reader to the articles ANALOGY (in logic) and PROBABILITY (in logic).

Fallacies, etc.—Any violation of a rule of valid inference is called a fallacy. In calling a conclusion fallacious it is not meant that it is not true, but only that it is *not valid,* that is to say, that it is not justified by the evidence. There are, of course, many kinds of fallacy, corresponding to the various conditions to which the different kinds of inference must conform. The commonest of them are dealt with in the article FALLACY, and some others are explained in the article on SCIENTIFIC METHOD. So the subject need not be further discussed here. Some other topics commonly dealt with in the treatises on traditional logic will be found explained in the articles on CATEGORY, PREDICABLES, JUDGMENT, CONSEQUENS.

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(A. Wo.)

LOGIC, HISTORY OF. Logic arose, at least for the Western world, in the golden age of Greek speculation which culminated in Plato and Aristotle. There is an Indian logic, it is true, but its priority is still disputed. In any case, no influence upon Greek thought can be shown. The movement which ends in the logic of Aristotle is self-contained.

A. GREEK LOGIC

I. BEFORE ARISTOTLE

Early Nature Philosophers.—Logic needs as its presuppositions that thought should distinguish itself from things and from sense, that the problem of validity should be seen to be raised in the field of thought itself, and that analysis of the structure of thought should be recognized as the one way of solution. Thought is somewhat late in coming to self-consciousness. Implied in every contrast of principle and fact, of rule and application, involved as we see after the event, most decisively when we react correctly upon a world incorrectly perceived, thought is yet not reflected on in the common experience. Its so-called natural logic is only the potentiality of logic. The same thing is true of the first stage of Greek philosophy. In seeking for a single material principle underlying the multiplicity of phenomena, the first nature-philosophers, Thales and the rest, did indeed raise the problem of the one and the many, the endeavour to answer which must at last lead to logic. But it is only from a point of view won by later speculation that it can be said that they sought to determine the predicates of the single subject-reality, or to establish the permanent subject of varied and varying predicates. A further step, then, was necessary, and it was taken at any rate by the Eleatics, when they opposed their thought to the thought of others, as the way of truth in contrast to the way of opinion. It was Zeno, the controversialist of the Eleatic school who was regarded in after times as the "discoverer" of dialectic.

The Sophists.—In the history of the origins of logic, the sophistic age is simply the age of the free play of thought in which men were aware that in a sense anything can be debated and not yet aware of the sense in which all things cannot be so. It is the age of discussion used as a universal solvent, before it has been brought to book by a deliberate unfolding of the principles of the structure of thought determining and limiting the movement of thought itself. The sophists furthered the transition from dialectic to logic in two ways. In the first place they made it possible. Incessant questioning leads to answers. Hair-splitting, even when mischievous in intent, leads to distinctions of value. Paradoxical insistence on the accidents of speech-forms and thought-forms leads in the end to perception of the essentials. Secondly they made it necessary. The spirit of debate run riot evokes a counter-spirit to order and control it. The result is a self-limiting dialectic. This higher dialectic is a logic. It is no accident that the first of the philosophical sophists, Gorgias, on the one hand, is Eleatic in his affinities, and on the other raises in the characteristic formula of his intellectual nihilism issues which are as much logical and epistemological as ontological. The meaning of the copula and the relation of thoughts to the objects of which they are thoughts are as much involved as the nature of being. It is equally no accident that the name of Protagoras is to be connected, in Plato's view at least, with the rival school of Heracliteans. The problems raised by the relativism of Protagoras are no less fundamentally problems of the nature of knowledge and of the structure of thought. The *Theaetetus,* indeed, in which Plato essays to deal with them, is in the broad sense of the word logical, the first distinctively logical treatise that has come down to us.

Socrates.—Among the pioneers of the sophistic age Socrates stands apart. He has no other instrument than the dialectic of his compeers, and he is as far off as the rest from a criticism of the instrument, but he uses it differently and with a difference of aim. He construes the give and take of the debate-game with extreme rigour. The rhetorical element must be exorcised. The set harangue of teacher to pupil, in which steps in argument are slurred and the semblance of co-enquiry is rendered nugatory, must be eliminated. The interlocutors must in truth render an account under the stimulus of organized heckling from their equals or superiors in debating ability. And the aim is heuristic, though often enough the search ends in no overt positive conclusion. Something can be found, and something is found. Common names are fitted for use by the would-be users being first delivered from abortive conceptions, and thereupon enabled to bring to the birth living and organic notions.

Aristotle would assign to Socrates the elaboration of two logical functions:—general definition and inductive method. Rightly, if we add that he gives no theory of either, and that his practical use of the latter depends for its value on selection. It is rather in virtue of his general faith in the possibility of construction, which he still does not undertake, and because of his consequent insistence on the elucidation of general concepts, which in common with some of his contemporaries, he may have thought of as endued with a certain objectivity, that he induces the controversies of what are called the Socratic schools as to the nature of predication. These result in the formulation of a new dialectic or logic of Plato. Manifestly Socrates' use of certain forms of argumentation, like their abuse by the sophists, tended to evoke their logical analysis. The use and abuse, confronted one with the other, could not but evoke it.

Plato.—Plato's logic supplies a theory of universals in the doctrine of ideas. Upon this it bases a theory of predication. And it sets forth a dialectic with a twofold movement, towards differentiation and integration severally, which amounts to a formulation of inference. The more fully analysed movement, that which proceeds downward from less determinate to more determinate universals, is named Division. Its associations, accordingly, are to the modern ear almost inevitably those of a doctrine of classification only. Aristotle, however, treats it as a dialectical rival to syllogism, and it influenced Galilei and Bacon in their views of inference after the Renaissance. If we add to this logic of "idea," judgment and inference, a doctrine of categories in the modern sense of the word which makes the *Theaetetus,* in which it first occurs, a forerunner of Kant's *Critique of Pure Reason,* we have clearly a very significant contribution to logic.

(*a*) Of the idea we may say that whatever else it is, it is opposed to that of which it is the idea as its intelligible formula or law, the truth or validity of the phenomenon from the point of view of nexus or system. The thing of sense in its relative isolation is unstable. It is and is not. What gives stability is the insensible principle or principles which it holds, as it were, in solution. These are the ideas, and their mode of being is naturally quite other than that of the sensible phenomena which they order. The formula for an indefinite number of particular things in particular places at particular times, and all of them presentable in sensuous imagery of a given time and place, is not itself presentable in sensuous imagery side by side with the individual members of the group it orders. The law, *e.g.,* of the equality of the radii of a circle cannot be exhibited to sense, even if equal radii may be so exhibited. It is the wealth of illustration with which Plato expresses his meaning, and the range of application which he gives the idea—to the class-concepts of natural groups objectively regarded, to categories, to aesthetic and ethical ideals, to the concrete aims of the craftsman as well as to scientific laws—that have obscured his doctrine, viz., that wherever there is law, there is an idea.

(*b*) The paradox of the one in the many is none, if the idea may be regarded as supplying a principle of nexus or organization to an indefinite multiplicity of particulars. But the principle of difference must be carried into the field of ideas. Not only sense is a principle of difference. The ideas are many. The multiplicity in unity must be established within thought itself. Otherwise the objection stands: man is man, and good is good, but to say that man is good is clearly to say the thing that is not. Plato replies with the doctrine of the interpenetration of ideas, obviously not of all with all, but of some with some, the formula of identity in difference with thought itself. Nor can the opponent fairly refuse to admit it, if he affirms the participation of the identical with being, and denies the participation of difference with being, or affirms it with not-being. The *Sophistes* shows among other things that an identity-philosophy breaks down into a dualism of thought and expression, when it applies the predicate of unity to the real, just as the absolute pluralism on the other hand collapses into unity if it affirms or admits any form of relation whatsoever. Identity and difference are all-pervasive categories, and the speech-form and the corresponding thought-form involve both. For the proposition and judgment involve subject and predicate and exhibit what a modern writer calls "identity of reference with diversity of characterization." Plato proceeds to explain by his principle of difference both privative and negative predicates, and also the possibility of false predication. It is obvious that without the principle of difference, error is inexplicable. Even Plato, however, perhaps scarcely shows that with it, and nothing else but it, error is explained.

(*c*) Plato's Division, or the articulation of a relatively indeterminate and generic concept into species and sub-species with resultant determinate judgments, presumes of course the doctrine of the interpenetration of ideas laid down in the *Sophistes,* as the basis of predication, but its use precedes the positive development of that formula, though not, save very vaguely, the exhibition of it, negatively, in the antinomies of the one and the many in the *Parmenides.* It is its use, however, not the theory of it, that precedes. The latter is expounded in the *Politicus* (260 *sqq.*) and *Philebus* (16*c sqq.*). The ideal is progressively to determine a universe of discourse till true *lowest species* are reached when no further distinction in the determinate many is possible, though there is still the numerical difference of the indefinite plurality of particulars. The process is to take as far as possible the form of a continuous disjunction of contraries. We must bisect as far as may be, but the division is after all to be into limbs, not parts. The later examples of the *Politicus* show that the permission of three or more co-ordinate species is not nugatory, and that the precept of dichotomy is merely in order to secure as little of a *saltus* as possible; to avoid, *e.g.*, the division of the animal world into men and brutes. It is the middle range of the μέσα of *Philebus*, 17*a* that appeals to Bacon, not only this but their mediating quality that appeals to Aristotle. The *mediate axioms* of the one and the *middle term* of the other lie in the phrase. Plato's division is nevertheless neither syllogism nor *method of exclusions*. It is not syllogism because it is based on the disjunctive, not on the hypothetical relation, and so extends horizontally where syllogism strikes vertically downward. Again it is not syllogism because it is necessarily and finally dialectical. It brings in the choice of an interlocutor at each stage, and so depends on a concession for what it should prove. Nor is it Bacon's method of exclusions which escapes the imputation of being dialectical, if not that of being unduly combrous, in virtue of the cogency of the negative instance. The Platonic division was, however, offered as the scientific method of the school. A fragment of the comic poet Epicrates gives a picture of it at work. And the movement of disjunction as truly has a place in the scientific specification of a concept in all its differences as the linking of lower to higher in syllogism. The two are complementary, and the reinstatement of the disjunctive judgment to the more honourable rôle in inference has been made by so notable a modern logician as Lotze.

(*d*) The correlative process of Combination is less elaborately sketched, but in a luminous passage in the *Politicus* (§ 278), in explaining by means of an example the nature and use of examples, Plato represents it as the bringing of one and the same element seen in diverse settings to conscious realization, with the result that it is viewed as a single truth of which the terms compared are now accepted as the differences. The learner is to be led forward to the unknown by being made to hark back to more familiar groupings of the alphabet of nature which he is coming to recognize with some certainty. To lead on, ἐπάγειν, is to refer back, ἀνάγειν to what has been correctly divined of the same elements in clearer cases. Introduction to unfamiliar collocations follows upon this, and only so is it possible finally to gather scattered examples into a conspectus as instances of one idea or law. This is not only of importance in the history of the terminology of logic, but supplies a philosophy of induction.

(*e*) Behind Plato's illustration and explanation of predication and dialectical inference there lies not only the question of their metaphysical grounding in the interconnection of ideas, but that of their epistemological presuppositions. This is dealt with in the *Theaetetus* (184*b sqq.*). The manifold affections of senses are not simply aggregated in the individual, like the heroes in the Trojan horse. There must be convergence in a unitary principle, soul or consciousness, which is that which really functions in perception, the senses and their organs being merely its instruments. It is this unity of apperception which enables us to combine the data of more than one sense, to affirm reality, unreality, identity, difference, unity, plurality and so forth, as also the good, the beautiful and their contraries. Plato calls these pervasive factors in knowledge κοινά and describes them as developed by the soul in virtue of its own activity. They are objects of its reflection and made explicit in the few with pains and gradually. That they are not, however, psychological or acquired categories, due to "the workmanship of the mind" as conceived by Locke, is obvious from their attribution to the structure of mind and from their correlation with immanent principles of the objective order. Considered from the epistemological point of view, they are the implicit presuppositions of the construction in which knowledge consists. But as ideas, though of a type quite apart, they have also a constitutive application to reality. Accordingly, of the selected "kinds" by means of which the interpenetration of ideas is expounded in the *Sophistes*, only motion and rest, the ultimate "kinds" in the physical world, have no counterparts in the "categories" of the *Theaetetus*.

II. ARISTOTLE

Aristotle was the first to conceive of reasoning itself as the definite subject of a special science. He was therefore the founder of Logic, although he never used that name. The Aristotelian treatises in which the foundations of Logic were laid are these:—(1) The *Categories*, on names signifying things which can become predicates; (2) *De Interpretatione*, on the enumeration of conceptions and their combinations by names and propositions; (3) The *Prior Analytics*, on syllogism; (4) The *Posterior Analytics*, on demonstrative syllogism; (5) The *Topics*, on dialectical syllogism, or argument; (6) The *Sophistical Elenchi*, on sophistical or contentious syllogism, or sophistical fallacies. Aristotle does not appear to have had any one name for all these investigations. But his followers called this collection of treatises the *Organon* (The *Instrument*, that is, of Knowledge), and from it there emerged gradually a system of Logic. Their production as relatively self-contained treatises accounts for the absence of a precise definition of their field of enquiry. And this original lack of precision in the delimitation of the scope of Logic haunts the subject to this day. Aristotle gave no clear intimation as to the relation in which he supposed this field of enquiry to stand to other disciplines. In his definite classification of the sciences, into First Philosophy, Mathematics and Physics, it has no place. Its axioms, such as the law of contradiction, belong to first philosophy, but the doctrine as a whole falls neither under this head nor yet, though the thought has been entertained, under that of mathematics, since logic orders mathematical reasoning as well as all other. The speculative sciences, indeed, are classified according to their relation to form, pure, abstract or concrete, *i.e.*, according to their object. The logical enquiry seems to be conceived as dealing with the thought of which the objects are objects. It is to be regarded as a propaedeutic, which although it is in contact with reality in and through the metaphysical import of the axioms or again in the fact that the categories, though primarily taken as forms of predication, must also be regarded as kinds of being, is not directly concerned with object-reality, but with the determination for the thinking subject of what constitutes the knowledge correlative to being. Logic, therefore, is not classed as one, still less a branch of one, among the 'ologies, ontology not excepted.

The way in which logical doctrine is developed in the Aristotelian treatises fits in with this view. Doubtless what we have is in the main a reflex of the heuristic character of Aristotle's own work as pioneer. But it at least satisfies the requirement that the enquiry shall carry the plain man along with it. Actual modes of expression are shown to embody distinctions which average intelligence can easily recognize, and will readily acknowledge, though they may tend by progressive rectification fundamentally to modify the assumption natural to the level of thought from which he begins. Thus we start from the point of view of a world of separate persons and things, in which thought mirrors these concrete realities, taken as ultimate subjects of predicates. It is a world of communication of thought, where persons as thinkers need to utter in language truths objectively valid for the common world. In these truths predicates are accepted or rejected by subjects, and therefore depend on the reflection of fact in proposition. These are combinatory of parts, attaching or detaching predicates, and so involving subject, predicate and copula. At this stage we are as much concerned with speech-forms as the thought-forms of which they are conventional symbols, with Plato's analysis, for instance, into a noun and a verb, whose connotation of time is as yet a difficulty. The universal of this stage is the universal of fact, what is recognized as predicable of a plurality of subjects. The dialectical doctrine of judgment as the declaration of one member of a disjunction by contradiction, which is later so important, is struggling with one of its initial difficulties, viz., the contingency of particular events, the future solution of which remains imperfect.

The doctrine of the *Categories* is still on the same level of thought, though its grammatico-logical analysis is the more advanced one which had probably been developed by the Academy before Aristotle came to think of his friends there as "them" rather than "us." It is what in one direction gave the now familiar classification of parts of speech, in the other that of thought-categories underlying them. If we abstract from any actual combination of subject and predicate and proceed to determine the types of predicate asserted in simple propositions of fact, we have on the one hand a subject which is never object, a "first substance" or concrete thing, of which may be predicated in the first place, "second substance," expressing that it is a member of a concrete class, and in the second place quantity, quality, correlation, action and the like. The list follows the forms of the Greek language so closely that a category emerges appropriated to the use of the perfect tense of the middle voice to express the relation of the subject to a garb that it dons. In all this the individual is the sole self-subsistent reality. Truth and error are about the individual and attach or detach predicates correctly and incorrectly. There is no committal to the metaphysics in the light of which the logical enquiry is at last to find its complete justification. The point of view is to be modified profoundly by what follows—by the doctrine of the class-concept behind the class, of the form or idea as the constitutive formula of a substance, or, again, by the requirement that an essential attribute must be grounded in the nature or essence of the substance of which it is predicated, and that such attributes alone are admissible predicates from the point of view of the strict ideal of science. But we are still on the ground of common opinion, and these doctrines are not yet laid down as fundamental to the development.

Dialectic, then, though it may prove to be the ultimate method of establishing principles in philosophy, starts from the probable and conceded premises, and deals with them only in the light of common principles, such as may be reasonably appealed to or easily established against challenge. To the expert, in any study which involves contingent matter, *i.e.*, an irreducible element of indetermination, *e.g.*, to the physician, there is a specific form of this, but the reflection that this is so is something of an afterthought. We start with what is prima facie given, to return upon it from the ground of principles clarified by the sifting process of dialectic and certified by thought. The *Topics* deal with dialectic and constitute an anatomy of argumentation, or, according to what seems to be Aristotle's own metaphor, a survey of the tactical vantage-points (τόποι) for the conflict of wits in which the prize is primarily victory, though it is a barren victory unless it is also knowledge. It is in this treatise that what have been called "the conceptual categories" emerge, viz., the predicables, or heads of predication as it is analysed in relation to the provisional theory of definition that dialectic allows and requires. A predicate either is expressive of the essence or part of the essence of the subject, viz., that original group of mutually underivable attributes of which the absence of any one destroys its right to the class-name, or it is not. Either it is convertible with the subject or it is not. Here, then, judgment, though still viewed as combinatory, has the types which belong to coherent systems of implication discriminated from those that predicate coincidence or accident, *i.e.*, any happening not even derivatively essential from the point of view of the grouping in which the subject has found a place. In the theory of dialectic any predicate may be suggested for a subject, and if not affirmed of it, must be denied of it, if not denied must be affirmed. The development of a theory of the ground on which subjects claim their predicates and disown alien predicates could not long be postponed. In practical dialectic the unlimited possibility was reduced to manageable proportions in virtue of the groundwork of received opinion upon which the operation proceeded. It is in the *Topics*, further, that we clearly have a first treatment of syllogism as formal implication, with the suggestion that advance must be made to a view of its use for material implication from true and necessary principles. It is in the *Topics*, again, that we have hints at the devices of an inductive process, which, as dialectical, throw the burden of producing contradictory instances upon the other party to the discussion. In virtue of the common-stock of opinion among the interlocutors, and their potentially controlling audience, this process was more valuable than appears on the face of things. Obviously tentative, and with limits and ultimate interpretation to be determined elsewhere, it failed to bear fruit till the Renaissance, and then by the irony of fate to the discrediting of Aristotle. In any case, however, definition, syllogism, induction all invited further determination, especially if they were to take their place in a doctrine of truth or knowledge. The problem of analytic, *i.e.*, of the resolution of the various forms of inference into their equivalents in that grouping of terms or premises which was most obviously cogent, was a legacy of the *Topics*. The debate-game had sought for diversion and found truth, and truth raised the logical problem on a different plane.

At first the problem of formal analysis only. We proceed with the talk of instances and concern ourselves first with relations of inclusion and exclusion. The question is as to membership of a class, and the dominant formula is the *dictum de omni et nullo*. Until the view of the individual units with which we are so far familiar has undergone radical revision, the primary inquiry must be into the forms of a class-calculus. Individuals fall into groups in virtue of the possession of certain predicates. Does one group include, or exclude, or intersect another with which it is compared? We are clearly in the field of the diagrams of the older text-books, and much of the phraseology is based upon an original graphic representation in extension. The middle term, though conceived as an intermediary or linking term, gets its name as intermediate in a homogeneous scheme of quantity, where it cannot be of narrower extension than the subject nor wider than the predicate of the conclusion. It is also, as Aristotle adds, middle in position in the syllogism that concludes to a universal affirmative. Again so long as we keep to the syllogism as complete in itself and without reference to its place in the great structure of knowledge, the nerve of proof cannot be conceived in other than a formal manner. In analytic we work with an ethos different from that of dialectic. We presume truth and not probability or concession, but a true conclusion can follow from false premises, and it is only in the attempt to derive the premises in turn from their grounds that we unmask the deception. The passage to the conception of system is still required. The *Prior Analytics*, then, are concerned with a formal logic to be knit into a system of knowledge of the real only in virtue of a formula which is at this stage still to seek. The forms of syllogism, however, are tracked successfully through their figures, *i.e.*, through the positions of the middle term that Aristotle recognizes as of actual employment, and all their moods, *i.e.*, all differences of affirmative and negative, universal and particular within the figures, the cogent or legitimate forms are alone left standing, and the formal doctrine of syllogism is complete. Syllogism already defined becomes through exhibition in its valid forms clear in its principle. It is a speech-and-thought-form in which certain matters being posited something other than the matter posited necessarily results because of them, and though it still needs to receive a deeper meaning when presumed truth gives way to necessary truth of premises, the notion of the class to that of the class-concept, collective fact to universal law, its formal claim is manifest. "Certain matters being posited." Subject and predicate not already seen to be conjoined must be severally known to be in relation with that which joins them, so that more than one direct conjunction must be given. "Of necessity." If what are to be conjoined are severally in relation to a common third, it does perforce relate or conjoin them. "Something other." The conjunction was by hypothesis not given, and is a new result by no means to be reached, apart from direct perception save by use of at least two given conjunctions. "Because of them," therefore. Yet so long as the class-view is prominent there is a suggestion of begging of the question. The class is either constituted by enumeration of its members, and passing by the difficulty involved in the thought of "its" members, is an empirical universal of fact merely, or it is grounded in the class-concept. In the first case it is a formal scheme which helps knowledge and the theory of knowledge not at all. We need then to develop the alternative, and to pass from the external aspect of all-ness to the intrinsic ground of it in the universal, which, whatsoever the assistance it receives from induction in some sense of the word, in the course of its development for the individual mind, is secured against dependence on instances by insight into the systematic nexus of things. The conception of linkage needs to be deepened by the realization of the middle term as the ground of nexus in a real order which is also rational.

Aristotle's solution of the paradox of inference, viz., of the fact that in one sense to go beyond what is in the premises is fallacy, while in another sense not to go beyond them is futility, lies in his formula of implicit and explicit, potential and actual. The real nexus underlying the thought-process is to be articulated in the light of the voucher by intelligence as to the truth of the principles of the various departments of knowledge which we call sciences, and at the ideal limit it is possible to transform syllogism into systematic presentation, so that, differently written down, it is definition. But for human thought sense, with its accidental setting in the matter itself incognizable, is always with us. The activity of thought is never so perfectly realized as to merge implication in intuition. Syllogism must indeed be objective, *i.e.,* valid for any thinker, but it is also a process in the medium of individual thinking, whereby new truth is reached. A man may know that mules are sterile and that the beast before him is a mule, yet believe her to be in foal "not viewing the several truths in connection." The doctrine, then, that the universal premise contains the conclusion not otherwise than potentially is with Aristotle cardinal. The datum of sense is only retained through the universal. It is possible to take a universal view with some at least of the particular instances left uninvestigated. Recognition that the class-concept is applicable may be independent of knowledge of much that it involves. Knowledge of the implications of it does not depend on observation of all members of the class. Syllogism as formula for the exhibition of truth attained, and construction or what not as the instrumental process by which we reach the truth, have in writers since Hegel and Herbart tended to fall apart. Aristotle's view is other. Both are syllogisms, though in different points of view. For this reason, if for no other, the conception of movement from the potential possession of knowledge to its actualization remains indispensable. Whether this is explanation or description, a problem or its solution, is of course another matter.

In the *Posterior Analytics* the syllogism is brought into decisive connection with the real by being set within a system in which its function is that of material implication from principles which are primary, immediate and necessary truths. Hitherto the assumption of the probable as the true rather than as what will be conceded in debate has been the main distinction of the standpoint of analytic from that of dialectic. But the true is true only in reference to a coherent system in which it is an immediate ascertainment of thought or to be deduced from a ground which is such. The ideal of science or demonstrative knowledge is to exhibit as flowing from the definitions and postulates of a science, from its special principles, by the help only of axioms or principles common to all knowledge, and these not as premises but as guiding rules, all the properties of the subject matter, *i.e.,* all the predicates that belong to it in its own nature. In the case of any subject-kind, its definition and its existence being avouched by thought, "heavenly body" for example, the problem is, given the fact of a non-self-subsistent characteristic of it, such as the eclipse of the said body, to find a ground which expressed the cause in virtue of which the adjectival concept can be exhibited as belonging to the subject-concept in the strict sense. We are under the necessity, then, of revising the point of view of the syllogism of all-ness. We discard the conception of the universal as a predicate applicable to a plurality, or even to all, of the members of a group. The exhaustive judgment, if attainable, could not be known to be exhaustive. The universal is the ground of the empirical "all" and not conversely. A formula such as the equality of the interior angles of a triangle to two right angles is only scientifically known when it is not of isosceles or scalene triangle that it is known, nor even of all the several types of triangle collectively, but as a predicate of triangle recognized as the widest class-concept of which it is true, the first stage in the progressive differentiation of figure at which it can be asserted.

Three points obviously need development, the nature of definition, its connection with the syllogism in which the middle term is cause or ground, and the way in which we have assurance of our principles.

Definition is either of the subject-kind or of the property that is grounded in it. Of the self-subsistent, definition is by exposition of genus and differentia. It is indemonstrable. It presumes the reality of its subject in a postulate of existence. It belongs to the principles of demonstration. *Highest genera* and groups below *lowest species* are indefinable. The former are susceptible of elucidation by indication of what falls under them. The latter are only describable by their accidents. There can here be no true differentia. The artificiality of the limit to the articulation of species was one of the points to which the downfall of Aristotle's influence was largely due. Of a non-self-subsistent or attributive conception definition in its highest attainable form is a recasting of the syllogism, in which it was shown that the attribute was grounded in the substance of the self-subsistent subject of which it is predicated. Eclipse of the moon, *e.g.,* is a privation of light from the moon by the interposition of the earth between it and the sun. In the scientific syllogism the interposition of the earth is the middle term, the cause or "because"; the residue of the definition is conclusion. The difference, then, is in verbal expression, way of putting, inflexion. If we pluck the fruit of the conclusion, severing its nexus with the stock from which it springs, we have an imperfect form of definition, while, if further we abandon all idea of making it adequate by exhibition of its ground, we have, with still the same form of words, a definition merely nominal or lexicographical.

The rest is a consideration of scientific inquiry as converging in the investigation of the link or "because" as ground in the nature of things. Real ground and thought-link fall together. The advance from syllogism as formal implication is a notable one. It is not enough to have for middle term a *causa cognoscendi* merely. We must have a *causa essendi.* The planets are near, and we know it by their not twinkling, but science must conceive their nearness as the cause of their not twinkling and make the *prius* in the real order of the middle term of its syllogism. In this irreversible catena proceeding from ground to consequent, we have left far behind such things as the formal parity of genus and differentia considered as falling under the same predicable, and hence justified in part Porphyry's divergence from the scheme of predicables. We need devices, indeed, to determine priority or superior claim to be "better known absolutely or in the order of nature," but on the whole the problem is fairly faced.

Of science Aristotle takes for his examples sometimes celestial physics, more often geometry or arithmetic, sometimes a concrete science, *e.g.,* botany. In the field of pure form, free from the disconcerting surprises of sensible matter and so a field of absolute necessity, no difficulty arises as to the deducibility of the whole body of a science from its first principles. In the sphere of abstract form, mathematics, the like may be allowed, abstraction being treated as an elimination of matter from the σύνολον by one act. When we take into account relative matter, however, and traces of a conception of abstraction as admitting of degree, the question is not free from difficulty. In the sphere of the concrete sciences where law obtains only ὡς ἐπὶ τὸ πολύ this ideal of science can clearly find only a relative satisfaction with large reserves. In any case, however, the problem as to first principles remains fundamental.

If we reject the infinite regress and the circle in proof (circulus in probando) which resolves itself ultimately into proving A by B and B by A, we are confronted by the need for principles of two kinds, those which condition all search for truth and those which are the peculiar or proper principles of special sciences, their "positions," viz., the definitions of their subjects and the postulates of the existence of these. All are indemonstrable and cannot be less sure than the body of doctrine that flows from them. They must indeed be recognized as true, primary, causative and the like. But they are not congenitally present in the individual in a determinate shape. The doctrine of latency is mystical and savours of Plato's reminiscence. Yet they must have something to develop from, and thereupon Aristotle gives an account of a process in the psychological mechanism which he illustrates by comparative psychology, wherein a λόγος or meaning emerges, a "first" universal recognized by induction. Yet νοῦς, intelligence, is the principle of first principles. It is infallible, while, whatever the case with perception of the special sensibles, the process which combines particulars is not. On the side of induction we find that experience is said to give the specific principles, "the phenomena being apprehended in sufficiency." On the side of intuition, self-evidence of scientific principles is spoken of. Yet dialectic is auxiliary and of methodological importance in their establishment. Mutually limiting statements occur almost or quite side by side. We cannot take first principles "as the bare precipitate of a progressively refined analysis" nor on the other as constitutive a priori forms. The solution seems to lie in the conception of a process that has a double aspect. On the one hand we have confrontation with fact, in which, in virtue of the rational principle which is the final cause of the phenomenal order, intelligence will find satisfaction. On the other, we have a stage at which the rational but as yet not reasoned concepts developed in the medium of the psychological mechanism are subject to processes of reflective comparison and analysis, and, with some modification, maintained against challenge, till at length the ultimate universals emerge, which rational insight can posit as certain, and the whole hierarchy of concepts from the "first" universals to τὰ ἀμερῆ are intuited in a coherent system. Aristotle's terminology is highly technical, but, as has often been observed, not therefore clear. Here two words at least are ambiguous, "principle" and "induction." By the first he means any starting-point, "that from which the matter in question is primarily to be known," particular facts, therefore, premises and what not. What, then, is meant by principles when we ask in the closing chapter of his logic how they become known? The data of sense are clearly not the principles in question here. The premises of scientific syllogisms may equally be dismissed. Where they are not derivative they clearly are definitions or immediate transcripts from definitions. There remain, then, primary definitions and the postulates of their realization, and the axioms or common principles "which he must needs have who is to reach any knowledge." In the case of the former, special each to its own science, Aristotle may be thought to hold that they are the product of the psychological mechanism, but are ascertained only when they have faced the fire of a critical dialectic and have been accepted from the point of view of the integral rationality of the system of concepts. Axioms, on the other hand, in which the sciences inter-connect through the employment of them in a parity of relation, seem to be implicit indeed in the psychological mechanism, but to come to a kind of explicitness in the first reflective reaction upon it, and without reference to any particular content of it. They are not to be used as premises but as immanent laws of thought, save only when an inference from true or admitted premises and correct in form is challenged. The challenge must be countered in a *reductio ad impossibile* in which the dilemma is put. Either this conclusion or the denial of rationality. Even these principles, however, may get a greater explicitness by dialectical treatment. The relation, then, of the two orders of principle to the psychological mechanism is different. The kind of warrant that intelligence can give to specific principles falls short of infallibility. Celestial physics, with its pure forms and void of all matter save extension, is not such an exemplary science after all. Rationality is continuous throughout. A λόγος emerges with some beings in direct sequence upon the persistence of impressions. Sense is of the "first" universal, the form, though not of the ultimate universal. The rally from the rout in Aristotle's famous metaphor is of units that already belong together, that are of the same regiment or order. On the other hand, rationality has two stages. In the one it is relatively immersed in sense, in the other relatively free. The same break is to be found in the conception of the relation of receptive to active mind in the treatise *Of the Soul*. The one is impressed by things and receives their form without their matter. The other is free from impression. It thinks its system of concepts freely on the occasion of the affections of the receptivity. Aristotle is fond of declaring that knowledge is of the universal, while existence or reality is individual. It seems to follow that the cleavage between knowledge and reality is not bridged by the function of thought in relation to "induction." What is known is not real, and what is real is not known. It is in induction, which claims to start from particulars and end in universals, that we must, if anywhere within the confines of logical inquiry, expect to find the required bridge. The Aristotelian conception of induction, however, is somewhat ambiguous. He had abandoned for the most part the Platonic sense of the corresponding verb, viz., to lead forward to the as yet unknown, and his substitute is not quite clear. Perhaps confrontation with facts is the general meaning. But how does he conceive of its operation? There is in the first place the action of the psychological mechanism in the process from discriminative sense upwards wherein we realize "first" universals. This is clearly an unreflective, prelogical process, not altogether lighted up by our retrojection upon it of our view of dialectical induction based thereon. The immanent rationality of this first form, in virtue of which at the stage when intelligence acts freely on the occasion of the datum supplied, it recognizes continuity with its own self-conscious process, is what gives the dialectical type its meaning. Secondly, we have this dialectical "induction as to particulars by grouping of similars" whose liability to rebuttal by an exception has been already noted in connection with the limits of dialectic. This is the incomplete induction by simple enumeration which has so often been laughed to scorn. It is a heuristic process liable to failure, and its application by a nation of talkers even to physics where non-expert opinion is worthless somewhat discredited it. Yet it was the fundamental form of induction as it was conceived throughout the scholastic period. Thirdly we have the limiting cases of this in the inductive syllogism, a syllogism in the third figure concluding universally, and yet valid because the copula expresses equivalence, and in analogy in which instances are weighed and not counted. In the former Aristotle's illustration does not combine particular facts into a lowest concept, but specific concepts into a generic concept, and in the construction of definite inductions the ruling thought with Aristotle is already, though vaguely, that of causal relation. It appears safer, notwithstanding, to take the less subtle interpretation that dialectical induction struggling with instances is formally justified only at the limit, and this, where we have exhausted and know that we have exhausted the cases, is in regard to individual subjects rarely and accidentally reached, so that we perforce illustrate rather from the definite class-concepts falling under a higher notion. After all, Aristotle must have had means by which he reached the conclusions that horses are long-lived and lack gall. It is only, then, in the rather mystical relation of νοῦς to the first type of induction as the process of the psychological mechanism, that an indication of the direction in which the bridge from individual being to universal knowledge is to be found can be held to lie.

Enough has been said to justify the great place assigned to Aristotle in the history of logic. He laid down the programme which the after history of logic was to carry out.

The Aristotelian theory of the universal of science as secure from dependence on its instances and the theory of linking in syllogism remain a heritage for all later logic, whether accepted in precisely Aristotle's formula or no. It is because the intervening centuries had the Aristotelian basis to work on, that the rest of our logical tradition is what it is. We stand upon his shoulders.

III. LATER GREEK LOGIC

After Aristotle we have, as regards logic, what the verdict of after times has rightly characterized as an age of *Epigoni*. So far as the Aristotelian framework is accepted we meet only minor corrections and extensions of a formal kind. If there is conscious and purposed divergence from Aristotle, enquiry moves, on the whole, within the circle of ideas where Aristotelianism had fought its fight and won its victory. Where new conceptions emerge, the imperfection of the instruments, mechanical and methodological, of the sciences renders them unfruitful until their rediscovery in a later age. We have activity without advance, diversity without development. Attempts at comprehensiveness end in the compromises of eclecticism.

The Stoics are of some importance. Despite the fact that their philosophic interests lay rather in ethics and physics, their activity in what they classified as the third department of speculation was enormous and has at least left ineffaceable traces on the terminology of philosophy. Logic is their word, and consciousness, impression and other technical words come to us, at least as technical words, from Roman stoicism. Even inference, though apparently not a classical word, throws back to the Stoic name for a conclusion.

Another doctrine of the Stoics which has interest in the light of certain modern developments is their insistence on the place of the λεκτόν in knowledge. Distinct alike from thing and mental happening, it seems to correspond to "meaning." Along the same lines is their use of the hypothetical form for the universal judgment, and their treatment of the hypothetical form as the typical form of inference.

The Stoical categories, too, have an historical significance. They are apparently offered in place of those of Aristotle, an acquaintance with whose distinctions they clearly presume. Recognizing a linguistic side to "logical" theory with a natural development in rhetoric, the Stoics endeavour to exorcise considerations of language from the contrasted side. They offer pure categories arising in series, each successive one pre-supposing those that have gone before. Yet the substance, quality, condition absolute πῶς ἔχον and condition relative of Stoicism have no enduring influence outside the school, though they recur with eclectics like Galen.

Epicureans.—In falling back upon the atomism of Democritus, Epicurus had to face some questions of logic. In the inference from phenomena to further phenomena positive verification must be insisted on. In the inference from phenomena to their non-phenomenal causes, the atoms, with their inaccessibility to sense, a different canon of validity obtains, that of non-contradiction. He distinguishes, too, between the inference to combinations of atoms as universal cause, and inference to special causes beyond the range of sense. In the latter case alternatives may be acquiesced in. The practical aim of science is as well achieved if we set forth possible causes as in showing the actual cause. More probably it reflects the fact that Epicurus was, on the whole, dominated by the influences that produced Pyrrhonism.

Sceptics.—The school of Pyrrho has exercised a more legitimate influence. The major premise of syllogism, says the Pyrrhonist, is established inductively from the particular instances. If there be but one of these uncovered by the generalization, this cannot be sound. If the crocodile moves its upper, not its lower jaw, we may not say that all animals move the lower jaw. The conclusion then is really used to establish the major premise, and if we still will infer it therefrom we fall into the circular proof. Could Mill say more? But again. The inductive enumeration is either of all cases or of some only. The former is in an indeterminate or infinite subject-matter impossible. The latter is invalid.

Neo-Platonists.—In the history of logic Neo-platonism is of importance because of its production of a whole series of commentators on the Aristotelian logic. Not only the *Introduction* of Porphyry, which had lasting effects on the Scholastic tradition, but the commentaries of Themistius and Simplicius. It was the acceptance of the Aristotelian logic by Neo-platonism that determined the Aristotelian complexion as the logic of the next age. If Alexander is responsible for such doctrines as that of the *intellectus acquisitus,* it is to Porphyry, with his characteristically Platonist preference for the doctrine of universals, and for classification, that we owe the scholastic preoccupation with the realist controversy, and with the *quinque voces, i.e.,* the Aristotelian predicables as restated by Porphyry.

B. SCHOLASTICISM

The living force in the spiritual life of the Roman empire was, after all, not philosophy, but religion, and specifically Christianity. With the extension of Christianity to the Gentile world, it at length became necessary for it to orientate itself towards what was best in Greek culture. There is a Stoic element in the ethic of the Pauline epistles, but the theological affinity that the Johannine gospel with its background of philosophic ideas, exhibits to Platonic and Neoplatonist teaching caused the effort at absorption to be directed rather in that direction. Neoplatonism had accepted the Aristotelian logic with its sharper definition than anything handed down from Plato, and except the logic of the Sceptics, there was no longer any rival discipline of the like prestige. The logic of the Stoics had been discredited by the sceptical onset, but in any case there was no organon of a fitness even comparable to Aristotle's for the task of drawing out the implications of dogmatic premises. Aristotelian logic secured the imprimatur of the revived Platonism, and it was primarily because of this that it passed into the service of Christian theology. The contact of the Church with Platonism was on the mystical side. Orthodoxy needed to counter heretical logic not with mysticism, itself the fruitful mother of heresies, but with argument. Aristotelianism approved itself as the controversial instrument, and in due course held the field alone. The upshot is what is called Scholasticism. Scholasticism is the Aristotelianism of mediaeval orthodoxy as taught in the "schools" or universities of Western Europe. It takes form as a body of doctrine drawing its premises from authority, sometimes in secular matters from that of Aristotle, but normally from that of the documents and traditions of systematic theology, while its method it draws from Aristotle, as known in the Latin versions, mainly by Boethius, of some few treatises of the *Organon* together with the *Isagoge* of Porphyry. It dominates the centres of intellectual life in the West, because, despite its claim to finality in its principles or premises, and to universality for its method, it represents the only culture of a philosophic kind available to the adolescent peoples of the Western nations just becoming conscious of their ignorance. Christianity was the one organizing principle that pulsed with spiritual life. The vocation of the student could find fulfilment only in the religious orders. Scholasticism embodied what the Christian community had saved from the wreckage of Greek dialectic. Yet with all its effective manipulation of the formal technique of its translated and mutilated Aristotle, Scholasticism would have gone under long before it did through the weakness intrinsic to its divorce of the form and the matter of knowledge, but for two reasons. The first is the filtering through of some science and some new Aristotelian learning from the Arabs. The second is the spread of Greek scholarship and Greek manuscripts westwards, which was consequent on the Latin occupation of Constantinople in 1204. It was respited by the opportunity which was afforded it of fresh draughts from the Aristotle of a less partial and purer tradition, and we have, accordingly, a golden age of revived Scholasticism beginning in the 13th century, admitting now within itself more differences than before. It is to the schoolmen of the two centuries preceding the Turkish capture of Constantinople that controversial refinements usually associated with the name of Scholasticism are attributable. The *Analytics* of Aristotle now entered quite definitely into the logical thought of Scholasticism and we have the contrast of a *logica vetus* and *logica nova.* The respite, however, was short. The flight of Byzantine scholarship westward in the 15th century revealed, and finally, that the philosophic content of the Scholastic teaching was as alien from Aristotle as from the spirit of the contemporary revolt of science, with its cry for a new medicine, a new nautical astronomy and the like. The doom of the Scholastic Aristotle was nevertheless not the rehabilitation of the Greek Aristotle. Between him and the tide of feeling at the Renaissance lay the whole achievement of Arab science. That impatience of authority to which we owe the Renaissance, the Reformation and the birth of Nationalism, is not stilled by the downfall of Aristotle as the *nomen appellativum* of the schools. The appeal is to experience, somewhat vaguely defined, as against all authority, to the book of nature and no other. At last the world undertakes to enlarge the circle of its ideas.

C. THE RENAISSANCE

Accordingly what is in one sense the revival of classical learning is in another a recourse to what inspired that learning, and so is a new beginning. There is no place for a reformed Aristotelian logic, though the genius of Zabarella was there to attempt it. Nor for revivals of the competing systems, though all have their advocates. Scientific discovery was in the air. The tradition of the old world was too heavily weighted with the Ptolemaic astronomy and the like to be regarded as other than a bar to progress. But from the new point of view its method was inadequate, too, its contentment with an induction that merely leaves an opponent silent when experiment and the application of a calculus were within the possibilities. The transformation of logic lay with the man of science, hindered though he might be by the enthusiasm of some of the philosophers of nature. Henceforth the Aristotelian logic, the genuine no less than the traditional, was to lie on the other side of the Copernican change.

The demand is for a new organon, a scientific method which shall face the facts of experience and justify itself by its achievement in the reduction of them to control. It is a notable feature of the new movement, that except verbally, in a certain licence of nominalist expression, due to the swing of the pendulum away from the realist doctrine of universals, there is little that we can characterize as Empiricism. Facts are opposed to abstract universals. Yes. Particulars to controlling formulae. No. Experience is appealed to as fruitful where the formal employment of syllogism is barren. But it is not mere induction, with its "unanalysed concretes taken as ultimate" that is set up as the substitute for deduction. Rather a scientific process, which as experiential may be called inductive, but which is in other regards deductive as syllogism, is set up in contrast to syllogism and enumeration alike. This is to be seen in Zabarella, in Galilei, and in Bacon. The reformed Aristotelian logic of the first-named with its *inductio demonstrativa,* the mathematico-physical analysis followed by synthesis of the second, the *exclusiva,* or method of exclusions of the last, agree at least in this, that the method of science is one and indivisible, while containing both an inductive and a deductive moment. That what, *e.g.,* Bacon says of his method may run counter to this is an accident of the tradition of the quarrel with realism. So, too, with the scholastic universals. Aristotle's form had been correlated, though inadequately, with the idea of function. Divorced from this they are fairly stigmatized as mental figments or branded as ghostly entities that can but block the path. But consider Bacon's own doctrine of forms. Or watch the mathematical physicist with his formulae. The faith of science looks outward as in the dawn of Greek philosophy, and subjectivism such as Hume's has as yet no hold. Bacon summing up the movement so far as he understood it, in a rather belated way, has no theory of knowledge beyond the metaphor of the mirror held up to nature. Yet he offers an ambitious logic of science, and the case is typical.

Galilei.—The science of the Renaissance differs from that of the false dawn in Greek times in the fact of fruitfulness. It had the achievement of the Old World in the field of mathematics upon which to build. It was in reaction against a dialectic and not immediately to be again entrapped. In scientific method, then, it could but advance, provided physics and mathematics did not again fail of accord. Kepler and Galilei secured it against that disaster. The *ubi materia, ibi geometria* of the one is the battle-cry of the mathematico-physical advance. The scientific instrument of the other, with its moments of analysis and construction, *metodo risolutivo* and *metodo compositivo,* engineers the road for the advance. The new method of physics is verifiable by its fruitfulness, and so free of any immediate danger from dialectic. Its germinal thought may not have been new, but if not new, it had at least needed rediscovery from the beginning. For it was to be at once certain and experiential. A mathematico-physical calculus that would work was in question. The epistemological problem as such was out of the purview. The relation of physical laws to the mind that thought them was for the time a negligible constant. When Descartes, having faithfully and successfully followed the mathematico-physical inquiry of his more strictly scientific predecessors, found himself compelled to raise the question how it was possible for him to know what in truth he seemed to know so certainly, the problem entered on a new phase. The scientific movement had happily been content for the time with a half which, then and there at least, was more than the whole.

Bacon was no mathematician, and so was out of touch with the main army of progress. By temperament he was rather with the Humanists. He was content to voice the cry for the overthrow of the dominant system as such, and to call for a new beginning, with no realist presuppositions. He is with the nominalists of the later Scholasticism and the naturalists of the early Renaissance. He echoes the cry for recourse to nature, for induction, for experiment. He calls for a logic of discovery. But at first sight there is little sign of any greater contribution to the reconstruction than is to be found in Ramus or many another dead thinker. The syllogism is ineffective, belonging to argumentation, and constraining assent where what we want is control of things. It is a mechanical combination of propositions, as these of terms, which are counters to express concepts often ill-defined. The flight from a cursory survey of facts to wide so-called principles must give way to a gradual progress upward from propositions of minimum to those of medium generality, and in these consists the fruitfulness of science. Yet the induction of the Aristotelians, the dialectical induction of the *Topics,* content with imperfect enumeration and throwing the burden of disproof upon the critic, is puerile, and at the mercy of a single instance to the contrary. In all this there is but little promise for a new organon. It is neither novel nor instrumental. On a sudden Bacon's conception of a new method begins to unfold itself. It is inductive only in the sense that it is identical in purpose with the ascent from particulars. It were better called *exclusiva* or elimination of the alternative, which Bacon proposes to achieve, and thereby guarantee his conclusion against the possibility of an instance to the contrary.

Bacon's method begins with a digest into three tables of the facts relevant to any inquiry. The first contains cases of the occurrence of the quality under investigation, colour, *e.g.,* or heat in varying combinations. The second notes its absence in combinations so allied to certain of these that its presence might fairly have been looked for. The third registers its quantitative variation according to quantitative changes in its concomitants. The method now proceeds on the basis of the first table to set forth the possible suggestions as to a general explanatory formula for the quality in question. In virtue of the remaining tables it rejects any suggestion qualitatively or quantitatively inadequate. If one suggestion, and one alone, survives the process of attempted rejection it is the explanatory formula required. If none, we must begin afresh. If more than one, recourse is to be had to certain devices of method, in the enumeration of which the methods of agreement, difference and concomitant variations find a place beside the crucial experiment, the glaring instance and the like. An appeal, however, to such devices, though a permissible "first vintage" is relatively an imperfection of method, and a proof that the tables need revision. The positive procedure by hypothesis and verification is rejected by Bacon, who thinks of hypothesis as the will o' the wisp of science, and prefers the cumbrous machinery of negative reasoning.

Historically he appears to have been under the dominance of the Platonic metaphor of an alphabet of nature, with a consequent belief in the relatively small number of ultimate principles to be determined, and of Plato's conception of Division, cleared of its dialectical associations and used experimentally in application to his own molecular physics. True it is that the rejection of all the co-species is a long process, but what if therein their simultaneous or subsequent determination is helped forward? They, too, must fall to be determined sometime, and the ideal of science is fully to determine all the species of the genus. This will need co-operative effort as is described in the account of Solomon's House in the *New Atlantis.* But once introduce the conception of division of labour as between the collector of data on the one hand and the expert of method, the interpreter of nature at headquarters on the other, and Bacon's attitude to hypothesis and to negative reasoning is at least in part explained. The hypothesis of the collector, the man who keeps a rain-gauge, or the missionary among savages, is to be discounted from as a source of error. The expert on the other hand may be supposed, in the case of facts over which he had not himself brooded in the course of their acquisition, to approach them without any presumption this way or that. He will, too, have no interest in the isolation of any one of several co-ordinate inquiries. That Bacon underestimates the importance of selective and of provisional explanatory hypotheses even in such fields as that of chemistry, and that technically he is open to some criticism from the point of view that negative judgment is derivate as necessarily resting on positive presuppositions, may be true enough. It seems, however, no less true that the greatness of his conception of organized common effort in science has but rarely met with due appreciation.

In his doctrine of *forms,* too, the "universals" of his logic, Bacon must at least be held to have been on a path which led forward and not back. His forms are principles whose function falls entirely within knowledge. They are the formulae for the control of the activities and the production of the qualities of bodies. Forms are qualities and activities expressed in terms of the ultimates of nature, *i.e.,* normally in terms of collocations of matter or modes of motion. (The human soul is still an exception.) Form is bound up with the molecular structure and change of structure of a body, one of whose qualities or activities it expresses in wider relations. A mode of motion, for instance, of a certain definite kind, is the form of heat. It is the recipe for, and at the same time is, heat, much as H_2O is the formula for and is water. Had Bacon analysed bodies into their elements instead of their qualities and ways of behaviour, he would have been the logician of the chemical formula. Here, too, he has scarcely received his meed of appreciation.

His influence on successors has rather lain in the general stimulus of his enthusiasm for experience, or in the success with which he represents the cause of nominalism, and in certain special devices of method handed down, till through Hume or Herschel they affected the thought of Mill. For the rest he was too Aristotelian, if we take the word broadly enough, or, as the result of his Cambridge studies, too Ramist, when the interest in scholastic issues was fading, to bring his original ideas to a successful market.

Bacon's Logic, then, like Galilei's, intended as a contribution to scientific method, a systematization of discovery by which, given the fact of knowledge, new items of knowledge may be acquired, failed to convince contemporaries and successors alike of its efficiency as an instrument. It was an ideal that failed to embody itself and justify itself by its fruits. It was otherwise with the mathematical instrument of Galilei.

Descartes stands in the following of Galilei. It is concurrently with signal success in the work of a pioneer in the mathematical advance that he comes to reflect on method, generalizes the method of mathematics to embrace knowledge as a whole, and raises the ultimate issues of its presuppositions. In the mathematics we determine complex problems by a construction link by link from axioms and simple data clearly and distinctly conceived. Three moments are involved. The first is an *induction, i.e.,* an exhaustive enumeration of the simple elements in the complex phenomenon under investigation. This resolution or analysis into simple, because clear and distinct, elements may be brought to a standstill again and again by obscurity and indistinctness, but patient and repeated revision of all that is included in the problem should bring the analytic process to fruition. It is impatience, a perversity of will, that is the cause of error. Upon the analysis there results *intuition* of the simple data. With Descartes intuition does not connote givenness, but its objects are evident at a glance when induction had brought them to light. Lastly we have *deduction,* the determination of the most complex phenomena by a continuous synthesis or combination of the simple elements. Synthesis is demonstrative and complete. It is in virtue of this view of derived or mediate knowledge that Descartes speaks of the (subsumptive) syllogism as "of avail rather in the communication of what we already know." Syllogism is not the synthesis which together with analysis goes to constitute the new instrument of science. The celebrated *Regulae* of Descartes are precepts directed to the achievement of the new methodological ideal in any and every subject matter, however reluctant.

D. MODERN LOGIC

I. THE LOGIC OF EMPIRICISM

Hobbes.—With Hobbes logic is a calculus of marks and signs in the form of names. Naming is what distinguishes man from the brutes. It enables him to fix fleeting memories and to communicate with his fellows. He alone is capable of truth in the due conjunction or disjunction of names in propositions. Syllogism is simply summation of propositions, its function being communication merely. Analysis is the sole way of invention or discovery. There is more, however, in Hobbes, than the paradox of nominalism. Spinoza could draw upon him for the notion of genetic definition. Leibniz probably owes to him the thought of a calculus of symbols, and the conception of demonstration as essentially a chain of definitions. His psychological account of syllogism is taken over by Locke. Hume derived from him the explanatory formula of the association of ideas, which is, however, still with Hobbes a fact to be accounted for, not a theory to account for facts, being grounded physically in "coherence of the matter moved." Finally Mill took from him his definition of cause as sum of conditions, which played no small part in the applied logic of the 19th century.

Locke.—Locke's logic comprises, amid much else, a theory of general terms and of definition, a view of syllogism, and a declaration as to the possibility of inference from particular to particular, a distinction between propositions which are certain but trifling, and those which add to our knowledge though uncertain, and a doctrine of mathematical certainty. As to the first, "words become general by being made the signs of general ideas, and ideas become general by separating from them" all "that may determine them to this or that particular existence. By this way of abstraction they are made capable of representing more individuals than one." This doctrine has found no acceptance. Not from the point of view for which idea means image. Berkeley, though at length the *notions* of spirits, acts and relations give him pause, prefers the formula which Hume expresses in the phrase that "some ideas are particular in their nature but general in their representation," and the after-history of "abstraction" is a discussion of the conditions under which one idea "stands for" a group. Not from those for whom general ideas mean schematic concepts, not imageable. The critic from this side has little difficulty in showing that abstraction of the kind alleged still leaves the residuum particular, *this* redness, *e.g.,* not *redness.* It is, however, of the sorts constituted by the representation which his abstraction makes possible that definition is given, either by enumeration of the simple ideas combined in the significance of the sortal name, or "to save the labour of enumerating," and "for quickness and despatch sake," by giving the next wider general name and the proximate difference. We define essences of course in a sense, but the essences of which men talk are abstractions, "creatures of the understanding." Man determines the sorts or nominal essences, nature the similitudes. The fundamentally enumerative character of the process is clearly not cancelled by the recognition that it is possible to abbreviate it by means of technique. So long as the relation of the nominal to the real essence has no other background than Locke's doctrine of perception the conclusion that what Kant afterwards calls analytical judgments a priori and synthetic judgments a posteriori exhaust the field follows inevitably, with its corollary, which Locke himself has the courage to draw, that the natural sciences are in strictness impossible. Mathematical knowledge is not involved in the same condemnation, solely because of the "archetypal" character, which, not without indebtedness to Cumberland, Locke attributes to its ideas. The reality of mathematics, equally with that of the ideals of morals drawn from within, does not extend to the "ectypes" of the outer world. The view of reasoning which Locke enunciates coheres with these views. Reasoning from particular to particular, *i.e.,* without the necessity of a general premise, must be possible, and the possibility finds warranty in a consideration of the psychological order of the terms in syllogism. As to syllogism specifically, Locke in a passage which has an obviously Cartesian ring, lays down four stages or degrees of reasoning, and points out that syllogism serves us in but one of these, and that not the all-important one of finding the intermediate ideas. He is prepared readily to "own that all right reasoning may be reduced to Aristotle's form of syllogism," yet holds that "a man knows first, and then he is able to prove syllogistically." The distance from Locke to Stuart Mill along this line of thought is obviously but small.

Hume.—Apart from the adoption by Hume of the association of ideas as the explanatory formula of the school—it had been allowed by Malebranche within the framework of his mysticism and employed by Berkeley in his theory of vision—there are few fresh notes struck in the logic of sensationalism. The most notable of these are Berkeley's treatment of "abstract" ideas and Hume's change of front as to mathematical certainty. What, however, Hume describes as "all the *logic* I think proper to employ in my reasoning," viz., his "rules by which to judge cause and effects," had, perhaps, farther-reaching historical effects than either. In these the single method of Bacon is already split up into separate modes. We have Mill's inductive methods in the germ, though with an emphasis which is older than Mill's Bacon's *form* has already in transmission through Hobbes been transmuted into *cause* as antecedent in the time series. It may, perhaps, be accounted to Hume for righteousness that he declares —whether consistently or not is another matter—that "the same effect never arises but from the same cause," and that he still follows Bacon in the conception of *absentia in proximo*. It is "when in any instance we find our expectation disappointed" that the effect of one of "two resembling objects" will be like that of the other that Hume proposes to apply his method of difference.

J. S. Mill.—Mill's *System of Logic* marked a fresh stage in the history of empiricism. Mill aspired after a doctrine of method such as should satisfy the needs of the natural sciences, notably experimental physics and chemistry as understood in the first half of the 19th century, and *mutatis mutandis,* of the moral sciences naturalistically construed. In uniting with this the Associationism which he inherited, through his father, from Hume, he revealed at once the strength and weakness of the dual conception of naturalism. His rare thoroughness and rarer candour made it at once unnecessary and impossible that the work should be done again.

If judged by what he denies, viz., the formal logic of Hamilton and Mansel, whose Aristotelian and scholastic learning did but accentuate their traditionalism, and whose acquiescence in consistency constituted in Mill's view a discouragement of research, such as men now incline to attribute at the least equally to Hume's idealism, Mill is only negatively justified. If judged by his positive contribution to the theory of method he may claim to find a more than negative justification for his teaching in its success. In the field covered by scholastic logic Mill is frankly associationist. He aims at describing what he finds given, without reference to insensible implications of doubtful validity and value. The upshot is a psychological account of what from one aspect is evidence, from the other, belief. So he explains "concept or general notions" by an abstraction which he represents as a sort of alt-relief operated by attention and fixed by naming, association with the name giving to a set of attributes a unity they otherwise lack. This is manifestly, when all is said, a particular psychological event, a collective fact of the associative consciousness. It can exercise no organizing or controlling function in knowledge. So, again, in determining the "import" of propositions, it is no accident that in all save existential propositions it is to the familiar rubrics of associationism—co-existence, sequence, causation and resemblance—that he refers for classification, while his general formula as to the conjunctions of connotations is associationist through and through. It follows consistently enough that inference is from particular to particular. Mill holds even the ideas of mathematics to be hypothetical, and in theory knows nothing of a non-enumerative or non-associative universal. A premise that had the utmost universality consistent with this view can clearly be of no service for the establishment of a proposition that has gone to the making of it. Nor again of one that has not. Its use, then, can only be as a memorandum. It is a shorthand formula of registration. Mill's view of ratiocinative process clearly stands and falls with the presumed impossibility of establishing the necessity for universals of another type than his, for what may be called principles of construction. His critics incline to press the point that association itself is only intelligible so far as it is seen to depend on universals of the kind that he denies.

In Mill's inductive logic, the nominalistic convention has, through his tendency to think in relatively watertight compartments, faded somewhat into the background. Normally he thinks of what he calls phenomena no longer as psychological groupings of sensations, "states of mind," but as things and events in a physical world howsoever constituted and apprehended. His free use of relating concepts, that of sameness, for instance, bears no impress of his theory of the general notion, and it is possible to put out of sight the fact that, taken in conjunction with his nominalism, it raises the whole issue of the possibility of the equivocal generation of formative principles from the given contents of the individual consciousness, in any manipulation of which they are already implied. Equally, too, the deductive character, apparently in intention as well as in actual fact, of Mill's experimental methods fails to recall the point of theory that the process is essentially one from particular to particular. The nerve of proof in the processes by which he establishes causal conjunctions of unlimited application is naturally thought to lie in the special canons of the several processes and the axioms of universal and uniform causation which form their background. The conclusions seem not merely to fall within, but to depend on these organic and controlling formulae. They follow not merely according to them but from them. The reference to the rule is not one which may be made and normally is made as a safeguard, but one which must be made, if thought is engaged in a forward and constructive movement at all. Yet Mill's view of the function of "universal" propositions had been historically suggested by a theory—Dugald Stewart's—of the use of axioms. Once more, it would be possible to forget that Mill's ultimate laws or axioms are not in his view intuitions, nor forms constitutive of the rational order, nor postulates of all rational construction, were it not that he has made the endeavour to establish them on associationist lines. It is because of the failure of this endeavour to bring the technique of induction within the setting of his Humian psychology of belief that the separation of his contribution to the applied logic of science from his sensationism became necessary, as it happily was easy. Mill's device rested special inductions of causation upon the laws that every event has a cause, and every cause has always the same effect. It rested these in turn upon a general induction enumerative in character of enormous and practically infinite range and always uncontradicted. Though obviously not exhaustive, the unique extent of this induction was held to render it competent to give practical certainty or psychological necessity. A vicious circle is obviously involved. It is true, of course, that ultimate laws need discovery, that they are discovered in some sense in the medium of the psychological mechanism, and that they are nevertheless the grounds of all specific inferences. But that truth is not what Mill expounds, nor is it capable of development within the limits imposed by the associationist formula.

It is deservedly, nevertheless, that Mill's applied logic has retained its pride of place amid what has been handed on, if in modified shape, by writers, *e.g.,* Sigwart and Bernard Bosanquet whose theory of knowledge is quite alien from his. He prescribed regulative or limiting formulae for research as it was actually conducted in his world. His grasp of the procedure by which the man of science manipulated his particular concrete problem was admirable. In especial he showed clear understanding of the functions of hypothesis and verification in the investigations of the solitary worker, with his facts still in course of accumulation, and needing to be lighted up by the scientific imagination. He was therefore enabled to formulate the method of what Bacon had tended to despise as merely the "first vintage." Bacon spent his strength upon a dream of organization for all future discovery. Mill was content to codify. The difference between Bacon and Mill lies chiefly in this, and it is because of this difference that Mill's contribution, spite of its debt to the Baconian tradition, remains both characteristic and valuable. It is of course possible to criticize even the experimental canons with some severity. The caveats, however, which are relevant within the circle of ideas within which Mill's lesson can be learned and improved on, seem to admit of being satisfied by relatively slight modifications in detail, or by explanations often supplied or easily to be supplied from points brought out amid the wealth of illustration with which Mill accompanied his formal or systematic exposition of method. The critic has the right of it when he points out, for example, that the practical difficulty in the Method of Agreement is not due to plurality of causes, as Mill states, but rather to intermixture of effects, while, if the canon could be satisfied exactly, the result would not be rendered uncertain in the manner or to the extent he supposes. Again the formula of the Joint-Method, which contemplates the enumeration of cases "which have nothing in common but the absence of one circumstance," is ridiculously unsound as it stands. Or, on rather a different line of criticism, the use of corresponding letters in the two series of antecedents and consequents, raises, it is said, a false presumption of correlation. Nay, even the use of letters at all suggests that the sort of analysis that actually breaks up its subject-matter is universally or all but universally applicable in nature, and this is not the case. Finally, the conditions of the methods are either realized or not. If they are realized the work of the scientist falls entirely within the field of the processes preliminary to the satisfaction of the canon. The latter becomes a mere memorandum or formula of registration. So is it possible "to have the engineer hoist with his own petard." But the conditions are not realized and in an experiential subject-matter are not realizable. Not one circumstance only in common, but "apparently one relevant circumstance only in common" is what we are able to assert. If we add the qualification of relevance we destroy the cogency of the method. If we fail to add it, we destroy the applicability.

The objections turn on two main issues. One is the exaggeration of the possibilities of resolution into separate elements that is due to the acceptance of the postulate of an alphabet of nature. This so soon as noted can be allowed for. It is to the combination of this doctrine with a tendency to think chiefly of experiment, of the controlled addition or subtraction of these elements one at a time, that we owe the theoretically premature linking of a as effect to A as cause. This too can be met by a modification of form. The other issue is perhaps of more significance. It is the oscillation which Mill manifests between the conception of his formula as it is actually applicable to concrete problems in practice, and the conception of it as an expression of a theoretical limit to practical procedure. Mill seems most often to think of the former, while tending to formulate in terms of the latter. At any rate, if relevance *in proximo* is interpolated in the peccant clause of the canon of the Joint-Method, the practical utility of the method is rehabilitated. So, too, if the canon of the Method of Agreement is never more than approximately satisfied, intermixture of effects will in practice mean that we at least often do not know the cause or antecedent equivalent of a given effect, without the possibility of an alternative. Finally, it is on the whole in keeping with Mill's presuppositions to admit even in the case of the method of difference that in practice it is approximative and instructive, while the theoretical formula, to which it aims at approaching asymptotically as limit, if exact, is in some sense sterile. Mill may well have himself conceived his methods as practically fruitful and normally convincing with the limiting formula in each case more cogent in form but therewith merely the skeleton of the process that but now pulsed with life.

Enough has been said to show why the advance beyond the letter of Mill was inevitable while much in the spirit of Mill must necessarily affect deeply all later experientialism. After Mill experientialism takes essentially new forms. In part because of what Mill had done. In part also because of what he had left undone. After Mill means after Kant and Hegel and Herbart, and it means after the emergence of evolutionary naturalism. Mill, then, marks the final stage in the achievement of a great school of thought.

II. THE LOGIC OF RATIONALISM

Spinoza.—A fundamental contrast to the school of Bacon and Locke is afforded by the great systems of reason, owning Cartesian inspiration, which are identified with the names of Spinoza and Leibniz. Spinoza's philosophy is expounded *ordine geometrico* and with Euclidean cogency from a relatively small number of definitions, axioms and postulates. But how we reach our assurance of the necessity of these principles is not made specifically clear. The invaluable tractate *De Intellectus emendatione,* in which the agreement with and divergence from Descartes on the question of method could have been fully elucidated, is unhappily not finished. We know that we need to pass from what Spinoza terms *vague experience,* where imagination with its fragmentary apprehension is liable to error and neither necessity nor impossibility can be predicated, right up to *intellection.* And what Spinoza has to say of the requisites of definition and the marks of intellection makes it clear that insight comes with coherence, and that the work of method on the "inductive" side is by means of the unravelling of all that makes for artificial limitation to lay bare what can then be seen to exhibit nexus in the one great system. When all is said, however, the geometric method as universalized in philosophy is rather used by Spinoza than expounded.

Leibniz.—With Leibniz, on the other hand, the logical problem holds the foremost place in philosophical enquiry. From the purely logical thesis, developed at quite an early stage of his thinking, that in any true proposition the predicate is contained in the subject, the main principles of his doctrine of Monads are derivable with the minimum of help from his philosophy of dynamics. *Praedicatum inest subjecto.* All valid propositions express in the last resort the relation of predicate or predicates to a subject, and this Leibniz holds after considering the case of relational propositions where either term may hold the position of grammatical subject, $A=B$ and the like. There is a subject, then, or there are subjects which must be recognized as not possible to be predicated, but as absolute. For reasons not purely logical Leibniz declares for the plurality of such subjects. Each contains all its predicates: and this is true not only in the case of truths of reason, which are necessary, and ultimately to be exhibited as coming under the law of contradiction, "or, what comes to the same thing, that of identity," but also in the case of truths of fact which are contingent, though a sufficient reason can be given for them which "inclines" without importing necessity. The extreme case of course is the human subject. "The individual notion of each person includes once for all what is to befall it, world without end," and "it would not have been our Adam but another, if he had had other events." Existent subjects containing eternally all their successive predicates in the time-series are substances, which when the problems connected with their activity or, dynamically speaking, their force, have been resolved, demand—and supply—the metaphysic of the Monadology.

Complex truths of reason or essence raise the problem of definition, which consists in their analysis into simpler truths and ultimately into simple—*i.e.,* indefinable ideas, with primary principles of another kind—axioms, and postulates that neither need nor admit of proof. These are identical in the sense that the opposite contains an express contradiction. In the case of non-identical truths, too, there is a priori proof drawn from the notion of the terms, "though it is not always in our power to arrive at this analysis" so that the question arises, specially in connection with the possibility of a calculus, whether the contingent is reducible to the necessary or identical at the ideal limit.

Leibniz's remaining legacy to later logicians is the conception of *Characteristica Universalis* and *Ars Combinatoria,* a universal denoting by symbols and a calculus working by substitutions and the like. The two positions that a subject contains all its predicates, and that all non-contingent propositions, *i.e.*, all propositions not concerned with the existence of individual facts ultimately analyse out into identities—obviously lend themselves to the design of this algebra of thought, though the mathematician in Leibniz should have been aware that a significant equation is never an identity. Leibniz, fresh from the battle of the calculus in the mathematical field, and with his conception of logic, at least in some of its aspects, as a generalized mathematic, found a fruitful inspiration, harmonizing well with his own metaphysic, in Bacon's alphabet of nature. He, too, was prepared to offer a new instrument. That the most important section, the list of forms of combination, was never achieved—this, too, was after the Baconian example while the mode of symbolization was crude with $a=ab$ and the like—matters little. A new technique of manipulation—it is, of course, no more—had been evolved.

III. KANT'S AND POST-KANTIAN LOGIC

Kant.—Kant's treatment of technical logic was wholly traditional, and in itself is almost negligible. It is comprised in an early essay on the mistaken subtlety of the syllogistic figures, and a late compilation by a pupil from the introductory matter and running annotations with which the master had enriched his interleaved lecture-room copy of Meyer's *Compendium* of 1752. Wolff's general logic, "the best," said Kant, "that we possess," had been abridged by Baumgarten and the abridgement then subjected to commentation by Meyer. With this traditional body of doctrine Kant was, save for matters of minor detail, quite content. Logic was of necessity formal, dealing as it must with those rules without which no exercise of the understanding would be possible at all. Upon abstraction from all particular methods of thought these rules were to be discerned a priori or without dependence on experience by reflection solely upon the use of the understanding in general. The science of the form of thought abstracted in this way from its matter or content was regarded as of value both as a propaedeutic and as canon. It was manifestly one of the disciplines in which a position of finality was attainable. Aristotle might be allowed, indeed, to have omitted no essential point of the understanding. What the moderns had achieved consisted in an advance in accuracy and methodical completeness. "Indeed, we do not require any new discoverers in logic," said the discoverer of a priori synthesis, "since it contains merely the form of thought." Applied logic is merely psychology, and not properly to be called logic at all. The technical logic of Kant, then, justifies literally a movement among his successors in favour of a formal conception of logic with the law of contradiction and the doctrine of formal implication for its equipment. Unless the doctrine of Kant's "transcendental logic" must be held to supply a point of view from which a logical development of quite another kind is inevitable, Kant's mantle, so far as logic is concerned, must be regarded as having fallen upon the formal logicians.

The Formal Logicians, of whom Twesten and H. L. Mansel may be regarded as typical, take thought and "the given" as self-contained units which, if not in fact separable, are at any rate susceptible of an abstraction the one from the other so decisive as to constitute an ideal separation. The laws of the pure activity of thought must be independently determined, and since the contribution of thought to knowledge is form, they must be formal only. They cannot go beyond the limits of formal consistency or analytical correctness. They are confined to the determination of what the truth of any matter of thought, taken for granted upon grounds psychological or other, which are extraneous to logic, includes or excludes. The unit for logic is the concept taken for granted. The function of logic is to exhibit its formal implications and repulsions. It is questionable whether even this modest task could be really achieved without other reference to the content abstracted from than Mansel, for example, allows. The analogy of the resolution of a chemical compound with its elements which is often on the lips of those who would justify the independence of thought and the real world, with an agnostic conclusion as to non-phenomenal or trans-subjective reality, is not really applicable. The oxygen and hydrogen, for example, into which water may be resolved are not in strictness indifferent one to the other, since both are members of an order regulated according to laws of combination in definite ratios. Or, if applicable, it is double-edged. Suppose oxygen to be found only in water. Were it to become conscious, would it therefore follow that it could infer the laws of a separate or independent activity of its own? Similarly forms of thinking, the law of contradiction not excepted, have their meaning only in reference to determinate content, even though distributively all determinate contents are dispensable. The extreme formalist is guilty of a fallacy of composition in regard to abstraction.

It does not follow, however, that the laws asserted by the formal logicians are invalid or unimportant. There is a permissible abstraction, and in general they practise this, and although they narrow its range unduly, it is legitimately to be applied to certain characters of thinking. As the living organism includes something of mechanism—the skeleton, for example—so an organic logic doubtless includes determinations of formal consistency. The skeleton is meaningless apart from reference to its function in the life of an organism, yet there are laws of skeleton structure which can be studied with most advantage if other characters of the organism are relegated to the background. To allow, however, that abstraction admits of degrees, and that it never obliterates all reference to that from which it is abstracted, is to take a step forward in the direction of the correlation of logical forms with the concrete processes of actual thinking. What was true in formal logic tended to be absorbed in the correlationist theories.

Herbart.—The brief logic of Herbart is altogether formal, too. Logical forms have for him neither psychological nor metaphysical reference. We are concerned in logic solely with the systematic clarification of concepts which are wholly abstract, so that they are not merely not ultimate realities, but also in no sense actual moments of our concrete thinking. The first task of logic is to distinguish and group such concepts according to their marks, and from their classification there naturally follows their connection in judgment. It is in the logic of judgment that Herbart inaugurates a new era. He is not, of course, the first to note that even categorical judgments do not assert the realization of their subject. That is a thought which lies very near the surface for formal logic. He had been preceded, too, by Maimon in the attempt at a reduction of the traditional types of judgment. He was, however, the first whose analysis was sufficiently convincing to exorcise the tyranny of grammatical forms. The categorical and disjunctive judgment reduce to the hypothetical. By means of the doctrine of the quantification of the predicate, in which with his Leibnizian conception of identity he anticipated Beneke and Hamilton alike, universal and particular judgments are made to pull together. Modal, impersonal, existential judgments are all accounted for. Only the distinction of affirmative and negative judgments remains unresolved, and the exception is a natural one from the point of view of a philosophy of pluralism. There was little left to be done here save in the way of an inevitable *mutatis mutandis,* even by Lotze and F. H. Bradley. From the judgment viewed as hypothetical we pass by affirmation of the antecedent or denial of the consequent to inference. This point of departure is noteworthy, as also is the treatment of the inductive syllogism as one in which the middle term is resoluble into a group or series (*Reihe*). In indicating specifically, too, the case of conclusion from a copulative major premise with a disjunctive minor, Herbart seems to have suggested the cue for Sigwart's exposition of Bacon's method of exclusions.

Herbart exercised a far-reaching influence in the development of later logic. Directly he affected a school of thought which contained one logician of first-rate importance in Drobisch. In less direct relation stands Lotze, who, although under other influences he developed a different view even in logic, certainly let no point in the doctrine of his great predecessor at Göttingen escape him. A Herbartian strain is to be met with also in the thought of writers much farther afield, for example F. H. Bradley, far though his metaphysic is removed from Herbart's. Herbart's influence is to be found, too, in the evolution of what is called *Gegenstandstheorie.*

Lotze.—As a logician Lotze stands among the masters. His *flair* for the essentials in his problem, his subtlety of anaylsis, his patient willingness to return upon a difficulty from a fresh and still a fresh point of view, and finally his fineness of judgment, make his logic so essentially logic of the present and of its kind not soon to be superseded, that nothing more than an indication of the historical significance of some of its characteristic features need be attempted here.

In Lotze's pure logic it is the Herbartian element that tends to be disconcerting. Logic is formal. Its unit, the logical concept, is a manipulated product and the process of manipulation may be called abstraction. Processes of the psychological mechanism lie below it. The paradox of the theory of judgment is due to the ideal of identity, and the way in which this is evaded by supplementation to produce a non-judgmental identity, followed by translation of the introduced accessories with conditions in the hypothetical judgment is thoroughly in Herbart's manner. The reduction of judgments is on lines already familiar. Syllogism is no instrumental method by which we compose our knowledge, but an ideal to the form of which it should be brought. It is, as it were, a schedule to be filled in, and is connected with the disjunctive judgment as a schematic setting forth of alternatives, not with the hypothetical, and ultimately the apodictic judgment with their suggestion that it is the real movement of thought that is subjected to analysis. Yet the resultant impression left by the whole treatment is not Herbartian. The concept is accounted for in Kantian terms. There is no discontinuity between the prelogical or sub-logical conversion of impressions into "first universals" and the formation of the logical concept. Abstraction proves to be synthesis with compensatory universal marks in the place of the particular marks abstracted from. Synthesis as the work of thought always supplies, besides the mere conjunction or disjunction of ideas, a ground of their coherence or noncoherence. It is evident that thought, even as dealt with in pure logic, has an objectifying function. Its universals have objective validity, though this does not involve direct real reference. The formal conception of pure logic, then, is modified by Lotze in such a way as not only to be compatible with a view of the structural and functional adequacy of thought to that which at every point at which we take thinking is still distinguishable from thought, but even inevitably to suggest it. That the unit for logic is the concept and not the judgment has proved a stumbling-block to those of Lotze's critics who are accustomed to think in terms of the act of thought as unit. Lotze's procedure is, indeed, analogous to the way in which, in his philosophy of nature, he starts from a plurality of real beings, but by means of a reductive movement, an application of Kant's transcendental method, arrives at the postulate or fact of a law of their reciprocal action, which calls for monistic and idealist interpretation. He starts, that is, in logic, with conceptual units apparently self-contained and admitting of nothing but external relation, but proceeds to justify the intrinsic relation between the matter of his units by appeal to the fact of the coherence of all contents of thought. Indeed, if thought admits irreducible units, what can unite? Yet he is left committed to his puzzle as to a reduction of judgment to identity, which partially vitiates his treatment of the theory of judgment. The outstanding feature of this is, nevertheless, not affected, viz., the attempt that he makes, inspired clearly by Hegel "to develop the various forms of judgment systematically as members of a series of operations, each of which leaves a part of its problem unmastered and thereby gives rise to the next." As to inference, finally, the ideal of the articulation of the universe of discourse, as it is for complete knowledge, when its disjunctions have been thoroughly followed out and it is exhaustively determined, carried the day with him against the view that the organon for gaining knowledge is syllogism. The Aristotelian formula is "merely the expression, formally expanded and complete, of the truth already embodied in disjunctive judgment, namely, that every S which is a specific form of M possesses as its predicate a particular modification of each of the universal predicates of M to the exclusion of the rest." Schleiermacher's separation of inference from judgment and his attribution of the power to knowledge in process cannot find acceptance with Lotze. The psychologist and the formal logician do indeed join hands in the denial of a real movement of thought in syllogism. Lotze's logic, then, is formal in a sense in which a logic which does not find the conception of synthetic truth embarrassing is not so. It is canon and not organon. In the one case, however, where it recognizes what is truly synthesis, *i.e.*, in its account of the concept, it brings the statics of knowledge, so to speak, into integral relation with the dynamics. And throughout, wherever the survival from 1843, the identity bug-bear, is for the moment got rid of in what is really a more liberal conception, the statical doctrine is developed in a brilliant and informing manner. Yet it is in the detail of his logical investigations, something too volatile to fix in summary, that Lotze's greatness as a logician more especially lies.

With Lotze the ideal that at last the forms of thought shall be realized to be adequate to that which at any stage of actual knowledge always proves relatively intractable is an illuminating projection of faith. He takes courage from the reflection that to accept scepticism is to presume the competence of the thought that accepts. He will, however, take no easy way of parallelism. Our human thought pursues devious and circuitous methods. Its forms are not unseldom scaffolding for the house of knowledge rather than the framework of the house itself. Our task is not to realize correspondence with something other than thought, but to make explicit those justificatory notions which condition the form of our apprehension. "However much we may presuppose an original reference of the forms of thought to that nature of things which is the goal of knowledge, we must be prepared to find in them many elements which do not directly reproduce the actual reality to the knowledge of which they are to lead us." The impulse of thought to reduce coincidence to coherence reaches immediately only to objectivity or validity. The sense in which presupposition of a further reference is to be interpreted and in which justificatory notions for it can be adduced is only determinable in a philosophic system as a whole, where feeling has a place as well as thought, value equally with validity.

Lotze's logic then represents the statical aspect of the function of thought in knowledge, while, so far as we go in knowledge thought is always engaged in the unification of a manifold which remains contradistinguished from it, though not, of course, completely alien to and unadapted to it. The further step to the determination of the ground of harmony is not to be taken in logic, where limits are present and untranscended.

Hegel.—The so-called "Logic" of Hegel and of other German idealists belongs to the history of Metaphysics rather than to the history of Logic properly so called.

IV. LOGIC FROM 1880–1928

The logic of this period exhibits, though in characteristically modified shapes, all the main types that have been found in its past history. There is an intellectualist logic coalescent with an absolutist metaphysic as aforesaid. There is an epistemological logic with sometimes formalist, sometimes methodological leanings. There is a formal-symbolic logic engaged with the elaboration of a relational calculus. Finally, there is what may be termed psychological-voluntaryist logic. It is in the rapidity of development of logical investigations of the third and fourth types and the growing number of their exponents that the present shows most clearly the history of logic in the making. All these movements are logic of the present, and a very brief indication may be added of points of historical significance.

Bradley.—Of intellectualist logic Bradley (*Principles of Logic* 1883) and Bernard Bosanquet (*Logic,* 1888) may be taken as typical exponents. The philosophy of the former concludes to an Absolute by the annulment of contradictions. His metaphysical method is, like Herbart's, not identifiable with his logic, and the latter has for its central characteristic its thorough restatement of the logical forms traditional in language and the text-book in such a way as to harmonize with the doctrines of a reality whose organic unity is all-inclusive. The thorough recasting that this involves, even of the thought of the masters when it occasionally echoes them, has resulted in a phrasing uncouth to the ear of the plain man with his world of persons and things in which the former simply think about the latter, but it is fundamentally necessary for Bradley's purpose. The negative judgment, for example, cannot be held in one and the same undivided act to presuppose the unity of the real, project an adjective as conceivably applicable to it and assert its rejection. We need, therefore, a restatement of it. With Bradley reality is the one subject of all judgment immediate or mediate. The act of judgment "which refers an ideal content (recognized as such) to a reality beyond the act" is the unit for logic. Grammatical subject and predicate necessarily both fall under the rubric of the adjectival, that is, within the logical idea or ideal content asserted. This is a meaning or universal which can have no detached or abstract self-subsistence. As found in judgment it may exhibit differences within itself, but it is not two, but one, an articulation of unity, not a fusion which could only be a confusion, of differences. With a brilliant subtlety Bradley analyses the various types of judgment in his own way, with results that must be taken into account by all subsequent logicians of this type. The view of inference with which he complements it is only less satisfactory because of a failure to distinguish the principle of nexus in syllogism from its traditional formulation and rules, and because he is hampered by the intractability which he finds in certain forms of relational construction.

In the new edition of his *Principles* (1922) Bradley repudiates his previous assumption of ideas divorced from judgments, and of judgments divorced from inferences. The concrete conceptual fact is inference, of which mere ideas and simple judgment are abstractions. Inference is the ideal self-development of a given object taken as real. The given object is an ideal content before us, and it is taken to be real as being in one with reality, or the real universe. The possibility of inference rests upon the fact that the object is not only itself, but is also contained as an element in a whole; in fact, it *is* itself only as being so contained. From the nature of the case inference must always be incomplete, and subject to unknown conditions. But this ultimate problem does not concern Logic.

Bosanquet is, perhaps, more able than Bradley has shown himself, to use material from alien sources and to penetrate to what is of value in the thought of writers from whom he disagrees. He treats the book-tradition, however, with a judicious exercise of freedom in adaptation, *i.e.,* constructively as datum, never eclectically. In his fundamental theory of judgment his obligation is to Bradley. It is to Lotze, however, that he owes most in the characteristic feature of his logic, viz., the systematic development of the types of judgment and inference from less adequate to more adequate forms. His fundamental continuity with Bradley may be illustrated by his definition of inference. "Inference is the indirect reference to reality of differences within a universal, by means of the exhibition of this universal in differences directly referred to reality."

In the new edition of his *Logic* (1911) Bosanquet defends at length his metaphysical absolutism and the coherence theory of Truth. No finite individual is self-dependent or self-contained, that is, a real substance. Even the self finds its reality in something beyond itself. Hence absolutism. But an individual not self-complete can be predicated of the whole of which it is a part. With regard to Truth he maintains that Truth is its own criterion, and can only be tested by more of itself. Any system can be tested further only by being made more complete. The coherence theory of Truth is further elaborated by Bosanquet in his *Implication and Linear Inference* (1920). All inference, it is maintained therein, is of the same type, namely, implication. The essence of implication is interrelation between the parts of a system (or concrete universal), which makes modification in some parts clues to the modification of others. Syllogistic inference, he says, is linear, not systematic, and therefore not true inference. In true inference we survey a system of facts, see it in its relation to the whole of reality, and read off the implications. The inference is immediate if we can read off the implications directly; it is mediate if we must construct this system first. The starting point of all inference is the realization that to deny the truth of *all* propositions would involve self-contradiction, as it would deny this very denial. We must consequently believe *some* propositions, even if we question the truth of this or that proposition. In true inference we transfer our certainty that *some* propositions are true to the truth of the proposition inferred. In the last resort, all inferences may be reduced to the alternatives. "Either this proposition is true, or no proposition is." Within the system from which we start we read off conclusions the denial of which would shatter the whole world of our experience.

Sigwart.—Of epistemological logic in one sense of the phrase, Lotze is still to be regarded as a typical exponent. Of another type Chr. Sigwart may be named as representative. Sigwart's aim was to "reconstruct logic from the point of view of methodology." His problem was the claim to arrive at propositions universally valid, and so true of the object, whosoever the individual thinker. His solution within the Kantian circle of ideas, was that such principles as the Kantian principle of causality were justified as "postulates of the endeavour after complete knowledge." What Kant has shown is not that irregular fleeting changes can never be the object of consciousness, but only that the ideal consciousness of complete science would be impossible without the knowledge of the necessity of all events. "The universal presuppositions which form the outline of our ideal of knowledge are not so much laws, which the understanding prescribes to nature . . . as laws which the understanding lays down for its own regulation in its investigation and consideration of nature. They are a priori because no experience is sufficient to reveal or confirm them in unconditional universality; but they are a priori . . . only in the sense of presuppositions without which we should work with no hope of success and merely at random and which therefore we must believe." Finally they are akin to our ethical principles. With this coheres his dictum, with its far-reaching consequences for the philosophy of induction, that "the logical justification of the inductive process rests upon the fact that it is an inevitable postulate of our effort after knowledge, that the given is necessary and can be known as proceeding from its grounds according to universal laws." It is characteristic of Sigwart's point of view that he acknowledges obligation to Mill as well as to Ueberweg. The transmutation of Mill's inductions into a postulate is an advance of which the psychological school of logicians have not been slow to make use. The comparison of Sigwart with Lotze is instructive, in regard both to their agreement and their divergence as showing the range of the epistemological formula.

Johnson.—The most ambitious of recent works on Logic is that of W. E. Johnson (3 vols. 1921–4, vol. 4 to follow). Johnson attempts to combine the epistemological with the empirical view of Logic. Logic, he holds, is concerned with the analysis and criticism of thought, and it is impossible to draw a rigid distinction between Logic and Philosophy, or between Logic and Science. Thought has two aspects, an epistemic and a constitutive aspect. The constitutive consists of the content of knowledge; the epistemic is that which depends on the variable conditions and capacities for the acquisition of knowledge. The unit of logic is the proposition, of which truth or falsity can be significantly predicated, and of which the intensive aspect is the most important. "Implication" is potential inference, and assumes different relations in different cases. There are two principles of deduction:—The applicative principle states that *All S is P* warrants the inference of *The given S is P;* (2) the implicative principle states that a compound proposition of the form *"x" and "x implies y"* warrants the inference of *"y."* The syllogism involves both principles. These principles require universal premises and these are obtained by *induction,* a term which he applies to every process of reaching a generalization from instantial premises. He enumerates four types of induction, namely (1) *intuitive,* (2) *summary,* (3) *demonstrative* and (4) *probable.* Of these the last corresponds to ordinary empirical induction; and the second is the old "perfect" induction. *Intuitive* induction is the process by which we obtain the principles of Logic, of Mathematics, etc. These are obtained by reflection on particular instances in one of two ways:—(1) the *counter-applicative* way, when we see that what is true of a given instance is true of any other instance; (2) the *counter-implicative* way, when, having made an inference which is valid we see that its validity is due to a certain form of relation between the premises and the conclusion. *Demonstrative* induction includes certain types of hypothetical syllogism in which an instantial premise leads to a universal conclusion, and the familiar canons of induction, reformulated by him as four "figures" of agreement, difference, composition and resolution. Under *probable* inductions he distinguishes *pure generalization* from *class-fractional inductions,* which are usually known as statistical generalizations. From all these forms of induction he distinguishes *eduction,* the argument from "certain instances of S which are M are P" to "the next S that is M will also be P." The discussion of many psychological and philosophical problems is a feature of Johnson's *Logic.*

New Principles, etc.—The above accounts of Bradley, Bosanquet and Johnson contain references to new formulations or reformulations of various logical principles and types of inference. In this connection reference may also be made to E. E. C. Jones's *New Law of Thought* (1918) which reformulates the old Law of Identity in the form of a "Law of Significant Association" (according to which every Subject of Predication is an identity of denotation in diversity of intension) and to A. Wolf's *Essentials of Logic,* and *Essentials of Scientific Method* (1925, 1926) in which there are formulated the "Principle of Uniformity of Reasons" (namely, whatever is regarded as a sufficient reason in any one case must be regarded as a sufficient reason in all cases of the same type), and a number of types of inference which had not been formulated before.

Symbolic Logic.—Of symbolic logic all that needs to be said here is, that from the point of view of logic as a whole, it is to be regarded as a legitimate praxis as long as it shows itself aware of the sense in which form alone is susceptible of abstraction, and is aware that in itself it offers no solution of the logical problem. "It is not an algebra," said Kant of his technical logic, and the kind of support lent recently to symbolic logic by the *Gegenstandstheorie* identified with the name of Alexius Meinong (b. 1853) is qualified by the warning that the real activity of thought tends to fall outside the calculus of relations and to attach rather to the subsidiary function of denoting. The future symbolic logic as coherent with the rest of logic, in the sense which the word has borne throughout its history, seems to be bound up with the question of the nature of the analysis that lies behind the symbolism and of the way in which this is justified in the setting of a doctrine of validity. The "theory of the object" itself, while affecting logic alike in the formal and in the psychological conception of it very deeply, does not claim to be regarded as logic or a logic, apart from a setting supplied from elsewhere.

Pragmatist Logic.—Finally we have a logic of a type fundamentally psychological, if it be not more properly characterized as a psychology which claims to cover the whole field of philosophy, including the logical field. The central and organizing principle of this is that knowledge is in genesis, that the genesis takes place in the medium of individual minds, and that this fact implies that there is a necessary reference throughout to interests or purposes of the subject which thinks because it wills and acts. Historically this doctrine was formulated as the declaration of independence of the insurgents in revolt against the pretensions of absolutist logic. It drew for support upon the psychological movement that begins with Fries and Herbart. It has been chiefly indebted to writers who were not, or were not primarily, logicians, to Avenarius, for example, for the law of the economy of thought, to Wundt, whose system, and therewith his logic, is a pendant to his psychology, for the volitional character of judgment, to Herbert Spencer and others. A judgment is practical and not to be divorced without improper abstraction from the purpose and will that informs it. A concept is instrumental to an end beyond itself, without any validity other than its value for action. A situation involving a need of adaptation to environment arises and the problem it sets must be solved that the will may control environment and be justified by success. Truth is the improvised machinery that is interjected, so far as this works. It is clear that we are in the presence of what is at least an important half-truth, which intellectualism with its statics of the rational order viewed as a completely articulate system has tended to ignore. It throws light on many phases of the search for truth, upon the plain man's claim to start with a subject which he knows, whose predicate which he does not know is still to be developed, or again upon his use of the negative form of judgment, when the further determination of his purposive system is served by a positive judgment from without, the positive content of which is yet to be dropped as irrelevant to the matter in hand. The movement has, however, scarcely developed its logic except as a polemic. What seems clear is that it cannot be the whole solution. While man must confront nature from the human and largely the practical standpoint, yet his control is achieved only by the increasing recognition of objective controls. He conquers by obedience. So truth works and is economical because it is truth. Working is proportioned to inner coherence. It is well that the view should be developed into all its consequences. The result will be to limit it, though perhaps also to justify it, save in its claim to reign alone.

BIBLIOGRAPHY.—Prantl's *Geschichte der Logik* (4 vols. 1885–70, re-issued 1926) gives a full account of the history of logic to the close of the Middle Ages; Harms's *Geschichte der Logik* (1881) brings the history up to Leibniz; Ueberweg's *System der Logik* (4th ed. 1874, Eng. Transl. 1871) and T. Ziehen's *Lehrbuch der Logik* (1920) contain historical sketches. *See* also the bibliographies under LOGIC, LOGISTIC, SCIENTIFIC METHOD and KNOWLEDGE, THEORY OF.

(H. W. BL.; A. WO.)

LOGISTIC is not a special branch of logic for it is the realization of the ideal of logic, the exhibition of form. The word "logistic" is an old name revived with a new meaning to denote what has been variously referred to as "symbolic logic," "algebra of logic," "mathematical logic" and "algorithmic logic." These different terms are, however, not exact synonyms. Symbolic logic is the study of the various types of deductions; it is distinguished from the special branches of pure mathematics by its generality. It uses symbols, but this is not its distinctive characteristic, for other sciences use symbols. The generality of symbolic logic is due to the fact that it is based upon a few fundamental, undefined concepts, called "primitives," and upon one or more fundamental postulates, called "primitive propositions" from which everything asserted is deduced. An "algebra of logic" denotes a special set of postulates and primitive concepts, so that there are various algebras differing with respect to the fundamental notions employed. "Mathematical logic" is concerned with the logistic development of mathematics from the fewest possible number of primitive concepts and primitive propositions. In the widest sense of the term, Logistic may be said to be the science of the most general principles of deduction, expressed in ideographic symbols, and developed so as to exhibit the interconnection of these principles.

Ideographic Symbols.—Ordinary language is not only ambiguous, it is also vague and insusceptible of precise analysis. It confounds those distinctions upon which exact reasoning must be based, and is thus often simple when the ideas involved are complex. Consequently civilized languages are well-suited to express complicated facts briefly but are ill-adapted to express simple notions simply. For example, the Commutative Laws, "$a+b=b+a$," "$ab=ba$," would, if expressed in ordinary language, be absurdly prolix. It is, therefore, impossible to carry out complicated processes of deduction without the aid of symbols specially devised to simplify the operations required. Symbols may be used merely to abbreviate the writing of ordinary words, but the utility of such symbols is slight. The S,M,P, used in expositions of the traditional syllogism were probably at the outset mere shorthand devices. Nevertheless, even these symbols suggest the importance for logic of form as such, since there is abstraction from the particular meanings for which S,M, or P, might stand. Abstraction is necessary in order to secure generality; hence, the importance of this device.

A satisfactory logical symbolism must satisfy two different kinds of conditions. First, the symbols must be as concise as possible, so that they can be easily comprehended at a glance; secondly, the symbols must be such as to facilitate the deduction of conclusions according to a mechanical process in which thinking is reduced to a minimum. The symbols must, in other words, provide a calculus of reasoning, *i.e.*, an instrument for economizing thought, so that difficult operations can be performed without the trouble of thinking about them. The importance of good symbolism is revealed in the development of mathematics which has, throughout, been conditioned by the adequacy of the symbols it employs. An adequate set of symbols both presupposes analysis of the fundamental ideas and aids further analysis. Ideograms, which directly represent concepts, are better fitted than phonograms to fulfil these requirements. Although conciseness is in practice indispensable, all that is logically necessary is that the symbols should be exact and unique. The purpose of these ideographic symbols is not to translate words already in use, but to denote unambiguously explicit concepts, involving no reference to any special subject-matter. Their use, therefore, marks the achievement of the ideal of form, which it is the purpose of logic to exhibit.

The Generalization of Logic.—To be completely formal is to be completely general. Consequently there are various degrees of approximation to this ideal of form. Aristotle's theory of the syllogism is the earliest attempt to exhibit the formal principles of deduction. It suffers from three main defects: (1) its restriction to a single mode of deduction, the syllogism; (2) its failure to symbolize the relations involved; (3) its defective analysis of these relations. The recognition of non-syllogistic modes of deduction, combined with the attempt to use symbols as the basis of operations, led to rapid elaboration of symbolic systems; whilst the distinction and analysis of the different relations employed in deduction made possible that logistic development of mathematics that marks the culmination of the ideal of form.

It is not difficult to see that the familiar syllogism: "All men are mortal, Socrates is a man, therefore Socrates is mortal" is not a logically simple form. Nor did even the traditional logic assert the conclusion but only the fact that the premises jointly imply the conclusion. It must then, first, be restated in the form: "If all men are mortal and Socrates is a man, then Socrates is mortal." Now it is clear that the validity of the reasoning does not depend upon the fact that *Socrates* is mentioned. It would do just as well if we substituted Plato, or Newton, or any other individual. Thus what we are asserting is a relation between "being a man" and "being a mortal." We can, therefore, replace "Socrates" by a symbol, x, denoting an undetermined individual. Such a symbol is called a variable. Let us write for the second premise "$\hat{x}$ is a man." Here x denotes an empty place to be filled with an appropriate individual. Such an expression as "x is a man" is called a propositional function. It becomes a proposition when the name of an individual is substituted for $\hat{x}$; it will be a true proposition if the individual is human. A similar analysis applies to "Socrates is mortal" which is of the same form. But "all men are mortal" is not of the same form, since it asserts a relation between all the individuals that are human and all those that are mortal. It is thus a compound proposition and requires analysis into "'$\hat{x}$ is a man' implies '$\hat{x}$ is mortal' no matter what x may be." Thus we see that the copula "are" in the major premise denotes a different relation from the copula "is" in the minor premise. The difference may be provisionally stated by saying that "all men are mortal" asserts a relation between the class *men* and the class *mortals*, whereas "Socrates is a man" asserts that a given individual belongs to a class. Confusion between these relations is hardly to be avoided so long as we rely for our analysis upon the verbal expression of these propositions. The separation between these two forms cannot be clearly effected until an adequate symbolism is devised. Such a symbolism will, at the same time, afford a basis of operations.

The Logical Calculus.—The canonical forms of the Aristotelian syllogism reveal an attempt to employ symbols to test the validity of the reasoning involved. We have seen that these symbols were inadequate so that the forms were not completely analysed. The purpose of a calculus is to state the premises in ideographic symbols in such a manner that all the conclusions implied can be drawn in accordance with rules of transformation analogous to those of mathematical operations. Thus thought is economized and accuracy ensured. In the first attempts to develop an adequate symbolism certain formal analogies with mathematical operations were stressed, sometimes with unfortunate results. The foundations of such an algebra of logic were laid down by George Boole (1815–64); it has been subsequently developed by Ernst Schroeder (1841–1902), Charles Saunders Peirce (1839–1914), Louis Couturat (1868–1914) and Mrs. Ladd-Franklin. Its transformation into an instrument for the logical analysis of mathematical concepts was not achieved until Peano invented a non-algebraic notation. This development cannot be followed in detail. All that can be attempted here is to give some account of certain fundamental notions employed in the subsequent logical analysis. We begin with the unanalysed concept of a class as a set of individual objects. Let us select from the universe of conceivable objects all those that are lawyers. This is the class "lawyers." In the same way, select the class "knights." It is assumed that the combination of two classes will itself be a class. There are two essential modes of combining classes, represented by the conjunctions "and" and "or." Thus we may form the class of those objects that are "lawyers and knights." This is the class "knighted lawyers." Obviously this mode of combination is analogous to mathematical multiplication. Hence, "knighted lawyers" is called the *logical product* of "knights" and "lawyers." Again, we may form the class of those objects that are either "knights" or "lawyers"; or of those who are either "solicitors" or are "barristers" and so on. Thus for example we obtain the class "solicitors or barristers." This mode of operation is obviously analogous to mathematical addition. Hence the class "solicitors or barristers" is called the *logical sum* of "solicitors" and "barristers." These two operations may be defined as follows:

The *logical product* of two classes is the class included in each of them and including every class included in each.

The *logical sum* of two classes is the class including each of them and included in every class including them.

In these definitions we have assumed the unanalysed concept of the relation of one class to another which contains it. This is analogous to the relation of part to whole. We may then say, somewhat metaphorically, that the logical product of two classes (x and y) is the *largest* class including them both; whereas their logical sum is the *smallest* class including them both. It is not necessary to assume that the elements of the logical sum should be exclusive. Following the mathematical analogies, we may represent the logical product of x and y by "$x \times y$" or by "xy"; and their logical sum by "$x+y$." Bearing in mind that these operations are to be completely formal, therefore completely general, we see that the symbols x and y must represent *any* classes. Also "xy" and "$x+y$" must also represent classes. But these may be classes the elements of which have no objects in common. Hence, since no objects are found in both classes, their logical product will be a class with no members. For example, the product of "squares" and "circles" is the class "squared circles." But there are no squared circles; hence, this is a class with no members. Or again, the product of "living beings" and "temples" is a class with no members. It follows, therefore, that in order to secure complete generality, we must admit the notion of an empty class, *i.e.*, a class with no members. This is called the "null-class." Let us represent the null-class by 0, standing for nothing. Clearly "$x+0=x$." Hence, from the above definition of the logical sum it follows that the null-class is contained in every class. Again, "$x \times 0=0$." That is, whatever x may be, the class "$x \times 0$" is the class containing both x and nothing. But what is both x and nothing is nothing. It is easy to see that the only class that remains unaltered no matter what class is selected from it is the class with no members, *i.e.*, the null-class.

Again following the mathematical analogies, we see that "$x \times 1=x$." From the above definition of the logical product of two classes, we see that, if x represents *any* class, "$x \times 1$" must represent that class which contains the individuals common to x and to 1. Hence, 1 represents the universe of conceivable objects, since this is the only class in which all the individuals in *any* class are contained. That is to say, any class x is contained in 1.

Inclusion and Implication.—So far we have been concerned only with the calculus of classes, and we have assumed the relation of "inclusion in." Boole constructed his calculus by means of the relation "equals." But we shall see that *equality* is not fundamental, for it can be defined in terms of *inclusion in.* The calculus of classes can be interpreted as a calculus of propositions if the literal symbols, x, y, etc., are regarded as the class of moments at which a proposition is true, or is false. Thus "$x=0$" would mean "x is false"; "$x=1$" would mean "x is true." There are, however, certain formal differences between the calculus of classes and the calculus of propositions, which makes their complete identification impossible. These differences cannot be discussed here. All that we can do is to show the bearing of this twofold interpretation upon the relations between propositions. We take as the fundamental relation "inclusion in." This is a primitive idea; hence, it is indefinable. Its meaning, therefore, can only be indicated. The relation "is included in" is frequently represented by $<$, owing to its formal analogy with "is less than." It is important to remember that $<$ as used in the logical calculus is an ideographic symbol and must not be translated as "less than." If now, we take x, y, etc., as representing classes, then "$x<y$" signifies that the class x is contained in, or makes part of, the class y. Hence, "$x<y$" can be read: "All the x's are y's."

Like "less than," $<$ has the important property of being asymmetrical. We can now see that "$=$" can be defined in terms of $<$, as follows:

$$\text{“}a=b \cdot = : a<b \cdot b<a\text{”}\ Df.$$

This definition affords a good example of logistic method. It must be observed that the symbol "$=$" which connects the two sides of the identity is not the same symbol as the "$=$" which connects a and b; for to the second $=$ belongs the symbol "*Df*" written at the end. That is, the symbol "$\ldots\ldots = \ldots\ldots Df$" must be taken as a whole. It signifies "is equivalent by definition." We shall see that this convention is of great importance in the development of logistic. The dot between "a<b" and "b<a" signifies the conjoint assertion of these two relations. This is analogous to the logical product of two classes. We see then, that the single relation "$=$" is equivalent to the simultaneous relation "a<b" and "b<a." The formal properties of equality can be deduced from this definition. Thus, for example, that it is symmetrical follows from the fact that it involves the conjunction of a relation and its converse. (*See* CONVERSION.) Again since, $<$ is transitive, and $=$ is defined in terms of $<$, it follows that $=$ is transitive. Thus we see that the properties of the defined relation "$=$" can be deduced from the properties of the fundamental relation. This fundamental relation, called *inclusion* for classes, is called *subsumption* for concepts, and *implication* for propositions. If now we substitute for x and y not the classes a and b, but the propositions p and q, then we read "p<q" as "p implies q." We can now define the equivalence of propositions in the same form as the equality of classes. Representing "is equivalent to" by "$\equiv$," we have:

$$\text{“}p\equiv q \cdot = \cdot p<q \cdot q<p\text{”}\ Df.$$

This can be read: "'p is equivalent to q' is the defined equivalent of 'p implies q' and 'q implies p'."

On the propositional interpretation of the calculus, p and q can have only the values 0 and 1, *i.e.*, "false" and "true." It must be borne in mind that we are throughout dealing with an extensional calculus. It follows that p is equivalent to q when, and only when, both are true, or both are false. These are called the truth-values of p and q. Thus the truth-value of p is *truth* when p is true, and falsehood when p is false. We here introduce an assumption that is not required in the calculus of classes but is required for the calculus of propositions, viz., that "The proposition, p, is equivalent to 'p is true'." Given that "not-p" is equivalent to "p is false," we have "$p=0 \cdot \equiv \cdot \text{not-}p=1$." It is convenient to write "$-p$" for "not-p," *i.e.*, for "p is false."

Now, we have seen that the null-class is contained in any class, x; and that any class, x, is contained in the universe 1. Symbolising this relation of inclusion by $<$, we have the following results:

$$0<x,\ x<1.\ 0<0,\ 1<1.$$

We can now state these results on the propositional interpretation. Let p and q represent any two propositions. Then if both are false, $p=q$ (*i.e.*, $p=0$; and $q=0$); if both are true, $p=q$ (*i.e.*, $p=1$, and $q=1$). In either of these cases p can be substituted for q, since we are concerned only with their truth-values, *i.e.*, their extensions. We can now rewrite the four combinations given above, in a form convenient for the propositional interpretation:

$$\text{(i) } -p<q;\ \text{(ii) } p<q;\ \text{(iii) } -p<-q;\ \text{(iv) } p<q.$$

Here $<$ denotes "implies." Thus we see from (i) that a false proposition implies any true proposition; and from (iii) that a false proposition implies any false proposition. Hence, *a false proposition implies any other proposition, true or false.* This is an inevitable consequence of the fact that the null-class is contained in every class. From (ii) and (iv) we see that a true proposition, q, is implied by any true proposition p, and from (i) that q is implied by any false proposition. Hence, *a true proposition is implied by any proposition.* The consequences given in italics are known as the "paradoxes of implication." They are not, however, paradoxes, but are the inevitable consequences of the extensional point of view of the calculus. The appearance of paradox is due to the confusion between implication and inference.

Propositional Functions and Descriptions.—So far, following the method of Boole, Peirce and Schroeder, we have taken the calculus of classes as fundamental and have interpreted it as applying either to classes or to propositions. This twofold interpretation has awkward results which cannot be discussed here. A more satisfactory method is to make the calculus of propositions fundamental and to derive the calculus of classes from it. This is the method developed by Bertrand Russell. Following his line of approach, we can now deal more precisely with the notion of a propositional function referred to above. A propositional function is an expression containing one or more variables, and is such that when appropriate values are substituted for the variables, it expresses a proposition. Thus "$\phi\hat{x}$" is a propositional function if the substitution of any symbol denoting an individual for x results in a proposition. For example, the substitution of the symbol A, representing a definite individual, in the function "$\hat{x}$ is a man," yields the determinate proposition "A is a man." It will be true if A is in fact the name of a man, false if A is not the name of a man. Individuals such as A,B,C, etc., which can be substituted for x in "$\hat{x}$ is a man" so as to make the resulting propositions true are the set of individuals satisfying the function. These are clearly the set of individuals who are human, *i.e.*, the class of *men.* Thus a class is the extension of a propositional function involving one variable. That is, it is the set of values which satisfy the function, and the function is a method of collecting together all the propositions in which the names of these individuals occur.

It must be noted that a proposition is true, or it is false. But a propositional function is always true, or sometimes true. This notion of being "always true" is quite different from being "true," for it means "true in all cases," whereas there are no cases of a proposition. It is this fact that gives rise to difficulty in the propositional interpretation of the class calculus. Let us write "$\phi\hat{x}$ always" for "$\phi\hat{x}$ is always true." Then, just as "$-p$" means "p is false," so "$-\phi\hat{x}$ always" means "$\phi\hat{x}$ is always false." Similarly, "$-\phi\hat{x}$ sometimes" means "$\phi\hat{x}$ is sometimes false."

We can now define the logical product and the logical sum of sets of propositions:

The *logical product* of a set of propositions is a propositional function that is always true, *i.e.*, true for all values of the variable.

The *logical sum* of a set of propositions is a propositional function that is sometimes true, *i.e.*, true for one or more values of the variable.

Russell employs the following convenient notation:

"$(x) \cdot \phi\hat{x}$" expresses "For all values of x, ϕx," *i.e.*, the logical product. "$(\exists x) \cdot \phi\hat{x}$" expresses "For some value of x, ϕx," *i.e.*, the logical sum. Thus, if ϕ represents "is mortal," then "$(x) . \phi\hat{x}$" would mean "Everything is mortal"; whilst "$(\exists x) \cdot \phi\hat{x}$" would mean "There is something which is mortal." Again, "ϕSocrates" would mean "Socrates is mortal."

Similarly, "(x)-$\phi\hat{x}$" asserts that "$\phi\hat{x}$ is always false." Hence, there is no set of values satisfying the function "$\phi\hat{x}$." Thus a propositional function that is always false determines the null-class.

We have so far assumed that the symbols that can be substituted for x in "ϕx" are *names, i.e.,* symbols for individuals. It is easy to see that there is an important difference between *names* and symbols which do not name an individual, but *describe* it, *e.g.,* "the oldest inhabitant," "the author of Waverley" and so on. Russell calls such symbols "definite descriptions" and he compares them with such symbols as "a man," "an author," which are called "indefinite descriptions." Thus a *definite description* is of the form "*the so-and-so*"; an *indefinite description* is of the form "*a so-and-so.*" The distinction between a name and a definite description is important. A name must be the name of *something*; that is, a name must have application. But a description need not apply, and in that case the propositional function in which the description occurs will be false. Thus "the author of the *Iliad*" will be a description that describes nothing, unless one, and only one, person wrote the *Iliad.* In this way we see that such phrases as "the author of Waverley," "the most perfect Being," "the man in the Moon" do not simply *name* individuals, but are descriptions which may, or may not, apply. It is clear that this analysis of descriptive phrases has an important bearing upon such traditional philosophical arguments as the ontological proof.

Just as every description of the form "The author of *Waverley*" has been falsely supposed to apply to something, so every grammatically correct sentence has been supposed to be significant. Hence arose certain difficulties known as "vicious-circle difficulties." To avoid these difficulties Bertrand Russell developed the theory of types. Very briefly we may state the theory as follows. It had been generally supposed that, given a function "$(x) \cdot \phi\hat{x}$," any values could be substituted for x, and that the result would be a significant proposition whether true or false. But Russell suggested that the difficulties could be avoided, if the values were restricted to those of a certain type, appropriate to the function. If an inappropriate value were substituted the result would be, not a false, but a meaningless proposition. As developed by Russell the theory of types avoided the contradiction of the vicious-circle difficulties, but itself depended upon the Axiom of Reducibility, which in turn gave rise to serious difficulties. The whole matter is too controversial to be dealt with here. A method which dispenses with the Axiom of Reducibility has been suggested by Frank P. Ramsey.

The Two Forms of Syllogism.—We can now see the exact nature of the distinction between the two premises of the syllogism that we considered before. "All men are mortal" asserts that for all values of the variables one propositional function implies another; whereas "Socrates is mortal" asserts that "Socrates" is a value that satisfies a given propositional function, *i.e.,* is a member of the class defined by the propositional function. This distinction was first recognized by *Gottlob Frege* and *Guiseppe Peano,* the second of whom denoted the relation of an individual to the class of which it is a member by ϵ. Let α denote a class. Then "$x\epsilon\alpha$" means "x is a member of the class α." We can now define the inclusion of one class in another in terms of implication. At this point we must distinguish "is included in" from "implies." Keeping $<$ for "implies," we will denote "is included in" by $\supset$. Then we obtain the following definition of "the class α is included in the class β."

$$\alpha \supset \beta : = \cdot x\epsilon\alpha <_x \cdot x\epsilon\beta \quad Df.$$

Here the subscript x has the same meaning as (x), viz. it means "for all values of x." Now write α for "men," β for "mortals" and x for "Socrates." Then we have:

$$\alpha \supset \beta \cdot x\epsilon\alpha <_x \cdot x\epsilon\beta \qquad (1)$$

Here we have made explicit the distinction between the two premises. Now consider the syllogism, "all men are mortal, all mortals are fallible, therefore all men are fallible." Using the same symbols as before and adding γ to denote the class of "fallible beings" the syllogism can be stated:

$$\alpha \supset \beta \cdot \beta \supset \gamma \cdot < \cdot \alpha \supset \gamma \qquad (2)$$

Again we see that the two syllogisms are of different forms. Syllogism (1) and (2) could be written in the notation of propositional functions as follows:

$$(x) \cdot \phi x < \psi x : \phi\gamma : < \psi\gamma \qquad (1)$$

$$(x) \cdot \phi x < \psi x : (x)\psi x < \psi\chi : < (x)\phi x < \chi x \qquad (2)$$

Here again the notation makes the distinction explicit.

The Calculus of Relations.—The earlier symbolic logicians made little, or no, attempt to deal with relations. Yet their importance is obvious. Most propositions of everyday life express relations between two or more terms, *e.g.,* "Brutus killed Caesar," "Peter gave Paul a sum of money for a reward," etc. Still keeping to the extensional point of view, we can see that relations can be regarded as a class of ordered couples, a class of ordered trios, etc. That is, just as a class is the set of values satisfying a propositional function involving one variable, so a relation is the set of values satisfying a propositional function involving two or more variables. Relations have, however, some properties which have no analogues for classes. These properties are of the utmost importance in the logistic development of mathematics, but they cannot be discussed here (*see* MATHEMATICS, FOUNDATIONS OF).

THE LOGISTIC DEVELOPMENT OF MATHEMATICS

Symbolic Logic and Mathematics.—Once symbolic logic was freed from its dependence upon the forms of ordinary algebra, it became an instrument of precision for the analysis of fundamental concepts. Moreover, in achieving its ideal of generality, logic and mathematics have become indistinguishable. That is to say, all the fundamental concepts of mathematics are defined in terms which are involved in any complicated process of thought, and are thus seen not to depend upon any specific notion such as that of discrete and continuous magnitude, as had been traditionally supposed. This position has been established in the only way in which it could have been established, viz., by the detailed working out of mathematics from purely logical concepts. This achievement is mainly due to the work of Frege, Peano, Russell and Whitehead, but it has recently been carried to a more satisfactory completion by Ludwig Wittgenstein and Frank P. Ramsey.

The method consists in the development of a system in which all the assumptions involved are made explicit, and all other propositions are deduced from these assumptions by the process of substituting for variables values of those variables, and by the use of defined equivalents. Frege laid the foundations of this logical analysis in the *Grundlagen der Arithmetik* (1884), *Grundgesetze der Arithmetik* (1893–1903) and various important articles in periodicals. In the latter book Frege developed arithmetic from purely logical premises. But his notation was so difficult that his work remained almost without influence upon subsequent investigators. Peano began in 1894 the publication of the *Formulaire de Mathématique,* in which he elaborated a symbolism fitted to perform the required analysis of fundamentals. Russell, using the notation of Peano, and basing his work upon the logical analysis of Frege, produced in 1910, in collaboration with Whitehead, the *Principia Mathematica,* which may be said to mark an epoch in the development of logistic. In this work we find an extreme logical rigour which results in a detailed analysis of *all* the concepts of mathematics. The advance on Peano consists in the fact that no postulates are required except those of logic; hence, the independence of various mathematical branches is no longer required. It is impossible here to do more than indicate the method employed.

In this system the negation of p, symbolised by "$\sim$p," which is read, "p is false," is taken as a primitive idea. Hence, we have p and $\sim$p. In order that deduction may be possible, there must be such a relation between one proposition and another that, if we know that the first is true, we can infer that the second is true. That is, we assume the fundamental principle "whatever is implied by a true proposition is true." Let p and q be two propositions between which this relation holds. Then we can state this relation as follows: "Either p is false or q is true." This is the logical sum of $\sim p$ and q. It is called *disjunction.* Assuming this relation as a second primitive idea, we can now define "implication" in terms of these two primitive ideas: *disjunction* and *negation*. Disjunction is symbolised by $\vee$. Hence, "$p \vee q$" means "either p or q." Thus we get:

$$“p < q \cdot = \cdot \sim p \vee q \ Df.”$$

This is the relation that holds between two propositions when it is not the case that the first is true and the second false. It is usually called "material implication." It is important to observe that this relation is not equivalent to formal deducibility. That is to say, from "$p < q$" we are not justified in asserting that it follows that "p can be inferred from q." In order that this latter relation should hold we need also the assertion that p is true. Thus, from "$p.p < q$" we can infer "q"; but from "$p < q$" alone we can only infer that it is not the case that p is true and q false. If this fact be remembered, the confusion between implication and inference, which gives rise to the appearance of paradox, will be avoided. Important though this relation of inferribility is, it is not required in the logistic development of mathematics.

It has been seen that in the system of *Principia Mathematica*, the relation of material implication is not assumed, but defined.

It must be noted that "definition" is not itself a primitive idea. A symbol, or set of symbols, is defined when some other set of symbols is given which can be substituted for it. Definition is, therefore, a symbolic device; it is technically convenient but not logically necessary. Nevertheless, the substitution for a given set of symbols of defined equivalents constitutes an important element in logistic method. Whereas in the development of a mathematical system the logical principles of proof have hitherto been taken for granted, this system employs formal principles which are used both as premises in the argument and as rules of deduction. There is required in addition a non-formal principle of deduction asserting that the primitive propositions apply to all the possible values of the variable propositions that occur in their statement. This assumption makes possible the substitution of sets of special cases of the original propositions, which make explicit the consequences of these propositions. In this way the whole system is developed from one, or more, primitive ideas and a few primitive propositions which are purely logical. Thus all the propositions of arithmetic are shown to follow from the analysis, in purely logical terms, of the fundamental ideas of arithmetic. In this way mathematics is reduced to pure logic, and the achievement of the ideal of form is complete.

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LOGOCYCLIC CURVE: *see* Curves, Special.

LOGOGRAPHI, in Greek λογογράφοι, writers of λόγοι or compositions of any sort, especially in prose. (1) In Attic, professional speech-writers. (2) In modern usage (since C. F. Creuzer, d. 1858), pre-Herodotean writers of chronicles, from the doubtfully historical Cadmus of Miletus (*q.v.*) to Pherecydes (*q.v.*), all make extensive use of mythology, hence the importance of their fragments; their attempts at systematization and criticism are primitive. Their dialect is Ionic. Mention may be made of the following: Hecataeus of Miletus (550–476); Acusilaus of Argos,[1] who paraphrased in prose (correcting the tradition where it seemed necessary) the genealogical works of Hesiod; Charon of Lampsacus (*c.* 450), author of histories of Persia, Libya, and Ethiopia, of annals (ὧροι) of his native town, and of the chronicles of Lacedaemonian kings; Xanthus of Sardis in Lydia (*c.* 450), author of a history of Lydia; Hellanicus of Mytilene; Stesimbrotus of Thasos, opponent of Pericles and reputed author of a political pamphlet on Themistocles, Thucydides, and Pericles; Hippys and Glaucus, both of Rhegium, the first the author of histories of Italy and Sicily, the second of a treatise on ancient poets and musicians; Damastes of Sigeum, pupil of Hellanicus, author of genealogies of the combatants before Troy (an ethnographic and statistical list), of short treatises on poets, sophists, and geographical subjects.

Bibliography.—*Fragments*, in C. W. Müller, *Fragmenta Historicorum Graecorum*, and F. Jacoby, *Fragmente der griechischen Historiker: comment*. *See* also Christ-Schmid, Geschichte d. gr. Literatur, 6, p. 449.

LOGOS, a common term in ancient philosophy and theology. It expresses the idea of an immanent reason in the world, and, under various modifications, is met with in Indian, Egyptian and Persian systems of thought. But the idea was developed mainly in Hellenic and Hebrew philosophy, and we may distinguish the following stages:

1. **The Hellenic Logos.**—To the Greek mind, which saw in the world a κόσμος (ordered whole), it was natural to regard the world as the product of reason, and reason as the ruling principle in the world. So we find a Logos doctrine more or less prominent from the dawn of Hellenic thought to its eclipse. It rises in the realm of physical speculation, passes over into the territory of ethics and theology, and makes its way through at least three well-defined stages. These are marked off by the names of Heraclitus of Ephesus, the Stoics and Philo.

It acquires its first importance in the theories of Heraclitus (6th century B.C.), who, trying to account for the aesthetic order of the visible universe, broke away to some extent from the purely physical conceptions of his predecessors and discerned at work in the cosmic process a λόγος analogous to the reasoning power in man. On the one hand the Logos is identified with γνώμη and connected with δίκη, which latter seems to have the function of correcting deviations from the eternal law that rules in things. On the other hand it is not positively distinguished either from the ethereal fire, or from the εἱμαρμένη and the ἀναγκη according to which all things occur. Heraclitus holds that nothing material can be thought of without this Logos, but he does not conceive the Logos itself to be immaterial. Whether it is regarded as in any sense possessed of intelligence and consciousness is a question variously answered. But there is most to say for the negative. This Logos is not one above the world or prior to it, but in the world and inseparable from it. Man's soul is a part of it. It is *relation*, therefore, as Schleiermacher expresses it, or reason, not speech or word. And it is objective, not subjective, reason. Like a law of nature, objective in the world, it gives order and regularity to the movement of things, and makes the system rational.

The failure of Heraclitus to free himself entirely from the physical hypotheses of earlier times prevented his speculation from influencing his successors. With Anaxagoras a conception entered which gradually triumphed over that of Heraclitus, namely, the conception of a supreme, intellectual principle, not identified with the world but independent of it. This, however, was νοῦς, not Logos. In the Platonic and Aristotelian systems, too, the theory of ideas involved an absolute separation between the material world and the world of higher reality, and though the term Logos is found the conception is vague. With Plato the term selected for the expression of the principle to which the order visible in the universe is due is νοῦς or σοφία, not λόγος. It is in the pseudo-Platonic *Epinomis* that λόγος appears as a synonym for νοῦς. In Aristotle, again, the principle which sets all nature under the rule of thought, and directs it towards a rational end, is νοῦς, or the divine spirit itself; while λόγος is a term with many senses, used as more or less identical with a number of phrases, οὗ ἕνεκα, ἐνέργεια, ἐντελέχεια, οὐσία, εἶδος, μορφή, etc.

In the reaction from Platonic dualism, however, the Logos doctrine reappears in great breadth. It is a capital element in the system of the Stoics. With their teleological views of the world they naturally predicated an active principle pervading it and determining it. This operative principle is called both Logos and God. It is conceived of as material, and is described in terms used equally of nature and of God. There is at the same time the special doctrine of the λόγος σπερματικός, the seminal

[1]There is some doubt as to whether this Acusilaus was of Peloponnesian or Boeotian Argos. Possibly there were two of the name. For an example of the method of Acusilaus *see* Bury, *op. cit.* p. 19.

Logos, or the law of generation in the world, the principle of the active reason working in dead matter. This parts into λόγοι σπερματικοί, which are akin, not to the Platonic ideas, but rather to the λόγοι ἔνυλοι of Aristotle. In man, too, there is a Logos which is his characteristic possession, and which is ἐνδιάθετος, as long as it is a thought resident within his breast, but προφορικός when it is expressed as a word. This distinction between Logos as *ratio* and Logos as *oratio*, so much used subsequently by Philo and the Christian fathers, had been so far anticipated by Aristotle's distinction between the ἔξω λόγος and the λόγος ἐν τῇ ψυχῇ. It forms the point of attachment by which the Logos doctrine connected itself with Christianity. The Logos of the Stoics (*q.v.*) is a reason in the world gifted with intelligence, and analogous to the reason in man.

JEWISH CONCEPTS

2. **The Hebrew Logos.**—In the later Judaism the earlier anthropomorphic conception of God and with it the sense of the divine nearness had been succeeded by a belief which placed God at a remote distance, severed from man and the world by a deep chasm. The old familiar name Yahweh became a secret; its place was taken by such general expressions as the Holy, the Almighty, the Majesty on High, the King of Kings, and also by the simple word "Heaven." Instead of the once powerful confidence in the immediate presence of God there grew up a mass of speculation regarding on the one hand the distant future, on the other the distant past. Various attempts were made to bridge the gulf between God and man, including the angels, and a number of other hybrid forms of which it is hard to say whether they are personal beings or abstractions. The Wisdom, the Shekinah or Glory and the Spirit of God are intermediate beings of this kind and even the Law came to be regarded as an independent spiritual entity. Among these conceptions that of the Word of God had an important place, especially the creative Word of Genesis i. Here, as in the other cases, we cannot always say whether the Word is regarded as a mere attribute or activity of God, or an independent being, though there is a clear tendency towards the latter. The ambiguity lies in the twofold purpose of these activities: (1) to establish communication with God; (2) to prevent direct connection between God and the world. The word of the God of revelation is represented as the creative principle (*e.g.* Gen. i. 3; Psalm xxxiii. 6), as the executor of the divine judgments (Hosea vi. 5), as healing (Psalm cvii. 20), as possessed of almost personal qualities (Isaiah lv. 11; Psalm cxlvii. 15). Along with this comes the doctrine of the angel of Yahweh, the angel of the covenant, the angel of the presence, in whom God manifests Himself and who is sometimes identified with Yahweh or Elohim (Gen. xvi. 11, 13; xxxii. 29–31; Exod. iii. 2; xiii. 21), sometimes distinguished from Him (Gen. xxii. 15, etc.; xxiv. 7; xxviii. 12, etc.), and sometimes presented in both aspects (Judges ii., vi.; Zech. i.). To this must be added the doctrine of Wisdom, given in the books of Job and Proverbs. At one time it is exhibited as an attribute of God (Prov. iii. 19). At another it is strongly personified, so as to become rather the creative thought of God than a quality (Prov. viii. 22). Again it is described as proceeding from God as the principle of creation and objective to Him. In these and kindred passages (Job xv. 7, etc.) it is on the way to become hypostatized.

The Hebrew conception is partially associated with the Greek in the case of Aristobulus, the predecessor of Philo, and, according to the fathers, the founder of the Alexandrian school. He speaks of Wisdom in a way reminding us of the book of Proverbs. The pseudo-Solomonic *Book of Wisdom* (generally supposed to be the work of an Alexandrian flourishing somewhere between Aristobulus and Philo) deals both with the Wisdom and with the Logos. It fails to hypostatize either. But it represents the former as the framer of the world, as the power or spirit of God, active alike in the physical, the intellectual and the ethical domain and apparently objective to God. In the Targums, on the other hand, the three doctrines of the word, the angel and the wisdom of God converge in a very definite conception. In the Jewish theology God is represented as purely transcendent, having no likeness of nature with man and making no personal entrance into history. Instead of the immediate relation of God to the world the Targums introduce the ideas of the *Mēmrā* (word) and the *Shechīnā* (real presence). This Memra (=Ma'amar) or, as it is also designated, *Dibbūrā*, is a hypostasis that takes the place of God when direct intercourse with man is in view. In all those passages of the Old Testament where anthropomorphic terms are used of God, the Memra is substituted for God. The Memra proceeds from God and retains the creaturely relation to God. It does not seem to have been identified with the Messiah.

3. **Philo.**—In the Alexandrian philosophy, as represented by the Hellenized Jew Philo, the Logos doctrine assumes a leading place and shapes a new career for itself. Philo's doctrine is moulded by three forces—Platonism, Stoicism and Hebraism. He detaches the Logos idea from its connection with Stoic materialism and attaches it to a thorough-going Platonism. It is Plato's idea of the Good regarded as creatively active. Hence, instead of being merely immanent in the Cosmos, it has an independent existence. Platonic too is the doctrine of the divine architect who seeks to realize in the visible universe the archetypes already formed in his mind. Philo was thus able to make the Logos theory a bridge between Judaism and Greek philosophy. It preserved the monotheistic idea yet afforded a description of the Divine activity in terms of Hellenic thought; the Word of the Old Testament is one with the λόγος of the Stoics. And thus in Philo's conception the Logos is much more than "the principle of reason, informing the infinite variety of things, and so creating the World-Order"; it is also the divine dynamic, the energy and self-revelation of God. The Stoics indeed sought, more or less consciously, by their doctrine of the Logos as the Infinite Reason to escape from the belief in a divine Creator, but Philo, Jew to the core, starts from the Jewish belief in a supreme, self-existing God, to whom the reason of the world must be subordinated though related. The conflict of the two conceptions (the Greek and the Hebrew) led him into some difficulty; sometimes he represents the Logos as an independent and even personal being, a "second God," sometimes as merely an aspect of the divine activity. And though passages of the first class must no doubt be explained figuratively —for Philo would not assert the existence of two Divine agents— it remains true that the two conceptions cannot be fused. The Alexandrian philosopher wavers between the two theories and has to accord to the Logos of Hellas a semi-independent position beside the supreme God of Judaea. He speaks of the Logos (1) as the agency by which God reveals Himself, in some measure to all men, in greater degree to chosen souls. The appearances recorded in the Old Testament are manifestations of the Logos, and the knowledge of God possessed by the great leaders and teachers of Israel is due to the same source; (2) as the agency whereby man, enmeshed by illusion, lays hold of the higher spiritual life and rising above his partial point of view participates in the universal reason. The Logos is thus the means of redemption; those who realize its activity being emancipated from the tyranny of circumstance into the freedom of the eternal.

CHRISTIAN ADAPTATIONS

4. **The Fourth Gospel.**—Among the influences that shaped the Fourth Gospel that of the Alexandrian philosophy must be assigned a distinct, though not an exaggerated, importance. There are other books in the New Testament that bear the same impress, the epistles to the Ephesians and the Colossians, and to a much greater degree the epistle to the Hebrews. The development that had thus begun in the time of Paul reaches maturity in the Fourth Gospel, whose dependence on Philo appears (1) in the use of the allegorical method, (2) in many coincident passages, (3) in the dominant conception of the Logos. The writer narrates the life of Christ from the point of view furnished him by Philo's theory. True, the Logos doctrine is only mentioned in the prologue to the Gospel, but it is presupposed throughout the whole book. The author's task indeed was somewhat akin to that of Philo, "to transplant into the world of Hellenic culture a revelation originally given through Judaism." This is not to say that he holds the Logos doctrine in exactly the same form as Philo. On the contrary, the fact that he starts from an actual knowledge of

the earthly life of Jesus, while Philo, even when ascribing a real personality to the Logos, keeps within the bounds of abstract speculation, leads him seriously to modify the Philonic doctrine. Though the Alexandrian idea largely determines the evangelist's treatment of the history, the history similarly reacts on the idea. The prologue is an organic portion of the Gospel and not a preface written to conciliate a philosophic public. It assumes that the Logos idea is familiar in Christian theology, and vividly summarizes the main features of the Philonic conception—the eternal existence of the Logos, its relation to God (πρὸς τὸν θεόν, yet distinct), its creative, illuminative and redemptive activity. But the adaptation of the idea to John's account of a historical person involved at least three profound modifications:—(1) The Logos, instead of the abstraction or semi-personification of Philo, becomes fully personified. The Word that became flesh subsisted from all eternity as a distinct personality within the divine nature. (2) Much greater stress is laid upon the redemptive than upon the creative function. The latter indeed is glanced at ("All things were made by him"), merely to provide a link with earlier speculation, but what the writer is concerned about is not the mode in which the world came into being but the spiritual life which resides in the Logos and is communicated by him to men. (3) The idea of λόγος as Reason becomes subordinated to the idea of λόγος as Word, the expression of God's will and power, the outgoing of the divine energy, life, love and light. Thus in its fundamental thought the prologue of the Fourth Gospel comes nearer to the Old Testament (and especially to Gen. i.) than to Philo. As speech goes out from a man and reveals his character and thought, so Christ is "sent out from the Father," and as the divine Word is also, in accordance with the Hebrew idea, the medium of God's quickening power.

What John thus does is to take the Logos idea of Philo and use it for a practical purpose—to make more intelligible to himself and his readers the divine nature of Jesus Christ.

5. **The Early Church.**—In many of the early Christian writers, as well as in the heterodox schools, the Logos doctrine is influenced by the Greek idea. The Syrian Gnostic Basilides held (according to Irenaeus i. 24) that the Logos or Word emanated from the νοῦς or personified reason, as this latter emanated from the unbegotten Father. The completest type of Gnosticism, the Valentinian, regarded Wisdom as the last of the series of aeons that emanated from the original Being or Father, and the Logos as an emanation from the first two principles that issued from God, Reason and Truth. Justin Martyr, the first of the sub-apostolic fathers, taught that God produced of His own nature a rational power, His agent in creation, who now became man in Jesus. With Tatian the Logos is the beginning of the world, the reason that comes into being as the sharer of God's rational power. With Athenagoras He is the prototype of the world and the energizing principle of things. Theophilus taught that the Logos was in eternity with God as the counsellor of God, and that when the world was to be created God sent forth this counsellor from Himself as the λόγος προφορικός, yet so that the begotten Logos did not cease to be a part of Himself. With Hippolytus the Logos, produced of God's own substance, is both the divine intelligence that appears in the world as the Son of God, and the idea of the universe immanent in God. The early Sabellians held that the Logos was a faculty of God, the divine reason, immanent in God eternally, but not in distinct personality prior to the historical manifestation in Christ. Origen, referring the act of creation to eternity instead of to time, affirmed the eternal personal existence of the Logos. In relation to God this Logos or Son was a copy of the original and as such inferior to that. In relation to the world he was its prototype and its redeeming power.

In the later developments of Hellenic speculation nothing essential was added to the doctrine of the Logos. Philo's distinction between God and His rational power or Logos in contact with the world was generally maintained by the eclectic Platonists and Neo-Platonists. By some of these this distinction was carried out to the extent of predicating (as was done by Numenius of Apamea) three Gods:—the supreme God; the second God, or Demiurge or Logos; and the third God, or the world. Plotinus explained the λόγοι as constructive forces, proceeding from the ideas and giving form to the dead matter of sensible things.

See the histories of philosophy and theology, and works quoted under HERACLITUS; STOICS; PHILO; JOHN, THE GOSPEL OF ST., etc., and for a general summary of the growth of the Logos doctrine, E. Caird, *Evolution of Theology in the Greek Philosophers* (1904), vol. ii.; A. Harnack, *History of Dogma;* E. F. Scott, *The Fourth Gospel,* ch. v. (1906); J. M. Heinze, *Die Lehre vom Logos in der griech. Philosophie* (1872); J. Réville, *La Doctrine du Logos* (1881); Aal, *Gesch. d. Logos-Idee* (1899); and the *Histories of Dogma,* by F. Loofs, R. Seeberg. (S. D. F. S.; A. J. G.)

LOGOTHETE, originally the title of a variety of administrative officials in the Byzantine empire, *e.g.,* the λογοθέτης τοῦ δρόμου, who was practically the equivalent of the modern postmaster-general; and the λογοθέτης τοῦ στρατιωτικοῦ, the logothete of the military chest. Gibbon defines the great Logothete as "the supreme guardian of the laws and revenues," who "is compared with the chancellor of the Latin monarchies." From the Eastern empire the title was borrowed by the West, though it only became firmly established in Sicily, where the *logotheta* occupied the position of chancellor elsewhere, his office being equal if not superior to that of the *magnus cancellarius.*

See Du Cange, *Glossarium, s.v. Logotheta.*

LOGROÑO, an inland province of northern Spain, the smallest of the eight provinces formed in 1833 out of Old Castile; bounded N. by Burgos, Álava and Navarre, W. by Burgos, S. by Soria and E. by Navarre and Saragossa. Pop. (1940) 221,160; area, 1,946 sq.mi. The portion skirting the Ebro forms a spacious and for the most part fertile undulating plain, called La Rioja. In the west the Cerro de San Lorenzo, the culminating point of the Sierra de la Demanda, rises 7,562 ft., and in the south the Pico de Urbion reaches 7,388 ft. The products of the province are chiefly cereals, good oil and wine (especially in the Rioja), fruit, silk, flax and honey. Large tracts of country are covered with vines and olive groves. Iron and argentiferous lead are mined in small quantities. A railway along the right bank of the Ebro connects the province with Saragossa, and from Miranda there is railway communication with Madrid, Bilbao and France. Besides Logroño and Calahorra (*qq.v.*) the only towns with over 5,000 inhabitants are Haro (8,353), Alfaro (8,067) and Arnedo (6,008). The province fell into the hands of Francisco Franco's insurgents in the first stages of the civil war of 1936–39.

LOGROÑO, the capital of the Spanish province of Logroño, on the right bank of the river Ebro and on the Saragossa-Miranda de Ebro railway. Pop. (1940) 43,709 (mun., 46,182). The district was in ancient times inhabited by the *Berones* or *Verones* of Strabo and Pliny, and their *Varia* is identified with the modern suburb of the city of Logroño now known as Varea. Logroño was named by the Romans *Juliobriga* and afterwards *Lucronius.* It was unsuccessfully besieged by the French in 1521, and occupied by them from 1808 to 1813. Nationalists captured it during the civil war of 1936–39. Logroño is an ancient walled town, finely situated on a hill 1,204 ft. high. Its bridge of twelve arches across the Ebro was built in 1138, but has frequently been restored. The crooked but picturesque alleys of the older quarters are in striking contrast with the broad avenues and squares laid out in modern times. Commercial centre of the fertile plain of the Rioja, Logroño has an important trade in wine.

LOGROSCINO (or LO GROSCINO), **NICOLA** (1700?–1763?), Italian musical composer, was born at Naples and was a pupil of Durante. In 1738 he collaborated with Leo and others in the hasty production of *Demetrio;* in the autumn of the same year he produced a comic opera *L'inganno per inganno,* the first of a long series of comic operas, the success of which won him the name of "il Dio dell' opera buffa." He went to Palermo, probably in 1747, as a teacher of counterpoint; as an opera composer he is last heard of in 1760, and is supposed to have died about 1763. As a musical humorist, however, he deserves remembrance, and may justly be classed alongside of Rossini.

LOGUE, MICHAEL (1840–1924), Irish ecclesiastic, was born at Kilmacrenan, Co. Donegal, on Oct. 1, 1840. He was appointed professor of theology and belles-lettres at the Irish College in Paris, where he was ordained a priest in 1866. He became Bishop of Raphoe in 1879, archbishop of Armagh in 1887, and in 1893 was raised to the cardinalate. During World War I he deprecated participation by the clergy in Sinn Fein agitations, but in 1918 opposed conscription on moral grounds. In 1919 and 1921 he rigorously denounced the campaign of murder against the police and the military, at the same time criticising severely the policy and methods of the British Government. He died at Armagh on Nov. 19, 1924.

LOGWOOD, an important dyestuff for fabrics made from fibres of vegetable origin. Logwood comes into commerce in blocks weighing about 400lb., which are hard and dense and possess a brown-red colour. It was imported into Europe soon after the discovery of South America, and has been cultivated in Jamaica since the year 1715. Logwood is the heartwood of the *Haematoxylon campechianum* (family *Leguminosae*), a tree distinguished by its peculiar ribbed appearance. It is largely employed for the production of black and compound shades on woollen material, mainly in conjunction with a chromium mordant, and for the black dyeing of silk. "Logwood extract," obtained by lixiviating the freshly cut wood with water and evaporating the solution in vacuo, is manufactured in the neighbourhood of the plantations, and imported into Great Britain for dyeing purposes. Logwood contains the colouring principle *haematoxylin*, $C_{16}H_{14}O_6.3H_2O$, which was first isolated by Chevreul in 1810. This, which is not a dyestuff, when oxidized, readily passes into *haematein*, $C_{16}H_{12}O_6$, the true colouring matter, and such an oxidizing process is now applied to logwood extract, and the so-called "haematein paste" which is largely in use is a product of this character. Unaged extracts can, however, also be employed for dyeing when an oxidizing mordant is employed. The constitution of haematoxylin and haematein have been elucidated by the researches of W. H. Perkin, R. Robinson and their pupils (*Chem. Soc. Trans.*, 1902, etc.). (A. G. P.)

LOHARU, an Indian state, in the southeast corner of the Punjab. Area, 226 sq.mi.; pop. (1941) 27,892; estimated gross revenue, £9,500. The town of Loharu had a population in 1931 of 2,956.

LOHENGRIN, the hero of the German version of the legend of the knight of the swan. The story is based on two common motives: the metamorphosis of human beings into swans, and the curious wife whose question brings disaster. Lohengrin's guide (the swan) was originally the little brother who, in one version of "the Seven Swans," was compelled through the destruction of his golden chain to remain a swan. The swan played a part in classical mythology as the bird of Apollo, and in Scandinavian lore the swan maidens, who have the gift of prophecy, constantly appear. The wife's inquisitiveness is "Cupid and Psyche" again, and bore in mediaeval times a similar mystical interpretation. The incidents of "Lohengrin" are localized on the Lower Rhine. By the Germans the tale was attached loosely to the Grail legend (*see* GRAIL, THE HOLY and PERCEVAL); in France it was adapted to glorify the family of Godfrey de Bouillon.

The German story appears at the end of Wolfram von Eschenbach's *Parzival*, where Parzival's son, Loherangrîn (*i.e.*, Garin le Loherain [*q.v.*], or Garin of Lorraine) is sent from the castle of the Grail to the help of the young duchess of Brabant. Guided by the swan he reaches Antwerp, and marries the lady on condition that she shall not ask his origin. On the breach of this condition years afterwards Loherangrîn departs, leaving sword, horn and ring behind him. About 1290, a Bavarian disciple of Wolfram's developed the story into an epic of nearly 8,000 lines, incorporating episodes of Lohengrin's prowess in tournament, his wars with Henry I. against the heathen, and incidentally providing a picture of noble life. The epic of Lohengrin is put by the anonymous writer into the mouth of Wolfram, who is made to relate it during the Contest of the Singers at the Wartburg, and the poem is thus linked to German tradition. Its connection with Parzival implies a mystic application. The consecrated wafer shared by Lohengrin and the swan is the means taken by the poet to give the tale the character of a Christian allegory. The story was followed in its main outlines by Wagner in his opera.

The French legend is attached to the house of Bouillon, and though William of Tyre refers to it about 1170 as fable, it was incorporated without question by later annalists. It forms part of the cycle of the *chansons de geste* dealing with the crusade, and relates how Helyas, knight of the swan, is guided by the swan to help the duchess of Bouillon and marries her daughter Ida or Beatrix in circumstances exactly parallel to the adventures of Lohengrin and Elsa of Brabant. Their daughter marries Eustache, count of Boulogne, and has three sons, the eldest of whom, Godfrey, is the future king of Jerusalem. But in French story Helyas is not the son of Parzival, but of the king of Lillefort, and the story of his birth, of himself, his five brothers and one sister is but the fairy-tale of "the Seven Swans" persecuted by the wicked grandmother. The house of Bouillon was not alone in claiming the knight as an ancestor, and the tradition probably originally belonged to the house of Cleves.

See *Lohengrin*, ed. Rückert (Quedlinburg and Leipzig, 1858); another version of the tale, *Lorengel*, is edited in the *Zeitschr. für deutsches Altertum* (vol. 15); modern German translation of *Lohengrin*, by H. A. Junghaus (Leipzig, 1878); Conrad von Würzburg's fragmentary *Schwanritter*, ed. F. Roth (Frankfurt, 1861). *See* Elster, *Beiträge zur Kritik des Lohengrin* (Halle, 1884), and R. Heinrichs, *Die Lohengrindichtung und ihre Deutung* (Hamm i. West., 1905).

French Versions.—Reiffenberg, *Le Chevalier au cygne et Godfrey de Bouillon* (1846–48), in *Mon. pour servir à l'hist. de la province de Namur;* C. Hippeau, *La Chanson du chevalier au cygne* (1874); H. A. Todd, *La Naissance du chevalier au cygne, an inedited French poem of the 12th cent.* (Mod. Lang. Assoc., Baltimore, 1889); *cf.* the Latin tale by Jean de Haute Seille (Johannes de Alta Silva) in his *Dolopathos* (ed. Oesterley, Strasbourg, 1873).

English Versions.—In England the story first appears in a short poem preserved among the Cotton mss. of the British Museum and entitled *Chevelere assigne.* This was edited by Utterson in 1820 for the Roxburghe club, and again by Gibbs in 1868 for the E.E.T.S., with a set of photographs of a 14th-century ivory casket, on which the story is depicted in 36 compartments. An English prose romance, *Helyas Knight of the Swan*, translated by Robert Copland, and printed by W. Copland about 1550, is founded on a French romance *La Génealogie . . . de Godeffroy de Boulin* (pr. 1504) and is reprinted by Thoms in *Early Prose Romances*, vol. iii. It was also printed by Wynkyn de Worde in 1512. A modern edition was issued in 1901 from the Grolier club, New York.

LOHMANN, GEORGE ALFRED (1865–1901), English cricketer, son of Stewart Lohmann, stockbroker, was born in London on June 2, 1865, and educated at Louvain School, Wandsworth. He worked on the Stock Exchange, but in 1884 became a professional cricketer, and played for Surrey. Lohmann was at the height of his form in the years 1888–90. From 1886, for ten years, he played in the Gentlemen *v.* Players matches, and during this period three times visited Australia. It was at Sydney in 1887, 1888 and 1892, that his best bowling was seen. Surrey's position in cricket was largely due to his skill as a bowler and to his all-round excellence. In 1893 he visited South Africa for his health, but returned to play for Surrey again in 1895. The England *v.* Australia match at Lords in 1896 witnessed his last appearance in first-class cricket. He returned to South Africa, where he died at Matjesfontein on Dec. 1, 1901.

LOIN, that part of an animal lying between the upper part of the hip-bone and the last of the false ribs on either side of the backbone, hence the butcher's term for a joint of meat cut from that part of the body. The upper part of a loin of beef is known as the "surloin," commonly corrupted into "sirloin." In the plural the word is a term for the lower part of the human body at the junction with the legs, covered by the loin-cloth, the almost universal garment among primitive peoples.

LOIRE, a department of central France, made up in 1793 of the old district of Forez and portions of Beaujolais and Lyonnais, all formerly included in the province of Lyonnais. Pop. (1936) 650,226. Area 1,853 square miles. It is bounded north by the department of Saône-et-Loire, east by those of Rhône and Isère, south by Ardèche and Haute-Loire, and west by Puy-de-Dôme and Allier. From 1790 to 1793 it constituted, along with that of Rhône, a single department (Rhône-et-Loire). The river Loire rises in the department of Haute Loire to the south but traverses the department of Loire from south to north, and that department reaches west to the Mts. du Forez and east to the hills edging the Rhône valley, going beyond these to reach that river just south of Vienne. The valley floor in the south is the basin of Forez, an ancient lake floored by Tertiary strata, and the Loire, after subsequently passing through narrow defiles, enters the smaller basin of Roanne, also an old lake basin similarly floored. The hill frame is mainly formed of Archaean and Carboniferous rocks set in north-east to south-west lines to form the Mt. Pilat (4,705 ft.), Mts. du Lyonnais, Mts. du Beaujolais and Mts. du Charolais on the east, and the Mts. du Forez (Pierre sur Haute, 5,381 ft.) on the west. The climate on the heights is cold and healthy, it is unwholesome in the marshy plain of Forez, mild in the valley of the Rhône. The annual rainfall varies from 39 to 48 in. on the Forez mountains, but only reaches 20 to 24 in. in the vicinity of Montbrison. The plains of Forez and Roanne produce wheat and rye, and some oats, barley and colza. The vine is cultivated in the valley of the Rhône, on the lower slopes of the Forez mountains and on the hills west of the plain of Roanne. The forests of Mt. Pilat and the Forez chain yield good-sized pines and wood for mining purposes. The so-called Lyon chestnuts are to a large extent obtained from Forez; the woods and pasture lands of Mt. Pilat yield medicinal plants, such as mint. The pasture lands of the plain and mountains of Forez support live stock, notably the famous Charolais oxen. Poultry-rearing and bee-keeping are considerable industries. The department is rich in mineral springs, the waters of St. Galmier, Sail-sous-Couzan, St. Romain-le-Puy and St. Alban being largely exported. The chief wealth of the department lies in the coal deposits of the basin of St. Étienne (*q.v.*), the second in importance in France; quarrying is also active. Metal-working industries are centred in the south-east of the department, where are the great manufacturing towns of St. Étienne, Rive-de-Gier, St. Chamond and Firminy. At St. Étienne there is a national factory of arms, in which as many as 10,000 were employed; it makes cycles, motorcars, dynamos and accessories for electric lighting, apparatus for making acetylene gas, locks, edge-tools, common cutlery, chain cables for the mines, files, rails, etc. The glass industry is carried on at Rive-de-Gier and St. Galmier. St. Étienne and St. Chamond are centres for the fabrication of silk ribbons, elastic ribbons and laces, and the dressing of raw silks. The arrondissement of Roanne manufactures cotton stuffs, muslins and the like. That of Montbrison produces table linen. The department has numerous dye-works, flour-mills, paper works, tanyards, brickworks, silk-spinning works and hat factories. It is served by the P.L.M. railway, Roanne being the junction of important lines from Paris to Lyon and St. Étienne. Within the department the Loire is hardly used for commercial navigation; there are canals from Roanne to Digoin (13 mi. in the department), and from Givors to Rive-de-Gier (7 mi.) and the Rhone (7 mi.).

Loire comprises three arrondissements—St. Étienne, Montbrison and Roanne—with 32 cantons and 338 communes. It is in the region of the XIII. army corps (Clermont-Ferrand) and the *diocèse* and *académie* (educational division) of Lyon, where also is its court of appeal. St. Étienne is the capital, other leading towns being Roanne, Montbrison, Rive-de-Gier, St. Chamond, Firminy and Le Chambon. St. Bonnet-le-Château, besides old houses, has a church of the 15th and 16th centuries, containing paintings of the 15th century; St. Rambert and St. Romain-le-Puy have priory churches of the 11th century; and at Charlieu there are remains of a Benedictine abbey founded in the 9th century, including a porch decorated with fine Romanesque carving, old houses, etc.

LOIRE, the longest river of France, rising at 4,500 ft. in the recent volcanic peak of Gerbier de Jonc on the central plateau, and flowing north and west to the Atlantic. After a course of 18 m. it follows a picturesque channel along the foot of the basaltic rocks of Le Puy district, through narrow gorges and small plains. At Vorey, it is joined by the Arzon (left) and becomes navigable for rafts. The north-westerly direction of the Loire and its affluent the Allier is due to a tilting of the central plateau of France in Tertiary times so that the river valleys are filled with Tertiary deposits, on to which the Loire flows after passing the gorges of St. Victor. It again penetrates the hills of Carboniferous rocks before reaching the plain of Roanne. In this course it is joined by a large number of streams, the most important being the Coise (right), the Lignon du Nord and the Aix (left). Below Roanne the Loire is accompanied by a canal to Digoin (35 m.), thence by the so-called "lateral canal of the Loire" to Briare (122 m.).

At Digoin the Loire receives the Arroux, and gives off the canal du Centre (which utilizes the valley of the Bourbince) to Chalon-sur-Saône. Before reaching Nevers the Loire passes off the central plateau and on to the Jurassic rocks which form the rim of the Paris basin, over which rocks it flows in a northerly direction. Just beyond Nevers it is joined by the Allier (left); this river rises 30 m. S.W. of the Loire and follows an almost parallel course. Above Nevers the Loire is joined by the Aron (right), along which a canal proceeds northward, and below the confluence of the Allier gives off the canal du Berry to Bourges. Near Sancerre the river leaves the Jurassic rocks and has worn a valley through the Cretaceous uplands. At Briare it gives off a canal northward to the Seine. Between Gien and Blois the river flows in a wide arc across the Tertiary rocks of the Paris basin, passing Orléans, whence the canal d'Orléans, following the river Cens, communicates with the Briare canal. Passing Blois the Loire receives (right) the Cisse, and, after passing Tours, the three important left-hand tributaries of the Cher, Indre and the Vienne. Below Saumur it is frequently divided by long sandy islands fringed with osiers and willows; while upon arriving at Les Ponts-de-Cé (south of Angers) it is split into several distinct branches and studded with islands. At Angers it passes off the Cretaceous and on to the Palaeozoic and Archaean rocks of the Armorican massif.

The principal tributaries are: left, the Thouet at Saumur, the Layon and the Evre; right: the Authion, and, most important tributary of all, the Maine, formed by the junction of the rivers Mayenne, Sarthe and Loir. It receives the Erdre (right) at Nantes and the Sèvre-Nantaise (left), and farther on the canalized Achenau (left) and the navigable Etier de Méan (right) near St. Nazaire. Below Nantes, between which point and La Martinière (below Pellerin) the channel is embanked, the river is known as the Loire Maritime and widens out between marshy shores, passing Paimboeuf on the left and finally St. Nazaire, where it is $1\frac{1}{2}$ m. broad. The length of the channel of the Loire is about 625 m. A lateral canal, known as the Maritime canal of the Loire, between Le Carnet and La Martinière enables large ships to ascend to Nantes. It is $9\frac{1}{2}$ m. long, and $19\frac{1}{2}$ (capable of being increased to 24) ft. deep. At each end is a lock 405 ft. long by 59 ft. wide. The canal de Nantes à Brest connects this city with Brest.

The Loire is navigable only in a very limited sense. During the drought of summer thin and feeble streams thread their way between the sandbanks of the channel; while at other times a stupendous flood submerges wide reaches of land. When the flood waters of two or more tributaries arrive serious inundations result. Attempts to control the river began at a very early date, and in the middle ages the bed between Orléans and Angers was enclosed by dykes 10 to 13 ft. high. In 1783 a double line of dykes 23 ft. high was completed from Bec d'Allier downwards. In modern times embankments, aided by dredging operations extending over a large number of years, have ensured a depth of 18 ft. in the channel between La Martinière and Nantes. Several towns have constructed special works to defend themselves against the floods; Tours, the most exposed of all, being surrounded by a circular dyke; and in the upper Loire reservoirs have been constructed to store flood waters.

LOIRE-INFÉRIEURE, a maritime department of France, made up in 1790 of a portion of Brittany on the right and of the district of Retz on the left of the Loire, and bounded west by the ocean, north by Morbihan and Ille-et-Vilaine, east by Maine-et-Loire and south by Vendée. Pop. (1936) 659,428. Area 2,695 sq.mi. The department consists of flat land on each side of the estuary of the Loire, and its surface is varied only by the presence of weak ribs running west-north-west and east-south-east and continuing those of Brittany; the northernmost one, on the borders of Ille-et-Vilaine, reaches 377 ft., the *Sillon* *de Bretagne* stretching on the right bank of the estuary from Nantes towards the Vilaine hardly exceeds 250 ft. Seaward from the *Sillon,* and behind St. Nazaire, are peat-bogs including Grande Brière which recently supplied old trees for joiners' work; near the coast are large salt-marshes, with Guérande as a salt-refining centre. The district south of the Loire lies equally low; its most salient feature is the lake of Grandlieu, covering 27 sq.m., and surrounded by low and marshy ground, but so shallow ($6\frac{1}{2}$ ft. at most) that drainage would be comparatively easy. Canals are an important feature of the department, and the Nantes to Brest canal uses the Erdre up to within four m. of Nort, where it crosses to a tributary of the Vilaine. The south side of the Loire estuary has been canalized from Le Pellerin to Paimboeuf, and vessels drawing over 21 ft. can reach Nantes. The climate is equable and drier than that of Brittany. At Nantes the mean annual temperature is 54·7°, the annual rainfall being 25·6 inches.

Horse, mule and cattle raising prospers. Good butter and cheese are produced. Poultry also is reared, and there is a good deal of bee-keeping. Much wheat, oats, buckwheat, potatoes and root-crops are grown, also leguminous plants, especially near Nantes. Vines and cider apples are grown. The woods are of oak in the interior and pine on the coast. Some iron is extracted in the department. North-west of Ancenis coal is obtained. The granite of the sea-coast and of the Loire up to Nantes is quarried. Steam-engines are built for the navy at Indret, below Nantes; the forges of Basse-Indre are famous for their iron; and large quantities of lead are smelted at Couëron. There are considerable foundries at Nantes, Chantenay and St. Nazaire, and shipbuilding yards at Nantes and St. Nazaire. Pickles and preserved meats are prepared at Nantes, sardines cured at Le Croisic, which is the centre of the fishing industry, and in the neighbouring communes, and sugar, brushes, macaroni and similar foods, soap and chemicals are made at Nantes, and paper, sugar and soap at Chantenay. The department is served by State railways, the Orleans company and the Western company. The department is divided into the three arrondissements of Nantes, Châteaubriant and St. Nazaire. There are 46 cantons and 220 communes. The appeal court is at Rennes, where is also the centre of the *académie* (educational division), to which it belongs. It is in the region of the XI. army corps (Loire. Inf.) (Nantes), and forms the bishopric of Nantes under the archbishop of Tours.

The principal places are Nantes, the capital, St. Nazaire and Châteaubriant. On the west coast the town of Batz, and neighbouring villages, are inhabited by a small community with a distinct costume and dialect, claiming descent from a Saxon or Scandinavian stock. Guérande has well-preserved ramparts and 15th century gates, a church dating from the 12th to the 16th centuries and other old buildings. At St. Philbert-de-Grandlieu there is a church with portions belonging to the beginning of the 11th century. Cisson has a 13th century castle and a market-hall built of wood. There are many megalithic monuments in the department.

LOIRET, a department of central France, made up of the three districts of the ancient province of Orléanais—Orléanais proper, Gâtinais, and Dunois. It is bounded north by Seine-et-Oise, north-east by Seine-et-Marne, east by Yonne, south by Nièvre and Cher, south-west and west by Loir-et-Cher and north-west by Eure-et-Loir. Area, 2,630 sq.mi. Pop. (1936) 343,865. The department is a plain drained by the Loire from east to west, receiving the Loiret in the west on its left bank; this stream is only a few miles long, but so large that it is supposed to be an underground branch of the Loire. Towards the north the drainage is to the Seine by the Essonne and the Loing. The Sologne (*see* LOIR-ET-CHER) and the Beauce (*see* EURE-ET-LOIR) extend into the department on the south-west and north-west respectively. In the east is La Gâtine (capital Montargis), a region of wildernesses producing saffron and honey. The historic forest north of Orléans is slowly giving place to arable land. The lateral canal of the Loire from Roanne stops at Briare, from which town the *canal de Briare* connects with the Seine by the Loing valley, which is joined by the Orléans canal below Montargis. The mean temperature is a little above that of Paris; the rainfall varies from 18·5 in. in the exposed Beauce to 27·5 in. in the well-wooded Sologne. Hailstorms cause destruction in the Loire valley and the neighbouring regions.

Sheep, cattle, horses, pigs, poultry, especially geese, and bees are reared. The chief cereals are wheat and oats, rye, barley, meslin, buckwheat; potatoes, beetroot, colza and forage plants and vines are grown, largely for vinegar. The woods consist of oak, elm, birch and pine; fruit trees thrive in the department, and Orléans is a great centre of nursery gardens. Gien is an important centre for the manufacture of faience. Porcelain buttons and beads are made at Briare. There are iron and copper foundries, which make agricultural and other implements. There are wool-spinning and wool manufacture carried on. The two arrondissements are those of Orléans and Montargis, with 31 cantons and 349 communes. The department forms part of the *académie* (educational division) of Paris. It forms also the bishopric of Orléans under the archbishops of Paris. It is in the military region of the Xth Army Corps (Orléans); and has its court of appeal at Orléans. The churches of Cléry (15th century), of Ferrières (13th and 14th centuries) of Puiseaux (12th and 13th centuries) and Meung (12th century) are interesting. At Germigny-des-Prés there is a church built originally at the beginning of the 9th century and rebuilt in the 19th century, on the old plan and to some extent with the old materials. Yèvre-le-Châtel has an interesting 13th century château, and Sully-sur-Loire the fine mediaeval château rebuilt at the beginning of the 17th century by Maximilien de Béthune, duke of Sully, the famous minister of Henry IV. There are remains of a Gallo-Roman town (perhaps the ancient *Vellaunodunum*) at Triguères and of a Roman amphitheatre near Montbouy.

LOIR-ET-CHER, a department of central France, formed in 1790 from a small portion of Touraine, the Perche, but chiefly from the Dunois, Vendômois and Blésois, portions of Orléanais. It is bounded N. by Eure-et-Loir, N.E. by Loiret, S.E. by Cher, S. by Indre, S.W. by Indre-et-Loire and N.W. by Sarthe. Pop. (1936) 240,908. Area, 2,479 sq.mi. The department stretches from the river Cher in the south through the one-time marshy Sologne, now largely drained, and across the Loire to the south-east corner of the hills of Perche, rising in the department to 840 ft., and draining to the Loir which flows westwards to join the Maine above Angers. Between Loir and Loire is the southern part of the Beauce (*see* EURE-ET-LOIR). In the tufa walls here and there in the valleys of Cher and Loir dwellings have been excavated, as at Les Roches in the Loir valley. The Sologne is famous for hunting and fishing. The Loire and, with the help of the Berry canal, the Cher are navigable. The climate is temperate and mild, though that of the Beauce tends to dryness and that of the Sologne to dampness. The mean annual temperature is between 52° and 53°. The department is primarily agricultural. The northern region of the department yields abundant wheat and oats, besides rye and potatoes. Vines thrive on the valley slopes, the vineyards falling into four groups—those of the Cher, which yield fine red wines, the Sologne, the Blésois and the Vendômois. In the valleys fruit-trees and nursery gardens are numerous; the asparagus of Romorantin and Vendôme is well-known. The Sologne supplies pine and birch for fuel, and there are extensive forests around Blois and on both sides of the Loir. There is good pasture in the valleys. Sheep are the chief stock; the Perche breed of horses is famous for lightness and strength. Formerly the speciality of Loir-et-Cher was the production of gun-flints. Stone-quarries are numerous. The chief industries are cloth-manufacture, leather-dressing, glove-making, lime-burning, the manufacture of "sabots" and boots and shoes, hosiery and linen goods. The department is served chiefly by the Orléans railway.

The arrondissements are those of Blois, Romorantin and Vendôme, with 24 cantons and 297 communes. Loir-et-Cher forms part of the educational division (académie) of Paris. Its court of appeal and the headquarters of the Xth army corps, to the regions of which it belongs, are at Orléans. Blois, the capital, the seat of a bishop under the archbishop of Paris, Vendôme, Romorantin and Chambord are the chief towns. In addition to those of Blois and Chambord there are numerous fine châteaux in the department, of which that of Montrichard with its 11th century donjon, that of Chaumont (15th and 16th centuries), and that of Cheverny (17th century) in the late Renaissance style are the most important. Those at St. Aignan, Lassay, Lavardin and Cellettes may also be mentioned. Churches wholly or in part Romanesque architecture are found at Faverolles, Selles-sur-Cher, St. Aignan and Suèvres. The village of Trôo is built close to ancient tumuli and has a 12th century church, and among other remains those of a lazar-house of the Romanesque period. There are several megaliths in the department.

LOISY, ALFRED FIRMIN (1857–1940), French Catholic theologian, was born at Ambrières in French Lorraine of peasant parents. The boy was sent into the ecclesiastical schools of St. Dizier, without any intention of a clerical career; but he decided for the priesthood, and in 1874 entered the Grand Seminaire of Chalons-sur-Marne. He was ordained priest in 1879. After being curé successively of two villages in that diocese, Loisy went in May 1881, to study and take a theological degree, to the Institut Catholique in Paris, where he ultimately became professor. He was dismissed from his professorship in 1893 in consequence of an article on "La Question biblique et l'inspiration des Ecritures" contributed by him to his bi-monthly review, *L'Enseignement biblique.* The promulgation of the papal bull *Providentissimus Deus* by Leo XIII. led him to discontinue the review. Meanwhile he had brought his *Evangiles synoptiques* down to the confession of Peter. Loisy then became chaplain to a Dominican convent and a girls' school at Neuilly, but he soon resigned these appointments to continue his critical work in seclusion at Bellevue. A paper on "La Religion d'Israel" (*Revue du clergé français,* Oct. 1900) was condemned by Archbishop Richard and by the pope. Loisy then began to lecture on biblical criticism at the Ecole des Hautes Etudes Pratiques. Meanwhile he made a European reputation by his *L'Evangile et l'église* (1902, Eng. trans., 1903), which was a Catholic answer to Harnack's *Wesen des Christentums.* The book was condemned by the archbishop, but Leo XIII. declined to condemn the *Etudes évangéliques,* which appeared about the same time. But after the accession of Pius X., both these books, with *Autour d'un petit livre* (1903) and *Le Quatrième Evangile* (1903) were placed on the Index. Loisy made a partial submission, which was regarded as unsatisfactory at Rome; he retired first to Dreux, then to his home in Lorraine.

But in 1908 he published the now completed *Evangiles synoptiques,* embodying the results of the "higher criticism," followed by *Simples Réflexions sur le décret Lamentabili et sur l'encyclique Pascendi.* The Holy Office pronounced the major excommunication on Loisy on March 7, 1908. From 1909 to 1932 Loisy was professor of Church history at the Collège de France. His works include *L'Evangile selon Marc* (1912); *Les mystères païens et le mystère chrétien* (1914); *Les Actes des Apôtres* (1920); *L'Apocalypse de Jean* (1923). Loisy died June 1, 1940.

The Loisy controversy attracted great attention throughout Europe, and the literature is extensive. *See* Loisy's own *Autour d'un petit livre* (1903); A. Houtin, *La Question biblique au XIXe Siècle* (1902); C. A. Briggs and F. von Hügel, *The Papal Commission and the Pentateuch* (1907).

LOJA (formerly written *Loxa*), a town of southern Spain, in the province of Granada, on the Granada-Algeciras railway. Pop. (1940) 11,023 (mun., 23,998). Loja, which has sometimes been identified with the ancient *Ilipula,* or with the *Lacibi* (*Lacibis*) of Pliny and Ptolemy, first emerges in the Arab chronicles of the year 890. It was taken by Ferdinand III. in 1226, but was soon afterwards abandoned, and was not finally recaptured until 1486. The narrow and irregular streets of Loja wind up the sides of a steep hill surmounted by a Moorish citadel; many of the older buildings, including a fine Moorish bridge, were destroyed by an earthquake in 1884, although two churches of the early 16th century remained intact. An iron bridge spans the river Genil, which flows past the town on the north. The place was of great military importance, ranking with the neighbouring town of Alhama as one of the keys of Granada. Its products consist chiefly of coarse woollens, silk, paper, leather and salt. Insurgents captured Loja early in the civil war of 1936–39.

LOKEREN, an important industrial town of Belgium between Ghent and Antwerp (in East Flanders on the Durme). Pop. (1939) 25,562. It lies at the southern point of the district called Waesland. It is sometimes called the "Garden of Belgium." The clayey-gravel nature of the soil and the dampness of the atmosphere are very favourable to the cultivation of flax. Root crops have been grown here with great success since the 18th century. Industries include the spinning of wool, flax and hemp, and the manufacture of linen, canvas, etc.

LOKO, a small tribe similar to the Losso and the Mende, between the Rokele and Great Skarcies rivers north-east of Freetown in Sierra Leone.

See N. W. Thomas, *Anthropological Report on Sierra Leone* (1916).

LOKOIYA: *see* LOATUKO.

LOKOJA, a town of Nigeria, British West Africa, at the junction of the Niger and Benue rivers, founded in 1860 by the British consul, W. B. Baikie. It became the military centre of the Royal Niger Company and, later, capital of Northern Nigeria. It is in the province of Kabba, 250 mi. from the mouth of the Niger. With the opening of railways the Benue and Niger rivers ceased to form the chief commercial highways, and Lokoja from about 1910 declined as a trading centre; it also ceased to be the capital of Northern Nigeria (*see* NIGERIA and KABBA).

LOLLARDS, the name given to the English followers of John Wycliffe (*q.v.*); it is of uncertain origin; but the generally received explanation derives it from the verb *lollen* or *lullen,* to sing softly. The word is much older than its English use; there were Lollards in the Netherlands at the beginning of the 14th century, who were akin to the Fratricelli, Beghards and other sectaries of the recusant Franciscan type. The earliest official use of the name in England occurs in 1387 in a mandate of the bishop of Worcester against five "poor preachers," *nomine seu ritu Lollardorum confoederatos.* It is probable that the name was given to the followers of Wycliffe because they resembled those offshoots from the great Franciscan movement which had disowned the pope's authority and set before themselves the ideal of *Evangelical poverty.*

The Dominium of the Poor.—In the 14th century it became manifest that the two different ideas of the place of the church in the world had become irreconcilable. The church chose to abide by the idea of Hildebrand and to reject that of Francis of Assisi; and the revolt of Ockham and the Franciscans, of the Beghards and other spiritual fraternities, of Wycliffe and the Lollards, were all protests against that decision. Gradually there came face to face a great political Christendom, whose rulers were statesmen, with aims and policy of a worldly type, and a religious Christendom, full of the ideas of separation from the world by self-sacrifice and of participation in the benefits of Christ's work by an ascetic imitation. The war between the two ideals was fought out in almost every country in Europe in the 14th century. In England Wycliffe's whole life was spent in the struggle, and he bequeathed his work to the Lollards. The main practical thought with Wycliffe was that the church, if true to her divine mission, must aid men to live that life of evangelical poverty by which they could be separate from the world and imitate Christ, and if the church ceased to be true to her mission she ceased to be a church. Wycliffe was a metaphysician and a theologian, and had to invent a metaphysical theory—the theory of *Dominium*—to enable him to transfer, in a way satisfactory to himself, the powers and privileges of the church to his company of poor Christians; but his followers were content to allege that a church which held large landed possessions, collected tithes greedily and took money from starving peasants for baptizing, burying and praying, could not be the church of Christ and his apostles.

Lollardy was most flourishing and most dangerous to the ecclesiastical organization of England during the ten years after Wycliffe's death. It had spread so rapidly and grown so popular that a hostile chronicler could say that almost every second man was a Lollard. Wycliffe had organized in Lutterworth an association for sending the gospel through all England, a company of poor preachers somewhat after the Wesleyan method of modern times, and, although proscribed, these "poor preachers" with portions of their master's translation of the Bible in their hand to guide them, preached all over England. In 1382, two years before the death of Wycliffe, the archbishop of Canterbury got the Lollard opinions condemned by convocation, and began the long conflict of the church with the followers of Wycliffe. His success was very limited. He could neither suppress Lollardy at Oxford, whence it spread rapidly among the clergy and ultimately reached Scotland, nor prevent the patronage of individual preachers by noblemen and gentlemen of Wycliffite sympathies. Merchants and burgesses supported the new movement with money, and when Richard II. issued an ordinance (July 1382) ordering every bishop to arrest all Lollards, the Commons compelled him to withdraw it. Thus protected, the "poor preachers" won masses of the people to their opinions, and Leicester, London and the west of England became their headquarters.

Innovations.—The most explicit statement of the opinions of the early Lollards is contained in the document commonly known as the Conclusions of 1395. This manifesto asserts that temporal possessions ruin the church and drive out the Christian graces of faith, hope and charity; that the priesthood of the church in communion with Rome was not the priesthood Christ gave to his apostles; that the monk's vow of celibacy had for its consequence unnatural lust, and should not be imposed; that transubstantiation was a feigned miracle, and led people to idolatry; that prayers made over wine, bread, water, oil, salt, wax, incense, altars of stone, church walls, vestments, mitres, crosses, staves, were magical and should not be allowed; that kings should possess the *jus episcopale,* and bring good government into the church; that no special prayers should be made for the dead; that auricular confession made to the clergy, and declared to be necessary for salvation, was the root of clerical arrogance and the cause of indulgences and other abuses in pardoning sin; that all wars were against the principles of the New Testament, and were but murdering and plundering the poor to win glory for kings; that the vows of chastity laid upon nuns led to child murder; that many of the trades practised in the commonwealth, such as those of goldsmiths and armourers, were unnecessary and led to luxury and waste. These Conclusions really contain the sum of Wycliffite teaching; and, if we add that the principal duty of priests is to preach, and that the worship of images, the going on pilgrimages and the use of gold and silver chalices in divine service are sinful, they include almost all the heresies charged in the indictments against individual Lollards down to the middle of the 15th century.

If the formal statements of Lollard creed are to be got from these Conclusions, the popular view of their controversy with the church may be gathered from the ballads current at the time, and from the Piers Ploughman poems. *Piers Ploughman's Creed* (*see* LANGLAND, WILLIAM) was probably written about 1394, when Lollardy was at its greatest strength; the ploughman of the *Creed* is a man gifted with sense enough to see through the tricks of the friars, and with such religious knowledge as can be got from the creed, and from Wycliffe's version of the Gospels. The *Ploughman's Complaint* tells the same tale. It portrays popes, cardinals, prelates, rectors, monks and friars, who call themselves followers of Peter and keepers of the gates of heaven and hell, and pale poverty-stricken people, cotless and landless, who have to pay the fat clergy for spiritual assistance, and asks if these are Peter's priests.

Persecutions.—With the accession of the Lancastrian dynasty the church began a more direct attack upon the Lollards. It was hampered by a strong anti-clerical party in the House of Commons, which twice petitioned the crown to seize the temporalities of the church and apply them to such national purposes as relief of taxation, maintenance of the poor and the support of new lords and knights. Nevertheless the church succeeded in obtaining statutory authority for the capital punishment of heretics, in particular by the act *De Heretico Comburendo* of 1401, and the period of persecution began. In the earlier stages of Lollardy, when the court and the clergy managed to bring Lollards before ecclesiastical tribunals backed by the civil power, the accused generally recanted and showed no disposition to endure martyrdom for their opinions. They became bolder in the beginning of the 15th century. William Sawtrey refused to recant and was burnt at St. Paul's Cross (March 1401), and other martyrdoms followed. The Lollards, far from daunted, united a struggle for social and political liberty to the hatred felt by the peasants towards the Romish clergy. Jak Upland (John Countryman) took the place of Piers Ploughman, and upbraided the clergy, and especially the friars, for their wealth and luxury. Wycliffe had published the rule of St. Francis, and had pointed out in a commentary upon the rule how far friars had departed from the maxims of their founder, and had persecuted the *Spirituales* (the Fratricelli, Beghards, Lollards of the Netherlands) for keeping them to the letter. Jak Upland put all this into rude nervous English verse:

> Freer, what charitie is this
> To fain that whoso liveth after your order
> Liveth most perfectlie,
> And next followeth the state of the Apostles
> In povertie and pennance:
> And yet the wisest and greatest clerkes of you
> Wend or send or procure to the court of Rome,
> . . . and to be assoiled of the vow of povertie.

Meanwhile, Archbishop Arundel was attacking Lollardy in its academic stronghold, the University of Oxford, and procured the issue of severe regulations in order to purge the university of heresy. In 1408 he proposed and carried in convocation the famous *Constitutiones Thomae Arundel* intended to put down Wycliffite preachers and teaching. They provided amongst other things that no one was to be allowed to preach without a bishop's licence, that preachers preaching to the laity were not to rebuke the sins of the clergy, and that Lollard books and the translation of the Bible were to be searched for and destroyed. Under Henry V. a more determined effort was made to crush Lollardy. Hitherto its strength had lain among the country gentlemen who were the representatives of the shires. The new king by directing the trial for heresy of Sir John Oldcastle, Lord Cobham thereby did something to check the spread of Lollardy among the aristocracy, and the persecution of the humbler Lollards continued. This policy aroused little resentment; during the successful war with France little sympathy was felt for men who had declared that all war was but the murder and plundering of poor people for the sake of kings. Mocking ballads were composed upon the martyr Oldcastle, and this dislike of warfare was one of the chief accusations made against him.

But Arundel could not prevent the writing and distribution of Lollard books and pamphlets. The *Ploughman's Prayer,* which appeared about this time, declared that true worship consists in three things—in loving God, and dreading God and trusting in God above all other things; and it showed how Lollards, pressed by persecution, became further separated from the religious life of the church. Notwithstanding the repression, Lollardy fastened in new parts of England, and Lollards abounded in Somerset, Norfolk, Suffolk, Essex, Lincolnshire and Buckinghamshire.

The termination of the Great Schism and the condemnation of Huss by the Council of Constance led to still more vigorous proceedings against Lollard preachers and books. From this time Lollardy appears to be banished from the fields and streets, and takes refuge in houses and places of concealment. There was no more wayside preaching, but instead there were *conventicula occulta* in houses, in peasants' huts, in sawpits and in field ditches, where the Bible was read and exhortations were given, and so Lollardy continued. In 1428 Archbishop Chichele confessed that the Lollards seemed as numerous as ever, and that their literary and preaching work went on as vigorously as before. It was found also that many of the poorer parish priests, and a great many chaplains and curates, were in secret association with the Lollards, so that in many places processions were never made and worship on saints' days was abandoned. For the Lollards were hardened by persecution, and became fanatical in the statement of their doctrines.

Survivals.—The opinions of the later Lollards can best be gathered from the learned and unfortunate Pecock, who wrote his elaborate *Repressor* against the "Bible-men," as he calls them. He summed up their doctrines under 11 heads: they condemn the having and using images in the churches, the going on pilgrimages to the memorial or "mynde places" of the saints, the holding of landed possessions by the clergy, the various ranks of the hierarchy, the framing of ecclesiastical laws and ordinances by papal and episcopal authority, the institution of religious orders, the costliness of ecclesiastical decorations, the ceremonies of the mass and the sacraments, the taking of oaths and the maintaining that war and capital punishment are lawful. When these points are compared with the Lollard Conclusions of 1395, it is plain that Lollardy had not greatly altered its opinions after 55 years of persecution. All the articles of Pecock's list, save that on capital punishment, are to be found in the Conclusions, and may be traced to Wycliffe himself. Pecock's idea was that all the statements which he was prepared to impugn came from three false opinions or "trowings," viz., that no governance or ordinance is to be esteemed a law of God which is not founded on Scripture, that every humble-minded Christian man or woman is able without "fail and defaut" to find out the true sense of Scripture, and that having done so he ought to listen to no arguments to the contrary; he elsewhere adds a fourth (i. 102), that if a man be not only meek but also keep God's law he shall have a true understanding of Scripture, even though "no man ellis teche him saue God." These statements, especially the last, show the connection between the Lollards and mystics of the 14th century, such as Tauler and Ruysbroeck, who accepted the teachings of Nicholas of Basel, and formed themselves into the association known as the Friends of God.

The persecutions were continued down to the reign of Henry VIII., and when the writings of Luther began to appear in England the clergy were not so much afraid of Lutheranism as of the increased life they gave to surviving Wycliffite opinions. "It is," wrote Bishop Tunstall to Erasmus in 1523, "no question of pernicious novelty, it is only that new arms are being added to the great band of Wycliffite heretics." Lollardy, which continued down to the Reformation, did much to shape the movement in England. The subordination of clerical to lay jurisdiction, the reduction in ecclesiastical possessions, the insisting on a translation of the Bible which could be read by the "common" man were all inheritances bequeathed by the Lollards.

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LOLLIUS, MARCUS, Roman general, the first governor of Galatia (25 B.C.), consul in 21. In 16, when governor of Gaul, he was defeated by the Sigambri (Sygambri), Usipetes and Tencteri, German tribes who had crossed the Rhine. This defeat is coupled by Tacitus with the disaster of Varus. Lollius was subsequently (2 B.C.) attached in the capacity of tutor and adviser to Gaius Caesar (Augustus's grandson) on his mission to the East. According to Velleïus Paterculus and Pliny, he was a hypocrite and cared for nothing but amassing wealth.

See Suetonius, *Augustus,* 23, *Tiberius,* 12; Vell. Pat. ii. 97. 102; Tacitus, *Annals,* i. 10, iii. 48; Pliny, *Nat. Hist.* ix. 35 (58); Dio Cassius, liv. 6; *see* also J. C. Tarver, *Tiberius the Tyrant* (1902), pp. 200 foll.

LOLO (*Nesu*), a hill people dwelling in the Chinese and Indo-Chinese borderlands, related to the Lisu (*q.v.*) and Moso and probably to the Mantse. They are particularly noted for a written character running in lines from top to bottom as in Chinese. Their mss. are numerous, and often finely illuminated. The Lolo writing was regarded by Lacouperie (*Journ. R. Asiat. Soc.* XIV., i.) as the link connecting the systems of India, Malaysia, Indo-China, Korea and Japan. Traces of polyandry have been reported of them. They worship the sky.

See Legendre, *Les Lolos, etc.,* T'oung Pao II., x. (1909); F. M. Savina, *Histoire des Miao,* Hongkong (1924). (J. H. H.)

LOMBARD LEAGUE. The attempt of the emperor Frederick I. to re-establish imperial power in Italy led to a coalition, formed in March 1167, between the cities of Cremona, Mantua, Bergamo and Brescia. This league was soon joined by other cities, among which were Milan, Parma, Padua, Verona, Piacenza and Bologna, and the allies began to build a fortress near the confluence of the Tanaro and the Bormida, which, in honour of Pope Alexander III. was called Alessandria. During the absence of Frederick from Italy from 1168 to 1174, the relations between the pope and the league became closer, and Alexander became the leader of the alliance. The decisive struggle began when Frederick attacked Alessandria in 1174, but the historical importance of the war is due to the defeat inflicted on the emperor by the league at Legnano, May 29, 1176. The peace of Constance (June 25, 1183) which ended the struggle left only a shadowy authority to the emperor in Italy.

In 1226 the league was renewed against the emperor Frederick II. and was one of the principal forces opposed to the Hohenstaufen thenceforward until their final overthrow.

For a full account of the Lombard League *see* C. Vignati, *Storia diplomata della Lega Lombarda* (Milan, 1866); J. Ficker, *Zur Geschichte des Lombardenbundes* (Vienna, 1868); H. Prutz, *Kaiser Friedrich I.,* Bd. ii. (Danzig, 1871–74); W. von Giesebrecht, *Geschichte der deutschen Kaiserzeit,* Bd. v. (Leipzig, 1888).

LOMBARDO, the name of a family of Venetian sculptors and architects; their surname was apparently Solaro, and the name of Lombardo was given to the earliest known, Martino, who emigrated from Lombardy to Venice in the middle of the 15th century and became celebrated as an architect. He had two sons, Moro and Pietro, of whom the latter (*c.* 1435–1515) was one of the greatest sculptors and architects of his time, while his sons Antonio (d. 1516) and Tullio (d. 1559) were hardly less celebrated. Pietro's work as an architect is seen in numerous churches, the Vendramini-Calargi palace (1481), the doge's palace (1498), the façade (1485) of the *scuola* of St. Mark and the cathedral of Cividale del Friuli (1502); but he is now more famous as a sculptor, often in collaboration with his sons; he executed the tomb of the doge Mocenigo (1478) in the church of San Giovanni e Paolo at Venice, and a bas-relief for the tomb of Dante at Ravenna, and in 1483 began the beautiful decorations in the church of Sta Maria de' Miracoli at Venice, which is associated with his workshop. (*See* also VENICE for numerous references to the work of the Lombardi.) Antonio's masterpiece is the marble relief of St. Anthony making a new-born child speak in defence of its mother's honour, in the Santo at Padua (1505). Tullio's best-known works are the four kneeling angels (1484) in the church of San Martino, Venice, a coronation of the Virgin in San Giovanni Crisostomo and two bas-reliefs in the Santo, Padua, besides two others formerly in the Spitzer collection, representing Vulcan's Forge and Minerva disputing with Neptune.

BY COURTESY OF UNDERWOOD, LONDON

A LOLO FROM INLAND CHINA, WITH ARM SHIELD

LOMBARDS or **LANGOBARDI,** a Suevic people who appear to have inhabited the lower basin of the Elbe and whose name is believed to survive in the modern Bardengau to the south of Hamburg. They are first mentioned in connection with the year A.D. 5, when they were defeated by the Romans under Tiberius, afterwards emperor. In A.D. 9, however, after the destruction of Varus's army, the Romans gave up their attempt to extend their frontier to the Elbe. At first, with most of the Suevic tribes, they were subject to the hegemony of Maroboduus, king of the Marcomanni, but they revolted from him in his war with Arminius, chief of the Cherusci, in the year 17. We again hear of their interference in the dynastic strife of the Cherusci some time after the year 47.

From this time they are not mentioned until the year 165, when a force of Langobardi, in alliance with the Marcomanni, was defeated by the Romans, apparently on the Danubian frontier. It has been inferred from this incident that the Langobardi had already moved southwards, but the force mentioned may very well have been sent from the old home of the tribe, as the various Suevic peoples seem generally to have preserved some form of political union. From this time onwards we hear no more of them until the end of the 5th century.

Shortly before this time the Langobardi appear to have taken possession of the territories formerly occupied by the Rugii whom Odoacer had overthrown in 487, a region which probably included the present province of Lower Austria. At this time they were subject to Rodulf, king of the Heruli, who, however, took up arms against them. The result was the total defeat of the Heruli by the Langobardi under their king Tato and the death of Rodulf at some date between 493 and 508. By this time the Langobardi are said to have adopted Christianity in its Arian form. Tato was subsequently killed by his nephew Waccho. The latter reigned for 30 years, though frequent attempts were made by Ildichis, a son or grandson of Tato, to recover the throne. Waccho is said to have conquered the Suabi, possibly the Bavarians, and he was also involved in strife with the Gepidae, with whom Ildichis had taken refuge. He was succeeded by his youthful son Walthari, who reigned only seven years under the guardianship of a certain Audoin. On Walthari's death (about 546?) Audoin succeeded. He also was involved in hostilities with the Gepidae, whose support of Ildichis he repaid by protecting Ustrogotthus, a rival of their king Thorisind. In these quarrels both nations aimed at obtaining the support of the emperor Justinian, who, in pursuance of his policy of playing off one against the other, invited the Langobardi into Noricum and Pannonia, where they now settled.

A large force of Lombards under Audoin fought on the imperial side at the battle of the Apennines against the Ostrogothic king Totila in 553, but the assistance of Justinian, though often promised, had no effect on the relations of the two nations, which were settled for the moment after a series of truces by the victory of the Langobardi, probably in 554. The resulting peace was sealed by the murder of Ildichis and Ustrogotthus, and the Langobardi seem to have continued inactive until the death of Audoin, perhaps in 565, and the accession of his son Alboin, who had won a great reputation in the wars with the Gepidae. It was about this time that the Avars, under their first Chagun Baian, entered Europe, and with them Alboin is said to have made an alliance against the Gepidae under their new king Cunimund. The Avars, however, did not take part in the final battle, in which the Langobardi were completely victorious. Alboin, who had slain Cunimund in the battle, now took Rosamund, daughter of the dead king, to be his wife.

In 568 Alboin and the Langobardi, in accordance with a compact made with Baian, which is recorded by Meander, abandoned their old homes to the Avars and passed southwards into Italy, where they were destined to found a new and mighty kingdom.

(F. G. M. B.)

The Lombard Kingdom in Italy.—Alboin's reign in Italy was brief. In 572, according to Lombard tradition, he fell a victim to the revenge of his wife Rosamund, the daughter of the king of the Gepidae, whose skull Alboin had turned into a drinking cup. But in these few years the Lombards had established themselves in the north of Italy, whence in the next decade they frequently raided Frankish territory beyond the Alps. Chiefs were placed, or placed themselves, first in the border cities, like Friuli and Trent, which commanded the north-eastern passes, and then in other principal places; and this arrangement became characteristic of the Lombard settlement. Its principal seat was the rich plain watered by the Po and its affluents, which was in future to receive its name from them; but their power extended across the Apennines into Liguria and Tuscany, and then southwards to the outlying dukedoms of Spoleto and Benevento. Ticinum (Pavia), the one place which had obstinately resisted Alboin, became the seat of their kings.

Alboin was succeeded by a Lombard noble named Cleph who reigned for only 18 months. For the next ten years (574–584) no single noble was able to obtain recognition as king. In the latter year, threatened by a Frankish invasion, the Lombards chose as king Authari, the son of Cleph, to whom is principally due the consolidation of the Lombard power in Italy. Under him the independence of the dukes was reduced and something was done towards their transformation into royal officers. In this, Authari's success was limited. The dukedoms of the northern marches, Trent and Friuli, with the important dukedom of Turin, long retained the independence natural to a border government in early times. The great dukedom of Benevento in the south, with its neighbour Spoleto, threatened at one time to be a separate principality, and even to the last resisted, with varying success, the full claims of the royal authority at Pavia.

The kingdom of the Lombards lasted more than 200 years, from Alboin (568) to the fall of Desiderius (774), but it was never complete in point of territory. Throughout the greater part of this period there were three capitals in Italy—the Lombard one, Pavia; the Latin one, Rome; the Greek one, Ravenna. It was, moreover, long before the Lombards became amalgamated with the native Italian population, and the process was very far from complete when the kingdom came to an end. The Lombards were profoundly influenced by Italian civilization. They ultimately accepted Catholic christianity, and their kings and dukes behaved like other Germanic rulers in the West as benefactors to churches. They allowed the subject Italian population to live under Roman law, and their own royal charters are full of formulas derived from the phraseology of the Roman private deed. Nevertheless throughout the period of their kingdom the Lombards were essentially aliens in Italy. They threatened the independence of the papacy, and its influence within Italy and beyond the Alps was normally hostile to them. The new element which they introduced into the Italian complex of races was never strong enough to dominate Italy as the Franks dominated northern Gaul.

Authari married Theodelinda, a daughter of Garibald, duke of the Bavarians. She played an important part in Lombard history as the mediator between the Lombards and the Catholic Church. Authari, who had brought her to Italy, died shortly after his marriage (591). But Theodelinda had so won on the Lombard chiefs that they bid her as queen choose the one among them whom she would have for her husband and for king. She chose Agilulf, duke of Turin (592–615), a Thuringian noble by birth. Agilulf remained an Arian, and he was a very uneasy neighbour, not only to the Greek exarch, but to Rome itself. But he was favourably disposed both to peace and to the Catholic Church. The Arian and Catholic bishops went on for a time side by side; but the Lombard kings and clergy gradually yielded to the religious influences around them. Gregory the Great, opposed as he was to the new barbarian kingdom, recognized that the empire could never expel the Lombards from Italy, and endeavoured to promote peace between the Italians and Agilulf. Under these conditions the pope and the king of the Lombards naturally became the two real powers in the north and centre of Italy.

Agilulf was followed, after two unimportant reigns, by his son-in-law, the husband of Theodelinda's daughter, King Rothari (636–652), the first Lombard king to issue a body of law in his own name. From Rothari (d. 652) to Liutprand (712–744) the Lombard kings strove to enlarge their boundaries, and contended with the aristocracy of dukes inherent in the original organization of the nation. Their old enemies the Franks and the Slavs or Huns, ever ready to break in on the north-east, and sometimes called in by mutinous and traitorous dukes of Friuli and Trent, were constant and serious dangers. By the popes they were always looked upon with dislike and jealousy; with the Greek empire there was chronic war. In the last phase of the kingdom it produced two rulers of unusual ability. Liutprand, who destroyed the independence of the great southern duchies, Benevento and Spoleto, and Aistulf who threatened Rome itself. Their success led directly to the events which brought the Lombard kingdom to an end. The popes, thoroughly alarmed, and hopeless of aid from the East, turned to the family which was rising into power among the Franks of the West, the mayors of the palace of Austrasia. Pope Gregory

III. applied in vain to Charles Martel. But with his successors Pippin and Charles the popes were more successful. In return for the transfer by the pope of the Frankish crown from the decayed line of Clovis to his own, Pippin crossed the Alps, defeated Aistulf and gave to the pope the lands won by the Lombards from the empire, Ravenna and the Pentapolis (754–756). Finally, invited by Pope Adrian I., Pippin's son Charlemagne once more descended into Italy. As the Lombard kingdom began, so it ended, with a siege of Pavia. Desiderius, the last king, became a prisoner (774), and the Lombard power perished. Charlemagne, with the title of king of the Franks and Lombards, became master of Italy.

For the subsequent history *see* the article ITALY. For the Lombard League *see* the articles under that title and COMMUNE: *Mediaeval. See* also T. Hodgkin, *Italy and her Invaders,* vols. v. and vi. (2nd ed. 1916) and bibliography in V. Chevalier, *Répertoire des Sources Historiques du Moyen Âge* (1905). (R. W. C.; X.)

LOMBARD'S KOP, BATTLE OF: *see* SOUTH AFRICAN WAR, 1899–1902.

LOMBARDY, a territorial division of Italy, bounded on the north by the Alps, south by Emilia, east by Venetia and west by Piedmont. It has an area of 9,183 sq.mi. Lombardy is divided into nine provinces with the following population figures according to the census of April 21, 1936.

Province	Area in sq. mi.	Population 1936	Density per sq. mi.
Bergamo	1,065	605,810	568.8
Brescia	1,833	744,571	406.2
Como	798	501,752	628.8
Cremona	678	369,483	544.9
Mantua	903	407,977	451.8
Milan	1,066	2,175,838	2,041.1
Pavia	1,144	492,096	430.2
Sondrio	1,234	142,919	115.8
Varese	462	395,896	856.9
Lombardy	9,183	5,836,342	635.6

Milan, the chief city, is the greatest railway centre of Italy, being the nearest great town to the tunnels of the St. Gotthard and the Simplon. The other railway centres of the territory are Mortara, Pavia and Mantua. The most important rivers are the Po, which follows, for the most part, the southern boundary of Lombardy, and the Ticino, one of the largest tributaries of the Po, which forms for a considerable distance the western boundary.

The majority of the Italian lakes, those of Garda, Idro, Iseo, Como, Lugano, Varese and Maggiore, lie wholly or in part within it.

The climate of Lombardy is thoroughly continental; in summer the heat is greater than in the south of Italy, while the winter is very cold, and bitter winds, snow and mist are frequent. In the summer rain is rare beyond the lower Alps, but a system of irrigation, unsurpassed in Europe, and dating from the middle ages, prevails, so that a failure of the crops is hardly possible.

There are three zones of cultivation: in the mountains, pasturage; the lower slopes are devoted to the culture of the vine, fruit trees (including chestnuts) and the silkworm; while in the regions of the plain, large crops of maize, rice, wheat, oats, rye, flax and wine are produced, and thousands of mulberry trees are grown for the benefit of the silkworms, the culture of which in the province of Milan has entirely superseded the sheep breeding for which it was famous during the middle ages.

Milan is the principal silk market in the world. Of the usual 50,000 workers in the silk weaving and allied industries, about half are employed in mills in or near Como, while the other mills are mostly in Milan and Turin. The chief centre of silk weaving is Como, but the silk is commercially dealt with at Milan, and there is much exportation. A very considerable amount of cotton is manufactured, but most of the raw cotton has to be imported, the cultivation being insignificant in Italy. Lombardy has 58.45% of the spindles and 71.7% of the looms existing in Italy. Milan also manufactures motor-cars, though Turin is the principal centre in Italy for this industry. There are copper, zinc and iron mines, and numerous quarries of marble, alabaster and granite. In addition to the above industries the chief manufactures are felt, woollens, hats, rope, paper-making, iron-casting, gun-making and printing.

Lombardy is indeed the most industrial district of Italy and as such was heavily bombed by the Allies in World War II.

In most of the provinces of Lombardy there are far more villages than in other parts of Italy except Piedmont; this is attributable partly to their mountainous character. There are numerous and important hydro-electric plants directly connected with those of the Apennines. For Lombardy in the Iron Age *see* GOLASECCA and COMACINES. Previous to the fall of the Roman republic Lombardy formed part of Gallia Transpadana, and it was Lombardy, Venetia and Piedmont, the portion of the Italian peninsula north of the Po, that did not receive citizenship in 89 B.C. but only Latin rights. The gift of full citizenship in 49 B.C. made it a part of Italy proper, and Lombardy and Piedmont formed the 11th region of Augustus (Transpadana) while Venetia and Istria formed the 10th. It was the second of the regions of Italy in size, but the last in number of towns; it appears, however, to have been prosperous, and cultivation flourished in its fertile portions.

Lombardy has been for the last 150 years politically the most active part of Italy; it played also a leading role in the rise and fall of fascism.

For details of subsequent history *see* LOMBARDS and ITALY; and for architecture *see* ARCHITECTURE. G. T. Rivoira in *Lombardic Architecture* (2 vols. London, 1910), successfully demonstrates the classical origin of much that had hitherto been treated by some authorities as "Byzantine." In the development of Renaissance architecture and art Lombardy played a great part, inasmuch as both Bramante and Leonardo da Vinci resided in Milan at the end of the 15th century.

LOMBOK, one of the Lesser Sunda islands, Dutch East Indies. It lies due east of Java, with the island of Bali between it and the Javanese coast, the Lombok strait separating it from Bali, with which it forms a residency. Lombok has an area of 1,825 sq.mi. It is very mountainous, being divided for nearly its whole length by two mountain chains, separated by a valley, which slopes upwards, gradually, in terrace formation, and is broken in the centre by a ridge of low hills. The southern chain, which runs from south-east to south-south-west, does not exceed 1,000 ft., but the northern chain, beginning with Gunong Wangsit, 11½ mi. N. of Ampenam, rises eventually to 12,290 ft. in Gunong Rinjeng or Rinjani (the Peak of Lombok) one of the highest volcanoes of the Malay archipelago. Lower peaks flank the mountain, united by a plateau 7,200 ft. in height, and containing a fine lake, Danu (Segara Anak). Of the many small rivers none is navigable. The coast is very bold in places, with cliffs rising precipitously from the sea, but there are good anchorages in bays on the west and east coasts.

The flora includes, amongst the palms usual to the tropics, a great palm, a species of *Corypha,* which is a striking feature of the plains, and several Australian forms; the fauna comprises monkeys (*Macacus cynomolgus*), deer, and wild pigs, and many beautiful birds, large green pigeons, eight kinds of kingfishers, a ground thrush (*Pitta concinna*), grass-green doves, little crimson and black flower-peckers, large black cuckoos, king-crows, golden orioles, and fine jungle-cocks, and dragon flies abound. For the scientist, Lombok possesses a very great interest, in that it is the most westerly point of a former Australian or Pacific continent which must have broken up before Java, Sumatra, Bali, etc., were separated from Asia, and probably before the extreme south-eastern portion of Asia was raised above the waters of the ocean. Lombok strait, which has depths exceeding 600 fathoms, marks the edge of the Asian continental shelf. Wallace drew a line from the strait northwards, between Celebes and Borneo, and then passing eastwards, between the Sangir islands and Mindanao, into the Pacific ocean, to denote the frontier between the Asian and the Australian regions, which has been known since as the *Wallace line.* It is supported by the fact that there are marked differences between the flora and fauna of Bali and Lombok, the barbets, fruit-thrushes, and woodpeckers of the former being practically unknown in the latter, whilst the cockatoos, honeysuckers, and mound-builders (Megapodidae), of Lombok are equally foreign to Bali. Recent observations however have established that some intermingling of species is taking place, and it has been ascertained since Wallace's time that the line cannot be applied strictly to all forms of life, and that to spiders, for instance, it cannot be applied at all, so that, to be exact, Lombok, in a biological sense, denotes the commencement of a transitional area in which the Asiatic forms of life are gradually supplanted completely by Australian forms.

The population of Lombok (1930) was 701,290 (146 Europeans and Eurasians), composed very largely of Sasaks, the indigenous inhabitants of the island, of Malayan origin, and akin to the indigenous population of the neighbouring island of Sumbawa, with some Balinese who confine themselves mostly to the north-west. The Sasaks are Mohammedan and a clean and industrious folk, with villages and houses built after the Balinese pattern, and with customs resembling those of the Balinese under whose domination they live. Sasaks use the Balinese script for writing and their literature consists of Javanese and Malayan translations. Industry has reached a fairly high level, clothes and mats are woven, there are workers in gold, silver, and iron, and the people are clever as agriculturists, their rice and coffee cultivation having reached a fairly advanced stage. There are some Chinese traders. Mataram is the capital and headquarters of administration, a short distance inland from Ampenam, the chief port of Lombok, which is on the western coast; landing there is difficult during the west monsoon. From Ampenam and the port of Labuan Hadji, on the east coast, a frequent steamer service is maintained by the Dutch Royal Packet Navigation Company with Bali and Java ports, Celebes (Macassar), and with Sumbawam Sumba, Flores and Timor. There is good road communication but no railway, and there is cable connection with Java, *via* Bali.

As early as 1640 Lombok was regarded by the sultan of Macassar as being under his rule, and when his power was shattered by the Dutch in 1667–8, a Sumbawa chief, signatory to the Bongay contract, endeavoured to impose his sovereignty on the island, in which the Dutch assisted, peacefully. Civil war in Sumbawa left Lombok the prey of, first pirate adventurers from Macassar, then of the Balinese who planted colonies in north Lombok and set about establishing their rule. Balinese intervention commenced about 1692, Dutch endeavours to get the signatories to the Bongay treaty to take action to counteract it were unsuccessful, and eventually the Balinese succeeded in establishing four kingdoms in Lombok; Mataram, Karang Asem, Pagasangen, and Pagutan. In 1843, Mataram entered into a contract with the Dutch, agreeing to acknowledge Karang Asem in Bali as the suzerain power. In 1849 the Dutch were at war with Karang Asem and Klungklung in Bali, and were assisted by Mataram, which, as a reward, was given Karang Asem (Bali), as a fief; but, although friendly relations with the Dutch and Mataram continued until 1872, in that year Mataram, looking upon itself as independent, and not suzerain to the Dutch, refused to send its regular embassy to Batavia, and, in 1891, interfered in the domestic politics of Bali. At the same time it cruelly oppressed the Sasak population of Lombok, so that the latter made ineffectual attempts to throw off the Balinese yoke, finally invoking Dutch aid. This was given, and in 1894, after one expedition had met with disaster, a second was successful in overthrowing the government of Mataram. Lombok was made a division of the residency of Bali and Lombok, under an assistant-resident at Ampenam, and was divided into two districts, East and West Lombok; a third district, Central Lombok, was created in 1898, the capitals of the three districts being at Mataram, Praja, and Sisi. Lombok was occupied by the Japanese in 1942.

See A. R. Wallace, *The Malay Archipelago* (1890); W. Cool, *With the Dutch in the East* (1897). (E. E. L.)

LOMBROSO, CESARE (1836–1909), Italian criminologist, was born on Nov. 18, 1836, at Verona, of a Jewish family. He studied at Padua, Vienna and Paris, and in 1862 became professor of psychiatry at Pavia, then director of the lunatic asylum at Pesaro, and later professor of forensic medicine and of psychiatry at Turin, where he eventually filled the chair of criminal anthropology. In 1872 he made announcement that the disorder known as *pellagra* (*q.v.*) was due to a poison contained in diseased maize, eaten by the peasants, and he returned to this subject in *La Pellagra in Italia* (1885). To Auguste Comte Lombroso owed an exaggerated tendency to refer all mental facts to biological causes, but he surpassed all his predecessors by the wide scope and systematic character of his researches. He held that the criminal population exhibits a higher percentage of physical, nervous and mental anomalies than non-criminals; and that these anomalies are due partly to degeneration, partly to atavism. The criminal is a special type, standing midway between the lunatic and the savage. (*See* CRIMINOLOGY.) Lombroso died suddenly at Turin on Oct. 19, 1909.

His works include; *L'Uomo delinquente* (1889); *L'Uomo di genio* (1888, Eng. trans. 1891); *Genio e follia* (1877); *La donna delinquente* (1893, 3rd ed. 1915, Eng. trans. 1895); *Le Crime, causes et remèdes* (1899, Eng. trans. 1911); *Delitti vecchi e delitti nuovi* (Turin, 1902); *Nuovi studi sul genio* (2 vols., Palermo, 1902).

See Kurella, *C. Lombroso* (Hamburg, 1892); a biography by his daughters, P. Carrara and G. Ferrero (1906 and 1915), and K. Kurella, *C. Lombroso: a Modern Man of Science* (1911).

LOMÉNIE DE BRIENNE, ÉTIENNE CHARLES DE (1727–1794), French politician and ecclesiastic, was born at Paris on Oct. 9, 1727, of a Limousin family, dating from the 15th century. After a brilliant career as a student he entered the Church. In 1752 he was appointed grand vicar to the archbishop of Rouen, in 1762 bishop of Condom, and in 1763 archbishop of Toulouse. In 1770 he became an academician. He was on three occasions the head of the *bureau de jurisdiction* at the general assembly of the clergy; he addressed to Turgot a number of *mémoires* on political and social questions, one of them, treating of pauperism, being especially remarkable. As president of the Assembly of Notables (1787) he attacked the fiscal policy of Calonne, whom he succeeded as head of the *conseil des finances* on May 1, 1787. He made the parlement register edicts dealing with internal free trade, the establishment of provincial assemblies and the redemption of the *corvée*. To crush opposition to the stamp duty and the proposed new general land-tax the parlement was exiled to Troyes (Aug. 15, 1787), and only returned to Paris on its agreement to an alternative plan prolonging for two years the tax of the two *vingtièmes* (a direct tax on income). But a further attempt to force the parlement to register an edict for raising a loan of 120 million *livres* met with determined opposition. The struggle of the parlement against the incapacity of Brienne ended on May 8 in its consenting to an edict for its own abolition; but with the proviso that the states-general should be summoned to remedy the disorders of the state. Brienne, who had been made archbishop of Sens, now had to face almost universal opposition; he was forced to suspend the *Cour plénière* which had been set up to take the place of the parlement, and himself to promise that the states-general should be summoned. On Aug. 29, he had to retire, leaving the treasury empty. On Dec. 15 following, he was made a cardinal, and spent two years in Italy. After the outbreak of the Revolution he returned to France, and took the oath of the civil constitution of the clergy in 1790 (*see* FRENCH REVOLUTION). He was repudiated by the pope, and in 1791 had to give up the biretta at the command of Pius VI. Both his past and present conduct made him an object of suspicion to the revolutionaries; he was arrested at Sens on Nov. 9, 1793, and died in prison, on Feb. 16, 1794.

The chief works published by Brienne are: *Oraison funèbre du Dauphin* (1766); *Compte-rendu au roi* (1788); *Le Conciliateur*, in collaboration with Turgot (Rome, Paris, 1754). *See* also J. Perrin, *Le Cardinal Loménie de Brienne . . . épisodes de la Révolution* (Sens, 1896).

LOMOND, LOCH, the largest and most beautiful of Scottish lakes, situated in the counties of Stirling and Dumbarton. It is about 23 m. long; its width varies from 5 m. towards the south end to $\frac{1}{3}$ m. at the narrows to the north of the Isle of the Vow; the greatest depth is 630 ft. It is only 23 ft. above sea-level. It contains 30 islands, the largest of which is Inchmurrin. Twenty-four of them form an archipelago at the widest part of the loch. From the west the loch receives the Inveruglas, the Douglas, the Luss, the Finlas and the Fruin. From Balloch in the south it sends off the Leven to the Clyde; from the east it receives the Endrick, the Blair, the Cashell and the Arklet; and from the north the Falloch. Ben Lomond (3,192 ft.) dominates the landscape; but there are other majestic hills, particularly on the west and north-west banks. The fish are sea-trout, lake-trout, pike and perch, with some salmon. Inversnaid, where a fort was built in 1713 to subdue the clan, was in the heart of the Macgregor country, and the name of Rob Roy is still given to his cave on the loch side a mile to the north and to his prison 3 m. to the south.

LOMONÓSOV, MIKHAIL VASILIEVICH (*c.* 1711–1765), Russian poet and man of science, was born in the village of Denisovka (the name of which was afterwards changed in honour of the poet), situated on an island not far from Kholmogorî, in the government of Archangel. His father, a fisherman, took the boy into his trade at the age of ten, but he had a passion for learning, and made his way to Moscow when he was 17. There he obtained admission into the Zaikonospasski school, and in 1734 he was sent from Moscow to St. Petersburg (now Leningrad). There he was chosen as one of the young Russians sent to complete their education in foreign countries. He studied metallurgy at Marburg; he also began to write poetry; imitating German authors, among whom he is said to have especially admired Günther. His *Ode on the Taking of Khotin from the Turks* was composed in 1739. On his return to Russia he was made professor of chemistry in the university of St. Petersburg; he ultimately became rector, and in 1764 secretary of State. He died in 1765.

In the history of Russian letters he is above all important as the man who reformed the Russian language and helped to make it an effective literary medium by his *Rhetoric,* his *Russian Grammar,* and his essay *On the Use of Sacred Books in the Russian Tongue*. His task was to find a middle course between the complicated Slavonic language used in the church services, with its elaborate syntax derived from Greek, and spoken Russian. Not only did he fix the literary language, but he wrote magnificent verse which had an enduring effect on later Russian poetry.

LOMZA, a town of Poland in the province of Bialystok on the Narew, 103 mi. by rail N.E. from Warsaw. Lomza is an old town, one of its churches having been erected before 1000. In the 16th century it carried on a brisk trade with Lithuania and Prussia. It was well fortified and had two citadels, but nevertheless often suffered from the invasions of the Germans and Tatars, and in the 17th century it was twice plundered by the Cossacks of the Ukraine. In 1795 it was under Prussian rule and after 1807 it was under Russian rule till 1918. Pop. (1931) 25,045. It was taken by the U.S.S.R., 1939, and Germany, 1941.

LONAVALA, a town of India, in the Poona district of Bombay, at the top of the Bhor Ghat pass in the Western Ghats, by which the Great Indian Peninsula railway climbs from Bombay to Poona. Pop. including Khandala (1941) 10,876. It contains locomotive works, and head works of the Tata Hydro Electric scheme are situated here.

LONDON ("JACK"), JOHN GRIFFITH, novelist, born at San Francisco (Calif.), Jan. 12, 1876. After a hard-working boyhood he became an oyster pirate, and then a member of the fish patrol, and at 17 signed as seaman on a sealing vessel. He went with the first rush to the Klondike in 1897, and tramped across the United States and Canada. In 1904 he went (as war correspondent) to Japan, and in 1914 to Mexico. In 1906 he and his wife started in a small yacht on a voyage round the world, described in *The Cruise of the Snark* (1911). He died at Glen Ellen (Calif.), Nov. 22, 1916. His novels, and other writings, fall sharply into two classes—those which he wrote for money, as he frankly admitted in his letters, and those whose sincerity and militancy made him at one time the American Socialist best known outside the U.S.A. *The Iron Heel* (1907), *The War of the Classes* (1904), *Revolution and other Essays* (1910), are the chief of these latter; *The Iron Heel* has had an enormous circulation in the Old World. With these should be classed *The People of the Abyss* (1903), a valuable sociological study of London's East End. Of his other works the best are his semi-autobiographical works: *Martin Eden* (1909) and *John Barleycorn* (1913); but wide popularity has been gained by his novels of adventurous life and wild or half-tamed animals, such as *White Fang* (1906), *The Call of the Wild* (1903) and *South Sea Tales* (1911).

See *The Book of Jack London,* by his wife, Charmian London (1921); and E. B. Payne, *The Soul of Jack London* (1926).

LONDON, a city and port of entry of Middlesex county, Ontario, Canada, situated 121 mi. S.W. of Toronto, on the river Thames and the Canadian National, Canadian Pacific, the London and Port Stanley railways and the Trans-Canada airways. Pop. (1941) 78,264. The local nomenclature is largely a reproduction of that of the great city whose name it has borrowed. Situated in a fertile agricultural district, it is a large distributing centre. Among the industries are petroleum refineries, and factories for the manufacture of agricultural implements, railway carriages and various minor commodities. The educational institutions include the Western university, with courses in arts, medicine and theology (founded in 1878 under the patronage of the Church of England). London was founded in 1825–26.

LONDON, the capital of England and the mother city of the British empire, is the largest city in the world, containing, in the administrative county and the ring of suburbs an area, known as Greater London, of about 693 sq.mi. and a population of 8,700,000 in 1938. The heart of London is "the City," the ancient core round which the gigantic urban and suburban area has developed. It covers but 677 ac. and constitutes one of the smallest of the 29 municipal divisions that go to make up the Administrative County of London, which has an area of about 117 sq.mi. The City is a county corporate, the other 28 divisions are metropolitan boroughs. The "outer ring," which is included within Greater London and the Metropolitan Police area, comes under the jurisdiction of one or other of the counties of Middlesex, Essex, Kent, Surrey and Hertfordshire, although each district has its own local administrative authority. The 28 metropolitan boroughs, each of which is noticed in a separate article, are:—

1. *North of the Thames.*—The following, commencing on the west, lie on the river: Hammersmith, Fulham, Chelsea, Westminster (here comes the City), Stepney and Poplar; north of these, and adjoining the northern boundary, are: Kensington, Paddington, Hampstead, St. Pancras, Islington, Stoke Newington and Hackney; and between these two groups are (St.) Marylebone, Holborn, Finsbury, Shoreditch and Bethnal Green.

2. *South of the Thames.*—Wandsworth, Battersea, Lambeth, Southwark, Bermondsey, Deptford, Greenwich and Woolwich (these touching the river and two small parts of Woolwich being on its north bank), Camberwell and Lewisham.

Geographical Situation.—London is situated in the London basin, which is drained by the lower Thames. The basin is formed by a downfold in the chalk, which underlies all the area between the North Downs and the Chilterns. This downfold is floored with very thick deposits of London clay, an impervious, sticky, water-holding deposit, upon which are scattered remnants of later coverings of sands and gravels.

The general relief of the land is low, the ground rarely rising above 400 feet. There are, nevertheless, two outstanding features. These are, first, the flood plain of the Thames, some 3 mi. wide, rising gently from the river to about 25 ft. (O.D.), covered with gravel and alluvial deposits, among which river silt, fine sand and peat predominate. Owing largely to the shrinkage of the previously water-logged peat and silt, which took place as a result of embanking and the consequent drying out of these softer elements, the gravels lie generally several feet above the level of the alluvium. Here and there the drop from one to the other can be distinguished in the low relief. Both gravel and silt, however, lie mainly below the level of high tide today, and but for the embankments would be more or less submerged at every high tide and would revert to marshland; the gravels in the neighbourhood of the Thames are saturated with water every time the tide rises. The flood plain throughout historical times has been avoided rather than sought out for settlement, but there is plenty

PHOTOGRAPH, MAXIMILIAN TOCH BY COURTESY OF THE CAMERA CLUB OF NEW YORK

A LONDON FOG

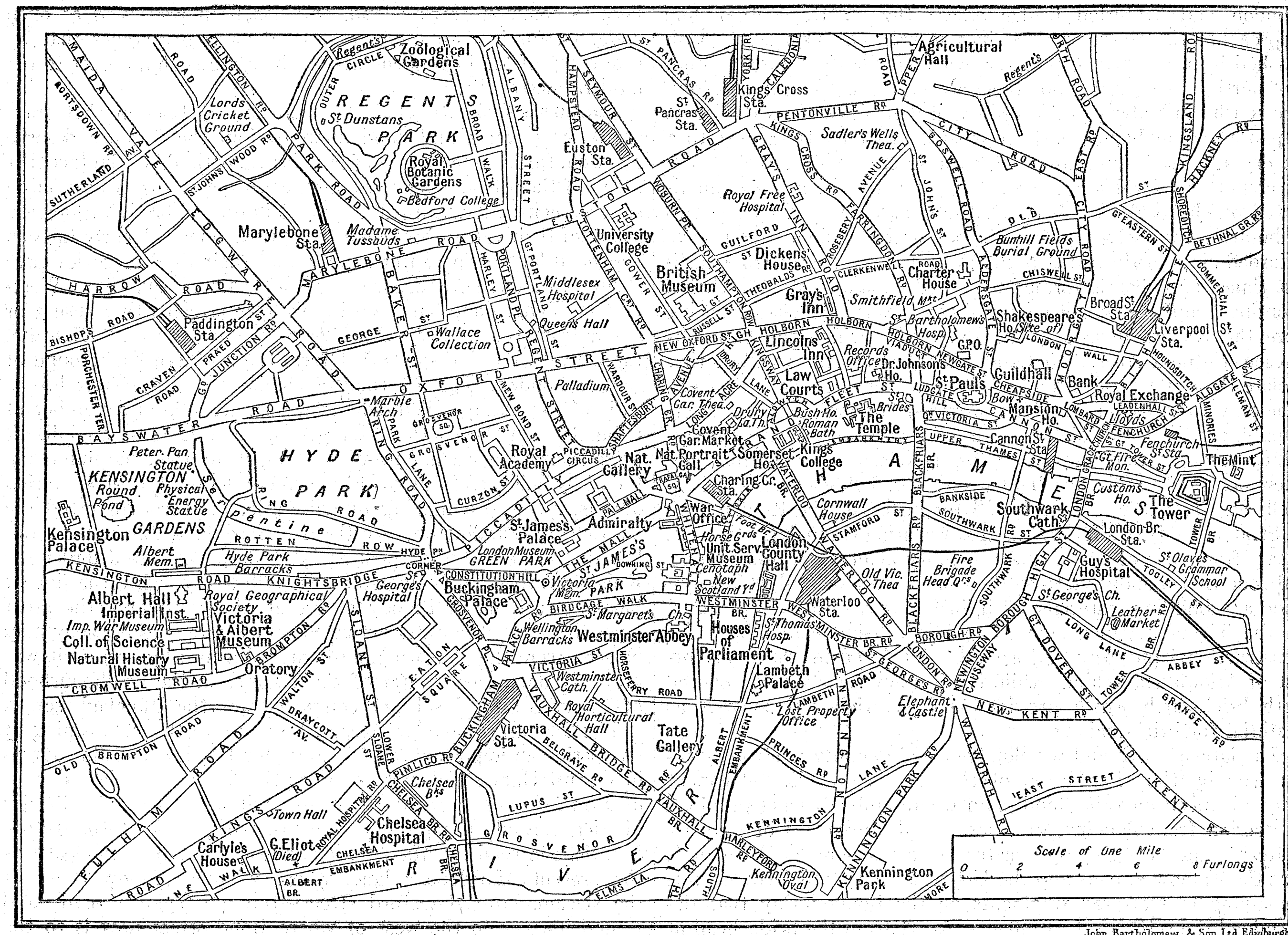
Towers of the Houses of Parliament as seen
from Westminster Bridge through a London fog

LONDON

CHICAGO AERIAL SURVEY FROM AEROFILMS

AERIAL VIEWS OF LONDON

1. View looking toward the Thames and Trafalgar square (top centre). Regent street, curving away from Piccadilly circus, runs from right to lower left in the picture, intersecting at Oxford circus with Oxford street, running diagonally from left to lower right. Cavendish square is at the bottom centre
2. View of St. Paul's cathedral (centre) and part of the City. Many of these buildings, including St. Paul's, were damaged or destroyed in the German air raids which began in Aug. 1940



MAP OF THE MAIN DISTRICTS OF LONDON SHOWING LOCATION OF STREETS, RAILWAY STATIONS AND PRINCIPAL BUILDINGS

of evidence that it formed the home of prehistoric peoples from the Stone age until the coming of the Romans.

The second feature consists of two low, undulating plateaus rising above the flood plain to north and south in a couple of usually well-marked terraces covered with gravel. The rise of the southern plateau is continuous with that of the North Downs beyond London, except in the southwest, where a broad, gravel-floored vale, once, possibly, occupied by a precursor of the river Mole, links the Thames at Kingston with the Wandle valley at Merton and isolates the hills of Richmond and Wimbledon. On the north the land rises steadily to the hills of Hampstead and Highgate, and beyond to Finchley and Hendon, but drops steeply to the broad trench of the Lea valley in the east, and more gently to the broad clay vale of the Brent in the northwest. The lower terrace of the plateau, known as the Taplow terrace, lies between 50 and 100 ft. above sea level and drops somewhat steeply to the flood plain 25 ft. or so below. It may be easily distinguished in the steep descent from the Strand to the Embankment, or from Upper and Lower Thames street to the river, or in the drop from St. Giles's to Charing Cross. Above this terrace a higher one may be distinguished, generally referred to as the Boyn hill terrace. It lies approximately at between 100 and 150 ft. above sea level; gravels which represent its floor form the greater heights of Richmond hill and Putney common and cap the long spur of Islington hill.

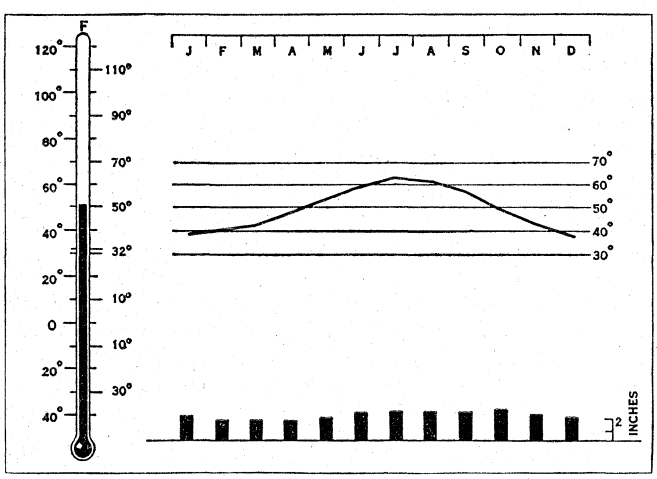
The Thames winds in broad, tidal meanders between the edges of the flood plain, cutting now into the northern, now into the southern rim. Before its regulation and confinement between embankments, backwaters and ancient channels surrounded many sandy islands along its course. The names of some of them are perpetuated in the districts of Battersea, Bermondsey and Chelsea. A group of such islots filled the angle that the river makes at Lambeth, the most northerly being the famous Thorney, on which the Abbey of St. Peter (the predecessor of our Westminster Abbey) was founded. The broad, shallow course of the Thames as it crossed the flood plain from Lambeth towards Charing Cross was probably a fordable reach in Roman times, and there has been much conjecture as to the probability of the crossing of the Roman road in the neighbourhood of Westminster (or even of Lambeth) bridge, before its diversion to pass through the City. The northern section of the Watling street seems to trend towards a crossing here, and the alignment of the road along the edge of the Tyburn valley could be laid out from the high ground west of the Darent, south of the Thames, near the known end of the southern section of the street. But the remains of Roman occupation are so few at Westminster that it is unlikely that the Watling street ever crossed the Thames by ford or ferry here.

Just below Westminster and Whitehall the river takes a sharp bend to the east and flows for a couple of miles at the foot of the Taplow terrace, leaving a great stretch of reclaimed marsh to the south, occupied now by Lambeth, Southwark, Bermondsey and Rotherhithe. Owing to the set of the current against the northern shore, in this reach the river is deeper and narrower than at Westminster or—further downstream—at the Isle of Dogs, where it is relatively broad and shallow. Across the brink of the gravel terrace which here directly overlooks the Thames, several small tributary valleys have been trenched, cutting the terrace into low hills which drop abruptly some 40 or 50 ft. to the river, and slope also steeply to the side valleys that separate them.

Two of these small hills appear to have formed the site of the earliest London, which, according to one widely held theory, began its existence with the construction of a bridge across the Thames by the Romans. The selection of the site by the Romans would be based on the practicability of an approach and crossing as far down stream as possible. As regards approach there is no place on the north bank except this stretch between the Tower of

London and Waterloo bridge where the 50 ft. contour line approaches the river, until Staines is reached. This steep bank washed by relatively deep water, would facilitate approach from the north and by river, but the crossing of the flood plain from the south must always have presented difficulties. It is this great expanse of marshland south of the City that lends support to a theory that London arose, not as a river crossing, but as the river port of Verulamium (St. Albans) with which it communicated by the ridgeways between Colne and Lea and by the two tributaries themselves. The Thames and the flood plain have afforded ample evidence that the river was a highway from earliest times, and that it formed a line of communication with the Continent and the numerous small riverside settlements long before the Roman invasion. The steep edge which the two hills present to the deep river at London and to the stream valleys that isolate them, must have made defense of the site relatively easy. The gravel that covers the hills provided London's earliest water-supply, for the banks of the small tributaries oozed with springs. Many of these were important throughout mediaeval times and their names are still household words—St. Bride's well, Clerkenwell, St. Clement's well, Holywell for instance; the Roman bath in Strand lane is still fed by water percolating through the gravels. Apart from ease of access and capability of defense, other physical conditions conducive to settlement would be the abundance of food and building materials. Fish, including salmon, was plentiful in the Thames; game, as well as timber—invaluable both for constructional purposes and as fuel—flourished in the great forest of Middlesex, behind, while the Taplow terrace was covered with brick-earth which provided a light, rich soil as well as material for brick-making.

The later growth and development of London was strongly influenced by the distribution of the terrace gravels. Settlement only advanced into the flood plain where embankments provided protection from flooding, or where small hummocks of gravelly material caused a slightly greater elevation. Outside London it was the Taplow gravels and the Upper Tertiary and Drift gravels remaining in scattered fragments on the London clay that determined the settlement in villages. Apart from the bridgehead at Southwark, it was not until water could be brought from a distance and distributed widely in pipes, and until scientific drainage and sewerage were introduced, that settlement of any density was



WEATHER GRAPH OF LONDON. THERMOMETER SHOWS NORMAL ANNUAL MEAN TEMPERATURE; THE CURVE, MONTHLY MEAN TEMPERATURE AND THE COLUMNS, NORMAL MONTHLY PRECIPITATION

possible on the flood plain or on the London clay; even today large areas of the latter and of the alluvial marshland remain untenanted.

Apart from the Thames gravel terraces, which have played so important a part in the site and expansion of London, and the small patches of gravel that provided sites for villages in the lowlying clay vale of the Brent, the sands and gravels of the London basin, where they cover large areas, have not been conducive to settlement, for they provided but poor soil. Much of the land became common grazing land, and has been preserved as open common, for it is to these sandy and gravelly patches that we owe many of the high open spaces which are such an asset to the modern metropolis.

London's Lost Rivers.—The streams of London that traversed the terraces and flood plain to join the Thames deserve mention, for in spite of 2,000 years of occupation and the fact that many of them have long been reduced to the status of covered-in sewers, their valleys can still be traced in the mild relief. Along the slopes of their valleys broke out the springs on which early London depended largely for water supply, and their tidal estuaries gave shelter to shipping and access to the heart of the City. Westbourne, Tyburn and Turnmill brook were streams that rose 3 or 4 mi. from the City, in the hills of Hampstead and Highgate, capped with Bagshot sands that form the northern background of central London. The Westbourne, Kilburn or Bayswater brook, as it was variously called, collected its waters from a number of tributaries on the south and west flanks of Hampstead hill. It flowed through what is now West Hampstead, took the line taken today by Kilburn High road and where Kilburn L.M.S. station now is, received a number of tributaries; it then traversed the districts of Paddington, Westbourne Park and Bayswater, followed the line of the Serpentine in Hyde park, flowed under the Knight's bridge (at Knightsbridge), followed roughly the line of Sloane street, under Bloody bridge at Sloane square (the great pipes that carry the water across Sloane square station today may be seen from the platform), and entered a marshy area that was probably once a backwater of the Thames in the neighbourhood of Ebury bridge. Its lower course is now the Ranelagh sewer.

The Tyburn, a smaller stream, but noteworthy as forming at one period an important water-supply for London, had its sources in central Hampstead, not far from Swiss Cottage, passed west of Primrose hill where it received a tributary from the Belsize district, flowed through our Regents park, crossed the future Marylebone road by Madame Tussaud's, took the same path as the present Marylebone lane, whose windings follow those of the stream, crossed Oxford street—the old Tyburn road—and wound its way to the west of where Bond street now is to the line of Piccadilly, just west of Half Moon street, where the dip in the main road can still be clearly distinguished. It crossed the Green park and, trenching the edge of the Taplow terrace, descended to the flood plain on the site of Buckingham palace. Then it probably lost itself in the tidal marshes. Today its representative storm sewer finds an artificial outlet a little to the south of Vauxhall bridge as the King's Scholars' Pond sewer.

The Turnmill brook, which has been identified with the Holborn and the River of Wells, and was known in its lower tidal section as the Fleet, had its upper tributaries in what are now the Highgate ponds. It flowed down through Kentish Town, Camden Town and the flats of Somers Town to a marshy area at King's Cross, where it was crossed by Battle bridge. Thence it cut a deep channel through the gravels of the Taplow terrace to enter the Thames close to where Blackfriars bridge now stands. Its deep valley was for long an obstacle to east and west traffic between the City and Westminster, owing to the steep gradients of Holborn hill and Snow hill. Today Farringdon street runs above the bed of the river and Holborn viaduct carries the traffic across the valley. A little to the north of the City, the Walbrook rose in a number of springs from the Taplow gravel. Its two head streams passed by culverts through the northern wall of the Roman city and the united stream passed beneath the site of the Bank of England and out to the Thames by a broad tidal creek about where Cannon street station stands. In the 15th century the northern section of Walbrook within the walls was vaulted over. At that time the stream was flowing some 18 ft. above its original bed. Down to the time of the Great Fire it formed one of the principal sewers of the City. The tidal estuary of the stream, known as Dowgate, was, perhaps, the earliest representative of the Port of London. Near its outlet and on the site of Cannon street station stood the guildhall of the merchants from the Rhine, known as the Steleyard.

On the south side of the Thames a succession of streams flowed from the low plateau on to the flood plain and followed more or less indeterminate courses to the Thames. Of these the Wandle and Ravensbourne, which rise as bournes on the dip slope of the North Downs, still bring down large volumes of water to the Thames, the former draining Croydon, Wallington and Carshalton, Mitcham, Merton, Earlsfield and Wandsworth, and the latter Addington, Hayes, Bromley, Catford, Lewisham and Deptford. The minor streams that drained the gravel terraces on the south—Effra, Falcon brook and a stream sometimes called the Neckinger, now flow underground. The waters of the Effra still occasionally cause trouble by flooding basements and undermining roads.

Thames Embankments.—The Thames follows a winding course through London and the fine embankments on its northern side form, in parts, an important means of communication between the City and the southwesterly parts of the town and exits, the finest of them, the Victoria embankment (popularly known as "the Embankment") runs between Blackfriars and Westminster bridges; formed in 1864–70, open gardens fringe it on the landward side, and it is lined with fine public and private buildings; beneath runs the District railway and on its surface the L.C.C. trams. The bold sweep of the Thames, here some 300 yd. wide, the towers of Westminster on the one hand and the dome of St. Paul's on the other, make up a fine prospect. Beyond the Houses of Parliament and the Victoria Tower gardens the embankment is continued by Grosvenor road and the Chelsea embankment (laid out in 1871–74) fronting Battersea park across the river, shaded by a pleasant avenue and lined with handsome houses. Below London bridge the river is embanked for a short distance in front of the Tower of London, and above Westminster bridge the Albert embankment extends for nearly 1 mi. along the south bank, in front of St. Thomas's hospital. The London County hall, completed 1932, has its own embankment; and the realization of a scheme, referred to below, for the development of the south bank of the Thames in the neighbourhood of Hungerford bridge may involve the continuation of the south side embankment at least as far as Waterloo bridge.

Bridges and Tunnels.—Fourteen road-bridges cross the Thames within the county of London. Of these London bridge, connecting the City with Southwark and Bermondsey, stands first in historical interest and in importance as a modern highway. The old bridge, famous for many generations, bearing its rows of houses and its chapel in the centre, was completed early in the 13th century. It was 308 yd. long and had 20 narrow arches through which the tides formed dangerous rapids. It stood some 60 yd. below the existing bridge, which was built of granite by John Rennie and his son, Sir John Rennie, and completed in 1831; it was widened in 1904, by means of corbels projecting on either side. There was no bridge below London bridge until 1894, when the Tower bridge was opened. This is a suspension bridge with a central portion, between two lofty and massive stone towers, consisting of bascules which can be raised by hydraulic machinery to admit the passage of vessels.

The bridges in order above London bridge are as follows: railway bridges being bracketed—Southwark (Cannon Street), (Blackfriars), Blackfriars, Waterloo (Charing Cross or Hungerford—with a footway), Westminster, Lambeth, Vauxhall (Grosvenor), Chelsea, Albert, Battersea (Battersea), Wandsworth (Putney—with footway), Putney and Hammersmith. In 1937 was completed the demolition of Waterloo bridge, a massive stone structure of nine arches carrying a level roadway, engineered by John Rennie and opened in 1817, and considered one of the finest stone bridges in the world. Serious subsidences of certain arches decided the London County Council, in spite of strong opposition from those who deplored the demolition of Rennie's work, to replace it by a bridge of five equal arches of 230 ft. span, designed by Sir Giles Gilbert Scott. The new bridge, which was opened without ceremony on Aug. 11, 1942, carries six lanes of traffic. The building of a great new road bridge to connect the south side at Waterloo station with the Strand and Charing Cross road has been for some time under consideration. The estimated cost of the scheme approaches £12,000,000. The present Westminster bridge, of iron on granite piers, was opened in 1862 and succeeded that built in 1739–50, the view from which was appreciated by Wordsworth in his sonnet beginning "Earth has not anything to show more fair." The complete reconstruction of Vauxhall bridge was undertaken in 1902, and the new bridge was opened in 1906. The new Lambeth bridge was opened in July 1932. Its length is 776 ft. There are five steel arches, the centre span being 22 ft. 9 in. above T.H.W. level. The overall width is 60 ft., and the roadway 36 ft. The Chelsea bridge was rebuilt as a self-anchored suspension bridge, with four traffic lanes and footways, and was opened in 1937. The old lattice-girder Wandsworth bridge was replaced by a new steel bridge, opened in Aug. 1940, built on two granite-faced piers and having four traffic lanes. Putney bridge was widened 1931–34 to take six traffic lanes.

Some of the "tube" and other metropolitan railway lines cross the river in tunnels beneath its bed. There are also several tunnels under the river below London bridge, namely: Tower subway, constructed in 1870 for foot-passengers, but no longer used; Greenwich tunnel (1902) for foot-passengers; Blackwall tunnel (1897), constructed by the County Council for both pedestrians and vehicles between Greenwich and Poplar; Woolwich tunnel, for foot-passengers only, opened in 1912, and the Rotherhithe tunnel (opened in 1908), $1\frac{1}{4}$ mi. long, for foot-passengers and vehicles. The Thames tunnel (1825–43), 2 mi. below London bridge, became a railway tunnel in 1865. The County Council maintains a free ferry at Woolwich. It has been decided to duplicate Blackwall tunnel.

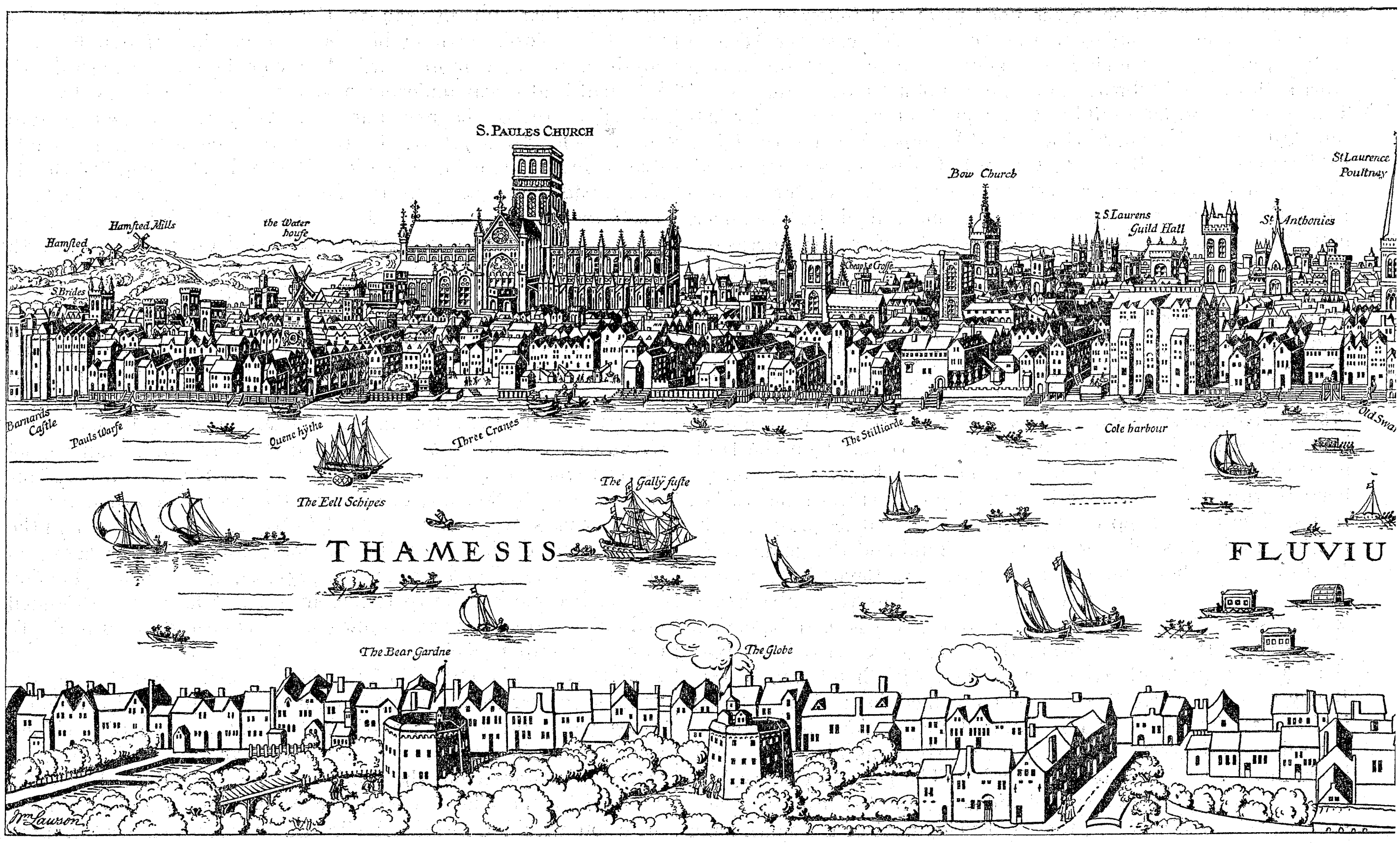
Climate.—The climate of London is equable and the weather variable, owing to the steady indraught of warm moisture-laden winds from the Atlantic and the frequent passage of cyclones, whose southern quadrants usually cross the London basin. Prevailing winds are from the southwest. As a result of the shelter afforded by the Chilterns and the North downs, and occasional inclusion within Continental climatic influences in winter, London has a smaller rainfall than the Wealden or Chiltern areas. It has also a greater range of temperature, and would experience more sunshine but for the pall of smoke that sometimes shuts out the sky in the winter half of the year. This nuisance is abating, however. The mean annual temperature is 50° F.; the mean annual rainfall is about $23\frac{1}{2}$ in.

Central London.—Central London can conveniently be considered in four sections:—the City, the Port, the East End, and the West End.

The City is essentially the small area situated upon the two low hills separated by the Walbrook valley, on which the Romans founded it. The lie of its streets is still to some extent determined by the lines of the Roman walls, upon the ruins of which the mediaeval walls were raised, and the gates that gave access to all parts of the country. Its wards still correspond more or less closely to estates formerly held by the great city families, and the boundaries in certain cases still represent the courses of ancient streams. The City is the market of London today, as in the past, though Cheapside, Eastcheap, Poultry and Vintry are now but street names. There are the great exchanges: the Baltic, Wool, Iron and Steel, and Coal; and the unique insurance corporation of Lloyd's. Finally we have the great money markets, including the Bank of England, the joint stock and merchant banks, the discount houses and the stock exchange. Apart from these it must be remembered that every important business house in the world has representatives in London. So it is also with the great transport organizations and the great news agencies. In other words London is a world exchange for almost every commodity.

Nor must it be forgotten that London is an important centre of industry. Light engineering and the preparation of foodstuffs are among the more important.

The Port of London is, of course, closely allied to the market, though less closely than in earlier days—for enormous quantities of goods are dealt in on the London markets that never touch the quays. The early silting up of the Walbrook meant that Dowgate was the first of the small London hithes to become obsolete; the Fleet was used at least till 1502, when we find that boats carrying fish and fuel could be rowed as far as Holborn bridge. Apart from these two stream estuaries, the port consisted,



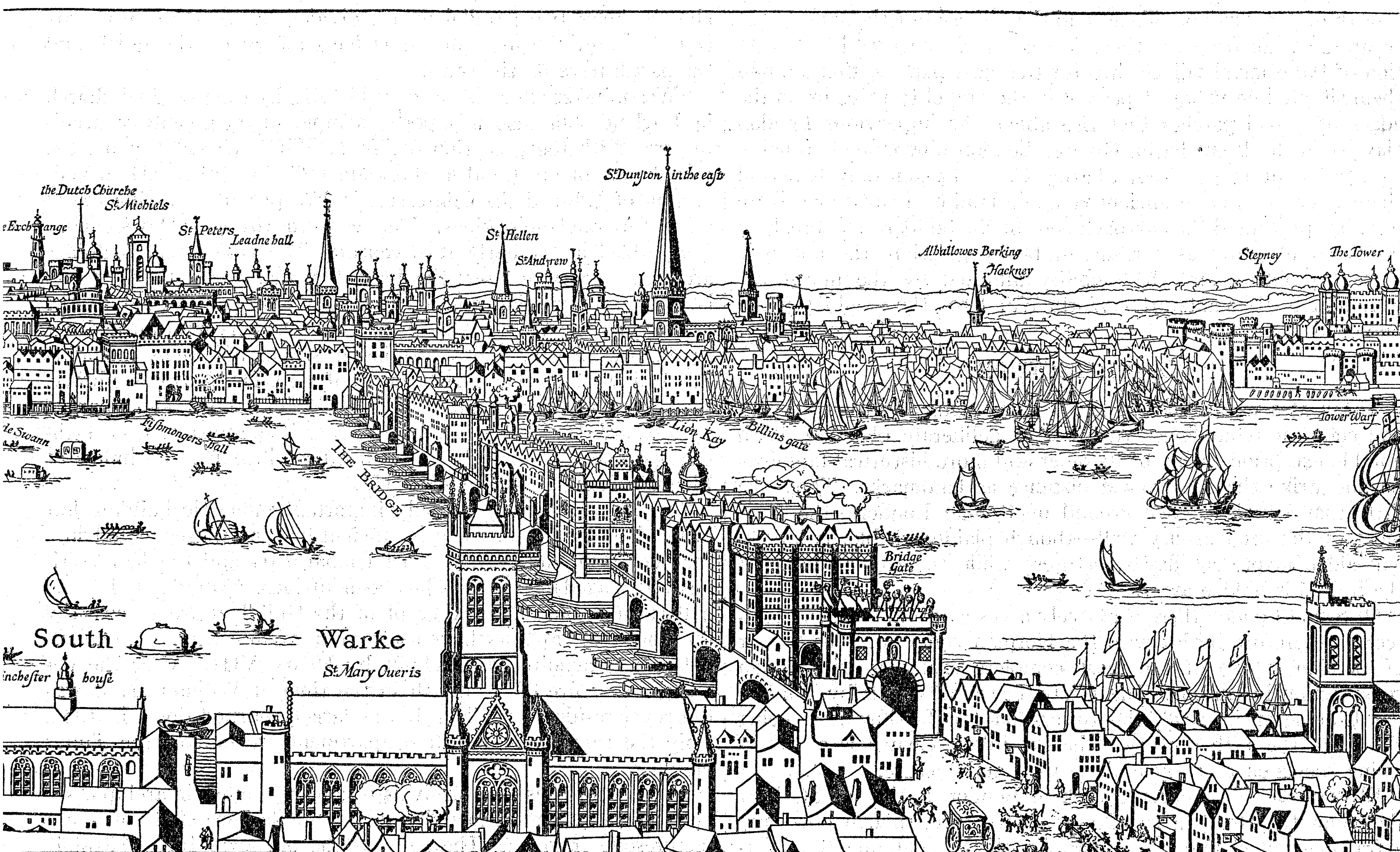
VIEW OF LONDON IN THE 17TH CENTURY, FROM THE SURREY SIDE OF THE THAMES, AFTER A DRAWING BY A CONTEMPORARY ARTIST, VISCHER. ON THE LEFT IS SHOWN "OLD ST. PAUL'S," BUILT DURING THE 12TH AND 13TH CENTURIES, AND DESTROYED BY FIRE IN 1666. IT WAS THE HIGHEST CHURCH IN EUROPE, BEING 520 FEET TO THE TOP OF THE STEEPLE. ON THE RIGHT IS THE ORIGINAL LONDON BRIDGE, BUILT BY

from very early Saxon times of the two hithes: Queenhithe and Billingsgate. Owing to the increasing tonnage of vessels and to the serious impediment caused by old London bridge, in spite of the drawbridge allowing ships to pass through it to Queenhithe, Billingsgate, below bridge, gradually overhauled and superseded its rival. Originally a general port, Billingsgate in 1699 became a free port for fish. By 1588, the congestion in the small hithes, where alone it was legal to land goods, became so great that other legal quays had to be established between Billingsgate and the Tower. By the middle of the 16th century London had drawn to herself the bulk of the trade of southeast England. In the reign of Charles I the Legal quays had to be supplemented by "Suffrance Wharves," whose numbers were gradually increased until by 1896 there were 113. Many of the old Legal wharves and quays retain their name to this day; Galley quay, Botolph's wharf, Three Cranes in the Vintry, for instance. The traffic of coal, which dates back to the 14th century, employed an increasing number of craft on the Thames; sea coal, so-called to distinguish it from charcoal, gave its name to Sea Coal lane, which leads east from Farringdon street, at a point just north of the old Fleet bridge (now Ludgate circus) where the colliers, before returning to the Tyne laden with ballast, discharge their coal; and today coal is one of the main items of traffic above the bridge.

The prosperity of the port as well as the growing tonnage of the ships necessitated constantly increasing accommodation. In 1661 the first of London's docks was built at Blackwall. This was a private undertaking and was not a dock in the modern sense, for it had no gates and could not retain the water at the ebb. In 1700 the Howland Great Wet dock at Rotherhithe was made, but it was not till a century later that, with the construction of the West India dock, the development of the modern port began. At the beginning of the 19th century it took a month or six weeks to discharge an East Indiaman; the construction of the St. Katharine dock in 1828 made it possible to accomplish the work in a week or less. The tonnage of a large ship at that time would be about 500; today a ship of 18,000 or 20,000 tons can be discharged in a couple of days. The trade of the modern port is not, however, confined to the docks. Riverside wharves with modern equipment and vast warehouse accommodation have sprung up, and making up in nearness to market and despatch in unloading what they lacked in facilities for dealing with large vessels at low water, have played a very important part in the development of the port. The Thames always has been, and probably always will be, a "lighter" port. The Thames lighter-men were for centuries an important company with important privileges; the wharfingers and the lighter-men between them now undertake something approaching half the traffic of the port.

The difficulty of obtaining sufficient water on the dock sills for the ever-increasing draught of modern shipping led to the construction of the Victoria and Albert docks (1880–85, extended 1921) in the flood plain north of the Woolwich reach, and—especially since 1909, when the Port of London Authority (see *Port and Commerce,* below) bought out the dock companies for £23,000,000 and put an end to the competition and inefficiency inseparable from multiple ownership and divided control—the port has continued to develop in a downstream direction. After World War I the Authority commenced a huge program: the Victoria and Albert docks were extended by the large and magnificently equipped George V dock in 1921; dredging of the channel as far as the entrance to the Millwall and West India docks was undertaken and maintained; and Tilbury dock (with a low-water depth of 38 ft. on the sills), which had been built in 1886 to accommodate the liners of the day, was extended in 1926–29 by a new entrance dock, 1,000 ft. long by 110 ft. wide, a dry dock (752 ft. by 110 ft.), and a passenger landing-stage large enough for the largest ocean-going steamers. (*See* TILBURY DOCKS.)

The East End.—The Port proper with London river and the Pool below bridge is closely associated with the East End, a somewhat squalid section of London, which has, nevertheless, a number of fine, wide streets. Here dwell the dock and riverside



A PRIEST, PETER OF COLE CHURCH; BEGUN IN 1176 AND FINISHED IN 1209, AFTER THE ARCHITECT'S DEATH, BY THREE LONDON MERCHANTS. THE ARCHITECT WAS BURIED IN A CHAPEL ON THE BRIDGE. UNTIL 1750 IT WAS THE ONLY BRIDGE ACROSS THE THAMES. ABOVE THE GATE ARE SEEN HEADS OF CRIMINALS. IN THE 18TH CENTURY THE HOUSES WERE REMOVED, AND IN 1825 THE PRESENT BRIDGE WAS BEGUN

workers, and here also are large settlements of foreigners, of whom a large proportion are Jews of varying nationality, engaged in small businesses such as clothing factories and retail shops. A dense population hems in the City on the north side in Bethnal Green, Shoreditch, Islington and Holborn, though the City itself has a resident population of only 8,780 (est. 1938). In this connection it is interesting to note that 4,949 suburban trains (of which 2,877 were London Passenger Transport Board trains) entered the City termini daily in the month of July 1937, and that the day population of the City is over 1,000,000 persons.

The West End, which originated as a separate entity with the establishment of the court and parliament in the neighbourhood of the Abbey of St. Peter on Thorney island, developed along the Oxford road and the Strand road that linked the City to Westminster. The marshy islands and tidal creeks round Thorney long remained uninhabited and were only densely settled in modern times. The old creeks at Whitehall, Scotland Yard and Millbank have always been liable to flood at spring tides, especially during a strong wind, as witness the disaster in Jan. 1928, when the tide at the flood spilled over the embankments and flooded the basements of houses in the lowlying districts.

The first important extension of London was along the Taplow terrace that extends west of the City and north of the Westminster flats. The Strand was lined with houses as far as Charing Cross by the middle of the 16th century, and buildings were continuous from the City to Hyde park by the beginning of the 18th century.

The fashionable West End residential area lies about the parks in Mayfair, Belgravia, Kensington, Brompton, with an extension southwards and northwards into parts of Chelsea and St. Johns Wood. Kensington and Brompton have always been high-class shopping centres, as well as high-class residential quarters; and it is noteworthy that in Park lane, the squares of Mayfair, the western half of Piccadilly and Belgravia, great hotels and huge blocks of flats and offices—in many cases with ground-floor shops—are now taking the places of splendid mansions and gardens.

The Shopping Area.—The great West End shopping area stretches from Holborn viaduct westwards along Oxford street to the Marble arch and St. James's, and starts again at Knightsbridge to continue through South Kensington to Chelsea. Southwark, the ancient bridge-head and southern outlet of the City, grew but slowly, like Westminster, on account of the marshes. The embankment, partly natural and partly artificial, and the causeway extending into the marsh were the earliest developed parts of the district.

A significant change of recent years has been the spread westward of activities formerly confined to the City. Much of Bloomsbury behind the British museum has been demolished and the site has been acquired for the University of London, whose 43 schools and colleges are scattered over a wide area. The new buildings designed by Charles Holden, were begun in 1933, the Tower building being opened in Oct. 1937. The Foundling site, sold for about £2,000,000, was preserved as a playground for neighbourhood children. Work on its layout began in 1936.

The character of many of London's streets has been altered. A change regretted by many is the passing of Nash's Regent street and the Quadrant. Devonshire house, one of the last of Piccadilly's great mansions, disappeared in 1924 and was replaced by hotels and flats; a like fate overtook the ducal mansions of Grosvenor house and Norfolk house. Dorchester house, in Park lane, was demolished and replaced by a hotel. There are many new theatres, "cinemas," and restaurants; Grosvenor street, which flanks Buckingham Palace gardens, is now a street of offices; the widening of the Strand proceeds slowly.

The City is changing its aspect even more rapidly. The Bank of England was refashioned and enlarged upwards within its sphinx-like outer walls; Lloyd's built a magnificent new home in the shipping quarter and tall modern buildings are springing up everywhere in the narrow City streets.

The Suburbs.—The London suburbs have been formed by the growth of surrounding villages and the filling-in of the spaces that separated them from the City. Water-supply governed the selection of the original village sites for the most part, so that we find them situated on valley slopes cut in the gravel terraces or on the edges of gravel patches that rise above the impervious London clay, as in the Brent basin. Greater London now extends roughly to a radius of 15 mi. from Charing Cross, broken only here and there where a patch of ancient common land or a royal or private park has prevented the encroachment of the builder. The breaking up of large estates as a result of heavy taxation, the domestic servant problem, and the mobility afforded by the motor car were active stimulants after World War I to "the swelling of the immortal Wen." (H. Or.; X.)

ARCHITECTURE

Taken as a whole London shows many signs of natural growth and constant rebuilding, and fewer of deliberate planning. With notable exceptions many of its older and more historical buildings do not strike the eye from a distance as landmarks. Thus, the little that remains above ground of Roman London—the fragment of the original city wall—though plainly visible, is largely embedded in present day structures; while the Roman bath off the Strand is hidden away.

Of Saxon London there is scarcely a vestige; and London architecture therefore begins with the Norman conquest. The Tower of London is one of the most complete examples of Norman construction in Europe. The White Tower was built by William the Conqueror in 1078, the towers on the fortifications being chiefly of the 13th century. The St. John's Chapel is an interesting specimen of early ecclesiastical architecture.

Churches.—The oldest church in London is that of St. Bartholomew the Great, a fine Norman structure, though now only a fragment; it should be compared with the contemporary Waltham Abbey, where will be found the counterpart to what is missing from it, and vice versa; it contains the tomb of Rahere, founder of the priory and of the adjacent hospital, which is the oldest in Great Britain.

The *Temple church (1185), which originally belonged to the Knights Templars, was one of the four ancient round churches in England; the entrance porch is Norman; the chancel one of the best pieces of Early English work in London. It was badly and drastically restored in the 19th century and the "round" was gutted in 1941.

Southwark cathedral, which has been restored with great care, was formerly the church of St. Mary Overie's Priory; it is a large cruciform building, mainly in a typical Early English style, and is rich in monuments contemporary with Shakespeare whose theatre, the Globe, was hard by.

The church of *Austin Friars comprised the 14th century nave of the old Augustinian Priory church and was the church of the London Dutch colony. It was completely destroyed by air raids.

Other interesting City churches which survived the Great Fire of 1666 are *All Hallows, Barking, the burial place of many who were executed on Tower Hill (largely 15th-century Perpendicular and noted for its fine brasses and late 17th-century carved wood font cover; very badly damaged, though the tower, 1658, survives; the wrecking revealed a Saxon arch); St. Andrew's Undershaft (so named because a maypole used to be set up before an older church), rebuilt 1520–32 and containing font and Jacobean tombs, including a monument to John Stow, the chronicler of the survey of London (d. 1605); St. Ethelburga, externally the quaintest old church in London, and containing a 15th-century arcade; *St. Giles, Cripplegate (14th century, rebuilt 1545 and recently restored), of which most of the mediaeval work, including the tower (upper part 1683–84), survives. The chapel at the east end of the north aisle contains Elizabethan and Jacobean monuments. It is the burial place of Fox, Milton and Frobisher; Cromwell was married and Defoe baptized there. St. Helen's, Bishopsgate (13th and 14th centuries), the Westminster abbey of the City, is rich in monuments, including those of Sir Thomas Gresham and other old City merchant princes. The present church shows two parallel naves, divided by a 15th-century arcade: that of the nuns of St. Helen's priory on the north and the parish nave on the south.

*Westminster abbey is not only historically the principal church in England, but also a superb example of 13th-century architecture. With the exception of Henry VIII's chapel (1519), the church was planned and in the main built by Henry III in veneration of Edward the Confessor, and to provide a fitting burial place for England's kings. The western towers (Hawksmoor) were added in the early 18th century. The conventual buildings are 13th century or later; the Jerusalem chamber at the west end is a most interesting annex. It was seriously damaged at the crossing during World War II, and the Deanery was burned out as was the cloister and Westminster school buildings, including the hall with its hammer-beam roof and Dr. Busby's library. Westminster hall was built by William Rufus (1097), and enlarged by Richard II (1398). St. Margaret's, Westminster, is a 15th-century Perpendicular church with a magnificent east window of Flemish glass (temp. Henry VII).

The *Charterhouse, the only important monastic building left in London, has lost many of its ancient buildings, used as lodgings for poor gentlemen. The chapel (unharmed) and the hall (seriously damaged) have fine Jacobean fittings. *Merchant Taylors hall (burned out) and the crypt of the Guildhall are noteworthy specimens of 14th–15th century civil architecture. St. James' palace was acquired and rebuilt by Henry VIII. After the destruction by fire of Whitehall in the time of William III it was the royal residence until itself was largely burned down in 1809. Only the gateway and certain apartments remain of the Tudor building.

London contains few survivals of ancient domestic architecture but the gables and timbered front of Staple Inn, Holborn, are a picturesque fragment. The halls of the old legal Inns (*Middle Temple, Lincoln's Inn, Barnard's Inn and Staple Inn) retain much of the woodwork of this period. The hall of *Gray's Inn, with hammer-beam roof and fine woodwork, along with the library, were gutted, while the east end of Middle Temple hall was badly damaged. Other contemporaneous buildings of which remains survive are the little group by Lincoln's Inn gateway, comprising the chapel and some of the rooms in Old square. Good specimens of domestic buildings are *Holland house, of which the library (Thorpe) and other parts were wrecked; Charlton house; Eastbury Manor house, Barking; and Trinity almshouses, Mile End road. Lambeth palace contains work of various periods. The chapel and crypt are Early English, dating from 1245 down to quite modern times.

Inigo Jones.—The dominating genius of Inigo Jones (1572–1652) has left its mark on nearly all Jacobean and Caroline work erected in England. The most remarkable of all his buildings is the Banqueting hall, Whitehall, the only part built of his grand conception for Whitehall palace. Other examples of his work are Lincoln's Inn chapel, the churches of St. Catherine Cree; St. Paul's, Covent Garden (much of which is only a reproduction of the original design, destroyed by fire); and alterations to *St. Alban's, Wood street, which was burned out, though the tower remains. He was also responsible for the arcade on the north side of Covent Garden, which was demolished in 1928, and for the west side of Lincoln's Inn fields; also the small but admirable Water gate at the bottom of Buckingham street, Adelphi; Queen's house and the River block, Greenwich hospital; and Lindsey house and Ashburnham house among domestic buildings. Jones's more important contemporaries include his assistant and relative, John Webb, and John Pratt, author of much of the work in the City, including the Vintners' hall. *Brewers' hall, the finest of those rebuilt after the fire of 1666 and dating from 1670–73 (Caine), was completely wrecked. The City halls, usually ascribed to Sir Christopher Wren, are undoubtedly the work of Pratt, Talman, May and Brettingham, who collaborated with Wren in the reconstruction of the City buildings after the great fire of 1666.

Wren.—Sir Christopher Wren's (1632–1723) majestic conception of *St. Paul's cathedral put him in the front rank of architects of all time. St. Paul's, the "trade mark of London,"

*Buildings marked with an asterisk were damaged in World War II as described.

is the finest example of Renaissance architecture in England, and owes very little to foreign influence. The altar was destroyed and the north transept damaged. The graceful lanterns, spires and steeples of Wren's churches, grouped round the dome of St. Paul's, lend to the City an architectural feature that stands comparison with any other city in the world. Notable among them are the wonderful steeples of *St. Mary-le-Bow (a superb piece of architectural design; interior gutted); *St. Bride's, Fleet street (completely gutted); *St. Vedast, Foster lane (wrecked and scorched, but can be restored); St. Magnus, London bridge; and the lead spires characteristic of Wren's genius, St. Martin's, Ludgate and St. Margaret Pattens. There are also some less successful essays in the Gothic manner, for which he had no sympathy: St. Mary Aldermary and St. Dunstan's-in-the-East—but his most successful effort in this style is the tower of St. Michael's, Cornhill, which is strongly reminiscent of Magdalen tower, Oxford. Internally, the main features are the skilful use of plaster such as was to be seen in *St. Stephen's, Walbrook, *St. Mildred's, Bread street and *St. Clement Danes, and which still exists in St. Margaret's Lothbury. St. Mildred's and St. Clement's were ruined, though St. Stephen's can be restored. Wren's richly ornamental woodwork survives in the pulpit of St. Margaret's; the altar piece of *St. James's, Piccadilly (badly damaged, but capable of reconstruction); though the organ case, fittings and vestry of *St. Lawrence Jewry (completely gutted) and the pulpit of *St. Clement Danes, a magnificent specimen of Grinling Gibbons's work, have been lost. Most of these pieces were of oak, a rather hard material, but Gibbons successfully introduced lime and pearwood for delicate carvings. In addition to Grinling Gibbons, Jonathan Mayne (carver), Jean Tijou (metal worker), Cibber and Bird (sculptors) were among the able craftsmen employed by Wren.

Among the public buildings erected by Wren for royalty and the government were Greenwich observatory, Westminster abbey (repairs), *Kensington palace (upper stories damaged); Hampton Court (additions), Winchester palace (not completed), Marlborough house, St. James's and Windsor (extensive alterations), the Monument (commemorating the Great Fire), and his wonderful additions to Inigo Jones's work at Greenwich hospital. His *Chelsea hospital (seriously hurt in one part) for old soldiers is of a magnificent homeliness. *Buckingham palace (slightly damaged) is the work, not of Wren, but of Capt. Wynn (largely altered by Nash). An excellent design of the period is the Middle Temple gateway. Morden college, Blackheath, a Wren design, shows clever blending of stone and brickwork.

Of Wren's successors perhaps only Sir William Chambers stands out prominently. His design for *Somerset house (river front damaged), though decidedly too utilitarian, is far finer than Barry's *Houses of Parliament (commons chamber burned out). The work of the brothers Adam was largely an adaptation, usually skilful but dull and lifeless, of Roman ornament to English mansions. A former feature of London was the number of residences built, usually fringing the parks, for peers, etc., by eminent architects; as Ely, Spencer, Dover, Gwydyr, Carrington, Stafford, Clarence and *Bridgewater houses, the last damaged but still standing. Their disappearance, owing to the heavy cost of upkeep, indicates the gradual displacement of the titled landlord by the new rich.

After the brothers Adam the caustic pen-drawings of Pugin brought about a return to true principles. To him is due the revival of Gothic detail, in many ways sound, but unsuited to modern times. Heavily transomed windows with leaded lights gave way at last to a demand for more light in this fog-laden atmosphere. Large windows, divided by heavy metal bars, giving a maximum of light, mark modern examples of London architecture: the County hall, Adelaide house, Bush house and Lloyds.

The developments of the 20th century on the whole indicated a slow awakening to the aesthetic advantages obtainable from strict adherence to the decorative minimum. The 19th century, however, in forging the means and tools by which a more satisfactory contemporary expression could be obtained, left largely a legacy of redundant extravagance which was not soon outlived. The legacy dies hard and the great concerns of state, local government, commerce and industry in the years before World War II still vied with each other in the magnificence of their buildings. This produced a city rich in individual examples of architecture. Among these, noteworthy buildings such as the County hall (1912), the offices of Adelaide house (1925), London Transport headquarters (1929), and London university (1937) showed progressive development in the increasing simplification of external appearance, together with a tendency to preserve classic calm and solidity. On the other hand, the more spatial expression made possible by steel, or reinforced concrete, frame construction (still with a classic restfulness) was visible in the Kodak buildings (1911), the premises of Messrs. Heal (1917), the Horticultural hall (1929) and a block of flats, 65 Ladbroke grove (1938). The absence of central guidance and control by planning legislation, however, not only denied the possibilities of relating such individual examples to their immediate localities, but prevented the realization of a wider necessity: that of welding London into a unified and interrelated whole. To this end, the County of London Plan (1943) for the redevelopment of the county area, prepared for the London county council (which accepted it in principle), suggested a comprehensive and elastic program which included the co-ordination of industry and the recreation of community life in the vast aggregate of Greater London. Greater architectural importance than ever before was thus planned for the buildings of the community, with the emphasis on schools, local and civic centres and churches, as an integral and pivotal part of the domestic development.

To understand the present state of London architecture a sense of history is essential. The ancient City, which for many centuries contained the majority of the population, has been rebuilt again and again, and the same holds true of the parts near the City; but there remain here and there in several districts of inner London interesting survivals of original building. Mayfair, despite encroachments, still stands as the quarter of 18th-century aristocracy as Bloomsbury remains that of the earlier 19th-century professional classes. Westminster again and Chelsea show streets and groups of houses belonging to an age before either of them was identified with London proper. North and south of Hyde park and Kensington gardens, are substantial residential districts typifying, though poorly, the last stand of style.

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(M. E. M.; X.)

COMMUNICATIONS

Railways.—From the grouping of the trunk railways effected at the beginning of 1923 it results that each company, excepting the Great Western (Paddington station) possesses more than one principal terminus in London. The Southern system has eight stations, terminal wholly or in part, of which Waterloo serves for the southwest of England and the rest for various services to the south and southeast; the Continental services are worked from Victoria, excepting those via Southampton (from Waterloo). The London, Midland and Scottish system has Euston (northwestern and Scottish services), St. Pancras (midland and Scottish), Broad street (suburban), and Fenchurch street, used jointly with the London and North-Eastern company and the Port of London Authority for services mainly to Thames estuarine stations (north bank). The London and North-Eastern system has King's Cross (northern and Scottish), Marylebone (midland), and Liverpool street (eastern services). Systems of joint lines and running powers, such as those over the West London extension line and the Metropolitan extension through the city, afford com-

*Buildings marked with an asterisk were damaged in World War II as described.

munication between the main lines, but for goods traffic mainly, with little passenger traffic. On the other hand the main lines, which themselves carry very heavy suburban traffic, especially southward, eastward, and northward, are adequately connected by the urban electric railway services next to be noticed, and in some instances have joint workings with them. The most extensive electrified suburban system in the world is that of the Southern railway, which extends to Maidstone, Gillingham, Brighton, Worthing, Hastings, Eastbourne, Portsmouth, Bognor Regis, Havant and Reading, as well as over most of London south of the Thames.

Underground Railways.—The purely urban railways include those running: (*a*) in tunnels (of brick) close below the surface, or in cuttings, (*b*) in deep-level "tubes," or metal-lined tunnels—though the outlying suburban extensions of both types of railway commonly come to the surface. The shallow underground lines of the first type are those of the Metropolitan and Metropolitan District systems, the earliest part of which was opened in 1863 and was worked by steam engines. The impossibility of proper ventilation, and various other disadvantages of steam traction, led to experiments with electric working in 1900, and complete electric traction was gradually introduced in 1906. The first "tube" railway in the world was the Tower subway, 1,340 ft. long. From Tower Hill it passed under the Thames to Vine street, about 200 ft. beyond Pickle Herring street. It was formally opened on Aug. 2, 1870, but ran for only a few months. On Christmas eve the same year the tunnel was opened to foot passengers, but it was finally closed to the public shortly after the opening of Tower bridge on June 30, 1894, although it had been popular until then. It is now used for other purposes. Although a failure as a cable-operated railway, its method of construction established the principles upon which the present electric system has been built (see *Railway Mag.* Nov.–Dec. 1943). The first "tube" with electric traction was the City and South London (1890), followed by the Waterloo and City (1898) and the Central London line (1900). Concurrently with the electrification of the old steam lines, extensions of lines proceeded rapidly, until now such outlying centres as Acton, Ealing, Hounslow, Putney and Uxbridge on the west, Aylesbury, Harrow, Chesham, Watford, Edgware, Cockfosters and High Barnet on the north, Barking on the east, and Wimbledon and Morden on the south, are directly connected by the urban electric railways with the centre of London. The lines were constructed by various companies, but control was exercised by the Underground Electric Railways company, which erected a great power house at Chelsea in 1904–05, over all the urban lines excepting those belonging to the trunk systems and the Metropolitan company, which had its power house at Neasden. By June 30, 1939, the route mileage worked by the Metropolitan and District systems was 113 mi. and by the "tubes" 96 mi.

London Passenger Transport Board.—In course of time London transport grew to be so complex and was provided by so many different companies that it became apparent that some form of unified control was needed if the best service was to be provided. The London Passenger Transport board was, therefore, constituted in 1933, "to secure the provision of an adequate and properly co-ordinated system of transport" within the London area, and was required to conduct its undertakings "in such a manner and for such fares and charges . . . as to secure that (its) revenues should be sufficient to defray all charges which are . . . required to be defrayed out of the revenues of the board." In the period 1933–34 there were transferred to the board 5 railway, 17 tramway and 135 bus and coach undertakings, the new undertaking being the largest system of urban transport in the world, serving an area of 1,986 sq.mi. with a population of about 9,500,000. The act of 1933 under which the board was set up also provided for the establishment of a standing joint committee of representatives of the board and the four main-line railway companies and for the creation of a pool of passenger receipts less operating allowances, so that in effect all the means of local passenger transport within the board's area could be treated as a unified system with a common financial interest. Thus a consolidated and unified transport system succeeded a complex and diverse one.

The board itself consists of seven members, two of whom are required to have had not less than six years local government experience in the area. The act further states that members must "have had wide experience, and have shown capacity in transport, industrial, commercial or financial matters or in the conduct of public affairs." The board is appointed by a body known as the appointing trustees, convened for the purpose by the minister of transport. This consists of the chairman of the L.C.C., a representative of the London Home Counties traffic advisory committee, the chairman of the Committee of London Clearing Bankers, the president of the Law society, and the president of the Institute of Chartered Accountants in England and Wales.

The board's first task was to complete the £10,000,000 program of improvements begun by the former companies, but plans were soon made for a further scheme, in conjunction with the main-line railways, involving the construction of 25 mi. of track extensions, the electrification of about 83 mi. of the L.N.E. and G.W. railways, the construction of 13 new stations and the remodelling of 70 existing stations. This program will raise the route mileage of lines owned by the board from 174 to 191 mi. and the route mileage run over by the board's trains from 209 to 275 mi., while through services will be provided to the west central and City areas from such outlying places as Ruislip, Denham, Loughton and Epping. Work was begun in 1936 and was to have been completed in 1941, but had to be suspended during World War II, though by 1943 two of the five new "tube" sections had been opened, namely, Baker street to Finchley road, connecting with the Metropolitan line, and the Northern line extension to East Finchley.

Some idea of the vast extent of the system may be gained from the following facts, as of June 30, 1939, the longest through "surface" line was from Liverpool street to Aylesbury (42 mi.), the longest "tube" line was from Cockfosters to Uxbridge (32 mi.), and the District line service from Ealing to Upminster was 27 mi. in length; the board's vehicles work 3,093 route miles of services (about 3,150 mi. on completion of present plans) and in the year 1938–39 carried over 3,872,000,000 passengers, the railways' share being 563,000,000, of whom about 50,000,000 used Piccadilly Circus station annually, a world record. Other interesting details are —the deepest station is Hampstead, 181 ft. below ground; the longest continuous tunnel is that between Morden and Golders Green, 16½ mi.; and the escalator at Leicester Square station, 180⅓ ft. long, with a vertical drop of 80¾ ft., is the longest in the world.

During World War II the "tubes" were extensively used as air raid shelters. In 1941 about 16,000,000 persons were accommodated at 79 underground stations. Approximately 8½ mi. of three-tier bunks, 7,600 in all, were installed on platforms and in subways, the short spur from Strand to Aldwych being permanently closed to traffic. At night food trains were sent round, and 11 tons of food were distributed nightly during raids. There were also 124 underground canteens. (*See* also *Tramways, Omnibuses* below.)

Tramways.—Tramways were introduced in London in 1860, the first line running from Marble Arch to Paddington, via Bayswater road. In 1905 electric traction appeared, but the surface tramway system of London could never be complete, as, within an area roughly represented by the boroughs of Chelsea, Kensington and Fulham, the city of Westminster and a considerable district north thereof, and the city of London, the existing streets could not accommodate tram lines along with other traffic over any great distance consecutively, and in point of fact there were never more than a few lines, beyond the Embankment line from Blackfriars bridge to Westminster bridge, which connects with the southern system, and the line running south from Islington, using the shallow-level subway under Kingsway and connecting with the Embankment line. The northern, western and eastern outskirts and London south of the Thames, however, came to be extensively served. Most of the lines were in the possession of the London county council when London Transport took over in 1933. Electric traction and (generally) underground transmission are used; but the tramway lines seriously congest the thoroughfares for other traffic, and the tramways, however necessary, do not pay in competition with omnibuses. In consequence, they began to be replaced by trolley buses in May 1931, and the conversion would have been completed by 1941 under the L.P.T.B.'s five-year scheme had it not been for the outbreak of World War II. By June 30, 1939, the tramway route mileage was 135 mi. and that of the trolley bus system was 236 mi. The complete conversion will raise the latter mileage to 362. During the war a number of tram routes were converted, and with the exception of two isolated cases the whole of the present (1943) tramway system comprises the area from the Embankment to south of the Thames. From the Embankment tram routes run to Greenwich, Woolwich, Abbey Wood, Lewisham, Lee Green, Eltham, Catford, Downham, New Cross, Camberwell, Brixton, Streatham, Croydon, Purley, Clapham, Balham, Tooting, Wimbledon, Battersea and Clapham Junction. In the year ended June 30, 1939, passengers carried by the trams and trolley buses numbered 1,086,738,072.

Omnibuses.—The first omnibus began operation between the Bank and Paddington on July 4, 1829, and accommodated 18 persons. In 1850 men were allowed to ride on top. The first motor omnibus ran from Victoria to Charing Cross in 1897. In 1905 and following years these vehicles began to a large extent to supplant horse traction, though the last horse bus was not withdrawn until 1916. The first covered-top omnibus was introduced in 1925. The principal company was the London General Omnibus company, founded 1855, but as time went on the number of its competitors grew, until after World War I scores of "pirate" companies, as they were called, were operating in cut-throat competition. The service provided was, however, very extensive, embracing the principal streets throughout the county and extending far beyond its boundaries—to Leatherhead, Windsor, St. Albans, Watford, etc. All the services were consolidated under the L.P.T.B., and by June 30, 1939, the route mileage worked by the board's 6,389 buses and coaches was 2,513 mi., while the number of passengers carried in the year 1938–39 was 2,222,695,228. The service consists of two main divisions—the town (red vehicles, mostly double-decker) and the country (green vehicles), the Green Line. In recent years many buses have been converted to diesel operation to reduce running costs.

Cabs.—"Hackney coaches" for hire are first mentioned in 1625, when they were kept at inns, and numbered 20. The horse-drawn "hansom," a two-wheeled vehicle so named after its inventor (1834), and the "four-wheeler" or "growler," began to be superseded by motor cabs about the same time as the omnibuses, and in 1907 many motor cabs provided with taximeters ("taxicabs") were put into service. In Jan. 1939, there were 7,500 "taxis" in Greater London. In August the number had fallen to 7,300 and by Oct. 1943 there were only 4,500 owing to the wartime gasoline shortage. Horse-drawn cabs are now mainly a novelty.

Thames Steamers.—A local passenger steamboat service on the Thames suffers from the disadvantage that the river does not provide the shortest route between points at any great distance apart, and that the main thoroughfares between east and west do not, as a rule, touch its banks, so that passengers along those thoroughfares are not tempted to use it as a channel of communication. High pier dues, moreover, contributed to the decline of the traffic, and attempts to overcome the disinclination of passengers to use the river except for pleasure show a record of failure. Steamboats were worked by various companies from 1840 until 1902. In 1904 the L.C.C. obtained powers to undertake the service and in June 1905 one was opened, only to be closed, a financial failure, in Oct. 1907. So matters rested until 1934, when the London and Home Counties traffic advisory committee reported after holding an inquiry that there was no evidence of a strong public demand for a river service and that having one would not relieve land transport pressure. During World War II, however, an emergency service was run from Westminster to Woolwich as an alternative means of transport between the places on the Thames where normal road and rail services had been affected by enemy action. It began operating on Sept. 13 and closed Nov. 11, 1940.

Traffic Problem.—One of the most serious administrative problems met with in London is that of locomotion, especially in the regulation of traffic in the principal thoroughfares and at the busiest crossings. The police have powers of control over vehicles and exercise them admirably; their work in this respect is a constant source of wonder to foreign visitors. But this control does not meet the problem of actually lessening the number of vehicles in the main arteries of traffic. Some idea of the volume of traffic and the delays is obtained from the fact that the seven most important intersections carry from 48,000 to 80,000 vehicles in 12 hours. In order of *traffic volume* these are Hyde Park corner. Trafalgar square (65,000), Marble Arch, Piccadilly circus, Chatham place (north end of Blackfriars bridge), Piccadilly (between Berkeley and Bond streets) and Victoria station (Vauxhall Bridge road and Ebury street). The seven most important intersections from the point of view of *delay* are Ludgate circus, Hyde Park corner, Trafalgar square, Elephant and Castle (36,000), Mansion House, Piccadilly (as above) and Piccadilly circus. The interesting point is, however, that the 80,000 vehicles using Hyde Park corner accumulate only 1,000 hours delay in the 12 hours compared with 1,200 hours accumulated by the 43,000 vehicles using Ludgate circus. In the narrow streets of the City, congestion is often exceedingly severe, and is aggravated when any main street is under repair, and diversion of traffic through narrow side streets becomes necessary. A "round-about" movement of traffic, first introduced at Trafalgar square in 1926, and supplemented by the use of "one-way" streets, alleviated the delay caused by crossing streams of vehicles, with great success in some instances, but not in all. The installation of traffic-operated automatic lights also considerably improved matters.

In 1903 a royal commission was appointed to consider the whole question of locomotion and transport in London, and it reported in 1905 (blue-book, Cd. 2,597, contains its general conclusions). One of its recommendations was that a traffic board should be established for London; and a London and Home Counties traffic advisory committee was appointed under the London Traffic act, 1924, to advise the ministry of transport (which had come into existence since the date of the royal commission). Its jurisdiction covers an area of 1,820 sq.mi., known as the London Traffic area. (The Metropolitan Traffic area for the licensing of public service vehicles is 2,415 sq.mi.) The emergence of new problems associated with the development of motor traffic diverted attention from some of the commission's recommendations as to the construction of new thoroughfares, and public attention was focused upon two main aspects of this problem: (*a*) the construction of arterial roads from the outer parts of London, continuing or connecting with certain of the trunk roads of the country; (*b*) the provision of more adequate communications north and south across the Thames. As for (*a*) it is mainly owing to the great post-World War I arterial road works (principally outside the county) that the London traffic situation is not far worse. Chief among these roads are Eastern and Western avenues, the North and South Circular roads, the Barnet, Watford and Kingston by-passes and the London-Southend road. An important improvement, for which powers were obtained in 1936, is the extension of West Cromwell road (Kensington) to the county boundary, thence to join up with the Great Chertsey road, the Great West road and the North Circular road. The completion of this scheme will provide a valuable traffic outlet to the west and southwest. Outstanding examples of radial routes are the Shooter's Hill by-pass and the Eltham by-pass (Sidcup road). But traffic within inner London has far to travel under congested conditions before it can escape by these channels. The alleviation of these ills is assisted by the widening of key bottle-neck sections, such as Notting Hill Gate, Horseferry road and Kensington High street, and the introduction of roundabouts, as at Vauxhall Cross, the junction of five important roads, where a large central island was laid out. The river-crossings which have come most closely under scrutiny are those at Charing Cross and near St. Paul's cathedral. The substitution of a road-bridge for the railway bridge at Charing Cross (or preferably the provision of a bridge serving both purposes), after being under discussion at least from 1904, was brought to a conclusion about 1937 when, following a report of the traffic advisory committee (June 1936), the L.C.C. pointed out that the scheme the committee favoured would cost £32,500,000. Its death blow was Sir Charles Bressey's opinion that other projects already being negotiated would give better value for the money and that the bridge scheme would itself probably aggravate traffic congestion on the south side of the river.

The bridges within the City of London, as distinct from those within the county, are London, Southwark (rebuilt), Blackfriars and Tower bridges. They are in the immediate care of the Bridge House Estates committee, a committee of the City corporation which takes its name from the "bridge house," mentioned as early as 1272 as the administrative centre for the property connected with London bridge, including the houses and shops upon the former bridge. Rents, tolls, etc., were the source of the committee's income. Proposals from this committee and from other quarters for a new road bridge over the river below St. Paul's cathedral, with new streets giving access to it, have been brought forward from time to time since 1852; they have encountered opposition from commercial interests, inevitable in so crowded an area, and from the authorities of St. Paul's cathedral, who fear the effects of additional vibration. The corporation was authorized to build a bridge by act of parliament in 1911, but World War I deferred the work, and an extension of time was granted in 1921. The question was still in abeyance in 1935. Improvements carried out on bridges under the county council are outlined on p. 349. (See *Report of Royal Commission on Cross River Traffic in London, 1926,* and *Highway Development Survey, 1937, Greater London,* Bressey Report.)

Post Office.—The General Post Office lies in the centre of the city on either side of the street called St. Martin's le Grand. The oldest portion of the buildings, Ionic in style, was designed by Sir Robert Smirke and erected in 1829. The headquarters of the parcels department are at Mount Pleasant, Clerkenwell; those of the post office savings bank at Blythe road, West Kensington, those of the money order department in Manor Gardens, Holloway, and those of the London telephone service at Faraday building, Queen Victoria street. An electric tube railway, completed in 1927 and the only one of its kind in the world, runs from the eastern district sorting office in Whitechapel to Paddington railway station, connecting with Liverpool Street station (L.N.E.R.) and the City delivery and parcels offices. It is 6½ mi. long and is operated from without, the trains carrying no men; 30,000 bags of mail are carried daily and the annual number of train miles is 1,700,000. The postal area of 234 sq.mi. is divided into ten districts, commonly designated by initials, and many subdistricts, designated by numerals (which it is customary to employ in writing addresses). The area excludes part of Woolwich within the county, but extends considerably beyond the county boundaries in other directions. About 50,000,000 letters are posted in London weekly, of which 21,000,000 are for the provinces.

Telephones.—The first London telephone exchange was opened in Aug. 1879 by "The Telephone Company." In the following year it amalgamated with the rival Edison Telephone company to form the United Telephone company, which introduced the first all-night service in London at Heddon street and Westminster exchanges in 1885, intended specially for the use of members of parliament. Four years later, on May 1, this company combined with the National Telephone company, which had been formed in 1881 and which gave its name to the new organization. This gradually absorbed rival concerns, and in 1894 the post office, through the telegraph, was its only competitor.

It was inevitable, however, that the post office should eventually absorb all its rivals, since the government, shortly after the formation of the United company, succeeded in obtaining a legal judgment that a telephone was a "telegraph" within the meaning of the Telegraph acts. Telephone conversations were, therefore, strictly within the province of the postmaster-general. This decision, combined with public complaints about the service, led first to the introduction of a separate system of exchanges and lines by the post office and finally to the post office's acquisition of the National system, which took place on Dec. 31, 1911, at a price later settled at £12,500,000.

The London telephone area in 1943 covered about 1,200 sq.mi., and extended from Welwyn in the north to Reigate in the south and from Gravesend in the east to Staines in the west. The toll exchange gave immediate connection, outside that area, with places as far as Letchworth, Buckingham, Newbury, Brighton, Margate and Aldeburgh. Beyond these limits the trunk system operated. Although the post office opened its first public automatic exchange at Epsom, Surrey, in 1912, the first in London were Bishopsgate, Holborn and Sloane, which were opened in the summer of 1927.

The District Messengers company affords facilities through local offices for the use of special messengers.

POPULATION, PUBLIC HEALTH, ETC.

The population of Greater London in 1938 was 8,700,000. Area of administrative county is 117 sq.mi.

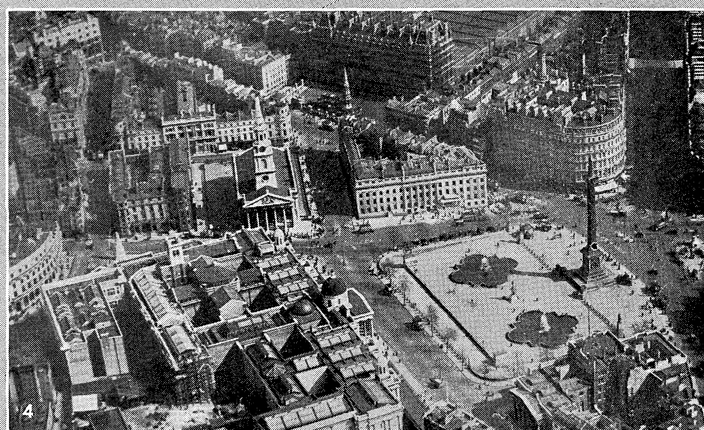
The following table gives comparisons between certain census returns for Greater London and its chief component parts, namely, the City, the administrative county and Outer London (*i.e.,* the zone outside the county boundary but inside Greater London). All the figures before those of 1921 are adjusted to these areas.

Year	City	County	Outer London	Greater London
1841	123,563	1,825,714	286,067	2,235,344
1881	50,569	3,779,728	936,364	4,766,661
1921	13,709	4,484,523	2,995,678	7,480,201
1931	10,996	4,397,003	3,806,939	8,203,942
1938	8,780	4,062,800	4,637,200	8,700,000

In the above table it will be noticed that the population of Greater London has been increasing steadily and that since 1921 a decline in the population of the administrative county has for the first time been added to the long decline in that of the City. The increase in the whole London area since 1921 has taken place, therefore, entirely outside the county boundary, and of this increase the most striking feature is the rapid growth, particularly since 1931, of Outer London. In fact, this area of only 576 sq.mi., showed an increase in population in the 17-year period 1921–38 almost equal to that of the whole of the remainder of England and Wales, the figures for each being 1,641,522 and 1,686,479 respectively. Thus there have been two distinct population movements, one outward from the centre and one inward from the provinces. The outward movement was, however, desirable, since the density in the administrative county was in places high, *e.g.,* Southwark, with about 150 persons per acre, but if adequate accommodation under proper conditions is to be provided in the future for the migrating inhabitants of the county in the space surrounding it, then the inward flow from the provinces must be diverted to other areas.

As the population of London has been increasing, so has its character been changing. For centuries London has been one of the greatest seaports of the world and a great centre of commerce, but never before had it been a centre of manufacturing industry in the way it was becoming up to the outbreak of World War II; and a great part of the new development was in the outer ring. One effect of this trend was to raise the proportion of the population born outside the area, through immigration that was to a great extent industrial in character. At the outbreak of World War II about half the population of Greater London and a considerably higher proportion of that of Outer London were foreign to them.

The birth-rate, which averaged 35.4 per thousand in 1861–80 and 30.3 in 1891–1900, had fallen to 13.4 in 1937. The death-rate (23.4 per thousand in 1861–80, 19.2 in 1891–1900), fell to 12.7 in 1937. The deaths of infants under one year old were 60 per thousand births. In 1937 the lowest death-rates among the metropolitan boroughs were returned by Lewisham (10.9), Woolwich (11.1), Hackney (11.2), and the City (11.5). The highest rate was 14.6 in Finsbury, followed by Chelsea and Southwark with 14.1 each.



BY COURTESY OF (6) THE WHITE STAR LINE; PHOTOGRAPHS, (1-3) BRITISH COMBINE, (4) AEROFILMS FROM EWING GALLOWAY, (5) ORIENT AND OCCIDENT

GENERAL VIEWS OF LONDON

1. Fleet street looking toward St. Paul's cathedral. Here is the publishing centre of London
2. Regent street, looking north. This street is one of the busiest in London and, especially in the vicinity of Piccadilly circus, is the capital's fashionable shopping centre
3. St. James's palace, built by King Henry VIII. It was the royal residence from the reign of William III until 1809, when it was almost completely destroyed by fire.
4. Aerial view of Trafalgar square, named in commemoration of Admiral Nelson's victory at Trafalgar, with the Nelson monument at the right. The National gallery (*see* fig. 6) is on the left and beyond it, the Church of St. Martin's-in-the-Fields. Charing Cross station and the Strand may be seen at the top of the picture
5. Looking down Piccadilly to Piccadilly circus (at top of picture), an irregularly shaped circus at the junction of several important streets. The curved street at the upper left is Regent street
6. The north side of Trafalgar square, occupied by the National Gallery and the National Portrait gallery. The Church of St. Martin's-in-the-Fields is at the right

LONDON

PHOTOGRAPHS, (1, 2) "THE TIMES," LONDON, (3) GENERAL PHOTOGRAPHIC AGENCY

VIEWS OF THE THAMES AND LUDGATE CIRCUS

1. Scene taken at night from Lambeth bridge, showing the Houses of Parliament, with Westminster Abbey in the left centre. In the distance, at the right, is seen Westminster Bridge, which crosses the Thames below the Houses of Parliament
2. Aerial view of the Thames, and Tower Bridge which was built at a cost of £1,500,000 and opened in 1894. The central span is 200 feet long; those on either side with chain suspension, 270 feet each. A raised footway, 142 feet above high water, is reached by stairs in the Gothic towers. The central portion of the roadway consists of bascules which can be raised to admit the passage of vessels
3. View of Ludgate Hill, showing St. Paul's Cathedral at the top and Ludgate Circus in the foreground

Housing.—It was not until the royal commission's report of 1884–85 on housing that public opinion became aroused to the necessity for action in the eradication of slums, and in 1890 was passed the Housing of the Working Classes act, the foundation of modern housing legislation, which consolidated the powers for dealing with unhealthful areas, of which there were about 200 under the county council, and for erecting new dwellings. At the turn of the century the metropolitan and borough councils began to provide flats and housing in addition to those replacing clearances, but progress was slow until after World War I. After 1919, however, enormous strides were made, due on the one hand to government demands and on the other to state aid to local authorities and subsidies and guarantees to private enterprise. The metropolitan and borough councils provided 12,692 new dwellings between 1889 and 1919, but in the following two years the L.C.C. alone built 9,430 new houses. Only a small proportion of this building represented slum clearance, attention having been directed toward the more pressing problem of additional housing, which in large part was provided in housing estates in the suburbs. The best known of these is the Becontree estate of 2,784 ac. in Essex, with a population of about 120,000 in 26,000 houses, the largest municipal housing estate in the world. Of the total area, 500 ac. have been reserved for open spaces, including a central area of 118 ac. Other estates are St. Helier (40,000 people in over 9,000 dwellings) and Downham (over 7,000 houses), while the White City estate of block dwellings is planned for 10,000 persons.

In June 1934, state aid for additional housing came to an end, since under the 1933 act government financial assistance was to be applied chiefly toward slum clearance, building to be by private enterprise, though under guaranteed mortgage loans if necessary. But by March 1938 the position was that 74,465 additional dwellings had been provided by the county council, the City and the metropolitan boroughs.

Slum Clearance.—In the meanwhile progress was being made in slum clearance and rehousing, though slowly until 1930, when an act was passed enabling the council to proceed on a bigger scale by giving it power to declare "improvement areas" and by so doing requiring owners of premises to make them sanitary or, if that was impossible, have them demolished by the borough council, who could provide new accommodation for people thus displaced. Five areas involving 11,000 persons were cleared under these powers and the rehousing was undertaken by the local authorities. In 1934 a scheme to clear all the London slums in 10 years, involving the displacement of about 250,000 people and costing nearly £35,000,000, was begun by adopting a three-year program for clearing 132 ac. affecting over 80,000 persons. Further progress was facilitated the following year by a new housing act which granted greater powers, whereby the council could clear and replan large areas ("redevelopment areas"). In July 1938 a single area of 46 ac., housing about 4,700 persons, was being dealt with.

Under the same act a new attack on overcrowding was begun. A survey completed in 1936 showed that about 71,000 families were living in overcrowded conditions in London, an average of 7 families in 100. Woolwich (under 3%) had least overcrowding and Shoreditch (over 17%) most. It was estimated that 24,000 dwellings would be required to abate this condition and by March 1938 the council had provided 2,363.

Slum clearance and rehousing, as distinct from additional housing and the abatement of overcrowding, may be summarized thus —between 1919 and March 1938 orders were confirmed for the clearance of 135 insanitary areas occupied by more than 127,000 persons. About 12,500 premises were demolished, displacing about 88,000 persons, and 16,132 dwellings were built for rehousing, of which 15,580 were in flats. The total expenditure was £12,000,000. During the same period the City and the metropolitan boroughs completed or had in hand schemes displacing 54,809 persons and erected 7,614 new dwellings for rehousing.

The achievement of the county council far exceeds any work of the kind previously carried out. At the end of March 1940 it owned and managed about 98,500 dwellings, occupied by about 424,000 persons, and its capital expenditure on dwellings and housing estates had exceeded £60,000,000. The rate of subsequent development was uncertain, owing to the destruction caused by World War II, which affected not only dwellings, of which about 1,500,000 were damaged, but also other properties that would have to be included in further building schemes.

Sanitation.—The London county council is a central sanitary authority; the City and metropolitan boroughs are sanitary districts, and the corporation and borough councils are local sanitary authorities. The county council deals directly with matters where uniformity of administration is essential, *e.g.*, main drainage, housing of working classes, infant life protection, common lodging-houses and shelters, and contagious diseases of animals. With a further view to uniformity it has certain powers of supervision and control over local authorities, and can make by-laws respecting construction of local sewers, sanitary conveniences, offensive trades, slaughter-houses and dairies, and prevention of nuisances outside the jurisdiction of local authorities.

The first act providing for a commission of sewers in London dates from 1531. Various works of a more or less imperfect character were carried out, such as the bridging over in 1637 of the river Fleet, which as early as 1307 had become inaccessible to shipping through the accumulation of filth. Scavengers were employed in early times, and sewage was received into wells and pumped into the kennels (channels) of the streets. A system of main drainage was inaugurated by the Commissioners of Sewers in 1849, but their work proceeded very slowly. It was carried on more effectively by the Metropolitan Board of Works (1856–88), and was transferred in 1889 to the newly created London county council, who completed and improved the system, which covers the county of London, Willesden, Tottenham, Wood Green, West Ham, Brent area (Willesden), Leyton, Walthamstow, Ilford, Barking and Penge and parts of Acton, Croydon, Beckenham, Hornsey and East Ham. There are actually two distinct systems, north and south of the Thames, having separate outfall works on the north and south banks of the river, at Barking and Crossness. In 1937 there were 420 mi. of main sewers vested in the council, excluding street sewers and sewers outside the county area draining into the main system. There are about 2,500 mi. of streets in the county, and the London main drainage area is about 160 sq.mi. The sanitary authorities are concerned only with the supervision of house drainage, and the construction and maintenance of local sewers discharging into the main system. The Thames and the Lea Conservancies have powers to guard against the pollution of the rivers.

Hospitals.—Until consolidated under the county council on April 1, 1930, the hospital services of London, excluding the voluntary hospitals (*see* below), were divided between the 25 boards of guardians and the Metropolitan Asylums board (established in 1867 as a poor law authority), and amounted, really, to a hospital branch of the poor law. Sickness of a general character was treated in the poor law institutions, while insanity and infectious diseases came under the jurisdiction of the asylums board. In course of time, and more rapidly in the asylums board hospitals, the poor law requirements were relaxed, as ideas regarding public health broadened, so that the sick poor, as distinct from the destitute, came to be treated.

The new doctrine was given effect by the Local Government act of 1929, under which the council was empowered to provide hospitals and was required to separate institutional treatment of the sick from the poor law administration as soon as possible. At the same time all the hospitals and institutions of the boards of guardians (abolished) and the asylums board were transferred to the council. These amounted to 140 hospitals, schools and other institutions—75,000 beds and about 180,000 people in receipt of relief.

A survey of the transferred poor law institutions revealed the necessity for a reclassification of the chronically sick and their separation from the able-bodied. As a result, 12 of the mixed institutions were selected for use as hospitals for the chronically sick and placed under the control of the Central Public Health committee, which was formed to undertake all the public health work of the council. (Some time later this committee was divided into the Hospitals and Medical Services committee and the Housing and Public Health committee.) After this transference the committee's control extended to the general hospitals, comprising 29 hospitals (formerly poor law infirmaries) containing 18,074 beds, the 12 institutions previously mentioned, containing 9,401 beds, and 2 colonies for sane epileptics containing 809 beds, in addition to the special hospitals of the asylums board, which comprised in the main 18 hospitals for infectious diseases, 9 for tuberculosis and 5 children's institutions. There were also the board's laboratories and land and river ambulance services.

The council immediately embarked upon a comprehensive program of hospital improvement and enlargement and a start was made to "appropriate" various hospitals, *i.e.,* to declare which of them would no longer be poor law hospitals. By mid–1932, 60 had thus been transferred, but after April 1938, all the council's hospitals, acute, chronic and special, were administered under its public health powers. About £3,000,000 had been spent by mid-1938 on improvements, well seen in Lambeth and Hackney hospitals, and in 1937 the council decided to build at Tooting, in the grounds of St. Benedict's hospital, a new hospital of 600 beds, the first to be built under its new power. Further provision for medical education was made by the establishment at Hammersmith hospital by the council, in co-operation with the ministry of health and London university, of a post-graduate medical school, which was opened by King George V in May 1935.

The county council in 1944 maintained 10 mental hospitals, 77 general and special hospitals, and an ambulance service of 173 vehicles, besides 13 institutions (workhouses), 2 emergency nurseries, 3 homes for the aged, 1 receiving home for children, 1 residential training centre, 2 hostels and 5 casual wards.

At the end of 1936 there were 107 voluntary hospitals, *i.e.,* hospitals not under public management, in the London county area, containing 15,443 beds. Some control over them is exercised by the King Edward's Hospital fund through its power of giving or withholding grants, for which voluntary hospitals and convalescent homes within a radius of 11 mi. of St. Paul's cathedral may apply. By the Public Health (London) act, 1936, the London county council may also grant funds to these hospitals, if by so doing it maintains or extends the efficiency of the hospital accommodation in the county. Most of London's best known hospitals are voluntary hospitals, such as St. Bartholomew's, the oldest, founded by Rahere in 1123, St. Thomas's (1200), Guy's (1724), St. George's (1733) and St. Mary's (1845); the London hospital (1740), with 865 beds in 1937, is the largest in the country.

There are several regular funds in London for the support of voluntary hospitals. The chief is the King Edward's Hospital fund (mentioned above), founded in 1897 and incorporated in 1907, with which the League of Mercy co-operates in the collection of small subscriptions. The Metropolitan Hospital Sunday fund (1873) draws the greater part of its revenue from collections in churches. The Hospital Saturday fund (1873) is made up chiefly of small sums collected in places of business, etc. The British Charities association (1923) raises money mostly by prize competitions and similar schemes. The Voluntary Hospitals commission, founded to administer a government grant of £500,000 in 1921, was later put on a permanent basis as a link between the government and the committees of the voluntary hospitals. The Medical Research council (1920) is in charge of government research funds.

To care for the anticipated large number of civilian casualties as a result of air raids in World War II, an emergency hospital scheme on a national scale was set up under an Emergency Medical Service division created in the ministry of health. Hospitals remained under their peace-time administration, but their work was controlled by the E.M.S. London was divided into 9 sectors (6 north and 3 south of the Thames), each with one or more teaching hospitals at its apex and stretching out to base hospitals up to 50 mi. away. At the outbreak of war 71,600 beds out of 98,000 in the London E.M.S. region were reserved for E.M.S. cases, an accommodation made possible by the discharge of patients or their removal to hospitals outside the danger area. During the period Aug. 1940–May 1941, air raids seriously damaged 43 voluntary hospitals and 30 others suffered, while only four or five county council hospitals escaped. Top floors had to be closed and work carried on in basements. By the end of 1941 the nine sectors had available 68,500 casualty beds, of which about 36,000 were in casualty receiving or advanced base hospitals. (*See* also PUBLIC HEALTH.)

Water Supply.—In the 12th century London was supplied with water from local streams and wells, of which Holy well, Clerk's well (Clerkenwell) and St. Clement's well, near St. Clement's Inn, were examples. In 1236 the magistrates purchased the liberty to convey the waters of the Tyburn from Paddington to the City by leaden pipes, and a great conduit was erected in West Cheap in 1285. Other conduits were subsequently built (*cf.* Conduit street off Bond street, Lamb's Conduit street, Bloomsbury); and water was also supplied by the company of water-bearers in leathern panniers borne by horses. In 1582 Peter Moris, a Dutchman, erected a "forcier" on an arch of London bridge, which he rented for 10s. per annum for 500 years. His works succeeded and increased, and continued in his family till 1701, when a company took over the lease. Other forciers had been set up, and in 1609, on an act of 1605, Sir Hugh Myddelton undertook the task of supplying reservoirs at Clerkenwell through the New river from springs near Ware, Hertfordshire; and these were opened in 1613. In 1630 a scheme to bring water from Hoddesdon on the Lea was promoted by aid of a lottery licensed by Charles I. The Chelsea Water company opened its supply from the Thames in 1721; the Lambeth waterworks were erected in 1783; the Vauxhall company was established in 1805, the West Middlesex, near Hammersmith, and the East London on the river Lea in 1806, the Kent on the Ravensbourne (Deptford) in 1810, the Grand Junction in 1811, and the Southwark (which amalgamated with the Vauxhall) in 1822.

For many years proposals to amalgamate the working of the companies and displace them by a central public authority were put forward, until in 1902 the Metropolis Water act constituted the Metropolitan Water board to purchase and carry on the undertakings of the eight then existing companies, and of certain local authorities. It consists of 66 members, appointed by the London county council (14), the City of London (2), the City of Westminster (2), the other metropolitan boroughs (27), the county councils of Middlesex, Hertfordshire, Essex, Kent and Surrey, the borough of West Ham, various groups of other boroughs and urban districts, and the Thames and the Lea Conservancies. June 24, 1904, was the date fixed on which control passed to the board and by 1943 it was the largest water company in the world. It serves an area of 576 sq.mi. (42 mi. from N. to S. and 34 mi. from E. to W.) and the area and capacity of the combined reservoirs are about 2,700 ac. and 20,000,000,000 gal. respectively. Roughly 60% of the water supplied by the board is taken from the Thames, next in importance being the Lea and New rivers. The principal reservoir is the Queen Mary reservoir at Littleton, Middlesex, which is the largest artificial reservoir in the world, with an area of 723 ac. and a capacity when full of 6,750,000,000 gal. The average amount of water supplied daily by the board was 293,500,000 gal. in 1942 and there were then 8,275 mi. of water pipes.

Public baths and washhouses are provided by local authorities under various acts between 1846 and 1896, which have been adopted by all the borough councils.

Lighting.—From 1416, citizens were obliged to hang out candles between certain hours on dark nights to illuminate the streets. An act of parliament enforced this in 1661; in 1684 Edward Heming, the inventor of oil lamps, obtained a licence to supply public lights; and in 1736 the corporation took the matter in hand, levying a rate. Gaslighting was introduced on one side of Pall Mall in 1809, though it is said that Golden Lane Brewery and portions of Beech and Whitecross streets were lit by gas in 1807. In 1810 the Gas Light and Coke company received a charter, and developed gaslighting in Westminster. There are now three principal companies within the county, the Gas Light and Coke, South Metropolitan and Commercial, though certain other companies supply some of the outlying districts.

The Metropolitan Board of Works, and the commissioners of sewers in the City began experiments with electric light, which was introduced in 1881 at the Royal Exchange and neighbourhood. At the close of the 19th and the beginning of the 20th century a large number of electric light companies came into existence, and some of the metropolitan borough councils, and local authorities within Greater London also undertook the supply. Under the Electricity Supply Act of 1926, the London and Home Counties joint electrical authority, composed of representatives of the county councils and the electrical undertakings, was formed, and made responsible for the supply over an area of 1,841 sq.mi., stretching from Guildford to Gravesend and from Hertford to Reigate. A large new power station was constructed at Chiswick. Battersea power station belongs to the Central Electricity board.

Fire.—In 1832 the fire insurance companies united to maintain a small fire brigade, and continued to do so until 1866. The brigade was confined to the central part of the metropolis; for the rest, the parochial authorities had charge of protection from fire. The central brigade came under the control of the Metropolitan Board of Works and was taken over by the county council in 1889, when it consisted of 48 steam engines, 78 manual engines, 146 fire escapes, and about 30 mi. of hose. In 1880 alarms had been introduced on the "open circuit" system, which remained as standard until 1938, when the council decided to replace it by a "closed circuit" system. Appliances for fighting riverside fires had been in existence for more than 25 years when the county council took over, but until 1900, when the first modern fireboat made its appearance, fire-engine rafts manoeuvred by tugs were used. In 1935 a more powerful type of boat, having a pumping capacity of 3,000 gal. a minute, was introduced. The famous brass helmets of the London firemen, which were provided first by Captain Shaw (later Sir Eyre Massey Shaw), commander of the brigade at the time of its transference to the council, are now obsolete, and in about 1935 began steadily to be replaced by a new type composed of a cork and canvas compound. This step was made necessary by the electrical risks encountered in a modern burning building. By 1938 the equipment mainly used by the brigade consisted of 56 "dual-purpose" engines, *i.e.*, machines combining a pump and a 50-ft. escape, 73 pumps (enclosed and otherwise), 20 escape vans (being replaced by dual-purpose engines), and 15 river craft. There were also 14 turntable ladders, about half being fitted with pumps, and 65 mi. of hose. In Oct. 1937 the first enclosed dual-purpose engine was introduced. It carried a steel escape, the first to be used by the brigade.

The headquarters of the brigade were formerly in Southwark Bridge road, but in July 1937 they were transferred to a new building, constituting both a land and river station, on the south bank of the Thames near Lambeth bridge. This accommodated the central administrative offices and the living quarters of the chief officer and 12 other officers. In 1888 the brigade consisted of 581 men, but 50 years later had risen to 2,562 persons. Only about 2% of the applicants for membership are recruited, owing to the high standard of physical fitness required. The cost of the brigade is borne mostly by the London ratepayers, but contributions are received from the government and the tariff insurance companies, who also maintain a salvage corps.

The chief development during World War II was the formation, on Aug. 18, 1941, as a wartime measure, of the National Fire Service under the Fire Services (Emergency Provisions) act, 1941, which transferred the whole fire brigade resources of the country from local to government control, London being constituted a region itself. The new organization embodied the professional and part-time brigades and the auxiliary fire services. By the spring of 1942 personnel totalled about 212,000, including 100,000 part-time men. Facilities for training had been extended, equipment brought up-to-date, and many local brigade buildings enlarged and improved. A large number of sites of bombed buildings had been converted into reservoirs and many more steel water tanks erected in the streets. The new service is considered to have more than justified itself, especially as regards its flexibility of operation.

Cemeteries.—The administrative authorities of cemeteries for the county are the borough councils and the City corporation and private companies. The large cemetery at Brompton is the property of the government. Kensal Green cemetery, the burial-place of many famous persons, is of great extent, but several large cemeteries outside the metropolis have come into use. Such are that of the London Necropolis company at Brookwood, near Woking, Surrey, and that of the parishes of St. Mary Abbots, Kensington, and St. George, Hanover square, at Hanwell, Middlesex. Crematoria are provided at Golder's Green, Norwood, Ilford (for the city of London), and Brookwood.

EDUCATION AND RECREATION

Education.—The British and Foreign School society (1808) and the National society (1811), together with the Ragged Schools Union (1844) were the only special organizations providing for the education of the poor until 1870, but in that year, when the London School board was created, more than half the child population of London had no school to attend. Under the Education (London) act, 1903, which was passed in pursuance of the system, put into operation by the Education act, 1902, of bringing general education within the scope of municipal government, the board's activities were transferred (1904) to the county council, which at the same time was given the responsibility of maintaining the voluntary schools.

By then the board had running a sound system of elementary education, and provision had been made for every child in need of education, while compulsory attendance had been enforced in 1876. In all there were transferred to the control of the council 521 board schools, with an average attendance of 485,000 students; 438 voluntary schools, with 175,000 students; special schools containing 5,000 blind, deaf and defective children; 356 domestic economy centres and 196 manual training centres; 373 evening schools, with 145,000 students, and 9 industrial schools.

Organized higher technical education was slower in coming and did not get under way until the formation in 1893 of the Technical Education board, under the county council, which was, therefore, from the first the authority for such education. It found a woeful lack of instruction in chemistry, electricity, art and technical subjects, but during its 11 years' existence did much to improve matters, partly through grants to existing voluntary technical institutions and partly through conducting centres itself. With the help of the parochial charities the number of polytechnics and technical institutes was raised from 8 to 26, day classes were increased threefold and the student hours of evening students fourfold. There were also established the Central School of Arts and the London Day Training college (since 1932 the Institute of Education), besides many science lecture rooms, laboratories, and workshops, while a scheme of scholarships to link elementary and secondary education was set up.

Provision for the foundation of polytechnics was made under the City of London Parochial Charities act, 1883, the model institution being that of Quintin Hogg, which had been opened in Regent street the previous year. Polytechnics give instruction in general knowledge and special crafts and trades and usually have art schools attached. In 1880 the City and Guilds of London institute was formed for the advancement of technical education, but before that time little had been done to promote such instruction, though useful lectures and examinations were held by the Science and Art department, founded in 1853.

The unification of educational control enabled the county council to proceed with a co-ordinated program to develop a complete system. This is now done through a succession of three-year plans, under which a forward movement is assured, and improvements are carried out as they relate to an ordered scheme. Prominent among the steps that have been taken by the council are—the improvement of teachers through the raising of qualifications, higher salaries, and promotion only through merit, besides the provision of refresher courses and a special library; the great increase in the number of scholarships connecting elementary with secondary education; and the creation of central and junior technical schools.

After 1907 only teachers holding certificates were eligible for the council's elementary schools, while secondary school teachers were normally required to have a university degree. The appointment of head teachers and principals is made by the education committee or its teaching staff subcommittee. Teachers for non-provided schools (*see* below) are selected by the school managers. The council maintains two training colleges for elementary school teachers, one for men specializing in handicrafts, and one providing courses in physical education. Special lecture courses are also held, and were attended in 1937 by about 37,000 teachers. The work of teachers was greatly facilitated by a reduction in the size of classes, which were limited to 40 students in senior and 48 in infants' departments.

Elementary schools are of two kinds—those that are provided by the council and those that are not, the latter being known as non-provided schools. These, however, are maintained by the council except for the buildings, which belong to managers who usually represent some religious body. The education given in both sorts of schools is the same, and in 1943 there were in all 892 elementary schools under the council, attended by 428,000 pupils. This represented a fall of 52,000 in attendance from the 1937 figure, the reduction being due to evacuation during World War II.

Compulsory attendance at school begins at the age of five, but before then children may be sent to nursery schools or babies' classes, where instruction is confined to training in good habits. There were about 20 nursery schools in 1937, but the number subsequently increased, and during World War II many residential nursery schools were established outside the London area for evacuated children.

The separation of primary and post-primary education was advanced by means of the "central" schools, established by the council in 1911. These were a development of the "higher-grade" schools set up by the school board in 1898, but in future were to provide a general education with a commercial or technical bias. At the end of March 1938 there were 87 central schools attended by about 31,700 students. At the same time there were 212 senior departments with over 73,300 pupils. These departments, or schools, originated in 1924 and were to secure that elementary school children over 11 years should have the advantage of spending their later school life in places expressly organized for them. The aim is to set up all the senior departments as separate schools.

The scholarship scheme is very extensive and in 1938 about 60% of the pupils in the secondary schools held some form of award. Scholarships are open, in the first place, to children of 11 years, taking them to the secondary schools, and from there they may proceed by means of further awards to a university, technical college or other institution providing advanced teaching. There are also technical and art scholarships and evening exhibitions for those in employment. The total number of scholarships, exhibitions and free places held in 1937 was about 28,000.

A number of secondary schools was already in existence when the county council became London education authority, many of them ancient foundations and some already receiving aid from the Technical Education board. The act of 1903, however, obliged the council "to supply, or aid the supply of, education other than elementary," and to do this effectively it soon became apparent that more secondary schools were needed. The council therefore founded many new ones, which were known as "maintained" schools, the rest being "aided" schools. In 1937 the former contained about 12,200 places and the latter about 22,000.

Technical and continued education includes both vocational and non-vocational studies at nearly 250 institutes of various kinds, comprising polytechnics, technical and trade schools, schools of art, day continuation schools and evening institutes. The evening institutes and all the day continuation schools but one are maintained by the council. Some of the technical schools and schools of art are maintained, while others receive aid, all the polytechnics being aided. During 1936–37 the total enrolment for technical and continued education was more than 250,000 and the number of student-hours worked reached 26,000,000.

In the technical schools evening classes are mainly for adults, but full-time day courses are provided in the form of junior technical schools, the first of which was established in 1904. Senior technical courses are available to students over 16 years. The day continuation schools came under the Education act of 1918 and are for students of 14 to 18 years of age. The courses are definitely vocational.

The present organization of evening institutes dates from 1913, when the whole system of evening education was overhauled and co-ordinated. The junior institutes are for students under 18 and the senior for those above that age. There are also institutes devoted to instruction in particular subjects, such as the St. Bride's Foundation institute, near Fleet street, for the printing trade, the School of Building at Brixton and the Poplar School of Engineering and Navigation. Classes are sometimes arranged for employees of particular firms. The evening institutes include senior and junior commercial and technical, literary and men's and women's institutes.

The educational system provides special schools for the defective. In 1943 there were under the council 110 schools (including open-air schools) for the blind, deaf and physically and mentally defective, some of which are outside the county, 10 residential homes (for children over three for whom indoor relief is required) and 11 hospital schools, which are attended by children undergoing prolonged treatment in the council's hospitals. The foundation of these special schools dates from 1874, when the school board established education for the blind and deaf. Eighteen years later came centres for helping the mentally and physically defective. These schools were legalized by the acts of 1893 and 1899, and by 1938 the enrolment was 534 blind, 486 deaf, 2,611 mentally defective and 2,522 physically defective children.

Philanthropic Institutions.—The labours of the clergy in the poorer parts of London, such as the "East End," Southwark, Bermondsey, St. Pancras and North Kensington, lie largely in the direction of social reform, and churches and missions have been established and are maintained by colleges, schools and other bodies. There are, further, "settlements" where members of the various bodies may reside in order to devote themselves to philanthropical work; and these include clubs, recreation rooms and other institutions for the use of the poor. Such are the Oxford house, Bethnal Green; the Cambridge house, Camberwell road; Toynbee hall, Whitechapel; Mansfield house, Canning Town; the Robert Browning settlement, Southwark; and the Passmore Edwards settlement, St. Pancras. There are also several women's settlements of a similar character. The People's palace, Mile End road, opened in 1887 as a recreative and an educational institution, suffered a disastrous fire in 1931. Its educational side now centres in Queen Mary college, formerly known as East London college.

Public Schools.—In early times the priories and other religious houses had generally grammar schools attached to them. Those at St. Peter's, Westminster and St. Paul's attained a fame which has survived, while other similar foundations lapsed, such as St. Anthony's (Threadneedle street, City), at which Sir Thomas More, Archbishop Whitgift and many other men of eminence received education. Certain of the schools were re-endowed after the dissolution of the monasteries. St. Peter's college or Westminster school (*see* WESTMINSTER) is unique among English public schools of the highest rank in maintaining its original situation in London. Other early metropolitan foundations have been moved in accordance with modern tendencies either into the country or to sites aloof from the heart of London. Thus Charterhouse school, part of the foundation of Sir Thomas Sutton (1611), was moved (1872) from Finsbury to Godalming, Surrey; St. Paul's school (1509) occupies modern buildings at Hammersmith since 1884, and Christ's hospital (1553) has been at Horsham, Sussex, since 1902. Of other schools, Merchant Taylors' was founded by the company of that name in 1561, and occupied the premises vacated by Charterhouse school from 1875 to 1933, when it moved to Sandy Lodge, near Rickmansworth. The Mercers' school, Holborn, originally attached to the hospital of St. Thomas of Acon, was refounded in 1447. It was taken over by the Mercers' company in 1542 and was transferred to Barnard's Inn in 1894. The City of London school (1442), refounded in Milk street, Cheapside, by the City corporation in 1835, occupies modern buildings on the Victoria embankment. Dulwich college originates in a licence granted in 1619 to Edward Alleyn to found a college in Dulwich. Under an act of 1857 two schools were constituted—Dulwich, or the Upper school, and Alleyn's, or the Lower school. St. Olave's and St. Saviour's Grammar school received its charter in 1561 and since 1896 has been in new buildings in Bermondsey.

London University.—The University of London was incorporated by royal charter in 1836, as an examining body for conferring degrees, but only those who had studied at an "approved institution" were admitted to examination. Under the charter of 1858, however, the examinations (other than medical) were thrown open to anyone from the British Isles and the empire. This charter also admitted graduates to the university government and conferred on them the right to assemble in convocation. A supplemental charter of 1878 admitted women to degree examinations, and London was thus the first university in the kingdom to do so. The university was also the first in the country to found a faculty of science, which it did in 1859.

Under the University of London act, 1900, the university was reorganized as both a teaching and an examining body, and there were set up an academic council to control teaching and research, a council for external students to control external examinations, and an extension board to supervise university extension work. It was further provided that teaching should be carried on in colleges, which in future were known as schools of the university, and research institutions were admitted as schools. An advisory service for external students was set up in 1924, whereby they were provided with complete schemes of reading by teachers of the university.

In 1929 revised statutes came into force. These had been drawn up by commissioners appointed for the purpose under the University of London act, 1926. The most important changes were the creation of a court (on which the L.C.C. has two representatives) to control finances; a collegiate council, consisting of the heads of the schools, whose duties included the co-ordination of the work of the schools and the organization and extension of social facilities for students; and the grouping of matriculation and schools examinations under one council. The senate is the supreme governing and executive body in all academic matters.

From 1835–55 the university occupied rooms in Marlborough house and then moved to Burlington house, where it remained until 1870, when it moved to a building in Burlington gardens later occupied by the Civil Service commissioners. From 1900–36 the university headquarters were in the Imperial institute in South Kensington, but in that year the administrative offices were moved to the new senate house and library in Bloomsbury. This site was acquired in 1927 with the help of a gift of £400,000 from the Rockefeller foundation and it was hoped that eventually it would accommodate all the university departments, several of which moved in after 1937. During World War II the buildings were occupied by the ministry of information.

Colleges incorporated in the university are University and King's colleges, and schools include King's college theological department and three other theological colleges, Queen Mary college, the London School of Economics, Royal Holloway college and Bedford college, the Institute of Education (formerly the London Day Training college), the Imperial College of Science and Technology, the South Eastern Agricultural college, King's College of Household and Social Science, various medical colleges and institutes, including the London School of Hygiene and Tropical Medicine and the Lister Institute of Preventive Medicine, and the medical schools of 12 hospitals. Important foundations are the Institute of Historical Research (1920) and the Courtauld Institute of Art (opened in 1932). A university observatory was founded in 1929 at Mill Hill, Hendon.

Other Educational Institutions.—The board of education directly administers the following educational institutions—the Victoria and Albert museum, South Kensington, with its branch at Bethnal Green, from both of which objects are lent to various institutions for educational purposes; the Geological Survey of the United Kingdom and the Museum of Practical Geology, South Kensington; the Solar Physics observatory, South Kensington; and the Royal College of Art, South Kensington. At Gresham college, Basinghall street, City, founded in 1597 by Sir Thomas Gresham, and moved to its present site in 1843, lectures are given in the principal branches of science, law, divinity, medicine, etc.

Some further important establishments and institutions may be tabulated here:—

Architecture.—The Royal Institute of British Architects, Conduit street, conducts examinations and awards diplomas.

Education.—The College of Preceptors, Bloomsbury, conducts examinations of persons engaged in education and awards diplomas.

Law.—The Inns of Court are four—Middle Temple, Inner Temple, Lincoln's Inn, Gray's Inn. A joint board of examiners examines students previous to admission. The Council of Legal Education superintends the education and subsequent examination of students. (*See* INNS OF COURT AND CHANCERY.) The Law society is the superintending body for examination and admission in the case of solicitors.

Medical.—The Royal College of Physicians is in Pall Mall East, and the Royal College of Surgeons is in Lincoln's Inn Fields. The Society of Apothecaries is in Water lane, City. The Royal College of Veterinary Surgeons is in Red Lion square, and the Royal Veterinary college at Camden Town.

Military and Naval.—The Royal Military academy is at Woolwich; the Royal Naval college at Greenwich.

Music.—The principal educational institutions are—the Royal Academy of Music, York gate, Marylebone road; the Royal College of Music, South Kensington; Guildhall school, City, near the Victoria embankment; London college, Great Marlborough street; Trinity college, Mandeville place; and the Royal College of Organists, Kensington Gore.

Scientific Societies.—Burlington house, in Piccadilly, built in 1872 on the site of a mansion of the earls of Burlington, houses adapted to the needs of the Royal society, the Chemical, Geological, Linnaean and Royal Astronomical societies, the Society of Antiquaries and the British Association for the Advancement of Science. The Society of Arts, John street, Adelphi, was established in 1754 for the encouragement of arts, manufactures and commerce. The Royal institution, Albemarle street, was founded in 1799, maintains a library and laboratories and promotes research in connection with the experimental sciences. The Royal Geographical society, occupying a building in Kensington Gore, maintains a map-room open to the public, holds lectures by prominent explorers and geographers, and takes a leading part in the promotion of geographical discovery. The London society, Lancaster house, St. James's, was founded in 1912 to stimulate interest in the development of London. The Royal Horticultural society maintains gardens at Wisley, Surrey, and has an exhibition hall in Vincent square, Westminster. The exhibitions of the Royal Agricultural society are held at Park Royal, near Willesden. The Zoological society maintains a magnificent collection of living specimens in the Zoological Gardens, Regent's park, a popular resort.

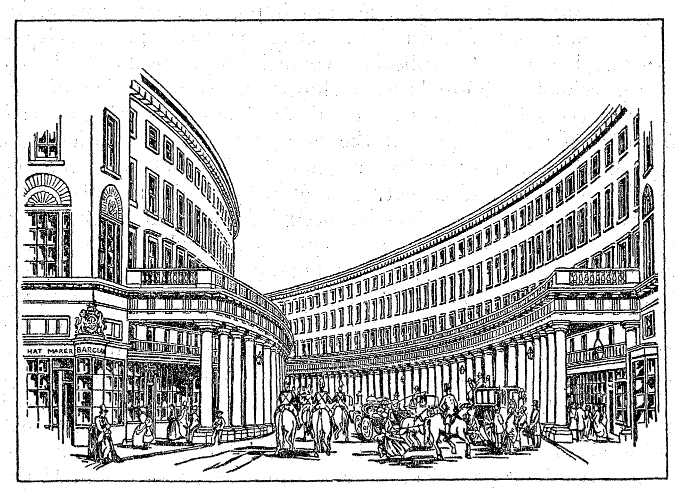
Museums, Art Galleries, Libraries.—In the British museum, London possesses one of the most celebrated collections in the world, originated in 1753 by the purchase of Sir Hans Sloane's collection, and library by the government. The great building in Bloomsbury (1828–52) with its massive Ionic portico, houses the collections of antiquities, coins, books, manuscripts and drawings, and contains the reading-rooms for the use of readers. The natural history branch was removed to a building at South Kensington (the Natural History museum) in 1881, where the zoological, botanical and mineralogical exhibits are kept. Close to this museum is the Victoria and Albert museum for which an extension of buildings, from a fine design by Sir Aston Webb, was begun in 1899. Here are collections of pictures and drawings, including the Raphael cartoons, objects of art of every description, including Japanese, Chinese and Persian collections, and an Indian section. The Science museum, near by, has divisions of industrial and mechanical engineering, transport in all its branches, and scientific instruments. In the vicinity, also, is the fine building of the Imperial institute, founded in 1887 as an exhibition to illustrate the resources of all parts of the empire, as well as an institution for the furtherance of imperial intercourse. The London museum, in Lancaster house, St. James's (1914; previously in Kensington palace) illustrates the antiquities and history of London. Other museums are Sir John Soane's collection in Lincoln's Inn Fields and the Museum of Practical Geology, South Kensington, while the scientific societies have libraries and in some cases collections of a specialized character, such as the museums of the Royal College of Surgeons, the Royal Architectural society, the Wellcome Historical Medical museum and the Parkes Sanitary museum. Among permanent art collections the first place is taken by the National gallery in Trafalgar square. This magnificent collection was originated in 1824, and the building dates from 1838, but has been more than once enlarged. The building of the National Portrait gallery, adjoining it, dates from 1896, but the nucleus of the collection was formed in 1858. The munificence of Sir Henry Tate provided the gallery, commonly named after him, by the Thames near Vauxhall bridge, which contains the national collection of British art. The Wallace collection of paintings and objects of art, in Hertford house, Manchester square, was bequeathed to the nation by the widow of Sir Richard Wallace in 1897. Of the periodical art exhibitions that of the Royal academy is most noteworthy. It is held annually at Burlington house from the first Monday in May to the first Monday in August. It consists mainly of paintings, but includes a few drawings and examples of sculpture. There are many art galleries in and about Bond street and Piccadilly, Regent street and Pall Mall. An industrial museum was opened in Horseferry road by the home office in 1927. The Imperial War museum in Lambeth road was founded in 1917.

Municipal provision of public libraries under acts of 1892 and 1893 is general throughout London, and these institutions are exceedingly popular for purposes both of reference and of loan. The London county council administers the Horniman museum at Forest Hill, Lewisham. The City corporation maintains the fine Guildhall library and museum. Besides the government reference libraries at the British museum and South Kensington there are other such libraries, of a specialized character, as at the patent office and the record office. Among lending libraries should be noticed the London library in St. James's square, Pall Mall.

Theatres and Places of Entertainment.—The principal London theatres and music halls lie between Piccadilly and Temple Bar, and High Holborn and Victoria street, the majority being in Shaftesbury avenue, the Haymarket, the neighbourhood of Charing Cross and the Strand. The Covent Garden theatre is the principal home of grand opera; the chief halls devoted mainly to concerts are the Royal Albert hall, close to the South Kensington museums, and, formerly, Queen's hall in Langham place, Regent street. This was destroyed in World War II. Among other popular places of entertainment may be mentioned the new Earl's Court exhibition, rebuilt 1936–37 and covering about 19 ac. It has iceskating, and with Olympia hall, Hammersmith road, is used for such purposes as military tournaments, motorcar "shows," "ideal home" exhibitions and the like; the celebrated waxwork exhibition of Madame Tussaud in Marylebone road, burned in 1925, restored, and again damaged in World War II; and the Agricultural hall, Islington, where agricultural and other exhibitions are held. Theatres, music halls, concert halls, cinematograph theatres and so forth, are licensed by the county council, except that the licence for stage plays is granted by the lord chamberlain under the Theatres act, 1843. The council provides for inspection of places of entertainment in respect of precautions against fire, structural safety, etc. The principal clubs are in and about Piccadilly and Pall Mall. (*See* CLUBS.)

(O. J. R. H.; X.)

Parks.—St. James's park, Green park, Hyde park and Kensington gardens (which, with Regent's park, Richmond, Bushey and Greenwich parks, and Kew gardens are royal parks), stretch in an irregular belt for nearly 3 mi. between Whitehall and Kensington. St. James's park was transformed from marshy land into a deer park, bowling green and tennis court by Henry VIII, extended and laid out as a pleasure garden by Charles II, and rearranged according to the designs of John Nash in 1827–29. Its lake, the broad Mall leading up to Buckingham palace, and the proximity of the government buildings in Whitehall, combine to beautify it. St. James's park is continued between the Mall and Piccadilly by the Green park. Hyde park, to the west, belonged originally to the manor of Hyde, which was attached to Westminster abbey, but was taken by Henry VIII on the dissolution of the monasteries. Two of its gateways are noteworthy, namely that at Hyde Park corner at the southeast and the Marble Arch at the northeast. The first was built in 1828 from designs of Decimus Burton, and comprises three arches with a frieze above the central arch copied from that of the Parthenon at Athens, now in the British museum. The Marble Arch was intended as a monument to Nelson; it was erected by John Nash in 1828 in front of Buckingham palace, and was moved to its present site in 1851. In 1908 this corner of the park was cut to give additional accommodation for the heavy traffic between Oxford street, Edgware road and Park lane, and the Marble Arch was left isolated. Hyde park and Kensington gardens between them contain a lake 1,500 yd. in length, known in its park portion as the Serpentine and in the gardens portion as the Long Water; from the bridge which marks the division one of the finest prospects in London is seen, extending to the distant towers of Westminster, and on the north bank of the Serpentine is the bird sanctuary with Epstein's "Rima" memorial to W. H. Hudson. Since the 17th century this park has been one of the most favoured resorts of fashionable society, and at the height of the "season," from May to the end of July, its drives present a brilliant scene. In the 17th and 18th centuries it was a favourite duelling ground, and in the present day it is not infrequently the scene of political and other popular demonstrations



AFTER A PRINT BY COURTESY OF THE ATHENAEUM CLUB

FIG. 1.—THE QUADRANT, REGENT STREET, AS IT APPEARED NEAR THE MIDDLE OF THE 19TH CENTURY. THE COLONNADE WAS REMOVED IN 1848

(as is also Trafalgar square), while the neighbourhood of Marble Arch is the resort of orators on social and religious topics. Kensington gardens were originally attached to Kensington palace, but were subsequently much extended; they are specially favoured by children, for here is the famous Round pond, and in 1912 Sir G. Frampton's statue of "Peter Pan" was placed here. They were magnificently timbered, containing plantations of rare shrubs and flowering trees. Regent's park, mainly in the borough of Marylebone, owes its preservation to George IV, who, when regent, intended to build a palace here, and had the park laid out by John

Nash in 1812. The other most notable open spaces wholly or partly within the county are: Hampstead heath in the northwest, a high-lying tract, preserved to a great extent in its natural state, which, with the adjoining Parliament hill, Ken wood and Golders Hill park, covers some 850 ac.; and in the southwest Wimbledon common and Putney heath (together 1,200 ac.) and the royal demesne of Richmond park (2,358 ac.), which from its higher parts commands a wonderful view up the rich valley of the Thames. The east, south and north are not lacking in open spaces, the chief of which are—Victoria park (217 ac.), in the northeast; Greenwich park (188 ac.), Blackheath (267 ac.) and Woolwich commons in the southeast, and Battersea park (200 ac.), and Wandsworth (183 ac.) and Tooting Bec (217 ac.) commons in the south; but there is an extensive inner area where at most only small gardens and squares break the continuity of buildings, and where, in some cases, old churchyards serve as public grounds. The L.C.C. maintains, in all, 104 open spaces of 6,690 ac., excluding the "greenbelt," which came into being following an offer by the L.C.C. in 1935 to assist county and borough councils to buy or otherwise preserve important land on the outskirts of the London area. The council has set aside £2,000,000 for this purpose and in 1943 over 20,000 ac. had been acquired. Grants towards the acquisition of a further 55,000 ac. have been approved.

Sports Grounds.—Among many sports grounds, the two best known cricket grounds are Lord's, near Regent's park (M.C.C.—Marylebone Cricket club—and Middlesex county matches, Oxford *v.* Cambridge university matches, Eton *v.* Harrow school matches, etc.), and the Oval in Kennington (Surrey county matches, etc.). At these two grounds there also take place any "test" matches played in London by teams representing England against overseas sides. International Rugby football matches (among others) are played at Twickenham; and the final ties of the English association football cup, of late years, at Wembley stadium, the vast arena originally erected in connection with the British Empire exhibition (1924–25). (O. J. R. H.; H. Or.; X.)

GOVERNMENT

Vestries.—The middle of the 19th century found the whole local administration of London still of a mediaeval character. Moreover, as complete reform had always been resisted, homogeneity was wanting. Greater London (in the sense in which that name might then have been applied) was governed by the inhabitants of each parish in vestry assembled, save that in some instances parishes had elected select vestries under the provisions of the Vestries act, 1831. In neither case had the vestry powers of town management. To meet the needs of particular localities, commissioners or trustees having such powers had been from time to time created by local acts. In 1855 these local acts numbered 250, administered by not less than 300 bodies either self-elected, or elected for life, or both, and therefore in no degree responsible to the ratepayers. There were two bodies having jurisdiction over the whole metropolis except the City, namely, the officers appointed under the Metropolitan Building act of 1844, and the Metropolitan Commissioners of Sewers, appointed under the Commissioners of Sewers act, 1848. Neither was responsible to the ratepayers.

Metropolitan Board of Works.—To remedy this chaotic state of affairs, the Metropolis Management act, 1855, was passed. Under that act a vestry elected by the ratepayers of the parish was established for each parish in the metropolis outside the City. The vestries for larger parishes were constituted by the local authorities; smaller parishes were grouped under district boards. A central body, the Metropolitan Board of Works, having jurisdiction over the whole metropolis (including the City) was also established, the members of which were elected by the common council of the City, the vestries and district boards, and the previously established local board of Woolwich (*q.v.*). The area of the metropolis for local government purposes was for the first time defined. The Metropolitan Board of Works was given certain powers of supervision over the vestries and district boards, and became the authority for main drainage and for the administration of the Building acts, and subsequently had many additional powers and duties conferred upon it. The vestries and district boards became the authorities for local drainage, paving, lighting, repairing and maintaining streets, and for the removal of nuisances, etc.

London County Council.—An objection to the Metropolitan Board of Works soon became manifest, inasmuch as the system of election was indirect. Moreover, enquiry by a royal commission disclosed the inefficiency of the board in certain respects, and also indicated the existence of corruption. Reform followed immediately. In 1888 the Local Government act, dealing with the area of the metropolis as a separate county, created the London county council as the central administrative body, possessing not only the powers of an ordinary county council, but also extensive powers of town management, transferred to it from the abolished board of works. Here, then, was the central body, under their direct control, which inhabitants of London had hitherto lacked. Under the Local Government act, 1929, the council's powers were extended through the transference to it in 1930 of the poor law administration, viz., the 25 boards of guardians, the Metropolitan Asylums board, the four boards of school district managers and the Central (Unemployed) Body. The council consists of 124 councillors elected triennially by the ratepayers, and 20 aldermen elected by the councillors and holding office for six years. A chairman, vice-chairman and deputy-chairman are elected in council. In 1935 the chairman became "right honourable." The first woman chairman was Mrs. Eveline M. Lowe, chairman 1939–40.

Metropolitan Boroughs.—The question of subsidiary councils remained to be settled after the act of 1888. The wealthier metropolitan parishes became discontented with the form of local government to which they remained subject, and in 1897 Kensington and Westminster petitioned to be created boroughs by the grant of charters under the Municipal Corporation acts. Instead, the London Government act of 1899 was evolved. It brought into existence the 28 metropolitan boroughs, so that the county of London may be regarded from the administrative standpoint as consisting of 29 contiguous towns, counting the City of London. One of these, Westminster, became later a city in itself. As regards the distribution of powers and duties between the county council and the borough councils, and the constitution and working of each, the underlying principle may be briefly indicated as giving all powers and duties which require uniformity of action throughout the whole of London to the county council, and powers and duties that can be locally administered to the borough councils. Primarily the borough councils are street and local sanitary authorities. Under the act of 1929 some minor powers were transferred to them from the L.C.C. They are the first authorities for assessing the annual value on which money required for local expenditure is raised and they are the rate-collecting authorities. Councils consist of a mayor and aldermen and councillors in proportion as one to six. In all, there are 1,604 members, 35 to 70 on each council. (*See* separate article on each borough.) Elections are triennial.

Corporation of the City of London.—The legislation of 1855, 1888 and 1899 left the government of the small area of the City in the hands of an unreformed corporation. Here the mediaeval system, in spite of any anomalies with respect to modern conditions, has resisted reform, and no other municipal body shares the traditions and peculiar dignity of the City corporation. This consists of a lord mayor, 25 aldermen and 206 common councilmen, forming the Court of Common Council, which is the principal administrative body. Its scope may be briefly indicated as including (*a*) duties exercised elsewhere by the borough councils, and by the London county council (although that body is by no means powerless within the City boundaries); and (*b*) peculiar duties such as control of markets and police. The City corporation also maintains several parks, mostly outside London, such as Epping Forest, Burnham Beeches, Coulsdon commons, West Ham park, Highgate woods, etc. The election of common councilmen, whose institution dates from the reign of Edward I, takes place annually, the electors being the ratepayers, divided among the 25 wards of the City. An alderman (*q.v.*) of each ward (save that the wards of Cripplegate Within and Without share one) is elected for life. The lord mayor is now elected by the court of aldermen from two aldermen nominated in the court of common hall by the livery, an electorate drawn from the members of the ancient trade guilds or livery companies (*q.v.*), which, through their control over the several trades or manufactures, had formerly an influence over the government of the city which from the time of Edward III was paramount.

Finance, Rating, etc.—Before 1899 the duties of overseers in London had been performed by most diverse bodies. In that year the new borough councils were constituted in every case the overseers within their respective boroughs, except that the town clerk of each borough performs the duties of overseers with respect to the registration of electors. Again, with regard to rates, there were till 1899 three or four different rates leviable in each parish. These are now consolidated into a single rate, called the general rate. Every precept sent by an authority in London for the purpose of obtaining money which has ultimately to be raised out of a rate within a borough is sent to the council of the borough. The metropolitan borough councils make one general rate, which includes the amount necessary to meet their own expenditure, as well as to meet the demands of the county council and the Metropolitan police. The total amount of rates raised in 1935–36 was £31,613,960, representing an average rate of 10*s.* 9.4*d.* in the pound (calculated on the basis of the net produce of a rate of a penny in the pound). Of this 8*s.* 1.3*d.* in a pound was levied centrally, 8*s.* 0.5*d.* for county purposes (London county council and Metropolitan police) and .8*d.* for local services (London county council grants to local authorities). The remainder, 2*s.* 8.1*d.* in the pound, was levied locally by the City corporation and the metropolitan borough councils.

The total expenditure of the London county council, borough councils, and other local authorities, in 1935–36 was £63,201,413, when payments included twice had been deducted. Receipts in aid were £19,398,558, and exchequer grants were £12,948,972, leaving £30,853,883 to be raised by rates (the amount actually raised was £31,613,959). This expenditure was divided among the following bodies:—London county council, £35,494,397; Metropolitan police (proportion), £5,327,086; City of London corporation, £2,431,053; Metropolitan borough councils, £15,855,621; other authorities, £4,093,256. Of the county council expenditure £13,696,493 went to health services; £13,476,286 to educational services and £3,271,262 to public assistance. The "other authorities" are the City Mental Hospital committee (£56,018) the Metropolitan Water board (£4,011,639) and the Borough Market (Southwark) Trustees (£25,599). A revaluation of properties is made every five years. In spite of attempts at equalization, rates still remain very unequal in London, and varied in 1935–36 from 9*s.* 6*d.* in the £ in Westminster, to 17*s.* 4*d.* in Poplar, though the latter rate had fallen from 25*s.* in 1927–28. The government at one time was compelled to intervene in the financial administration of this borough, which was convicted of extravagance and laxity.

Besides the annual expenditure of the various authorities, large sums have been borrowed to defray the cost of works of a permanent nature. The debt of London, like that of other municipalities, has considerably increased and shows a tendency to go on increasing, although certain safeguards against too ready borrowing have been imposed. Every local authority has to obtain the sanction of some higher authority before raising a loan, and there are, in addition, certain statutory limits of borrowing. Metropolitan borough councils have to obtain the sanction of the L.C.C. to their loans, with the exception of those for electrical works, for which the sanction of the Electricity commissioners is required, and those for a few services for which sanction is asked of the minister of health. The county council itself has to obtain (since 1891) the sanction of parliament. This is done annually by means of a Money act, put forward as a private bill. The means of borrowing are not specified in the act, but are through the creation and issue of consolidated stocks and bonds; the employment of the moneys of the Consolidated Loan fund (*i.e.,* the general sinking fund for the redemption of stock); the issue of London County bills; and temporary loans. Power also exists to issue terminable annuities and obtain mortgages. Under the L.C.C. (Money) act, 1936, the powers to use moneys of the Consolidated Loans fund were extended to superannuation, insurance, reserve and similar funds, while the Housing act, 1935, gave powers to make like use of moneys of the housing repairs fund. The debt of the county council in March 1937 was approximately £80,350,000.

Non-administrative Arrangements.—The Local Government act of 1888 dealt with the metropolis for non-administrative purposes as it did for administrative, that is to say, as a separate county. The arrangements of quarter-sessions, justices, coroners, sheriffs, etc., were thus brought into line with other counties, except in so far as the ordinary organization is modified by the existence of the central criminal court, the Metropolitan police, police courts and magistrates, and a paid chairman of quarter-sessions. The powers of the governing body of the City, moreover, are as peculiar in this direction as in that of municipal administration, and the act left the City as a county of a city practically unchanged. Thus the lord mayor and aldermen possess judicial authority, and the police of London are divided into two separate bodies, the Metropolitan and the City police. (*See* POLICE.)

The chief courts for the trial of criminal cases are the central criminal court and the court of quarter-sessions. The central criminal court, taking the place of the provincial assizes, was established by an act of 1834. There are 12 sessions annually, under the lord mayor, aldermen and judges. They were formerly held in the "Old Bailey" sessions-house, but a fine new building from designs of E. W. Mountford took the place of this in 1906. There are 4 general quarter-sessions and various adjourned quarter-sessions totalling 20 meetings annually. General quarter-sessions are held at Newington causeway. The separate court of the lord mayor and aldermen is held at the Guildhall. The Metropolitan police courts became 13 in number with the closing of Westminster court in 1942. The police courts of the city are held at the Mansion House, the lord mayor or an alderman sitting as magistrate, and at the Guildhall, where the aldermen preside in rotation. The prisons within the metropolis are Brixton, Holloway, Pentonville, Wandsworth and Wormwood Scrubbs. There are 12 coroners' districts, 16 petty sessional divisions, and 14 county court districts, including the City in each case. The boundaries of these divisions do not correspond with each other, or with the police divisions, or with the borough or parish boundaries. The registration county of London coincides with the administrative.

Parliamentary Representation.—London returns 62 members to parliament. Each division of each borough, or each borough where not divided, returns one member, save that the City of London returns two members.

Ecclesiastical Divisions and Denominations.—The diocese of London, founded in 314, covers the cities of London and Westminster, the county of Middlesex and the boroughs of the county of London north of the Thames. In the diocese are the bishoprics suffragan of Fulham, Kensington, Stepney and Willesden. The bishopric of Southwark was created in 1904, having been previously a bishopric suffragan in the diocese of Rochester. It contains the bishoprics suffragan of Woolwich and Kingston-upon-Thames. Westminster is the seat of the Roman Catholic archbishopric in England, and Southwark is a bishopric. Among the numerous chapels of dissenting bodies there may be mentioned the City temple, Congregational, on Holborn viaduct (burned out in World War II); the Metropolitan tabernacle, Baptist, in Southwark (also burned out), the creation of which was the outcome of the labours of the famous preacher Charles Spurgeon (d. 1892); and Wesley's chapel, City road, in the graveyard of which is the tomb of John Wesley; his house, which adjoins the chapel, being open as a memorial museum. In 1903 the Wesleyans acquired the site of the Royal aquarium, near Westminster abbey, for the erection of a central hall. The Great Synagogue of the Jews is in St. James's place, Aldgate. The headquarters of the Salvation Army are in Queen Victoria street, City. There are numerous foreign churches, among which may be mentioned the

French Protestant churches in Monmouth road, Bayswater and Soho square; the Greek church of St. Sophia, Moscow road, Bayswater; and the German Evangelical church in Montpelier place, Brompton road. (O. J. R. H.; X.)

PORT AND COMMERCE

The forces which led to the development of the port of London and which continue to operate arise primarily from its geographical position and physical advantages. It is situated on a broad deep tidal river with a current sufficient to keep up a natural scour which maintains the channel, yet not too fast to prevent the safe navigation of the largest vessels.

Another contributing cause to London's commercial advancement was the adoption of the system of bonded warehouses first introduced by Walpole in 1733 but not legalized until 1803. But no factor has contributed so much to the port's prosperity as the enormous expansion of British colonies and possessions during the last three centuries. Goods coming to London which are identified with empire expansion include wool, sugar, rubber, tea, refrigerated meat, furniture woods, provisions, metals, rum, spices, ivory and ostrich feathers. Among the products of countries outside the empire sold in the London markets are soft wood (deals), gasoline, tobacco, cigars, silk, wine and brandy. The total value of the imports of all classes of merchandise from overseas in 1936 was £353,067,978, representing 42% of the total for Great Britain and Northern Ireland. The value of goods imported for transshipment under bond was £16,751,596. While the port has attracted an unparaleled import trade, its export trade though very extensive is second to that of Liverpool, amounting in 1936 to £120,455,240 as against £130,270,495 at Liverpool, these figures excluding the value of exports of imported merchandise, which in the case of London was £36,213,195. London is the largest manufacturing city in Great Britain and a large percentage of its manufactures are shipped at the London docks, but Liverpool has the advantage of contiguity to the cotton, woollen and steel manufactories of the north, and offers better facilities for their shipments than London.

The sum total of foreign imports and exports of the port of London for the year 1936 was £473,523,218, the highest in the kingdom. Besides the foreign trade, London has the largest coastwise trade of any port in Britain, the principal commodity carried being coal.

The following are the particulars of the net registered tonnage of shipping entering and leaving the port during 1936:

	Foreign	*Coastwise*	*Total*
Arrived	22,385,652	8,482,729	30,868,381
Departed . . .	20,136,125	11,146,804	31,282,929

These figures represent 20.4% of the total tonnage for Great Britain.

A feature of modern London has been the industrialization of Outer London, particularly in the northwest and west, the new industries being for the most part highly mechanized. Out of the 25 aircraft factories existing in 1935, for instance, 12 were in or near London and a further five were in the southeastern counties. Moreover, some of the most important electrical firms, one of the largest motor car manufacturers, and the only manufacturers of large scale cold storage equipment in the country have been established in the London area. The flood of lighter manufacturing industries concentrating in Outer London brought in its wake other industries and services required by the vastly increased population. One of the chief causes of this development has been the vast size of London itself, which made the city the finest market in Europe, if not in the world, for manufacturers and distributors of consumption goods, and so provided an almost irresistible attraction to new ventures. One result, however, has been to take earning power away from other parts of the country. This is evidenced by the enormous growth of the port of London, which in the period 1913–1935 increased its foreign trade by over 14%, while the principal west coast ports lost about 11% of theirs. To some extent the decline in the latter ports was due to the loss of the export coal trade, but this would not apply to Liverpool, where conditions were very difficult for some years before World War II, nor would it entirely account for the heavy loss of the South Wales ports. It is clear, therefore, that between the two world wars the tendency for the control of overseas trade to be concentrated in London increased, and this tended to bring to the London area, for distribution in the rest of the country, trade which had formerly gone to the chief west coast ports.

Administration.—The administration of the port of London has undergone many changes in the course of its history. In its earliest days the port was governed by the crown. With the Norman conquest, the City corporation obtained the recognition of certain rights as the conservators of the Thames, which enabled the corporation to collect revenues without any responsibility for guardianship of the interests of the port. A third stage was inaugurated with the accession of Elizabeth in 1558 when a number of privately owned quays were given the monopoly of landing dutiable goods. Another stage was reached in 1799 when William Pitt established three systems of docks built by companies which were privileged to accommodate particular classes of trade for 21 years. On the expiry of that period, the port was thrown open for a general competition of facilities between the docks and river wharfingers. On March 31, 1909, under the powers of an act of parliament passed on the initiative of D. Lloyd George, the Port of London authority commenced its career by assuming the functions of the Thames conservancy in the lower river and those of the old dock companies in the docks with the special duty of improving the accommodation in the port.

The authority is a board of 28 members. Seventeen of them are elected by payers of dues, by wharfingers and owners of river craft, 1 by wharfingers only and the remainder are appointed by the admiralty (1), the ministry of transport (2), the City corporation (2), the London county council (4) and Trinity House (1). Labour has two representatives. The authority's jurisdiction in the river extends from Teddington lock down to an imaginary line drawn from Warden point in Kent to Havengore creek in Essex. This line is 50 mi. below London bridge and 69 mi. from Teddington lock. On this part of the river, the authority is the conservator. It controls the licensing of all erections on the river banks, the regulation of the navigation of the river, the prevention of pollution, and the licensing of lightermen and their craft. The control of the lighting and buoying of the river as well as of pilotage is in the hands of Trinity House.

After 1909 the river channel was deepened and widened. From the Nore to Cold Harbour point, there is a channel of 1,000-ft. width with a minimum depth of 30 ft. at low water spring tides. From Cold Harbour point to the Royal Albert dock, the channel is 600 ft. wide with a depth of 27 ft. An addition of from 17 to 21 ft. must be made to the above figures of depth to ascertain the depth of water available at high water.

In the docks, the authority, as the successors of the dock companies, furnishes every class of accommodation, except storage for mineral oils and explosives. At the upper docks, the authority undertakes the discharging of ships, whereas at the lower docks, shipowners discharge their own ships, the only exception being bulk grain for which the authority provides floating elevators and carries out the work with its own staff. The actual loading of ships is not performed by the authority, its only service to export goods being the handling of such cargo as passes over the dock quays. The most important functions of the authority in the docks are connected with operations on goods stored in its warehouses and intended for sale in the wholesale markets of the City. In the year ending March 31, 1937, the Port of London authority received 1,077,926 tons of goods for warehousing and the stock of goods in the warehouses at that date was 553,287 tons. In addition 1,228,166 tons of goods were landed for immediate delivery. Of export goods, 728,813 tons were received for shipment from the dock quays during the same period. The length of dock quays in the port is about 45½ mi. The largest lock at the King George V dock has a length of 800 ft. and a width of 100 ft. The lock at the Tilbury dock was opened in 1929 and is 1,000 ft. long, with a width of 110 ft. The equipment of the docks of London has been greatly improved by the Port of

London authority especially in regard to dry docks, electric cranes and railways.

Besides the accommodation of the authority, facilities are provided on the river side by private wharfingers both for shipping and for the warehousing of goods. The tonnage of shipping using riverside accommodation forms about 38% of the total and consists mostly of colliers, continental and coastwise traffic and oil tankers.

Markets.—Sales of goods in the wholesale markets of London are effected at various centres in the city and are based upon either inspection at the warehouse of storage or upon samples supplied by the port authority or the private warehouse keepers. Wool is sold at the Wool exchange in Coleman street and grain at the Corn exchange in Mark lane. The Commercial sale rooms in Mincing lane are devoted to tea, rubber, sugar, wines, spirits and other foreign and colonial produce. The Coal exchange is in Lower Thames street. The Hop exchange and the Metal exchange are in the Borough and Whittington avenue respectively.

There are some markets in London controlled by the City corporation. These include the central markets in Smithfield for meat, poultry and provisions, Billingsgate market for fish, and Spitalfields for vegetables. Leadenhall market is a retail market, chiefly for meat and poultry. The Covent Garden market, which is the chief market in the metropolis for vegetables, fruit and flowers, is the property of private owners.

London's predominance as a port has been the foundation of its predominance as a financial centre of the world. For a description of the financial system of London *see* the various articles dealing with banking and insurance. (J. G. Br.; X.)

HISTORY

The Origin of London.—The few facts available indicate that London first rose out of complete obscurity early after the Roman occupation of Britain, in the 1st century of the Christian era. Its geographical position was the determining factor. A British *oppidum,* or stronghold, of the Catuvellauni that became Roman Verulam and is today St. Albans was sheltered behind the Middlesex forest when Julius Caesar, having landed in Kent in 54 B.C., made his raid. Upon that he marched, crossing the Thames at some point that remains uncertain. Caesar makes no mention of London. The inference is that London did not exist. A British trackway, and later the Roman Watling street, from the Kentish ports to Verulam forded the Thames at Westminster. In A.D. 5 Cunobelin, or Cymbeline, succeeded to the throne of the confederated tribes in southern Britain. Early he transferred his seat of government to what became Roman Camulodunum (Colchester). London's site was well placed for the service of both cities. The Thames at this point greatly narrowed, twin hills rose upon the left bank, and there was easy access from the sea. The belief now widely held is that London's emergence was due to its service as a landing stage, or bridgehead, for continental trade with Britain.

When London appears in history it is not as a capital. Tacitus, who wrote early in the 2nd century, refers to it as having been in A.D. 61 a place much frequented by merchants. The name London is not Roman, but Celtic, and the Romans adopted it in their own Londinium. A coin of Cunobelin and a few late Celtic objects have been recovered in city excavations and the Thames bed. Evidence of a pre-Roman settlement, whether a trading or fishing village, is, however, extremely vague. Fragments of Arretine and British pottery found in the area are regarded, not as pre-conquest objects, but as survivals of types into the Roman era.

Roman London.—Aulus Plautius, a general of the emperor Claudius, landed in Britain with Roman troops in A.D. 43. With the fall next year of British Colchester and St. Albans, the whole of southeast Britain after no long interval passed under Roman domination. From Dion Cassius's enigmatical statement (early 3rd century) there was already at the invasion a bridge, "a little above the mouth of the river." The evidence is much stronger that the Romans at some later date themselves constructed a bridge joining London, on the northern bank, with Southwark. This must, indeed, have become a necessity for them. Close by Old London bridge wooden piles, many thousands of Roman coins, medallions and quantities of broken tile and pottery have been found in the Thames bed. What survives of the Roman city is now buried at depths of from 12 ft. to 19 ft. below the ground surface.

The first actual knowledge of London comes with its destruction in A.D. 61, when the Roman governor, Suetonius, retired and Boudicca's (Boadicea's) hordes sacked the city and massacred the remaining inhabitants. A crushing victory over the British restored Roman authority, which thereafter endured in London and in England for three-and-a-half centuries.

The Romans cast a wall about the city, with a ditch beyond. Massive fragments of the wall remain. Its thickness at the base is about 8 ft., the height being unknown. It consists of a core of rubble faced with Kentish rag-stone, with bonding tiles at regular intervals, and a chamfered footing of sandstone outward. It is structurally the same wherever found, was evidently carried out as a single undertaking, and evidence now available from silt and deposit against the wall where the Wallbrook entered the City indicates that it was built in the 1st century, after Boudicca's ravages were repaired. Burials imply that the first Roman city was a small rectangle about Cornhill. The area walled, 324 acres, is immense, much greater than that of any other Roman town in Britain, and equalled by few in the world-empire. Londinium's importance is attested not only thereby, but by the fact that from it the chief Roman roads radiated, linking up the most distant areas of the province with London. Excavations at Newgate in 1908 definitely established a Roman gateway there. Other original gates were probably at or near Aldgate, Aldersgate and opening upon the river bridge. Ludgate has been considered a Saxon postern; but the discovery in 1927 of a Roman cemetery, with urn burials, in Shoe lane, by the side of Fleet street, strengthens the belief that Ludgate, too, was Roman. Late in the Roman occupation, probably 4th century, the wall was strengthened by bastions, of which there are examples underground at Newgate, at St. Giles Cripplegate (mediaeval above the surface) and beneath the vestry of Allhallows, London Wall.

Not a column of any building has been left standing in historical times, and in a city without stone, which had to be brought in from distant parts of Kent and Surrey, it is likely that the Roman houses were largely of brick or timber construction. The city wall is Londinium's greatest monument. Remains of very thick walls with an apsidal structure found in 1881 beneath Leadenhall market have been believed to disclose the basilica and forum; an amphitheatre has been conjectured; the spade has uncovered evidence of riverside wharves; but no definite indication of the street plan of Roman London is to be traced in the modern city.

London Stone, a fragment of which is fixed in the exterior wall of St. Swithin's church, Cannon street, has been deemed a *milliarium,* marking a starting point for the measurement of distances along the Roman roads; but there is no actual evidence of its purpose.

Abundant relics in sculptured altars and tombs, bronzes, tesselated pavements, hypocausts, pottery, domestic utensils and articles of apparel attest a very high state of culture that Roman London attained. Guildhall museum, the London museum and the British museum have rich collections of these. Remains of a Roman house are preserved undisturbed beneath the Coal exchange at Billingsgate. Christianity was introduced late in the 3rd century, but its records are very meagre. Restitutus is named as a bishop of London at the Council of Arles in A.D. 313.

The political history of Roman London remains vague. Although it became a chief city and centre of administration it did not receive the superior title Augusta until A.D. 368. Information is available concerning the province, but it is curious that London is rarely linked with it. Hadrian presumably passed through on his visit to Britain in A.D. 122; the wonderful bronze head of this emperor, of colossal size, that was dredged from the Thames bed near London bridge and is now in the British museum, is the most perfect example of Roman art found in Britain. After Boudicca's ravages, there is no mention of London by any classical author till late in the 3rd century, and what little is known is derived solely from archaeology. London, then possessing a mint, appears again in record after the revolt of Carausius and his murder by Allectus, when the Frankish seamen and mercenaries of the last named were trapped in the city in A.D. 296. Its sacking was stayed by the timely arrival of Constantius Chlorus and his fleet. A Roman boat, preserved in the London museum, was recovered from the Thames mud at Lambeth where today the county hall stands, and is conjectured to have been a craft in Allectus's fleet sunk in the fight; coins of both Carausius and Allectus were associated with the find.

Following a peaceful period, the last half-century of the Roman occupation was much disturbed. London was in jeopardy on several occasions after A.D. 360 from raids by Picts and Scots, augmented by Northern races from overseas, who ultimately penetrated as far south as Kent. The Roman general Theodosius, sent by the emperor Valentinian, cleared them from southern Britain, and in A.D. 368 he made a triumphal entry into London. Near the end of this century internal troubles were almost continuous; and early in the 5th century Rome, in grave peril herself, withdrew her legions from Britain.

Saxon and Danish.—Thereafter the "dark centuries" descend, and London completely disappears from record. Of its fate nothing is known. The "Anglo-Saxon Chronicle" is not silent for those years. It tells of piratical raids upon the English coasts by Saxons and Franks, and battles with the invaders and bloodshed and destruction, and the fact that nothing is related of London tends to support the belief that there was nothing to relate—that the city was depopulated. Even the name of London has no mention till about 597, when Pope Gregory sent Augustine to teach pagan Britain Christianity, expecting that he would found a see at London, though for sufficient reasons his choice first fell upon Canterbury, in Kent.

Mellitus was despatched by Augustine to London to become its bishop in 604, and on its re-emergence at this date London was the tribal capital of the East Saxons, whose kingdom was subordinate to the power of the kings of Kent. Already recurrent invasions had resulted in a considerable Saxon settlement in Britain, but the newcomers were not by choice town-dwellers. Sebert was then king in London, and Mellitus appears to have been well received. With Sebert's death in 616, and that of his overlord, Ethelbert of Kent, the East Saxons relapsed into paganism. The bishop fled; and though after an interval Cedd (633) and Wine (665) are mentioned as bishops, and laboured to restore Christianity, it was in the period of Earconwald, who about 675 was appointed by Archbishop Theodore as "bishop of the East Saxons in the city of London," that the faith was firmly re-established. Bede gives Ethelbert as the builder of the first cathedral of St. Paul's, and in the years of returned heathenism it is to be presumed that his fabric was destroyed.

Names of successive bishops occur; a London mint was founded in the 7th century; but there is little light thrown into the darkness in which London was engulfed till Bede, writing about 730, draws an unexpected picture of London as the "mart of many nations resorting to it by sea and land." The overlordship of the kingdom of the East Saxons passed successively from Kent to Wessex, to Northumbria, to Mercia, back to Wessex, and again to Mercia, all of which indicates a period of considerable disturbance. London, "a royal town," was under Coenwulf the capital of Mercia in 796, and so remained until in 827 the Saxon kingdoms became united under Egbert, king of Wessex, who established his authority over all England.

The 9th century was an active period of Danish raids which were to disturb England for a century and a half. London frequently recurs in the brief incisive passages of the "Anglo-Saxon Chronicle." A fight with the Danes, with great slaughter, occurred in 839; in the mid-century the city appears to have been intermittently in Danish hands; and it was the Danes whom Alfred attacked when in 886 he occupied London (*gesette Lundun burg*—presumably restored its ruinous defenses). A governor for London was found in Ethelred, and in the more restful period it enjoyed while England was under Alfred's strong rule London's overseas commerce developed, and the city and port rose to a place of first importance in the kingdom. Evil days returned after Alfred's death in 899.

The tangled record of London in the 10th century is one of repeated raids by the warlike Scandinavians. While the surrounding country was harried and plundered, London for the greater part maintained its independence. The city had thrice been destroyed by fire in the 7th and 8th centuries, and was again burned in 982. Olaf and Sweyn, with 94 ships, besieged it in 994, but the Londoners offered stout and successful resistance. "In wrath and sorrow" the invaders sailed away. The first decade of the 11th century witnessed several attacks, and in 1009 the city was in great jeopardy from the invading army of the Norse earl, Thurkhill. "Glory be to God," says the pious chronicler, "it yet standeth sound." A gallant defense against the Danes was maintained in 1013, but later that year the city fell to Sweyn. Independence was restored under Ethelred, who on Sweyn's death next year was elected king by the English. King Olaf of Norway gave his aid to them, and one of the most charming of Icelandic sagas describes a battle fought at London bridge.

On Ethelred's death in 1016, the gemot in London chose his son, Edmund Ironside, as king, though the country outside London had accepted Sweyn's son, Canute. London was again besieged; the citizens repulsed successive attacks, and under Edmund reconquered the neighbouring country. Edmund's reign, however, lasted but seven months, and on his death all England acknowledged Canute as king. The Londoners had no alternative but to "make a truce with the army and buy themselves a peace."

London paid tribute to Canute of £10,500, a sum that indicates its importance and, despite the constant hostilities, its wealth, for it represented one-eighth of the payment made by the whole of England. Under that farsighted monarch peace was assured, London's commerce rapidly developed, and the city definitely established its predominant position in national affairs.

A renewed period of unrest followed Canute's death in 1035. Edward, afterwards known as the Confessor, was chosen king in 1042 by the people assembled in London. In his reign Norman influence strongly permeated the government. Duke William of Normandy paid England a visit, and according to his subsequent claim, Edward's oath that he should succeed to the kingdom was confirmed by the gemot of London, but evidence of this is wanting. The election of Harold as king at the Confessor's death in Jan. 1066 was a denial of Duke William's pretensions. London sent its hosts to the field of Hastings on Oct. 14, where they fought under the leadership of Ansgar the Stallar, guarding the king's person and standard. In this place of peril it is probable that few of them survived the defeat and rout. William wasted the country through which his army passed, but purposely avoided London, though a detached force of Normans burned Southwark. His march brought William to Berkhamsted, where he camped, and there in December, two months after his victory, he received from a representative body of ecclesiastics and eldermen the submission of London.

Norman and Plantagenet.—Norman London starts with a definite act, the grant by the Conqueror to the citizens of a charter. A narrow strip of parchment 6 in. in length, it bears no date. In 1927 A. H. Thomas, clerk of the records at Guildhall, skilfully pieced together fragments of a wax seal originally attached to the document, and it proved to be King William's second great seal; but all probabilities suggest that the grant was made at Berkhamsted or in London immediately after the submission, the formal warrant being delayed. The charter is remarkable in its terms:

William, King, greets William, Bishop, and Gosfregth, Portreeve, and all the burgesses within London, French and English, friendly. And I give you to know that I will that ye both be worthy of all those laws that ye were worthy of in King Edward's day. And I will that every child be his father's heir after his father's day, and I will not suffer that any man offer you any wrong. God keep you.

Thus early London possessed a government in which the secular authority of the portreeve combined with the ecclesiastical authority of the bishop. No new powers were given. The citizens were confirmed in the enjoyment of their laws, which were the growth of many years. The king was their sole overlord, and would suffer none to wrong them. London's privileged position, dependent upon no man save the king, became a basis of its commercial pre-eminence.

The Anglo-Saxon laws to which King William assented had raised London to equality with a shire. It had rights beyond the walls. Its folk-moot, or general assembly, was an ancient institution, enjoying powers to discuss and decide matters that were essential to the welfare of the community. In the 10th century there is mention of the Hustings of London—the equivalent of a shire court—which in modified form still survives. There is much to suggest that the sheriff presided. It transacted a large part of the work for which the folk-moot had become too cumbersome a body. The Norman portreeve doubtless was the successor of the Saxon reeve, and Dr. Round has shown that Gosfregth (or Gosfrid), to whom among others the Conqueror's charter to London is addressed, was Geoffrey de Mandeville, the sheriff. The charter, moreover, bears testimony to the large proportion of Normans resident in London. In the state of settled security that followed, the ranks of these oversea traders were largely augmented.

So long as William reigned, both the king and London kept the pact.

It was less honoured by William Rufus, who oppressed the people by building his great hall at Westminster, strengthening the Tower of London (*q.v.*) erected by his predecessor at the water gate, and in the repair of the Thames bridge that floods had mostly carried away. Fire in 1087 destroyed St. Paul's and a large part of the city.

London supported the election of Henry I to the throne, and from this king obtained a charter of liberties that is of outstanding importance, though it did not become really effective till King John, when encountering supreme difficulties in conflict with his rebellious subjects, was forced to recapitulate its provisions. The citizens of London were given the county of Middlesex at farm, and they were to appoint from among themselves one who would be sheriff over it. Elsewhere the sheriff (shire-reeve) was, and for centuries has remained, a royal officer appointed by the king; his concern was with the collection of revenues, the profits of justice and the military organization of the shire. The delegation of the royal authority to election by the citizens marks the unique position which London attained.

London enlarged its pretensions when, on Stephen's appearance as a claimant to the English throne in 1135, the citizens asserted that it was their right and special privilege, on occasion of the king's decease, to provide another in his place, and they proceeded to election. Later, when Stephen was held prisoner for Matilda, after the battle of Lincoln, the Londoners appeared by a delegation of leading men, refused to enter into debate and demanded that their lord the king be released. A revolt of the Londoners finally drove Matilda from the kingdom.

MIDDLE AGES: RISE OF THE MAYORALTY

The rise of London's mayoralty is associated with the reign of Richard I, and more especially those years when John (afterwards king) acted as regent during the monarch's absence on the crusades. Then was definitely established the rule by a mayor, to whose side was drawn a body of aldermen and councilmen, which has endured till this day. London thus became the first municipal corporation in England, and upon its model 28 mediaeval towns afterwards drafted their charters.

The corporation of the City of London has greater antiquity than the English parliament. It is not of English origin. The model is French, and the French title *maire* remains for the chief ruler. To the citizens the idea of a commune was not new. They had claimed to be such when they demanded Stephen's release. No public recognition of London citizens as constituting a body corporate is, however, to be traced. In France and Flanders this trend towards corporate life had rapidly developed in the chief centres of mercantile activity, notably Rouen; and London, with its large trading activities, was not slow to profit by the example.

Not for the first time in her history, nor the last, the crown's difficulty was London's opportunity. Longchamp's tyrannical administration of England as the appointed representative of the absent king, Richard I, brought him into fierce conflict with John, the king's brother, who championed the popular cause. In the resulting deadlock, the London citizens made the acceptance by John of their "commune" the price of their support. The chroniclers tell that on Oct. 8, 1191, the barons of the realm and the citizens of London met in St. Paul's, deposed Longchamp from office and recognized John as head of the kingdom. Immediately thereafter John formally granted the commune, and took oath before all assembled to maintain the dignities of the city.

Of events that preceded this remarkable change in London government nothing is known, and some historians have conjectured a revolt in the city. Formidable obstacles to corporate administration were to be found in the existence of many sokes, or private territorial liberties, each with its separate jurisdiction.

It is not till two years later (1193) that mention occurs of the first mayor, Henry FitzAilwyn. He held the office till his death in 1212. Much remains obscure. Certain aldermen, when they appear in subsequent jurisdiction, were territorial magnates, representatives of the wards which they held in personal possession; and there are many indications that they exercised powers anterior to the creation of the mayoralty. It is probable that from their body were derived the "more discreet men of the city" who were called into council. Certainly by the reign of Edward I the aldermen had become the main administrative body, as for centuries they remained. Every mayor down the ages has been chosen from the aldermen, and is so chosen today. With the institution of London's mayor the portreeve disappears, and the sheriff falls back into a secondary place.

King John's charter to London of 1215 granted to the citizens the right to elect their mayor from among themselves annually, directing that they should present their choice to the sovereign or his minister for the royal approval. From the "ridings" to Westminster for this purpose originated the Lord Mayor's show, which survives as the most popular of London's pageants.

The mayor of London was one of the treasurers of Richard I's ransom. In John's reign of misgovernment, the city espoused the cause of the barons, whom they admitted within the walls and supported with men and money. Robert FitzWalter, the Castellain of London and owner of Baynards castle, the city's western fortress by the river, was chosen leader of the barons. Both the mayor of London and FitzWalter are named in Magna Carta among those charged to see that the terms of the great charter were strictly carried out. Incidentally those terms specifically preserved the city's privileges and customs.

The long period covered by the reigns of Henry III and Edward I is made notable in civic history by the various occasions upon which the city was "taken into the King's hands," its mayor being arbitrarily displaced from office, and a royal warden appointed. London always supported the popular cause against tyrannical kings. A body of Londoners fought against Henry III under Simon de Montfort's banner at the battle of Lewes in 1264. For a period of five years (1265–70) Henry III ruled London by his *custos,* as did Edward I for 13 years (1285–98).

Thirteenth and Fourteenth Century London.—London records become much more full in the 13th century, especially its later years. Chroniclers' narratives are supplemented by contemporary City archives (now in part printed) such as the Letter Books which begin under Edward I, the rolls of the mayor's court and Hustings court, and citizens' wills enrolled in the latter. From these is derived information of the trading and social activities of the citizens, and—still very imperfectly—of the panorama that the town presented. London ranged along the Thames-side, nowhere extending far back from the water, having a small outpost on the opposite bank at Southwark. A London custumal lays emphasis upon "the many folk of the city, and they are housed close together and are more crowded early and late than other people are"—the common condition of any walled town.

Of the houses, some knowledge is derived from specifications still extant. The merchants lived in timber-framed dwellings.

FitzAilwyn, the first mayor, gave to London that assize which is honoured as the first building act. It aimed at protection against fires, which frequently devastated the city. Thatch was prohibited for roofs, party walls were to be of stone, though for centuries after this provision was ignored. Many citizens' houses carried a solar, or sleeping-room above. A building agreement of 1384 provides for an important dwelling in timber of three stories, to have a hall, 40 ft. by 24 ft. parlour, kitchen, buttery and cellars, with storehouses adjoining. More sumptuous dwellings than this were built for nobles and the richest merchants.

London when the mayoralty was set up was already spreading out beyond the city wall into the western liberty, where many ecclesiastics had their town hostels. The Knights Templars migrated from Holborn to the Thames-side, where they had raised their Round church by 1189. The greatest enterprise for London's development undertaken in the middle ages was the construction of the first stone bridge to replace the earlier successive wooden structures. Old London bridge is customarily dated from King John, in whose reign it was completed, and it served the city till 1832, when it was taken down. Peter of Colechurch began the work in 1176; he died during its progress; and it took more than 30 years to complete. The bridge consisted of 19 arches and a drawbridge, the largest span being 30 ft.; the original breadth above the stonework was 20 ft. This was widened in later centuries. It bore houses from early times, partly overhanging the water and supported by struts.

Although the chief city and commercial capital of England, London city since Canute has never been the political capital. Alfred and other Anglo-Saxon rulers of England made Winchester their capital; the Confessor's royal palace was at Westminster. When Winchester ceased to have that use, in the 12th century, the kings established themselves at Westminster, where William Rufus had begun the building of a great Norman palace, of which Westminster hall survives as a glorious relic. The royal courts of justice and the exchequer became established at Westminster, where later the parliaments assembled in the abbey chapter-house and at St. Stephen's chapel. Henry VIII built Bridewell, in the City's western liberty, and Henry VII lodged at Baynards castle; but no king of England chose to live permanently in London.

Lacking the royal palace and most offices of state, London's greatest buildings throughout the middle ages, as was to be expected, were those of the church. The Guildhall vied with some of these in spaciousness, but the existing Guildhall was not built till the early 15th century. It stood alone, and about it were ecclesiastical buildings of unsurpassed splendour. Old St. Paul's was, when erected, not only England's greatest cathedral; it was the greatest in Europe. Its wooden steeple, destroyed in Queen Elizabeth's reign (1561), rose as high as the present cross, and was accounted a world's wonder. St. Martin-le-Grand, of Saxon origin, had been refounded by William the Conqueror. Rahere's priory and hospital of St. Bartholomew, Smithfield, was founded in 1123. What remains of the church, a fragment notable for its beautiful late Norman work, is merely the chancel and transepts and the restored Lady chapel; all the vast nave has gone. Conventual houses within the city or upon its confines included the priory of Holy Trinity, just within Aldgate, of which no trace remains; the nunnery of St. Helen's, Bishopsgate, the nuns' nave forming part of the existing church; the abbey of the Poor Clares (Minoresses), a fragment of which survives in one wall of the old church of Holy Trinity, Minories; St. Mary Grace, east of Tower hill; the Carthusian monastery, today's Charterhouse; the priory of St. Mary Overy, Southwark, represented by Southwark cathedral; and the priories at Bermondsey and Clerkenwell and the Augustinian nunnery of Holywell, in Shoreditch, and St. Mary Spital.

The coming of the friars in the 13th century had marked influence upon London's life in the middle ages, and was destined to give to the city many imposing religious buildings. They came in poverty, and for many years their work was amongst the poor and the outcast. First to arrive in England were the Dominicans, in 1221. From their settlement in Holborn they moved down, in 1276, to the Thames-side district still known as Blackfriars, having obtained authority from King Edward I to pull down the city wall from Ludgate to the river and in its rebuilding to enclose their precinct. The Franciscans reached London in 1224, and established themselves within Newgate. The Carmelites (1241) built their house in Fleet street. Last of the chief mendicant orders were the Austin Friars (1253). Of all their buildings there remained only the nave of Austin Friars church and this was completely destroyed in World War II. For more than 300 years it was used by the Dutch Protestant congregation.

Wealth came to these religious orders, and with its accumulations they raised churches which were the largest in London, rivalled only by the cathedral. The arrogant magnificence of the Blackfriars' church, its "gay glittering glas glowing as the sun," provoked bitter denunciation in Piers Plowman's verse. The Franciscan (Greyfriars) church, begun in 1306 under royal patronage, was largest of all. Two English Queens, Margaret, second wife of King Edward I, and Isabella, wife of his successor, were interred there.

The normal peace of the city was twice broken by risings: first, the peasants' revolt under Wat Tyler (*q.v.*) in 1381, and secondly, Jack Cade's (*q.v.*) rebellion in 1450.

Throughout the middle ages the trades and crafts of London were highly organized in a guild system, the memory of which is perpetuated in the existing city livery companies, though their powers have long since lapsed, and today their energies and funds are mostly devoted to educational and philanthropic purposes. Fellowships of craftsmen are traced back to a remote past, and in the late 13th and the 14th centuries many of these obtained incorporation for the better development of the industries. The weavers had royal permission as early as Henry I to hold their guild; Henry II in 1160 imposed fines upon no fewer than 18 London guilds for having been set up without the king's licence. Membership of a guild, which gave the coveted city freedom, became almost universal.

London enjoyed a great and increasing trade. It was by far the most populous city in England, needing large imports to meet its own wants, and it was also a principal distributing centre for the country. Vessels drew up at the little Thames ports of Queenhithe and Billingsgate, and the receipt and storage of continental goods further necessitated the provision of many wharves along the river. The Hansa merchants were settled in London by 1157. As late in the 14th century the fairs in the country began to lose their original importance, the bulk of commerce fell to the London merchants, many of whom, like Richard Whittington, the famous mayor, John Pounteney, John Philpot and other mayors, made great fortunes. The cloth industry in the 15th century also created a large export trade from London. The accumulation of so much of the nation's wealth in the capital enabled London to finance the wars of Edward III and Henry V for the conquest of France.

The long internecine struggles of the Wars of the Roses had no marked effect upon London. Disillusioned by the mismanagement of affairs and costly extravagance under the Lancastrian king, Henry VI, London transferred its allegiance to the Yorkist Edward IV, with whom the mediaeval period ended.

LONDON TO THE FIRE

Tudor London.—The significance of the Tudor period in London history lies in the vast changes that the Reformation brought about in the aspect of the capital, and in its social and economic life. Henry VIII found the city crowded with majestic ecclesiastical buildings, fruits of the piety and artistic skill of preceding centuries. Large numbers of these he left in ruins or converted to secular uses, when not actually razed to the ground, and the scars remained in Elizabeth's reign. The great conventual houses of the monastic orders and of the friars were the first to fall. Amid the vast destruction the citizens were able to save much for their permanent advantage. Rahere's Priory of St. Bartholomew was wholly destroyed save for the parts of the church still in parochial use and the attached medical hospital, of which Henry figures as the refounder. St. Thomas's hospital by London bridge, on the Southwark side (removed in the 19th century to Lambeth) was also refounded under the same royal patronage, as was Bethlehem hospital for the insane. City livery companies, the Mercers and the Leathersellers among them, obtained halls for themselves from the spoils of the church.

In the short reign of Henry's son, Edward VI, the Greyfriars buildings at Newgate, mostly left standing, were converted into Christ's hospital for the maintenance and education of poor children. The derelict Bridewell royal palace was in like manner given to the citizens as a house of correction for rogues, vagabonds and refractory city apprentices, and the training of boys for industry.

By the suppression of the monastic houses London was faced anew with urgent problems of the relief of the poor, to which the religious brotherhoods had largely ministered, and the education of the young. Henry's methods of treating the first were chiefly oppressive, and it was not until Elizabeth's last years that the first workable Poor Law act was instituted. The rise of the merchant class to greater power and social prestige was an outstanding feature of the Tudor epoch, and nowhere was more strongly evidenced than in the City of London. Elizabeth's reign was marked by many efforts to establish grammar schools. To the enterprise of London merchant citizens is due the foundation of such famous public schools as Rugby, Oundle and Tonbridge. London also owes Charterhouse, St. Paul's (to which Dean Colet devoted part of his fortune inherited from his father, a City mercer), the City of London school, and the Merchant Taylors' and Mercers' schools to the munificence of the citizens.

Twice during the Tudor epoch the City of London became the scene of armed risings against the crown. In 1554 Sir Thomas Wyat's rebellion against Queen Mary collapsed when, after the march of his followers from Kingston-on-Thames, he found the city gate at Ludgate closed to keep him out. The earl of Essex's effort against Queen Elizabeth in 1601, made from his house at Temple Bar, had no promise of success. In each case the citizens withheld their support.

Mary's accession was subjected to brief delay by the plot to place on the throne Lady Jane Grey, the queen of the nine days' reign. The mayor abstained from attending at Cheapside at the proclamation of Jane, which was received with coldness—"few or none said 'God save her'"—but was present with the recorder and many aldermen when on July 11, 1553, Mary was proclaimed queen at the same place.

London, always intensely patriotic in national movements, rallied to the side of Elizabeth for defense against the Spanish Armada, sending a large contingent of armed men to Tilbury. In prosperous years under the queen the population greatly increased. The City and liberties became closely built upon the dispossessed lands of the ecclesiastics, and the beginnings are detected of a "trek" outwards by substantial merchants to pleasant country houses beyond its confines. Maps and views by Van den Wyngaerde (1550), Braun and Hogenberg (1572–73), and Ralph Agas' map a little later for the first time give an adequate pictorial representation of London, showing a considerable extension of the town westward towards Westminster, especially by large houses built by ecclesiastics and nobles by the Thames front.

Stuart London.—A Scottish monarch stepped up to the throne as King James I of England in 1603. There came in his train the first large migration of Scots to London. It continued in succeeding centuries, and by their characteristic enterprise, industry and ability the capital has largely benefited both in commerce and in culture. Inigo Jones began under James and Charles I, to introduce town planning; but the first experiments at Covent Garden and Lincoln's Inn Fields had made small progress when the Civil War intervened. Two notable civic enterprises mark James I's reign. First was the New River scheme, which gave to the capital a much-needed supply of pure water. It was in origin a City corporation project, carried out, when the corporation did nothing, by Hugh Myddelton, a wealthy citizen, with financial assistance from the king. The second enterprise was the plantation of the Irish province of Ulster, and its development by funds raised by the London livery companies. The link survives in the Irish society.

London history under Charles I is chiefly that of struggles with the king, whose financial expedients of forced loans, ship money, tonnage and poundage estranged the City. Monopolies and trade restrictions further incensed the merchants, and Charles had few friends in London when the Civil War became inevitable. The five members whom the king attempted to arrest in the house of commons on Jan. 4, 1642, on accusation of treason, took refuge in the City. "The birds are flown," he remarked, looking round the benches; and next day he went in person to Guildhall to demand their surrender. Again he met with no success, and as he left the council chamber cries of "Privileges of parliament!" rang in his ears. London became the natural capital of the king's enemies.

It was but once in military peril, in Nov. 1642, when three weeks after the opening battle at Edgehill Charles and his army, moving south, occupied Brentford 9 mi. distant. At Turnham Green the king found Lord Essex's troops, augmented by a large body of Londoners, arrayed against him, and after a reconnaissance he retired to Reading and Oxford. London saw nothing of the king until his trial and execution at Westminster in Jan. 1649.

Cromwell's Protectorate witnessed the readmission of Jews. They had been banished from the kingdom by Edward I in 1292, and for three-and-a-half centuries thereafter, very rarely is a Jewish name found. A small but definite settlement of Spanish and Portuguese Jews in London occurred in Charles I's reign, refugees from the terrors of the Inquisition, who crossed from the Netherlands *via* Amsterdam. Charles no doubt found them useful in his financial negotiations with Amsterdam. Cromwell utilized them in his secret service, giving "endenization" to their leader, Antonio Fernandez Carvajal (*q.v.*), thus making him the first English Jew. A conference, at which Rabbi Menasseh Ben Israel was the chief spokesman, was held at Whitehall in 1655, with the ultimate result of wresting an admission that English laws did not forbid the settlement of Jews. A synagogue was opened undisguised at Creechurch lane in the City in 1657, and a burial ground obtained at Mile End.

REBUILDING OF THE CITY

The Great Plague in 1665.—London suffered two vast calamities early after Charles II's restoration, by the great plague in 1665, followed by the great fire next year. Bubonic plague had scourged London for centuries. It is an error to regard the great plague of 1665 as an isolated event, or as a foreign importation. It began in London's suburb of St. Giles-in-the-Fields. Comparatively few deaths occurred in the walled city. The greatest devastation was in the town's outskirts, at Stepney, Shoreditch, Clerkenwell, Cripplegate, St. Giles's and Westminster, quarters wherein the poor were densely crowded. It was known as "the poor's plague."

The king and court fled from London in June, and did not return till the following February; parliament kept a short session at Oxford, where a legal term was held, lasting a few days only. The duke of Albemarle alone among Charles's ministers remained in London, and with the assistance of magistrates whom the king directed to stay exercised authority in the out-parishes, the lord mayor (Sir John Lawrence) accepting responsibility for the City. Defoe's vivid narrative in his *Journal of the Plague Year* is valuable as a picture of the time, but is historically inaccurate by reason of his assumption that the lord mayor's orders were faithfully carried out, which was not the case. The bills returned 97,306 deaths in London in 1665; 68,596 were attributed to plague.

The Great Fire.—Plague had not actually disappeared from London when the great fire occurred. A baker's shop in Pudding lane, near London bridge, was alight about one o'clock on the morning of Sunday, Sept. 2. The flames spread among crowded wooden houses down to the Thames wharves, whereon were stored quantities of inflammable goods. The water-wheel by the bridge was early destroyed, and thereby the water supply to neighbouring parts of the City was cut off. In the night the fire burned up into the City, and in the afternoon of the second day was raging about the Royal exchange, Lombard street and Cornhill, among the dwellings and shops of the richest brokers and merchants.

A wind blew freshly throughout three of the four days that London burned, always driving the flames farther into the City. By midnight on Monday, the second day, vast destruction had been done in an area that spread for nearly a mile along the river front, and in its northward extension the fire involved the whole of Cornhill, the Poultry, and was at the entrance of Cheapside. About the waterside much of the City lay dead and blackened, and the fire at night assumed the form of that huge "bow of flame" which so greatly impressed the diarist Pepys. Fire appliances consisted of iron hooks on poles for pulling down the burning wooden houses, axes and ladders, the only means of projecting water being brass hand-squirts worked by three men.

The king displaced the irresolute lord mayor (Sir Thomas Bludworth) from supreme authority, which he gave to James, duke of York; soldiers and dockyardsmen were sent in. Nearly half the walled City was burning by Tuesday morning. That third day the Guildhall was alight, the custom house and Royal exchange were destroyed, and late that night fire broke out on the roof of St. Paul's and ultimately left the great Gothic cathedral in ruins. In its onward rush the fire burned through Cheapside and reached London's northern wall at Cripplegate, and westward passed the wall at Newgate and Ludgate, and burned the larger part of the liberty, extending to Holborn bridge and throughout the length of Fleet street to within a few houses of Temple Bar. The wind falling during the night, the fire made but small advance on the fourth day, when save in a few isolated places it burned itself out.

The City surveyors' return shows concisely the extent of the calamity:—Area of the City burned, 273 ac. within the walls, 63 ac. without the walls; 87 parish churches, besides chapels, burned; 13,200 houses burned in over 400 streets and courts. Only one-fifth of the walled city was left standing.

Reconstruction.—With undaunted courage the citizens faced the vast task of rebuilding their city. Sir Christopher Wren and John Evelyn devised model plans, but amid the resulting distress and in the absence of any national contribution these could not be carried out, and the mediaeval street plan was retained. The Rebuilding act of 1667 directed that brick and stone only should be used. Four types of houses alone were to be permitted, for which specifications were given. A brick-built city slowly arose that was orderly in design, and in marked contrast to the picturesque jumble of gabled dwellings that it superseded. A few main streets were widened and straightened. Forty-four City companies' halls had been burned, and these, with the custom house and Royal exchange, were first rebuilt. Repairs to the Guildhall lasted till 1675. Four years after the fire construction began of ten of Wren's churches; the 51 churches rebuilt were not completed when the century ended. St. Paul's was finished in 1712.

No other single event exerted such influence upon the city's future and the welfare of its inhabitants as the great fire. The Reformation destroyed the predominating ecclesiastical character that London had maintained throughout the middle ages; the fire made the City within the lord mayor's jurisdiction the main commercial centre that it has since been. Under the first Stuart kings the nobility, moving out from the City, created a fashionable west-end at Covent Garden and Lincoln's Inn Fields; loyalists returned with King Charles II built themselves houses farther west. At the close of the reign Aldersgate street alone in the City remained a place of fashionable residence.

After the fire London for the first time was given a central sanitary authority. Municipal service hardly existed. Lighting such as the streets enjoyed, by candles exposed in horn lanterns before the house fronts, it was the duty of individual householders to provide; they formed the watch (police); there was no public control of drainage; repair of the street surface to the centre line and cleansing of the streets were obligations cast upon residents, each man before his own house. A Sewers act of 1671 gave to London in perpetuity a public body called the commissioners of sewers, nominated by the corporation, with power to raise a rate, and to this body was confided the laying out, repair, drainage and cleansing of the City streets.

For the last time a king of England sought to curtail the City of London's ancient liberties and franchises, by proceedings under the writ *Quo warranto,* which resulted in 1683 in various aldermen and officers being ejected, and for a few years their places, together with the mayoralty, were filled by royal nominees. The legality of the proceedings was never acknowledged; it became known only later that two of the King's Bench judges who favoured the City's cause were arbitrarily removed before judgment. Charles died on Feb. 6, 1685, and in the crisis of King James II's short reign that followed full restitution was made of the City's liberties.

On the flight of King James II from London in Dec. 1688, lords spiritual and temporal came to Guildhall as a place of greatest security, and there drew up the Declaration of Allegiance to the prince of Orange. The common council voted an address welcoming the prince. It was significant of the City's great position and prestige, that to the authoritative assembly which met after William of Orange's arrival in London he summoned not only the members of past parliaments, but also the lord mayor, the aldermen, and 50 representatives of the common council.

The characters of the successive Georges did little to endear them to the populace, among which was a not inconsiderable Jacobite faction. But London, with its vast commercial and financial interests, had everything to gain by settled government and order, and in the crises provoked by the Jacobite risings of 1715 and 1745 gave its weighty support to the throne. Later there came a distinct cleavage between the corporation and the court party. The only statue to a lord mayor that the City has raised in Guildhall is to William Beckford, and beneath it is set out in golden letters the strong, if still courteous, remonstrance that he addressed to King George III, touching a violated right of election.

The mayoralty in a struggle with the house of commons performed conspicuous service in advancing the liberty of the press. Parliament held publication of its debates to be a breach of privilege. In March 1771, certain printers abandoned the subterfuge of giving fictitious names, date and place, and reported the debates openly. Thereupon a messenger armed with the speaker's warrant arrested Miller, the printer of the *Evening Post,* in the City. Aldermen John Wilkes and Oliver declared the warrant illegal, released Miller and placed the messenger under arrest and bond. Brass Crosby, the lord mayor, upheld the City's franchise to execute the laws within its jurisdiction. Great processions of citizens accompanied Crosby and Oliver (Wilkes was not molested) to the house of commons, by which, after having been heard, they were committed to custody in the Tower. The prorogation of parliament six weeks later set them free, when the full common council, gowned, with the City officers and a multitude of people, attended at the Tower gates to receive the mayor and alderman, and escorted them amid tumultuous enthusiasm to the Mansion house. At night the city was illuminated. Thereafter the ban upon reporting the debates was tacitly withdrawn.

Vast destruction was done in London during the Gordon riots in June 1780, which followed upon the act of parliament for relieving Roman Catholics of certain disabilities. The disorders were finally put down by the soldiers, with 285 dead by musket fire and 173 wounded civilian prisoners. Such was the official return, but the actual casualties were believed to exceed 700.

London lost its character as a walled city by the demolition in 1760–66 of the last City gates and the last sections of the wall. This was but a small part of the change that the Georgian era brought about. Before the century ended the historic area of the lord mayor's jurisdiction distinguished today by the name of "the City," was left embedded as the small nucleus of a capital that spread for miles distant on every side.

The Thames had been from time immemorial the chief highway for communications about the town and for the passage of heavy merchandise. Pepys, the diarist, records many occasions on which he took boat at the stairs for Westminster and Lambeth and to Deptford dockyard. In Queen Anne's reign the world of fashion largely adopted the sedan chair. The bridge between the City and Southwark stood alone until 1750, when an additional bridge crossing the Thames at Westminster was opened, followed 19 years later by a third bridge at Blackfriars.

Architecture in the capital underwent considerable development at the hands of Chambers, Soane, Gibbs, Kent, the brothers Adam—who gave the Adelphi in the Strand—and the elder and younger Dance. Important buildings of the period are Somerset house, its river front then washed by the tide; the Bank of England, of which Soane's finely conceived encircling wall remains in the reconstruction; the Mansion house, the Horse Guards and Lansdowne house. Bloomsbury was laid out in garden squares which today bear their Georgian names, and set an example to builders farther west from which London has greatly benefited. The signs that after the great fire had been placed flat on the house fronts were withdrawn in the middle 18th century, when the numbering of houses was introduced. Oil lamps gave better lighting to the streets, though it was not until 1736 that street lighting was accepted as a municipal duty. In turn these gave place to gas, introduced in 1807, and to electricity.

Recent Developments.—After Queen Victoria's accession in 1837 the City was almost wholly given up to commerce. New streets opened out its congestion, but the larger developments were in the West End. Regent street, the West End's principal shopping thoroughfare, was part of the ambitious project of the prince who became King George IV. The advent of railways gave additional impetus to the extension of the metropolis; and in 1851 the Great Exhibition, held in Hyde Park, set the example of international exhibitions to other nations, added largely to the trade of the country, and made the capital itself far better known to foreign visitors.

The larger part of the City has been newly built in stone, but brick and concrete predominate outside its limits, the former being largely used for blocks of flats and the latter for commercial buildings. London made a worthy contribution both in men and treasure to World War I and for the first time since the days of William the Conqueror was attacked by forces from overseas. Air-raids by zeppelin and aeroplane took place at intervals from May 31, 1915, to May 20, 1918; 355 incendiary and 567 explosive bombs were dropped in the City, completely destroying 174 buildings, seriously damaging 617 others, killing 524 persons and injuring 1,264, and doing damage to the estimated value of £2,042,000.

The figures for World War I are trifling compared with those for World War II. In the 11 months from Sept. 1940, to the end of July 1941, for instance, it is computed that between 45,000 and 50,000 bombs were dropped on the London region, of a total weight of roughly 7,500 tons, excluding incendiary bombs. Close on 10,000 persons were killed and 17,000 seriously wounded. Bombing continued for 57 successive nights (Sept. 7–Nov. 2, inclusive) and roughly 20,000 bombs were dropped in this period. During the two years 1940–41 about 10,000 tons of bombs were dropped. The second great fire of London occurred on the night of Dec. 29–30, 1940, when more than 100 aeroplanes showered incendiary bombs on the City. Some 1,500 fires were started, including six conflagrations and 16 major fires. A large area round St. Paul's cathedral was laid waste, the Guildhall was all but gutted, eight Wren churches suffered seriously and the Law Courts and the Tower were hit. During the previous September great fires had also been caused in the docks and the more eastern part of the City. On the night of April 16–17, 1941, the houses of parliament, the Law Courts and St. Paul's were hit, while on May 10–11 the commons chamber of parliament was destroyed and Westminster abbey, Westminster hall, the British museum, the Law Courts again, the war office, the mint, the Mansion House and again the Tower were hit. Five of the halls of City companies were destroyed and many famous churches were damaged.

In the months that followed the air raids diminished, until in 1942 and 1943 there were long periods when no raids took place; few planes penetrated the extensive balloon barrage and the progressively improving anti-aircraft defenses. In the final reckoning, therefore, the bulk of the damage, amounting to hundreds of thousands of buildings, if houses are included, and to millions of pounds in value, will be found to have been caused during 1940–41.

The corporation of the City of London is now surrounded by 28 municipal boroughs (including the City of Westminster) and an inhabited area of some 700 square miles.

Bibliography.—Much information concerning the earliest period is contained in the Roman and Anglo-Saxon sections of *Victoria County History of London*, vol. i. (1909); W. Lethaby's *Londinium* (1923), for architecture; W. Page's *London: Its Origin, etc.* (1923), which carries the history through Norman times; *London*, vol. iii. (1928) of the Historical Monuments Commission; and Prof. Haverfield's works, particularly *Journal of Roman Studies*, vol. i. Sir G. L. Gomme, in *The Governance of London* (1907), *London*, and other books, has striven to find an unbroken link between the historic City and London of the Romans.

For the middle ages sources are very numerous. Liebermann's *Gesetze der Angelsachsen* contains many London records of early date. J. H. Round's *Geoffrey de Mandeville* (1896) and *The Commune of London* (1899), and Miss Bateson's "A London Municipal Collection of the Reign of John," in *English Historical Review*, vol. xvii., must be read for Norman London and the rise of the mayoralty. The City corporation has published many of its muniments, which remain the basis of civic history. Included in these are the following edited by H. T. Riley: *Munimenta Gildhallae* (1859, Rolls Series), which contains the *Liber Albus*, written in 1419, and the *Liber Custumarum* (an English translation of the first-named printed in 1861); *Chronicles of the Mayor and Sheriffs of London*, 1180–1274 (1863) and translations of the *Liber de Antiques Legibus;* and *French Chronicle of London*, 1259–1343 (1844–46, Camden Society); and *Memorials of London and London Life in the 13th, 14th and 15th Centuries* (1868), the last a selection of documents from the records known as the City Letter Books. Complete Calendars of these Letter Books from A to L—Edward I. to Henry VII.—have been edited by R. R. Sharpe (1899–1912), who also has edited the *Hustings Wills* (1889–90) and early *Coroner's Rolls*. Other archives at Guildhall, edited by A. H. Thomas, are *Plea and Memoranda Rolls*, 1323–64 (1926) and *Early Records of the Mayor's Court*, 1298–1307 (1924). Full translations of the City's charters are given in W. de G. Birch's *Historical Charters and Constitutional Documents of the City of London* (1887).

John Stow's *Surveigh of London* (1598, 1603) edited by C. L. Kingsford (1908), invaluable for its pictures of London in the Elizabethan age, is a basis of much knowledge of earlier times. It also contains the first written description of London, by Fitzstephen in the year 1174. Kingsford's *Chronicles of London* (1905) brings together chronicles written between 1200 and 1516. H. B. Wheatley's *The Story of London* (Mediaeval Towns series, 1904) and W. J. Loftie's *A History of London* (1883) cover the period. Accounts of trade and craft guilds are contained in W. Herbert's *Twelve Great Livery Companies of London* (1837); W. C. Hazlitt, *Livery Companies* (1892); G. Unwin, *Gilds and Companies of London* (1918). Many of the Companies have published their separate histories.

London's religious houses and ecclesiastical affairs are dealt with in detail by the *Victoria County History of London*, vol. i., and Dugdale's *Monasticon;* and the parishes till 1700 by Newcourt's *Repertorium*, and its continuation, G. Hennessy's *Novum Repertorium* (1898). A. B. Beaven's *Aldermen of the City of London* (1908–13) is a full record of that body. W. G. Bell's *Great Plague in London in 1665* (1924) and *Great Fire of London* (1920) give accounts of the two catastrophes based on recent research. Dr. Reginald Sharpe's *London and the Kingdom* (1894–95), written from the civic archives, is an admirable exposition of the City's political history. The London Topographical Society has published facsimiles of early London maps. Views of typical buildings of past ages are given in J. T. Smith's *Ancient Topography of London* (1815), J. W. Archer's *Vestiges of Old London* (1851) and P. Norman's *London Vanished and Vanishing* (1905). Many of the larger historical buildings still standing and certain parishes are the subject of monographs by the London Survey committee.

General histories of London begin with Stow. J. Howel's *Londinopolis* (1657) is Stow's book with additions, and it is largely augmented in J. Strype's edition of 1720, a standard work, and subsequent issues. Other histories of wide scope are Maitland's *London* (1739); T. Pennant's *London* (1790); J. P. Malcolm's *Londinium Redivivum* (1803); T. Allan, *History and Antiquities of London* (1827–29); Sir W. Besant's *Survey of London* (1902–08); and notably H. P. Wheatley and Cunningham's *London Past and Present* (1891). *The Times* "Book of the City of London" (1928), by various authors, presents the results of recent scholarship. For outer London, D. Lyson's *Environs of London* (1792–1811) is authoritative, and much information is given by W. Thornbury and E. Walford's *Old and New London* and *Greater London* (1873–78).

Among recent works may be mentioned—G. H. Cunningham, *London* (1927), for buildings and historical monuments; *An Encyclopaedia of London* (1937); *New Survey of London Life and Labour* (9 vols., 1930–35); W. A. Robson, *The Government and Misgovernment of London* (1939); Sir G. Gibbon and R. W. Bell, *History of the London County Council, 1889–1939* (1939); J. M. Richards (ed.), *The Bombed Buildings of Britain* (1942), pp. 5–80. The catalogue of the Members' Library, L.C.C., vol. I, is devoted to London history and topography. The publications of the L.C.C. should be consulted. (W. G. B.; X.)

LONDON, a village of Ohio, U.S.A., 25 mi. W. by S. of Columbus; the county seat of Madison county. It is on federal highway 42 and is served by the Big Four and the Pennsylvania railways. The population in 1920 was 4,080; it was 4,141 in 1930 and 4,697 in 1940 by the federal census. London was settled about 1811.

LONDON, CONFERENCES OF. Many important international conferences have been held in London during the 19th and 20th centuries. The first, in June 1814, was the outcome of the visit of the Allied sovereigns to the prince regent after the downfall of Napoleon, the opportunity being used to effect some of the settlements agreed upon in the first treaty of Paris, notably the conditions attached to the erection of the kingdom of the United Netherlands. From 1815 onwards, too, diplomatists of the Allies accredited to Great Britain formed a conference in London for the purpose of discussing measures for the suppression of the slave trade and of the Barbary pirates.

Greece.—In 1827 a conference met in London to attempt to settle the affairs of Greece. This conference (the first international gathering to be usually thus described) met on July 12, 1827, and sat till 1832. It was attended only by the representatives of the three powers which had signed the treaty of London (July 6, 1827), *i.e.*, France, Great Britain and Russia. The treaty of London of May 7, 1832, however, which established the kingdom of Greece, with Prince Otto of Bavaria as king, was signed also by Baron de Cetto on behalf of the king of Bavaria.

Belgium.—In 1830, while this conference was still in session, the insurrection of the Belgians against the king of the Netherlands led to the summoning of another conference in London, to deal with the dangerous situation thus created. The personnel of both conferences was in part the same, both France and Russia being represented in both by their ambassadors, Talleyrand and Matuszewicz, while Palmerston, when he succeeded Aberdeen as foreign secretary, presided at the Greek conference and also, from the fourth session onwards, over that on the Belgian question. But in the latter Austria, Prussia and Holland were also represented. This conference first met on Nov. 4, 1830, and there were in all 70 sessions. After the independence of Belgium had been recognized and Leopold of Coburg had been elected king (June 4, 1831) a Belgian plenipotentiary was also admitted. On Oct. 1, 1832, Austria, Prussia and Russia having refused to agree to the French proposal to coerce the Dutch king into accepting the 24 articles embodied in the treaty of Nov. 15, 1831, the conference virtually broke up, the further proceedings being conducted by the representatives of France and Great Britain. These ended on May 21, 1833, with the signature of a convention between the two powers and Holland, providing for the non-renewal of hostilities and freedom of navigation on the Scheldt and Meuse. Thus matters remained till 1839 when, the king of Holland having at last consented to recognize the inevitable, the plenipotentiaries of all the five powers met in London to sign with those of

Holland, on April 7/19, a treaty to which the 24 Articles of Nov. 15, 1831, were annexed (*see* BELGIUM).

Schleswig-Holstein and Luxembourg.—In 1848 the war between Prussia and Denmark over the Schleswig-Holstein Question (*q.v.*) led to the assembling of an international conference in London. It met after the pressure of the Powers had forced Prussia to conclude the truce of Malmö (Aug. 26) and resulted in the peace signed at Berlin on July 2, 1850, which left the main problems unsolved. By the protocol signed on May 8, 1852, the conference settled the succession to the Danish throne and the duchies of Schleswig and Holstein on Christian of Glücksburg.

In 1864, during the war between the two great German Powers and Denmark Great Britain invited the signatories of the Protocol of 1852 to a conference in London, with a view to a settlement. The conference met on April 25, immediately after the storming of the Düppel lines; but, owing to Bismarck's skilful diplomacy, it broke up on June 25 without having effected anything.

In 1867 an important international conference met in London, at the instance of the king of the Netherlands, to deal with the situation in regard to Luxembourg created by the war of 1866 and the consequent dissolution of the old German Confederation. The conference consisted primarily of the representatives of the States signatory of the treaty of 1839, by which the status of the grand duchy of Luxembourg had been determined, *i.e.,* Austria, Belgium, France, Great Britain, Holland-Luxembourg, Prussia and Russia, but on the motion of Lord Stanley, who presided, the Italian ambassador was also invited to assist. The conference resulted in the Treaty of London of May 11, 1867, by the terms of which the Prussian troops, which had garrisoned the city of Luxembourg since 1815, were to be withdrawn and the fortress demolished. On the motion of the Prussian plenipotentiary, Count Bernstorff, a clause was introduced placing the neutrality of Luxembourg under the guarantee of the signatory Powers.

Russia.—In 1871, during the Franco-German War, the denunciation by Russia of the Black Sea clauses of the Treaty of Paris of 1856 led to the assembling of a conference in London, in order to regularize the situation thus created by a revision of the treaty of 1856, so far as regarded the neutralization of the Black sea, the Straits of the Dardanelles and Bosphorus, and the navigation of the Danube. The conference, which sat from January to March, and was attended by the representatives of North Germany, Austria-Hungary, Great Britain, Italy, Russia and Turkey, while revising the treaty in accordance with Russia's wishes, asserted the principle of the inviolability of treaties (*see* TREATIES).

Treaty of Berlin.—In 1883 a conference sat in London (Feb. 8–March 10) to consider the execution of Arts. 54 and 55 of the Treaty of Berlin of July 13, 1878, concerning the navigation of the Danube (*q.v.*). It was attended by representatives of all the Powers which had signed the Berlin treaty, and those of the other riverain States (*i.e.,* Serbia and Rumania) which had not signed the treaty were invited to attend, but without a deliberative voice. Bulgaria, as a vassal state, was represented by the Turkish delegate. Rumania refused to accept these conditions, but the Serbian plenipotentiary attended the sessions.

Egypt.—In 1885 a conference between the great Powers and Turkey was held in London to deal with the situation arising out of the financial crisis in Egypt. The result was the signature, in March, of what is known as the London Convention, the terms of which were embodied in a khedivial decree and, with some modifications, remained for 20 years the organic law governing the administration of the finances of Egypt (*q.v.*).

In 1887, in response to an invitation issued by the British Government on July 2, an international conference met in London to deal with the question of sugar bounties. The debates led up to the convention of Aug. 30, 1888, which was signed by all the representatives except the French. It was, however, never ratified.

Naval Conference.—In 1908, at the invitation of the British Government an international naval conference met in London to attempt a settlement of those questions regarding contraband, blockade, etc., which had been raised at the second Hague Conference. The conference met on Dec. 4, 1908 and continued in session until Feb. 26, 1909, the outcome of its labours being the Declaration of London. This Declaration was never ratified.

The Balkans.—In 1912 and 1913 conferences were held in London to arrange terms of peace between Turkey and the Allied Balkan States, Bulgaria, Greece, Montenegro and Serbia. The conference, which was attended by representatives of the belligerent states, was opened on Dec. 16, 1912, by the British foreign secretary, but was suspended without result on Jan. 6. It met again on May 30, 1913, the outcome being the Treaty of London signed on the same day. The conference was dissolved on June 9, and its work was rendered abortive by the outbreak, immediately afterwards, of the second Balkan war.

Post-war Conferences.—In 1921–1922 four conferences of Allied statesmen were held in London, to adjust matters arising out of the peace treaties which ended the World War. The first met from Feb. 21 to March 14, 1921, and carried on alternately two sets of negotiations, one with the Athens, Constantinople and Angora Governments on the near Eastern question (*see* TURKEY), the other with the German Minister for Foreign Affairs, Dr. Simons, on the subject of reparations. The result in both cases was failure. The conference was hardly over before the Greeks launched a new offensive against the Turkish Nationalists, while the unacceptable counter-proposals made by Dr. Simons to the demands put forward by the Allies at the Paris Conference of Jan. 24–30 led, early in March, to fresh sanctions being taken against Germany (occupation of Düsseldorf, etc.).

On April 29 the Allied statesmen, after a preliminary meeting at Lympne on the 23rd and 24th, met again in London to decide what was to be done in view of the expected default of Germany in the matter of the payment of the first installment of reparations due, under Art. 235 of the Treaty of Versailles, on April 30. New sanctions against Germany were discussed. But the Reparations Commission having on April 27 declared an estimate of Germany's total liability, the Allied statesmen made this the basis of a "schedule of Payments describing the Time and Manner for securing and discharging the entire Obligation of Germany for Reparation under Articles 231, 232 and 233 of the Treaty of Versailles." This document was sent to Berlin on May 5, with an ultimatum, and on the 11th the German Government accepted the Allies' terms.

In 1922, owing to the failure of the German Government to carry out the above agreement, the Allied statesmen again met in conference in London, from Aug. 7 to Aug. 14. At this meeting M. Poincaré, as conditions precedent to granting Germany a moratorium, put forward proposals for "productive guarantees," which he attempted to carry out after the Franco-Belgian occupation of the Ruhr district in 1923. An irreconcilable difference of opinion having arisen as to the effectiveness of such measures, the conference broke up without reaching any decision. The conference held in London later in the year for the same purpose met with no better result. At this meeting, which lasted from Dec. 9 to Dec. 11, M. Poincaré again put forward his proposal for "productive guarantees." As in this matter, as in other respects, no agreement could be reached between the French and British representatives, the conference was adjourned (*see* REPARATIONS).

(W. A. P.)

LONDON AND NORTH EASTERN RAILWAY COMPANY, THE, is the second largest railway company in Great Britain, incorporating the former Great Central, Great Eastern, Great Northern, Hull and Barnsley, North Eastern, North British and Great North of Scotland companies. It has a total mileage of 6,349 miles which covers the whole of eastern England, and East and West Scotland between the Thames and Moray Firth.

High speed streamlined trains run as follows: "Coronation"—London (King's Cross) and Edinburgh (6 hours); "Silver Jubilee"— London (King's Cross) and Newcastle (4 hours); "West Riding Limited"—London (King's Cross) and Leeds and Bradford. Restaurant car expresses, including the "Flying Scotsman", run between London (King's Cross) and the North of England and Scotland; London (Marylebone) and the Midlands and Liverpool; London (Liverpool Street) and the Eastern Counties. Sleeping car services operate between London (King's Cross) and the North of England and Scotland. Fast freight services operate between most stations on the system.

The company employs approximately 170,000 people, owns 2,500 stations and goods depots, and is the largest dock owning railway company in the world. Its property includes docks at Grimsby, Immingham, Hull, Middlesbrough, the Hartlepools, Silloth, Burntisland, Methil, Alloa and Bo'ness.

The company's rolling stock includes 6,500 locomotives, 20,000 passenger vehicles, and 260,000 goods and mineral wagons. Its annual traffic figures are 262,000,000 passengers, 101,000,000 tons of merchandise and minerals, and 2,750,000 head of livestock.

The London and North Eastern Railway also owns 33 steamships and operates services between Harwich and Hook of Holland, Antwerp and Zeebrugge and is associated with the operation of services between Humber and Continental ports. Three train ferries are worked between Harwich and Zeebrugge. (G. Do.)

LONDONDERRY, EARLS AND MARQUESSES OF. The 1st earl of Londonderry was Thomas Ridgeway (*c.* 1565–1631), a Devon man, who was treasurer in Ireland from 1606 to 1616 and was engaged in the plantation of Ulster. Ridgeway was made a baronet in 1611, Baron Ridgeway in 1616 and earl of Londonderry in 1623. The Ridgeways held the earldom until March 1714, when Robert, the 4th earl, died without sons. In 1726 Robert's son-in-law, Thomas Pitt (*c.* 1688–1729), son of Thomas Pitt, "Diamond Pitt," governor at Madras and uncle of the great earl of Chatham, was created earl of Londonderry, the earldom again becoming extinct when his younger son Ridgeway, the 3rd earl of this line, died unmarried in Jan. 1765. In 1796 Robert Stewart (1739–1821), of Mount Stewart, Co. Down, was made earl of Londonderry in the Irish peerage. He had been created Baron Londonderry in 1789 and Viscount Castlereagh in 1795; in 1816 he was advanced to the rank of marquess of Londonderry. The 3rd marquess married the heiress of the Vane-Tempests and took the name of Vane instead of Stewart; the 5th marquess called himself Vane-Tempest and the 6th marquess Vane-Tempest-Stewart.

LONDONDERRY, CHARLES STEWART HENRY VANE-TEMPEST-STEWART, 7TH MARQUESS OF (1878–), British statesman, born in London on May 13, 1878, was the son of Charles Stewart Vane-Tempest-Stewart (b. 1852, *see* LONDONDERRY, CHARLES WILLIAM STEWART [VANE]). Educated at Eton and Sandhurst, he entered the House of Commons in 1906 as Unionist member for Maidstone. From 1914–19 he served in the World War, being twice mentioned in despatches. Made a privy councillor for Ireland in 1918 and a K.G. in 1919, in 1920–21 he was under-secretary for air, and minister of education for Northern Ireland, 1921–26. He was first commissioner of works, 1928–29 and 1931, and air minister from 1931 to 1935, in which year he was leader of the House of Lords.

LONDONDERRY, CHARLES WILLIAM STEWART (VANE), 3RD MARQUESS OF (1778–1854), British soldier and diplomatist, was the son of the 1st marquess by a second marriage with the daughter of the 1st Earl Camden. He entered the army and served in the Netherlands (1794) on the Rhine and Danube (1795), in the Irish rebellion (1798), and Holland (1799), rising to be colonel. He was elected M.P. for Kerry and became under-secretary for war under his half-brother Castlereagh in 1807. In 1808 he was given a cavalry command in the Peninsula. In 1809, and in the campaigns of 1810–1811, as major-general, he served under Wellington in the Peninsula as his adjutant-general, and was at the capture of Ciudad Rodrigo, but at the beginning of 1812 he was invalided home. Castlereagh (*see* LONDONDERRY, ROBERT STEWART) then sent him to Berlin as minister, to represent Great Britain in the allied British, Russian and Prussian armies and he played an important part in the subsequent fighting, while ably seconding Castlereagh's diplomacy. In 1814 he was made a peer as Baron Stewart, and later in the year was appointed ambassador at Vienna, and was a member of the important congresses which followed. In 1822 Castlereagh's death made him 3rd marquess of Londonderry, and shortly afterwards, disagreeing with Canning, he resigned, being created Earl Vane (1823), and for some years lived quietly in England. In 1835 he was for a short time ambassador at St. Petersburg. In 1852, after the death of Wellington, he received the order of the Garter. He died on March 6, 1854. He was twice married, first in 1808 to the daughter of the earl of Darnley, and secondly in 1819 to the heiress of Sir Harry Vane-Tempest, when he assumed the name of Vane. Frederick William Robert (1805–72), his son by the first marriage, became 4th marquess; and on the latter's death in 1872, George Henry (1821–84), the eldest son by the second marriage, after succeeding as Earl Vane (according to the patent of 1823), became 5th marquess. In 1884 he was succeeded as 6th marquess by his son Charles Stewart Vane-Tempest-Stewart (1852–1915), a prominent Conservative politician, who was viceroy of Ireland (1886–89), chairman of the London School Board (1895–97), postmaster-general (1900–02), president of the Board of Education (1902–05) and lord president of the Council (1903–05). He was a prominent leader of the opposition to the Home Rule Bill of 1912, and was one of the first to sign the Ulster Covenant, Sept. 28, 1912. He died at Stockton-on-Tees, on Feb. 8, 1915.

LONDONDERRY, ROBERT STEWART, 2ND MARQUESS OF (1769–1822), British statesman, was the eldest son of Robert Stewart of Ballylawn Castle, in Donegal, and Mount Stewart in Down, an Ulster landowner, of kin to the Galloway Stewarts, who became baron, viscount, earl and marquess in the peerage of Ireland. The son, known in history as Lord Castlereagh, was born on June 18, in the same year as Napoleon and Wellington. His mother was Lady Sarah Seymour, daughter of the earl of Hertford. He went from Armagh school to St. John's College, Cambridge, but left at the end of his first year. With Lord Downshire, then holding sway over the County Down, Lord Stewart had a standing feud, and he put forward his son, in July 1790, for one of the seats. Young Stewart was returned, but at a vast cost to his family, when he was barely twenty-one. He took his seat in the Irish House of Commons at the same time as his friend, Arthur Wellesley, M.P. for Trim, but sat later for two close boroughs in England, still remaining member for Down at College Green.

From 1796, when his father became an earl, he took the courtesy title of Viscount Castlereagh, and becoming keeper of the privy seal in Ireland, he acted as chief secretary, during the prolonged absence of Pelham, from February 1797. Castlereagh's conviction was that, in presence of threatened invasion and rebellion, Ireland could only be made safe by union with Great Britain. In Lord Camden, as afterwards in Lord Cornwallis, Castlereagh found a congenial chief. Though his favour with these statesmen was jealously viewed both by the Irish oligarchy and by the English politicians who wished to keep the machine of Irish administration in their own hands. Pitt was doubtful of the expediency of making an Irishman chief secretary, but his view was changed by the influence of Cornwallis. In suppressing Lord Edward Fitzgerald's conspiracy, and the rebellion which followed in 1798, Castlereagh's vigilance and firmness were effective. The various forces which feared the consequence of the Union, coalesced against him in Dublin. Even there Castlereagh, though defeated in a first campaign (1799), impressed Pitt with his ability and tact. With Cornwallis he joined in holding out, during the second Union campaign (1800), the prospect of emancipation to the Roman Catholics.

When the Act of Union was carried through the Irish parliament, in the summer of 1800, Castlereagh's official connection with Ireland practically ended. Before the Imperial Parliament met he urged upon Pitt the measures which he and Cornwallis thought requisite to make the Union effective. But the king flatly refused to sanction emancipation, and Pitt and his cabinet made way for the Addington administration. Thereupon Castlereagh resigned, with Cornwallis. He took his seat at Westminster for Down, the constituency he had represented for ten years in Dublin. The leadership of an Irish party was offered to him, but he declined so to limit his political activity. His father accepted, at Portland's request, an Irish marquessate, on the understanding that in the future he or his heirs might claim the same rank in the Imperial legislature; so that Castlereagh was able to sit in the

House of Commons as Marquess in 1821–22.

In 1802, Castlereagh, at Pitt's suggestion, became president of the Board of Control in the Addington cabinet. He had, though not in office, taken charge of Irish measures under Addington, including the repression of the Rebellion Bill, and the temporary suspension of the Habeas Corpus in 1801, and he continued to advocate Catholic relief, tithe reform, state payment of Catholic and dissenting clergy and "the steady application of authority in support of the laws." To Lord Wellesley's Indian policy he gave a staunch support, warmly recognized by the governor-general. On Pitt's return to office (May 1804), Castlereagh retained his post, and, next year, he took over the duties of secretary for war and the colonies. His house became a meeting-place of the party; and his influence in parliament grew. After Pitt's death his colleagues failed to form a cabinet able to face the combination known as "All the Talents," and Castlereagh acquiesced in the resignation. But to the foreign policy of the Fox-Grenville ministry and its conduct of the war he was always opposed.

In 1807 Castlereagh returned to the War Office under Portland, but grave difficulties arose, though Canning at the Foreign Office was then thoroughly at one with him. The operations to avert the ruin of the coalition at Friedland came too late. The Tsar Alexander believed that England would no longer concern herself with the Continental struggle, and Friedland was followed by Tilsit. The seizure of the Danish squadron at Copenhagen, and the measures taken to rescue the fleets of Portugal and Sweden from Napoleon, crushed a combination as menacing as that defeated at Trafalgar. The expedition to Portugal, though Castlereagh's influence was able only to secure Arthur Wellesley a secondary part at first, soon dwarfed other issues. In the debates on the Convention of Cintra, Castlereagh defended Wellesley against parliamentary attacks. Early in 1809, Castlereagh secured his friend's appointment as commander-in-chief of the second Portuguese expedition.

Disagreement with Canning.—Meanwhile a breach arose between Castlereagh and Canning. Canning was not openly opposed to the Walcheren expedition, and on the Peninsular question he mainly differed from Castlereagh and Wellington in fixing his hopes on national enthusiasm and popular uprisings. Castlereagh's proposal of action in the Netherlands was for a *coup de main*, under strict conditions of celerity and secrecy, as Antwerp was unable to make any adequate defence. But the expedition, planned at the end of March, did not reach Walcheren till the end of July 1809; and more time was lost, until sickness in the army necessitated its withdrawal in September. Public opinion threw the whole blame upon Castlereagh, who then found that his colleagues had determined on his removal six months earlier. Castlereagh held himself justified in sending a challenge to the original author, as he held, of a disloyal intrigue against a colleague. In the subsequent duel Canning was wounded and the rivals simultaneously resigned. Though Wellington's retreat after Talavera had been included, with the disasters of the Corunna and Walcheren campaigns, in the censures on Castlereagh, and though ministers were often depressed and doubtful, Castlereagh never lost faith in Wellington's genius. Lord Wellesley's resignation in 1812, when the Whigs failed to come to terms with the regent, led to Castlereagh's return to office as foreign secretary (March 1812). The assassination of Percival soon threw upon him the leadership of the House of Commons, and this double burden he continued to bear during the rest of his life.

The Duel with Napoleon.—From March 1812 to July 1822 Castlereagh's biography is, in truth, the history of England. He set himself at once to meet Napoleon's designs in northern Europe, where Russia was preparing for her life-and-death struggle. Castlereagh wisely rejected Napoleon's insincere overtures for peace. After the Moscow *débâcle* Napoleon's fate was affected not only by Wellington's progress in Spain, but by the attitude of the northern powers and by the action of Turkey, due to Castlereagh's opportune disclosure to the Porte of the scheme of partition at Tilsit. The British subsidies to the Allies were largely increased as the operations of 1813 developed, but all Castlereagh's skill was needed to keep the Coalition together. The Allied powers were willing, even after Leipzig, to treat with France on the basis of restoring her "natural frontiers"—the Rhine, the Alps and the Pyrenees; but Castlereagh protested. Early in 1814 his colleagues, who needed him in the House of Commons, reluctantly consented to his visit to the allied headquarters. The Great Alliance showed signs of weakness and division. Austria was holding back; Prussia had almost broken away; above all, the ambiguous conduct of Alexander bred alarm and doubt. Napoleon's military genius, confronting a hesitant and divided enemy, was at its best. Castlereagh strove to keep the Allies together, to give no excuse for those separate arrangements upon which Napoleon was reckoning, to assert no selfish policy for England, to be tied by no theoretical consistency. At the Châtillon conferences England was represented by others, but Castlereagh was present with supreme authority over all. He declined to commit his country either to a blank refusal to negotiate with Napoleon or to the advocacy of a Bourbon restoration. He insisted on the return of France within her ancient limits as the basis of a settlement. Even before the Châtillon conference was dissolved (March 18), Castlereagh saw that Caulaincourt's efforts would never bend Napoleon's will. The Allies adopted his view and signed the treaty of Chaumont (March 1), "my treaty," as Castlereagh called it, with an unusual touch of personal pride. At Bar-sur-Aube, when at a council of all the representatives of the powers the retreat of the allied armies was discussed, Bernadotte, playing a waiting game in Holland, was unwilling to reinforce Blücher, then in a dangerous position, by the Russian and Prussian divisions of Winzingerode and Bülow, temporarily placed under his orders. Castlereagh, without consulting the Cabinet at home, threatened the withdrawal of the British subsidy. Bernadotte gave in. Blücher was reinforced by the two divisions; the battle of Laon was fought and won, and the allies occupied the French capital. In April 1814 Castlereagh arrived in Paris. He did not like Napoleon's position at Elba, close to the French coast, and he summoned Wellington from the south to the embassy in Paris.

His appointment as British representative at Vienna, where the congress was to meet in September, was foreseen. At Vienna he realized at once that the ambition of Russia might be as formidable to Europe and to Great Britain as that of Napoleon. His aim had been to rescue Europe from military domination; and when he realized the ambitions of Russia and Prussia, he did not hesitate to take a new line. He brought about the secret treaty (Jan. 3, 1815) between Great Britain, Austria, and France, directed against the plans of Russia in Poland and of Prussia in Saxony. Through Castlereagh's efforts, the Polish and Saxon questions were settled on the basis of compromise. The threat of Russian interference in the Low Countries was dropped.

Castlereagh had come home for a short visit (Feb. 1815), at the urgent request of the cabinet, just before Napoleon escaped from Elba. The shock revived the Great Alliance under the compact of Chaumont. Napoleon promptly published the secret treaty which Castlereagh had concluded with Metternich and Talleyrand. But Russia and Prussia, though much displeased, dared not weaken the Alliance. British subsidies were again poured out like water. After Waterloo, Castlereagh successfully urged Napoleon's removal to St. Helena.

Peace and the Holy Alliance.—Some of the continental powers demanded fines and cessions that would have crushed France; but in November a peace was finally concluded, mainly by Castlereagh's endeavours, minimizing the penalties exacted, and abandoning on England's part the whole of her share of the indemnity. Castlereagh's policy, impressed upon British representatives abroad, was "to turn the confidence Great Britain inspired to the account of peace, by exercising a conciliatory influence in Europe." Brougham's action, at the end of 1815, denouncing the Holy Alliance, even in its early form, was calculated to embarrass England, though she was no party to what Castlereagh described as a "piece of sublime mysticism and nonsense."

While he saw no reason in this for breaking up the Grand Alliance, which he looked upon as a convenient organ of diplomatic intercourse and as essential for the maintenance of peace, he agreed with Wellington that to attempt to crush France, as the Prussians desired, or to keep her in a perpetual condition of tutelage under a European concert from which she herself should be excluded, would be to invite the very disaster which it was the object of the Alliance to avoid. It was not till Metternich's idea of extending the scope of the Alliance, by using it to crush "the revolution" wherever it should raise its head, began to take shape, from the conference of Aix-la-Chapelle (1818) onward, that Great Britain's separation from her continental allies became inevitable. Against this policy of the reactionary powers Castlereagh from the first vigorously protested. As little was he prepared to accept the visionary schemes of the emperor Alexander for founding an effective "confederation of Europe" upon the inclusive basis of the Holy Alliance (*see* ALEXANDER I. of Russia).

Home Politics.—Meanwhile financial troubles at home, complicated by the resumption of cash payments in 1819, led to acute social tension. "Peterloo" and the "Six Acts" were furiously denounced. Throughout, Castlereagh maintained his ascendancy in the House of Commons, though he had few colleagues who were capable of standing up against Brougham. Canning, indeed, had returned to office and had defended the "Six Acts," but Castlereagh bore the whole burden of parliamentary leadership, as well as the responsibilities of the Foreign Office. In 1821, on Sidmouth's retirement, he assumed the duties of the Home Office. The policy of "intervention," with which Great Britain had consistently refused to identify herself, had been proclaimed to the world by the famous Troppau Protocol, signed by Russia, Austria and Prussia (*see* TROPPAU, CONGRESS OF). The immediate occasion was the revolution at Naples, where the egregious Spanish constitution of 1812 had been forced on the king by a military rising. Castlereagh was prepared to allow the intervention of Austria, if she considered her rights under the treaty of 1813 violated, or her position as an Italian Power imperilled. But he protested against the general claim, embodied in the Protocol, of the European powers to interfere, uninvited, in the internal concerns of sovereign states.

THE EASTERN QUESTION

To Troppau, accordingly, no British plenipotentiary was sent, since the outcome of the conferences was a foregone conclusion; though Lord Stewart came from Vienna to watch the course of events. At Laibach an attempt to revive the Troppau proposals was defeated by the firm opposition of Stewart; but a renewal of the struggle at Verona in the autumn of 1822 was certain. Castlereagh, now marquess of Londonderry, was again to be the British representative, and he drew up for himself instructions that were handed over unaltered by Canning, his successor at the Foreign Office, to the new plenipotentiary, Wellington. In the threatened intervention of the continental powers in Spain, as in their earlier action towards Naples and Sardinia, England refused to take part. The Spanish revolutionary movement, Castlereagh wrote, "was a matter with which, in the opinion of the English cabinet, no foreign power had the smallest right to interfere." Before, however, the question of intervention in Spain had reached its most critical stage the development of the Greek insurrection against the Ottoman government brought up the Eastern Question in an acute form, which profoundly modified the relations of the powers within the Alliance, and again drew Metternich and Castlereagh together in common dread of an isolated attack by Russia upon Turkey. A visit of King George IV. to Hanover, in October 1821, was made the occasion of a meeting between Castlereagh and Metternich, with whom he joined in taking advantage of the emperor Alexander's devotion to the principles of the Alliance to prevent his taking an independent line in the Eastern Question. It was, indeed, the belief that this question would be discussed at the congress that led Castlereagh to agree to be present at Verona; and in his *Instructions* he foreshadowed the policy afterwards carried out by Canning, pointing out that the development of the war had made the recognition of the belligerent rights of the Greeks inevitable, and quoting the precedent of the Spanish American colonies as exactly applicable.

The Tragic End.—The tragic ending of Castlereagh's strenuous life was near; and the credit of carrying out the policy foreshadowed in the *Instructions* was to fall to Canning. During the session of 1822 Wellington warned Dr. Bankhead that Castlereagh was unwell, and, perhaps, mentally disordered. Bankhead went down to North Cray and took due precautions. Castlereagh's razors were taken away, but a penknife was forgotten in a drawer, and with this he cut his throat (Aug. 12, 1822). The testimony of statesmen of all parties to Castlereagh's gifts and charm is in strong contrast with the flood of calumny poured out upon his memory by those who knew him not.

BIBLIOGRAPHY.—Castlereagh's correspondence and papers were published by his brother and successor (1850–53) in 12 volumes. *See* also Sir Archibald Alison's *Biography* (3 vols., 1861); and lives by Lady Londonderry 1904, and A. Hassall (1909). For an account of his post-war diplomacy *see* C. K. Webster, *The Foreign Policy of Castlereagh 1815–22* (1925).

LONDONDERRY, a county of Northern Ireland, bounded north by the Atlantic, west by Lough Foyle and Donegal, east by Antrim and Lough Neagh, and south by Tyrone. The area is 523,432 acres, or 817.9 sq.mi. Pop. (1937) exclusive of Londonderry county borough is 94,923. Old Red sandstone and Lower Carboniferous sandstone overlie old rocks in the south and east, meeting the igneous "green rocks" of Tyrone, and the granite intrusive in them, at the north end of Slieve Gallion. Triassic sandstone covers the lower slope of Slieve Gallion on the south-east towards Moneymore, and rises above the Carboniferous sandstone from Dungiven northward. At Moneymore the western scarp of the White Limestone (Chalk) and the overlying basalt of the great plateaus dip down eastward under Lough Neagh. The basalt scarp, protecting chalk and patches of Liassic and Rhaetic strata, rises to 1,260 ft. in Benevenagh north of Limavady. A raised shelf with post-glacial marine clays forms the flat land west of Limavady. Haematite has been mined on the south flank of Slieve Gallion. The principal river is the Roe, which flows northward from the borders of Tyrone into Lough Foyle below Newton-Limavady. Farther west the Faughan also falls into Lough Foyle, and the river Foyle passes through a small portion of the county near its north-western boundary. In the south-east the Moyola falls into Lough Neagh, and the Lower Bann from Lough Neagh forms for some distance its eastern boundary with Antrim. The only lake in the county is Lough Finn on the borders of Tyrone, but Lough Neagh forms about 6 mi. of its south-eastern boundary. Castlerock, Downhill, Magilligan and Portstewart are seaside resorts.

Early inhabitants were the O'Cathans or O'Catrans, who were tributary to the O'Neills. Towards the close of the reign of Elizabeth the county was seized and received the name of Coleraine, having that town for its capital. In 1609, after the confiscation of the estates of the O'Neills, the citizens of London obtained possession of the towns of Londonderry and Coleraine and adjoining lands, 60 acres out of every 1,000 being assigned for church lands. The common council of London elected a body of twenty-six for its management, who in 1613 were incorporated as the Irish Society, and retained possession of the towns of Londonderry and Coleraine. Their estates were sequestrated by James I, and in 1637 the charter of the Irish Society was cancelled. Cromwell restored the society to its former position, and Charles II granted it a new charter. In the insurrection of 1641 many towns and villages were burned. There are several stone circles, and a large number of artificial caves. The horned cairn at Ballybriest is 100 ft. long by 50 ft. broad. Of the castles erected by the English, those of Dungiven and Muff are largely reconstructed. The ruins of Dungiven Priory, founded *c.* 1100, are notable as containing perhaps the most beautiful sepulchral monument in Ulster, that to an O'Cahan chieftain.

The excessive rainfall and the cold and uncertain climate are unfavourable for agriculture. Along the seacoast there is a district of red clay formed by the decomposition of sandstone, and near the mouth of the Roe is a tract of marl. The staple manufacture of the county is linen. The manufacture of coarse earthenware is also carried on, and there are large distilleries and breweries and some saltworks. Coleraine is the headquarters for salmon and eel fisheries on the Bann. The deep-sea and coast fisheries are centred at Moville in Co. Donegal. The city of Londonderry is an important railway centre. The L.M.S.R. (N.C.C.) main line reaches it by way of Coleraine and the north coast of the county, and the same railway serves the eastern part of the county. The Great Northern railway reaches Londonderry from the south, and the city is also the starting point of the Londonderry and Lough Swilly railway. The county contains one county and one municipal borough and two urban and four rural districts, as well as four Poor Law unions. Londonderry (including borough of Londonderry) returns 5 members to the parliament of Northern Ireland and 1 member to the United Kingdom parliament.

LONDONDERRY or DERRY, a city, county and parliamentary borough, and the chief town of Co. Londonderry, Northern Ireland, 4 mi. from the junction of the river Foyle with Lough Foyle, and 95 mi. N.N.W. of Belfast. Pop. (1937) 47,813. Area, 3.44 sq.mi. Derry, the original name of Londonderry, is derived from *Doire,* the "place of oaks." It owes its origin to the monastery founded by Columba about 546. With the bishopric which arose in connection with this foundation, that of Raphoe was amalgamated in 1834. From the 9th to the 11th century the town was frequently taken by the Danes, but they were finally driven from it by Murtagh O'Brien about the beginning of the 12th century. In 1311 it was granted by Edward II to Richard de Burgh. After the Irish Society of London obtained possession of it, it was incorporated in 1613 under the name of Londonderry. The fortifications, begun in 1600, were completed in 1618. In 1688 Derry had become the stronghold of the Protestants of the north. In April 1689 it was besieged by the forces of James II but was relieved in July.

The city stands on an eminence rising abruptly from the west side of the river to a height of about 120 ft. It is surrounded by an ancient rampart about a mile in circumference, having seven gates and several bastions, but buildings extend beyond this boundary and across the river, over which is the Craigavon road and railway bridge, opened in 1933 and the largest in Ulster, being 1,200 ft. long by 40 ft. wide. The summit of the hill, at the centre of the town, is occupied by a quadrangular area, known as the Diamond, from which the main streets diverge. Some old houses with high pyramidal gables remain but are much modernized. The Protestant cathedral of St. Columba, in Perpendicular style (1633), was enlarged and restored in 1887. The spire was rebuilt in 1802. The bishop's palace (1716) occupies the site of the abbey founded by Columba. The abbot of this monastery, on being made bishop, erected in 1164 Temple More or the "Great Church," one of the finest buildings in Ireland previous to the Anglo-Norman invasion. It was demolished in 1600. There is a Roman Catholic cathedral (*c.* 1870) dedicated to St. Eugenius. Educational establishments include Magee University college (1865), formerly M'Crea Magee college, the first in Ireland to admit women. It was affiliated to Dublin University in 1909. Foyle college, a boys' school, dates from 1617. About 5 mi. W. of the city is the Grianan of Aileach, consisting of three concentric ramparts and an interior fortification of stone.

The staple industry of Londonderry is the manufacture of shirts and collars, and there are also iron foundries, sawmills, box and yeast factories; while pork curing, biscuitmaking and shipbuilding are carried on. The borough returns one member to the United Kingdom parliament and two members to that of N. Ireland. The salmon fishery on the Foyle is valuable.

LONDON GENERAL OMNIBUS CO., LTD. This British joint stock company was founded in Paris in 1855 and commenced operations in London in 1856. The passing of the Stage Carriage Act of 1832 had produced a boom in omnibus business and led to a congestion of many services. The London General Omnibus Co., Ltd., purchased 600 of the omnibuses in service and paid the proprietors £250,000 for the right to work them on the established routes. A scheme of fare reduction and extended service was at once initiated and a prize of £100 was offered for an improved new type of omnibus, which was promptly nicknamed the "knifeboard" owing to the arrangement of its outside seats. In 1880 the London Road Car company began work and introduced omnibuses with the so-called garden seats; the removal of the staircase to the rear of this type of omnibus marks the inception of the modern omnibus. It was not until 1904 that the first motor omnibus of the London General Omnibus Co., Ltd., was licensed to work between Kennington and Victoria. In 1908 the London General Omnibus Co., Ltd., was amalgamated with the London Road Car company and the Vanguard company.

The London General Omnibus Co., Ltd., still continued to run horse-drawn omnibuses, the maximum number of these vehicles operated being 1,418 in 1905, with a stud of nearly 18,000 horses. The last horse-drawn omnibus operated between London bridge and Moorgate street until Oct. 1911.

In Jan. 1912 the company passed under the control of the Underground Electric Railways Company of London, Ltd. From then onwards, the company began operating the omnibuses of other companies, the Metropolitan Steam Omnibus Co., Ltd., from Oct. 1912; Tramways (M.E.T.) Omnibus company from Jan. 1913, the Gearless Motor Omnibus Co., Ltd., from April 1913 and the Southern from Aug. 1913. Working arrangements were entered into with many other companies, and in 1926, the company acquired an interest in the small independent concerns which had begun work in 1922.

Under the powers conferred by the London Electric Railway Facilities Act of 1915, an agreement was entered into by the company with the City and South London, Central London, London Electric and Metropolitan District railways as to the payment into a common fund after meeting revenue liabilities of any surplus which might remain. In 1933 the company was merged in the London Passenger Transport Board. (L. C. M.)

LONDON MIDLAND AND SCOTTISH RAILWAY, British railway company, was formed on Jan. 1, 1923, by amalgamation, under the Railways Act of 1921, of the London and North Western, Midland, Lancashire and Yorkshire, Caledonian, and Glasgow and South Western and other railway companies. The system includes the Liverpool and Manchester Railway upon which in 1829 the famous "Rocket" demonstrated the practicability of the steam locomotive and originated the modern railway. The capital expenditure of the company amounts to £459,000,000 and it owns 6,842 mi. of line, the total length of track including sidings being 19,246 mi., serving 5,300 stations and 3,700 connections with private sidings of traders. Its working stock includes 7,600 locomotives, 24,000 carriages and 280,000 wagons, and on road services it employs 3,500 motor vehicles and 7,400 horses with 18,200 vehicles. Other assets include 40 steamers, 25 docks with quays upwards of 92,000 ft. in length, 535 mi. of canals and 29 hotels. Extending from London by two main lines through the industrial area of England to the extreme north of Scotland it is the largest of the British railways and in 1938 carried 434,000,000 passengers, 124,000,000 tons of goods and minerals and 5,500,000 head of livestock, representing approximately 7,500,000,000 passenger miles and 6,800,000,000 ton miles. The net revenue from all sources in 1938 amounted to 11,000,000 pounds, and this distributed to 323,000 stockholders represented an average return of 2.63% upon the capital invested by them. The number of employees of all grades was 233,000 in 1938, their remuneration being 41,000,000 pounds.

Recent developments include streamlining of locomotives, softening of water for locomotive purposes, colour light signalling, electrification of the Wirral Railway, provision of Scientific Research Laboratory and Staff College at Derby, co-operation with Omnibus and other Road Transport companies, operation of Air Services in conjunction with other main line companies.

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LONDON NAVAL CONFERENCE, 1930, THE. The work of limitation of naval armaments has advanced slowly since the close of World War I. The first real achievement came at the Washington Conference of 1921–22, where the five principal Naval Powers, who eight years later were to meet in London, conferred. There they succeeded in setting limits to the total displacement tonnages of the categories of capital ships and aircraft-carriers to be possessed by each of them on a certain date, and also in establishing a maximum unit tonnage, gun calibre and age limit for vessels in each of these categories. When the delegates endeavoured to agree concerning the limitation of smaller fighting vessels—cruisers, destroyers and submarines—they failed. The building of these categories was left unrestricted, except that a maximum unit tonnage and gun calibre for cruisers was fixed.

The failure to reach an agreement on auxiliary craft was due mainly to the difficulty of settling on tonnage figures in the various categories acceptable to all the five Powers. But it became evident in subsequent discussions (which came to a head at the meetings of the Preparatory Disarmament Commission at Geneva early in 1927) that the difference of opinion between the naval powers was not simply one on the particular figures which should be entered for each of them in a programme limiting every category of ship, but also on the general principles on which that programme should be constructed. The French, supported by the Italians, advocated limitation by "global tonnage", meaning that only the tonnage for the whole of a fleet should be limited, and that within this total a Power could allot what tonnage it liked to each category. The British, with the support of the United States representatives, urged that not only should the maximum total tonnage for each fleet be fixed, but that it should be agreed how this total was to be divided between the categories.

There were thus two major problems left unsolved by the Washington Treaty and subsequent discussions, and they were still unsettled when the Powers met in London in January 1930. There was the issue of the general principle on which limitation programmes should be constructed and the question of agreeing, whatever principle was adopted, on actual figures for limiting the building of auxiliary craft.

Between March 1927 and 1929 there were separate attempts at solving, at least partially, each of these problems. First the British Empire, the United States and Japan endeavoured at the Three Power Conference in Geneva late in 1927 to reach an agreement on actual figures for the limitation of every class of fighting ship in their own navies. Their discussions failed, because the United States and the British Empire could not agree about cruisers. The root of their trouble was that whereas the need of the former was for 10,000 ton cruisers mounted with 8 inch guns (the maximum permitted under the Washington Treaty) the latter required a larger number of smaller cruisers armed with 6 inch guns. The two Powers had agreed in the most friendly spirit that parity should exist between them, but could not discover a strict mathematical equality in cruiser strengths which would give each of them different numbers of different kinds of ships. This Anglo-American cruiser problem was a difficult obstacle to a complete agreement which the discussions immediately preceding and at the London Conference had to clear away.

Secondly, after the breakdown of the Geneva Conference there were conversations in particular between Great Britain and France with a view to reaching an agreement on the "global" versus "category" tonnages controversy. This resulted in the ill-fated Anglo-French compromise proposals of 1928. These were virtually dead from the moment it became known that they were unacceptable to the United States Government. They were rejected in Washington principally because they proposed restrictions in the building of cruisers carrying 8 inch guns but not of cruisers armed with smaller guns. As the former was the type required by the United States, their Government could not consent to the limitation of this type whilst no limit was set to ships more useful to other Powers.

These failures were a serious set-back to the movement for Naval limitation. Above all they led to strained relations between the United States and Great Britain, when confidence and co-operation between them, as being the two principal Naval Powers, were essential to the work. Their differences were still on the cruiser problem, and it was clearly of vital importance that the matter should be settled between them before there was any hope of tackling successfully the two other outstanding questions between the five Powers. That was the position when Mr. Hoover became President of the United States.

This sketch of the history of the problem is essential to an understanding of what the negotiations preceding and during the Naval Conference achieved.

The Yard Stick.—A way out of the Anglo-American difficulty was indicated in a speech made by Mr. Gibson, the representative of the new American administration, during the meetings of the Preparatory Commission at Geneva in April 1929. He proposed that in estimating equivalent naval strengths other factors than unit displacement tonnages should be considered. In the case of categories in which there were marked variations as to unit characteristics, the age of ships and the calibres of their guns might also be taken into account. Here was a method—known as "the yard stick"—of calculating parity between the cruiser fleets of the United States and Great Britain even though they differed in the numbers, tonnages and gun calibres of their ships. The American fleet might contain a larger number of 8 inch gun cruisers whilst the British possessed a still greater preponderance of the smaller ships. The fruitless search after strict mathematical parity could be abandoned.

The two Governments lost no time in exploring the possibilities of this method, and their efforts ended successfully. In June conversations commenced between General Dawes, the new Ambassador of the United States in London, and Mr. Ramsay MacDonald, who had become Prime Minister ten days previously. Their informal negotiations were continued for three months, at the end of which time the difference of opinion between their Governments as to how their cruiser fleets might be limited so as to achieve parity whilst allowing variety, had been reduced to a minimum. But for a matter of 30,000 tons the two Governments were indeed agreed on programmes for the limitation of every category of ship in their two navies. But they never lost sight of the fact that the United States and Great Britain alone could not solve the Naval limitation problem. Their conversations were a preliminary to a conference of the five Washington Treaty Powers, the summoning of which had been in the minds of President Hoover and Mr. MacDonald ever since they faced the Naval problem in the summer. Therefore their negotiations were not intended to reach an agreement which they would present as a *fait accompli* to be accepted or rejected in its entirety by the other three Powers. The understanding between them was a provisional one, to liquidate the Anglo-American cruiser difficulty and to form a basis for negotiations between all the five Powers together. The other interested Governments were at each stage informed of the progress of their negotiations.

The Conference Meets.—On October 7th invitations to a Naval Conference to meet in London in January 1930 were sent with the authority of both Governments to the French, Italian and Japanese Governments, and not many days later were accepted. Meanwhile Mr. MacDonald had sailed for the United States, on a visit to the President which still further strengthened the confidence and friendliness between the two great English-speaking peoples, a deplorable lack of which had previously threatened to destroy the work for Naval disarmament. On his return to London conversations with the three other Governments were commenced, with a view to disposing of any preliminary difficulties.

The London Naval Conference was opened by His Majesty King George V. on January 21st, 1930. Although it was called a Five Power Conference, there were actually twice that number of delegations attending it, for five British Dominion Governments sent delegates to co-operate with the United Kingdom Delegation in discussions of vital importance to the Navy which protects them as a whole. The Conference sat until April 22nd, when the London Naval Treaty was signed by all the delegates.

The Conference's work would have been comparatively simple had it been a meeting of only the three Geneva Conference Powers. Recognising the complications which would be introduced if it were a gathering of the five Washington Conference Powers, President Hoover and Mr. MacDonald had considered whether the easier task should not be finished first, but they came to the conclusion that the London Conference should be one of the five Powers. When it met, forebodings of difficulty proved correct.

It became clear that the five Powers did not form one unified group; indeed, that though there were five Powers represented there were really two groups, so to speak, of three Powers each. One group consisted of the United States, Great Britain and Japan, and became known as the High Seas Group; the other, which was called the Continental Group, consisted of France, Italy and, again, Great Britain. In each Group the first two Powers could, strictly from their own geographical point of view, consider their Naval affairs independently of discussion in the other Group; but Great Britain was interested in the proposals of both Groups; and from the point of view of securing a Five Power Treaty it was necessary that the conclusions of both Groups should be combined into a harmonious whole. This was not easy to achieve. No differences existed, for instance, amongst members of the High Seas Group on the question of limitation by categories, and a Conference confined to them would have engaged simply in programme making, a task which had already been simplified for them by the almost complete Anglo-American agreement on cruisers. But France and Italy were advocates of the principle of limitation by global tonnage, so that the Conference was divided on and had to face immediately this problem. At the London Conference a compromise on this question was reached. This agreement was not included in the text of the Treaty, for the Italian Delegation had declared that they would only be prepared to accept it if the question of the ratio of naval strength between all the contracting parties were first settled, a condition which was not satisfied. Nevertheless in principle and on its merits all the Delegations did agree to the compromise which was reached on this previously baffling question, and accordingly Mr. MacDonald as President of the Conference reported its details in a letter to the Chairman of the Preparatory Commission at Geneva, to whose work it would clearly be of extreme value. The agreement provides that in practice the Powers should accept programmes which limit their warship building category by category, though it allows a slight transfer between certain categories. A complete Five Power agreement, which is embodied in the Treaty, was also reached upon such matters as definitions, rules for replacement, rules for scrapping, etc.

Parity.—To this achievement was added an agreement on actual programmes between the three Principal Powers. France and Italy were unable to join in this section (Part III) of the Treaty owing to a particular difficulty which the Conference at the time of its adjournment had been unable to dissolve. As the United States and Great Britain had agreed on parity between themselves, so Italy claimed Naval parity with the strongest Continental European Naval Power, which meant France. The Washington Treaty had recognised parity between France and Italy in capital ships and aircraft-carriers, and the Italian Delegation in London asked that the principle should be extended to other categories. The French did not agree, and therefore no figures for either country are included in Part III of the London Treaty. But hope of settling this question has not been abandoned. So far as negotiations on the point were concerned, the Conference was only adjourned and conversations have since been proceeding with a view to settling the Franco-Italian difficulty.

As for the members of the High Seas Group, the United States and Great Britain had already agreed that parity in each category of ships should exist between them. Japan, whose capital ship and aircraft-carrier tonnages had been fixed in the Washington Treaty at 60% of the strengths of each of the other two Powers, put forward in London a claim for an increased ratio in the various classes of auxiliary ships. In the negotiations all difficulties between the Three Powers were composed, and they were able to sign an agreement which for the first time limits the building of cruisers, destroyers and submarines of all types. Thus limitation was extended far beyond the Washington Treaty provisions. Nor was the extension confined to categories not covered by that Treaty. With regard to capital shipbuilding restriction was carried a stage further than it had been left in 1922. The following are the principal provisions of the London Treaty concerning specific programmes.

The Washington Treaty provided for a maximum capital ship replacement tonnage of 525,000 (15 units) each for the United States and the British Empire, 315,000 tons (9 units) for Japan and 175,000 for France and for Italy; these figures as to numbers of units to be reached by 1936 and as total tonnages by 1942. At the time of the London Conference the first three Powers still had ships in excess of these figures, the British Empire possessing 20, the United States 18 and Japan 10 ships. The London Treaty decided that the surplus ships, instead of being retained until 1936 should be rendered unfit for warlike service within eighteen months after the coming into effect of the Treaty. Moreover, the Washington Treaty would have permitted further building for replacement of older capital ships before 1936. Great Britain and the United States, for instance, could each have completed five new battleships and commenced a further five by then. The London Treaty withdrew these provisions and declared a battleship "holiday" until 1936, except that France and Italy retained their right to build up to the tonnage, which they do not now possess, allowed them under the Washington Treaty. Apart from the great economies which this "holiday" means for the three principal Naval Powers, it will give time before the next Naval Conference for a thorough consideration of the question of the future of the capital ship.

With regard to aircraft-carriers the position was left practically as it had been by the Washington Treaty, except that carriers of less than 10,000 tons, which were previously not subject to limitation, are now taken into account. The figures agreed upon for the cruiser, destroyer and submarine fleets of the three Powers are as follows, an Anglo-American effort to persuade the Conference to agree to the total abolition of the submarine having failed:

British Commonwealth of Nations.

		Tons
8-inch gun cruisers	15 units	146,800
6-inch gun cruisers		192,200
Destroyers		150,000
Submarines		52,700
Total		541,700

United States.

		Tons
8-inch gun cruisers	18 units	180,000
6-inch gun cruisers		143,500
Destroyers		150,000
Submarines		52,700
Total		526,200

Japan.

		Tons
8-inch gun cruisers	12 units	108,400
6-inch gun cruisers		100,450
Destroyers		105,500
Submarines		52,700
Total		367,050

The United States undertake not to complete more than fifteen 8-inch cruisers before 1935. It is open to the United States Government, moreover, instead of building to the figures entered for itself, to adopt a programme almost exactly identical with that fixed for Great Britain. The three Navies are to be brought within these strengths by December 31st, 1936, before which date it is agreed that a further Naval Conference shall be held to decide what regulation is to follow that. Meanwhile, since Great Britain cannot be indifferent to the size of the auxiliary fleets of European Powers, which for the present remain unrestricted, a clause in Part III of the Treaty provides that an alteration in the figures can be made on notification by one Power to the other two that in its opinion expansion is necessary to meet the requirements of national security consequent on new construction by a Power not bound by Part III of the Treaty. The other two Powers would then be entitled to make proportionate increases. But it is hoped that this clause need never be operated.

In addition all the five Powers reached an agreement strictly limiting the use of the submarine, ensuring its compliance with the rules generally recognised to be applicable to all surface vessels.

The London Naval Conference set out to achieve limitation of every category of ship in the largest Navies, and, if possible, reductions in them as well. Reduction did not necessarily mean a reduction in the size of existing fleets. If the Conference could produce reductions in the programmes for expanding those fleets which the various Powers had already in project—programmes which would have been put into effect in the next few years but for a new Treaty of limitation—the Conference would have achieved its second object. The Conference did succeed in doing this. It also succeeded in actually reducing the existing fleets of all the three Powers in the categories of battleships, destroyers and submarines. But even had the Conference failed in these respects and achieved limitation alone, it would have been a signal contribution to confidence, disarmament and peace between nations. For one of the most fruitful causes of international distrust and war in the past has been competition in building up armaments. Agreed limitation stops that competition. In naval armaments competition had recommenced seriously after the breakdown of the Geneva Conference, but so far, at any rate, as the United States, Great Britain and Japan are concerned, the London Naval Treaty has ended it. Thus the Treaty starts a new era between those naval Powers in which their relations are free from the distrust bred from hostile shipbuilding. The nations can take advantage of this during the next few years to improve the security offered by political machinery for settling international disputes, in which case the naval powers would, it is hoped, be induced at their next Conference to make further reductions in their naval forces. Thus disarmament will come stage by stage. The chief practical achievement of the London Treaty is that it calls a halt at certain figures to the building of every kind of war vessel, and it is for future Conferences to bring those armament figures lower and lower until they reach negligible proportions.

(J. R. M.; H. L. STI.)

LONDON PRIDE: *see* SAXIFRAGE.

LONDON UNIVERSITY. Sir Thomas Gresham in the 16th century laid down a noble plan for a university in London, but for various reasons it failed and the present university may be said to have had its origin with the foundation in 1827 of the non-sectarian University college, which, in the hope and expectation of receiving a charter empowering it to grant degrees, bore for some time the title of University of London. This was followed by the foundation, as a Church of England institution, of King's college, which received a charter of incorporation in 1829. The movement to grant a charter to University college was bitterly opposed and finally in 1836 two charters were granted, one incorporating University college and the other setting up a new body with examining functions and degree-giving powers, and known as the University of London. In the first instance students from University and King's colleges only were admissible to examinations for degrees, but the list of colleges was rapidly expanded by supplementary charters, until by the middle of the century its degrees, except in medicine, were thrown open to all candidates who cared to present themselves for examination, irrespective of their place of education. In 1878 a further charter was granted making all degrees, etc., open to women on equal terms with men.

Reorganization.—Various proposals were put forward from time to time for the establishment of a teaching university in London, and after two royal commissions had reported on the matter the university was re-constituted in 1900 in accordance with the University of London Act of 1898.

The work of the University of London as reconstituted by the Act of 1898 falls into three main divisions: (1) teaching and research, carried on by professors and other university teachers in the colleges and schools of the university, the students of which, if matriculated, are known as internal students; (2) the examination of other students ("external students"), principally from institutions not forming part of the university, *e.g.*, provincial universities and private students; and (3) university extension.

In addition to the colleges and institutions which under the act were affiliated as schools of the university other teaching institutions have been added, and research institutions have been added under a statute which empowered the senate to admit institutions for purposes of research. The institutions belonging to or affiliated to the university in which teaching and research are carried on include University college, King's college, Goldsmiths' college (*see* below), the Imperial college of science and technology, Royal Holloway college, Bedford college, East London college, the London school of economics, Westfield college, Birkbeck college, the London Day Training college, the School of Oriental studies, the Medical schools of the twelve great London hospitals, four theological colleges, the London school of hygiene and tropical medicine, and a number of other institutions admitted as research institutions. There are also the Institute of Historical Research (*see* below), the Galton laboratory for eugenics, and the Bartlett school of architecture housed at University college.

By the University college Transfer Act of 1905 that college and its property and trust funds, except such as belonged to or were held in trust for University college hospital and its medical school and the boys' school carried on by the college, were transferred to the university as from June 1, 1907. The college is managed by a committee appointed by the senate. By a similar act, King's college Transfer Act of 1908, the property, etc., of that college in faculties other than in the faculty of theology was transferred to the university as from Jan. 1, 1910. The act also provides for the separate government of King's college hospital medical school and King's college hospital.

In 1905 the Goldsmiths' company gave to the university their institute at New Cross with 4½ acres of unoccupied land. The institute, now named Goldsmiths' college, is a large and successful training college for teachers. In 1921 funds were raised for the establishment of an institute of historical research and in July of that year the present (temporary) building was opened as a centre for the post-graduate study of history.

Great progress has been made in all branches of the work of the university since its reconstitution. Research has been promoted by scholarships, the establishment of research funds, by a publication fund to facilitate the production of learned and scientific works, and the creation of research degrees. The number of university professors in 1928 was 181, of readers 85, and other teachers 815. The number of matriculated students pursuing degree courses in the university (internal students) was over 9,000.

The number of external students has doubled since the reconstitution of the university. The number examined in 1927 was 6,689.

The university extension board, in addition to extending university extension work, conducts the inspection and examination of schools and arranges vacation courses for foreign students. A joint committee of the board and the Workers' Educational Association has developed a scheme of university tutorial classes for working people.

Constitutional Changes.—In 1909 a royal commission on the university under the chairmanship of R. B. (afterwards Lord) Haldane was appointed with very wide terms of reference. Its final report was published in 1913 and in the same year a departmental committee was set up to report as to the steps necessary to give effect to the commission's recommendations. Soon after the outbreak of the World War the committee abandoned its sittings and, although some of the recommendations of the commission were brought into effect administratively, no action was taken on its recommendations as to the constitution of the university until 1924. In that year another departmental committee was appointed to consider the "Haldane" report and to indicate what were the principal changes now needed in the constitution of the university. That committee reported in 1926.

The most important of their recommendations are two: the first is the creation of a small body composed (as to its majority) of representatives of the senate, with representatives of the Crown and London county council which is to control finance and to be the channel for all public grants to the university and its schools. The second is the constitution of a new body known as the collegiate council consisting of the heads of the greater colleges who will together with the representatives of the faculties and convocation make up the senate.

By the University of London Act of 1926 a body of commissioners was appointed to make statutes in general accordance with the recommendations in the report, subject to any modifications which might appear expedient. Draft statutes were published, if approved, to become operative in 1929.

Provision is made for the financial body (to be known as the court) referred to above, but the senate is to remain the supreme governing body in academic matters. It will be advised by five standing committees: (1) the academic council, elected by the faculties and concerned with the teaching work of the university; (2) the external council, composed principally of representatives elected by the graduates and concerned with external students; (3) the collegiate council, referred to above; (4) the university extension and tutorial classes council; and (5) the matriculation and schools examination council.

University Headquarters.—Up to the reconstitution of 1900 the senate had occupied buildings in Burlington gardens but soon after these were given up and the senate accepted in their place a portion of the premises of the Imperial Institute at South Kensington. These have, however, proved unsuitable in many respects and the Haldane commission recommended that the university should obtain for the use of the senate, its administrative staff, the library, and for the development of the social and corporate life of the university, permanent buildings of appropriate design, adequate and apt for the purpose, conveniently situated and bearing its own name. In 1912 efforts had been made to acquire a site for the purpose in Bloomsbury but for various reasons the project was abandoned. In 1920 the Government offered to the university for its use and that of King's college a site of about 11½ acres north of the British Museum. The offer was subject to a condition that King's college should surrender to the Crown the lease (held on a nominal rent) of its premises in the Strand to which condition the authorities of the college were unable to agree. The offer accordingly expired and the Government resold the site to the vendor.

The position was one which caused the senate some concern since in anticipation that the university would become the owner of the site some university institutions had been erected on it. In 1927, largely with the assistance of a munificent benefaction from the Rockefeller Trustees, the senate were able to repurchase the site free of any conditions. The question of the development of the site is now (1928) under consideration; obviously a good deal of money will be necessary to create a centre worthy of the University of the capital of the British Empire.

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LONE STAR ROUTE HIGHWAY, an American highway about 1,190 m. long, connecting the Great Lakes with the Gulf of Mexico. Starting at Chicago, Ill., it passes through the agricultural centre of that State to St. Louis, Mo., and thence follows the valley of the Mississippi river on its western side to Lake Charles, La. The roadway is paved through Illinois and in and out of Little Rock, Ark.; the balance is either improved or graded. Other cities served by the highway are Poplar Bluff, Mo., Little Rock, Ark. and Alexandria, La.

LONG, CRAWFORD WILLIAMSON (1815–1878), American physician, was born at Danielsville, Ga., on Nov. 1, 1815. He graduated at Franklin college, Ga., and secured his medical education at Transylvania university and the University of Pennsylvania. After finishing his course he spent 18 months in New York city hospitals observing and performing surgical operations. In 1841 he returned to Jefferson, Ga., to open his practice and there, on March 30, 1842, he administered ether to a patient before removing a tumour from the neck, the first recorded use of an anaesthetic in surgery. Dr. Long performed at least eight other operations with the use of ether before 1849, when he published an account of his discovery in the *Southern Medical and Surgical Journal.* He died at Athens, Ga., on June 16, 1878.

See C. T. Jackson, "First Practical Use of Ether in Surgical Operations," *Boston Medical and Surgical Journal* (April 11, 1861); George Fory, *Crawford Williamson Long* (1886); Charles Johnson, "Dr. Crawford Long," in the *Illinois Medical Journal* (Aug. 1917); J. Jackson, *Dr. Crawford W. Long* (1919); "Crawford W. Long," 69th Cong., 1st Sess., *Sen. Doc. No. 160* (1926); F. L. Taylor, *Crawford Williamson Long* (1928).

LONG, HUEY PIERCE (1893–1935), U.S.A. Senator, was born Aug. 30, 1893, at Winnfield, La., where he secured a public education. He studied law at Oklahoma and Tulane universities but, after a brief trial of private practice, turned to politics. Rapidly advancing from membership on the La. Railroad Commission (1918–21) and the Public Service Commission (1921–28) to the governor's chair (1928–32) and finally to the United States Senate (1931–), Long became undisputed "leader" of the backcountry of Louisiana (*q.v.*). Long's filibustering activity in the Senate and his third party threat for the 1936 elections were only removed by his assassination by a victim of his own autocracy.

LONG, WALTER HUME LONG, 1st Viscount (1854–1924), English politician, was born at Bath on July 13, 1854. He was educated at Harrow and Christ Church, Oxford. He entered parliament in 1880 as Conservative member for North Wilts, and sat in the House of Commons till he was created a peer in May 1921, though he changed his constituency several times. He obtained office early, and showed administrative power and common sense as parliamentary secretary to the Local Government Board (1886–92), president of the board of agriculture (1895–1900) and president of the Local Government Board (1900–05).

In March 1905 Long was chosen by Balfour to succeed Wyndham, after the latter's breach with Irish Unionism, as chief secretary for Ireland. The impression which he produced in Ireland in the few months before Balfour's resignation was so considerable that he, an Englishman, was returned to Parliament in the general election of 1906 for a Dublin seat. When Balfour resigned the leadership of the Conservative party, Nov. 1911, Long was the candidate of its more conservative branch, but, with his rival, Austen Chamberlain, stood aside in favour of Bonar Law. He joined the first Coalition Ministry in 1915 as president of the Local Government Board, and the second Coalition in 1916 as colonial secretary. He sponsored the Franchise bill (1918) granting the vote to women over 30. In 1919–21 he served as first lord of the Admiralty and was created Viscount Long of Wraxall in 1921. He died on Sept. 26, 1924 at Rood Ashton, Wiltshire.

LONG. A buyer or holder of securities is said to be "long" of the market or "long" of stock if he has more of a particular security than he has contracts to deliver. The longs are usually those who have bought expecting a rise in prices, and are commonly included among those known as "bulls" (*q.v.*). The opposite term, "short," is applied to one who has contracted to deliver more of a certain security than he holds. The shorts are principally those who have "sold short" in anticipation of a drop in prices, in which event they will buy at the lower price for delivery. They are often included among those known as "bears" (*q.v.*).

LONG BEACH, a city of Los Angeles county, California, U.S.A., on San Pedro bay, 20 mi. S. of Los Angeles; a recreation resort and an important industrial and commercial centre. It is served by the Pacific Electric, the Southern Pacific and the Union Pacific railways, and has a well equipped municipal airport of 749·6 ac., 4½ mi. from the business district. The land area is 30·97 sq.mi. The population was 2,252 in 1900; 142,032 in 1930 and 164,271 in 1940. In front of the city lies Catalina island, which protects it from violent storms. There is a wide beach, more than 7 mi. long. A fine harbour, with a depth of 40 ft. and 25 sq.mi. of anchorage for naval and merchant ships, makes Long Beach an important defence base. It has an inside channel connecting with Los Angeles harbour. The federal government and the two municipalities co-operate in port development. Within the city and its environs is the Signal hill oil field (6,500 ac.).

producing 43,446 bbl. daily in 1941. The city owns about one-sixth of the field. Long Beach harbour district also owns 1,860 ac. of oil land, with a daily production of 47,922 bbl. in 1941. The combined fields produce 49,000,000 cu.ft. of gas per day, giving an abundant supply of natural gas. Harbour and city revenue from oil royalties in 1940 totalled $1,800,000. Manufacturing establishments include an automobile assembly plant, an aircraft factory, a vegetable oil refinery, other oil refineries and fish, vegetable and fruit canneries. Output for 1940 was $50,000,000. Bank clearings for 1940 were $196,986,091 and the assessed value of property was $233,811,265. Bank deposits (1940) totalled $73,930,788.

LONG BRANCH, a city of Monmouth county, N. J., U.S.A., on the eastern or long branch of the Shrewsbury river and the Atlantic coast, 30 mi. S. of New York city. It is served by the Central of New Jersey, the New York and Long Branch, and the Pennsylvania railways, and by steamboats to New York. The population was 13,521 in 1920 (17.8% foreign-born white) and 1940, 17,408. Long Branch is one of the oldest of American seaside resorts. It is situated on a bluff which rises abruptly 20 to 35 ft. from the beach. Along the edge of the bluff runs Ocean ave. (60 ft. wide) now part of a continuous highway connecting the resorts which edge this section of the Jersey coast (from Highlands on the north to Point Pleasant at the mouth of the Manasquan river). In a cottage in Elberon (the south part of the city) Gen. Grant spent many summers, and in another, President Garfield died in 1881. Fort Monmouth, 4 mi. N.W., is an important army post, the headquarters of the Signal school and the radio laboratories. The city was chartered in 1904.

LONGCHAMP, WILLIAM (d. 1197), chancellor of England and bishop of Ely, entered public life at the close of Henry II's reign as official to the king's son Geoffrey, for the archdeaconry of Rouen. Henry II, who disliked him, called him the "son of two traitors." He soon deserted Geoffrey for Richard, who made him chancellor of the duchy of Aquitaine. As Richard's envoy, in Paris, he defeated Henry II's attempt to make peace with Philip Augustus (1189). On Richard's accession William became chancellor of the kingdom and bishop of Ely. When Richard left England (Dec. 1189), he put the tower of London in his hands and chose him to share with Hugh de Puiset, the great bishop of Durham, the office of chief justiciar. William immediately quarrelled with Hugh, and by April 1190 had ousted him from office. In June 1190 he received a commission as legate from Pope Celestine.

John returned to England in 1191; he and his adherents were immediately involved in disputes with William. At last (June 1191) Geoffrey, archbishop of York and William's earliest benefactor, was violently arrested by William's subordinates on landing at Dover. They exceeded their orders, which were to prevent the archbishop from entering England until he had sworn fealty to Richard. This outrage was made a pretext for a general rising against William, whose legatine commission had now expired, and whose power was balanced by the presence of the archbishop of Rouen, Walter Coutances, with a commission from the king. William shut himself up in the Tower, but he was forced to surrender his castles and expelled from the kingdom. In 1193 he joined Richard in Germany. Richard employed Longchamp in confidential and diplomatic missions in Germany, in France and at Rome. He died in Jan. 1197.

LONGCLOTH, a plain cotton cloth originally made in comparatively long pieces. The name was applied particularly to cloth made in India. Longcloth, which is now commonly bleached, comprehends a number of various qualities. It is heavier than cambric, and finer than medium or Mexican. As it is used principally for underclothing and shirts, most of the longcloth sold in Great Britain passes through the hands of the shirt and underclothing manufacturers, who sell to the shopkeepers, though there is still a considerable if decreasing retail trade in piece-goods. The lower kinds of longcloth, which are made from American cotton correspond in quality to the better kinds of "shirting" made for the east, but the best longcloths are made from Egyptian cotton, and are fine and fairly costly goods.

LONG EATON, an urban district of Derbyshire, England, 10 mi. E.S.E. of Derby, on the L.M.S. railway. Pop. (1938) 26,120. Area, 5.6 sq.mi. The church of St. Lawrence has Norman portions, and an arch and window apparently of pre-Conquest date. There are lace manufactures and railway carriage works. To the north is the township of Sandiacre, where the church has a noteworthy Decorated chancel and Norman and early English portions.

LONGEVITY, or length of days, is the prolongation of life to or beyond the standard duration. Generally speaking there is a rough correspondence between the bodily bulk and the span of life; thus the imagines of ephemerids or dayflies after an hour or two of "aerial life devoted to love" die, whereas the tortoise may survive for one or even two centuries; but this relation is not absolute, parrots, ravens, and geese live longer than many larger birds and than most mammals (Mitchell); some fish, such as salmon (100 years), carp (150) and pike (200), have a longevity contrasting with the 30 years of horses. Trees are constructed on an entirely different plan from that underlying the complex higher animals, and are thus endowed with a kind of potential immortality. The section of the trunk of a mammoth tree (*Sequoia gigantea*) in the Natural History Museum, South Kensington, showing 1,335 rings, might have been as many years old.

Death, the termination of life, is avoided in the protozoa by the division of the individual into two, which thus start afresh, so that, as Weismann long ago argued, the organism is immortal. But in the higher grades of the animal kingdom such rejuvenation is impossible, and the processes of senescence and death must be regarded as the penalty to be paid for their higher differentiation; they are dependent for their term of life on an inherited physico-chemical constitution, and are thus, like a clock, set for a definite period. After the time of Aristotle, the vital cycle has been thought to be a multiple of the period of growth; Francis Bacon considered that as a rule animals should live eight times, Flourens five times, as long as they take to reach maturity; in the case of man both Buffon and Flourens, though on rather different grounds, estimated that 100 years is the physiological duration of life, and this has been widely accepted, in spite of the psalmist's "three score years and ten," with perhaps a sorrowful extension to four score.

In more modern times the number of reputed centenarians has been shown by critical enquiry to be much in excess of the real figure, and that the ages popularly ascribed to Henry Jenkins (169), Thomas Parr (152), Katherine, Countess of Desmond (140), and many of the 1,712 centenarians in James Easton's list covering the years A.D. 66 to 1799 cannot be accepted as authentic. Fallacies easily creep in and memories and records fail; thus in the census of 1911 the excess of persons alive over 91 and the deficit of those between 85 and 90 could only be explained by exaggeration of their age by old people.

It is desirable to distinguish clearly between the concept of the life span and that of the average length of life. The former term is best reserved to denote the extreme limit of life characteristic of the species, say a little more than 100 years in the case of man. On the other hand, the term *average length of life* is applied to a figure computed from a life table; it measures the average number of years lived by the individuals of a large cohort of persons passing from birth to death in accordance with the mortality exhibited in the life table. The average length of life, so defined, is also often spoken of as the expectation of life at birth. Similarly, the average number of years lived beyond a given age, such as age 30 for example, is called the expectation of life at that age. While the life span has probably changed little, if at all, in all historic time, the average length of life has been greatly extended, especially in modern times. So, *e.g.*, the average length of life, as given by the registrar-general for England and Wales in 1838–54, was 39.91 years for males and 41.85 years for females; by 1937, the latest year for which a life table is available (1947), the corresponding figures were 60.18 and 64.40 years. The expectation of life at later ages, that is to say the average after-lifetime; also shows improvement; thus in 1854, males at the age of 60 had an expectation of 13.53 years, females an expectation of 14.34 years. The corresponding figures for 1937 were 14.32 and 16.48 years. In the United States, the expectation of life at birth for both sexes combined in the white population in 1901 was 48.23 for males and 51.08 for females; by 1944, these figures had risen to 63.55 and 68.95 years respectively. The gain has been chiefly in the childhood ages. It is due in large part to the success gained in the treatment, and even more in the prevention, of infectious diseases. The diseases characteristic of middle life and advanced age—the so-called degenerative diseases, especially those associated with hardening of the arteries—have so far yielded little to efforts of control.

Presumably if all were placed under similar environmental circumstances, there would be certain racial differences in longevity. This statement is hardly capable of definite test, since the more outstanding racial differences in different parts of the world cannot be separated from accompanying environmental differences. As to sex differences, in all civilized countries females have a lower mortality than males at most ages of life. Figures for the last census year, 1940, in the United States show that if deaths from causes connected with childbirth are excluded, the difference in favour of female mortality extends to all ages of life. An interesting observation by Graham Bell, in his analysis of the Hyde genealogy, dealing with 8,972 persons and dating from the 17th century, shows that, in this group at least, the proportion of those living long increased with size of family up to families containing nine and ten children, and then fell in the case of still larger families. It also appeared that the first born lived as long as subsequent children, and that children born between four and eight years after their parents' marriage were on the average longer lived than those born earlier or later.

Heredity.—The two great factors influencing the length of life are heredity and environment in its broadest sense; for obvious reasons it is impossible to disentangle them and ascertain what share each of these two factors contributes. That longevity well beyond the average tends to run in families seems to be well established. To this topic an important contribution has been made by the late Raymond Pearl in a book under joint authorship with his daughter, Ruth DeWitt Pearl, entitled *The Ancestry of the Long-Lived.* A most striking example of apparently hereditary longevity quoted by these authors is that of a group of seven persons, grandparents, parents and son, whose aggregate age at death was no less than 699 years; at that, two of them died by accident. Another significant investigation of inheritance of longevity, conducted on the basis of records of insurance companies by Louis I. Dublin and Herbert Marks, showed very clearly how longevity of parents favourably influences the longevity of offspring.

Inborn vitality may counteract the evil influences of unhealthy environment and bad habits, such as overcrowding in towns and alcoholism, and so explain the occasional longevity of those who have lived in most unfavourable circumstances; *e.g.*, the contrast between two aged brothers, one a confirmed toper, the other a total abstainer. Of the hereditary factors innate vitality of the nervous and the circulatory systems are the most important; the nervous system decides the mental disposition and the reactions of the body as a whole. Cazalis' aphorism "Man is as old as his arteries" expresses the advantage of possessing a circulatory system which does not degenerate readily, harden into the condition of arteriosclerosis, or show an excessive blood pressure; for it is well known that the members of some families tend to die about the age of 60 from apoplexy, heart or kidney disease, the latter being often the result of arterial disease in the kidneys.

Environment.—One way in which environmental conditions affect longevity is through diseases contracted in the course of life. It has been stated that only those who have escaped illness up to the age of 60 years are likely to reach extreme old age, but nearly half of the 824 persons between the ages 80 and 100, analysed by Sir George Humphry, had passed through a severe illness, in many of them an acute infection. An acute illness may be the apparent starting point of old age and senescence, especially if sufficient time for convalescence is not allowed. It has been suggested that the deteriorating influence of malaria on individuals may, by its mass effect, account, in some degree at any rate, for the decadence of Magna Graecia (W. H. S. Jones). Functional activity, mental and bodily, plays an important part in postponing the advent of morbid old age, and there is more danger of rusting out than of wearing out, provided the body is healthy and the mind free from worry. The advanced ages of many dignitaries of the Church and the bench and of prime ministers, though many of these may be supermen, point to the beneficial influence of long-continued activity. Among painters Giovanni Bellini, Michelangelo, and Sidney Cooper worked up to nearly their death, and Titian was painting with "incomparable steadiness of hand" when cut off by the plague at the age of 99. The same retention of productivity was seen in Voltaire, Littré, Anatole France, Goethe, von Ranke, and Frederick Harrison. The members of the Académie Française are long-lived, and thus doubly justify their title of "the immortals." Retirement, often looked forward to in early life, is a source of danger, as it may bring with it cessation from activity.

The majority of centenarians have been small eaters, and several aphorisms point to the evil, if slow, effect of being a good trencherman, such as Montaigne's "Man does not die, he kills himself" and the forcible proverb "You dig your grave with your teeth." Overfeeding by overworking the resources of the body leads to metabolic disease, such as diabetes mellitus, and to arterial, heart and kidney affections, which are preceded often by long periods of latency during which the individual flatters himself on his vigour, but in which his arterial blood pressure is unduly high. During World War I it was observed that in certain countries the death rate from diabetes was reduced, and this has been attributed to dietary curtailment. Poverty, within limits, is an advantage inasmuch as it removes the dangers of excessive eating, particularly of meat, after the body has reached maturity. The beneficial effects of a meagre dietary were set forth by the noble Venetian Luigi Cornaro (1467–1566), by Metchnikoff, Henry Thompson the surgeon, Hermann Weber, and many others who practised their own precepts. With regard to the influence of alcohol there can be no doubt, as the actuarial reports of life assurance companies amply prove, that excess is harmful.

It is true that Raymond Pearl's statistical enquiry into over 5,000 lives at Baltimore showed that "a moderate use of alcohol does not tend to shorten life." But what constitutes moderation is open to question.

Prolongation of life towards its limits may be healthy or attended by morbid manifestations. Healthy or normal old age is attended by diminution in functional activity which corresponds with the characteristic changes of atrophy and involution in the structure of organs and tissues and of a diminished area of the capillary blood vessels. With the waning of sexual power the mind becomes calmer and more philosophic, so that the limitations of activity are more cheerfully accepted; but fatigue is more readily produced, memory, especially for names, becomes less agile, and will power, like the gait, becomes less certain. The mental outlook is largely determined by that of the individual in the past, happy and kindly, or pessimistic and uncharitable. Often there is a tendency to ego-centricity and to nervous apprehension, as the preacher (Koheleth) in Ecclesiastes said "Fears shall be in the way." It may be pointed out that the glands of internal secretion become old with the rest of the body, not that their atrophy causes old age. For it has been thought that senescence results from failure of the thyroid, and especially of the interstitial cells of the testes, and experiments and operations by Steinach and Voronoff to supplement this want have been followed by dramatic, if temporary, rejuvenation, which in animals at least cannot be explained by suggestion; but that life is thus prolonged as well as being made to burn more brightly remains to be proved in the case of man.

It is hard to draw a sharp line of demarcation between normal old age (senescence), with its limitations due to atrophic changes in the body, on the one hand, and on the other hand the manifestations in the elderly resulting from past infections and diseases (senility). Physiological old age, that is freedom from any pathological change, is agreed to be rare, and it has been said by Terence, Cicero, Sanctorius, and often since that old age is itself a disease.

Eli Metchnikoff attributed the senile accompaniments of advanced years to pathological and preventable causes, especially poisons produced by bacteria in the large intestine, these toxins causing degeneration of the bodily cells which are eaten up by more resistant cells called macrophages; this hypothesis has been much discussed.

That disease may produce the picture of morbid old age prematurely is well established, and in the remarkable but rare condition of progeria this occurs in childhood. The various parts of the body do not all grow old at the same time, but when these changes are much more advanced in a vital organ, especially the brain, than elsewhere, the proper harmony of the system is so disturbed that the condition becomes pathological, and then instead of a happy, healthy and pleasant old age there is the picture of incapacity, pain and misery so that existence becomes a burden to the individual and to his family.

Some diseases are especially prone to attack the aged, though they are not entirely confined to the evening of life. The chief diseases mainly concentrated in later life are diabetes, cancer and the cardiovascular-renal group. This last is closely related to arteriosclerosis which may affect various parts of the body, such as the kidneys, the brain and the heart.

The acute fevers, such as measles, typhoid, scarlet fever and diphtheria, rarely attack the old, probably because immunity has gradually been acquired, but pneumonia and erysipelas are exceptions to this rule, and pneumonia, with but few symptoms, often proves to be the last straw in breaking the feeble thread of existence.

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LONGFELLOW, HENRY WADSWORTH (1807–1882), American poet, was born in Portland (Me.), on Feb. 27, 1807, of a family for generations domiciled in New England. After studying at a private school and at the Portland academy, he entered Bowdoin college, graduating there in 1825. Even as a boy he wrote prose and verse for newspapers and magazines, and showed an interest in native themes for literature and a talent for imitation of other poets, notably Bryant. He longed to be a man of letters, though his father disapproved. In 1826 he went to Europe to prepare himself to teach at Bowdoin, and when he returned in 1829 he was elected professor of modern languages and librarian of the college. In 1831 he married Mary Storer Potter of Portland, a former schoolmate. In connection with his work as a teacher he did some text-book writing, translating, and editing of foreign texts, and wrote several essays on French, Italian and Spanish languages and literature. His *Outre-Mer,* a book of European sketches, came out in 1835, showing strongly Irving's influence though based on Longfellow's impressions during his first visit to the Old World. In 1834 he was offered the Smith professorship of modern languages at Harvard, then vacated by George Ticknor. He accepted and went abroad to study. After pleasant months in England, Sweden and Denmark, he met tragedy for the first time when Mrs. Longfellow died in Rotterdam, on Nov. 29, 1835.

He went alone to Germany and Switzerland, coming to Cambridge to begin his work at Harvard in Dec. 1836. After a few months he took rooms at the historic Craigie House, which later became his own, and is now celebrated as the Longfellow House. His *Hyperion,* a prose romance, appeared in 1839, as did *Voices of the Night,* a volume of poems which won general favour and praise even from such critics as Poe. At Harvard he lectured on French, Spanish, Italian and German, apparently with success. In 1841 his *Ballads and other Poems* increased his celebrity as a poet. He was in Europe for part of the next year, and on the journey home prepared his *Poems of Slavery* (1842), his one considerable excursion into the field of contemporary social and political debate. Hawthorne wrote to him: "I never was more surprised than at your writing poems about slavery. . . . You have never poetized a practical subject hitherto." It is significant that, although Longfellow heartily opposed slavery, the ardent abolitionists found his anti-slavery verse "perfect dish-water beside Whittier's." Margaret Fuller called *Poems of Slavery* "the thinnest of all Mr. Longfellow's thin books" and said, "The subject would warrant a deeper tone." In 1843, he married Frances Elizabeth Appleton, of Boston. *The Spanish Student,* a poetic drama, came out in book form in 1843; *The Belfry of Bruges,* another volume of verse, in 1846, and *Evangeline,* interesting as his first long poem on an American theme and as one of the better known compositions in English hexameters, in 1847. A novel, *Kavanagh,* praised by Emerson but not otherwise distinguished, was issued in 1849; and in 1850 still another book of verse, *The Seaside and the Fireside,* was added to the list of his publications.

By 1854 he found teaching a burden, and resigned from Harvard, turning his whole attention to poetry. Eight other volumes of short poems, most famous of which is his *Tales of a Wayside Inn* (1863), were printed before his death. *Hiawatha* came out in 1855. It attempted to weave together the legends and traditions of the American Indians. The metre, trochaic dimeter, was suggested by the Finnish *Kalevala.* In 1858 he used hexameters for another American theme, *The Courtship of Miles Standish.* The two most ambitious works of his later life were his translation of Dante's *Divina Commedia,* and his *Christus,* a trilogy, which he planned as his greatest achievement. He had begun to translate Dante in 1843. *Christus,* too, he began early. Though the whole poem did not appear till 1872, its three parts, *The Golden Legend,* a re-working of a mediaeval tale, *The New England Tragedies,* two dramas of Puritan America, and *The Divine Tragedy,* had already appeared as separate works.

His second wife died on July 10, 1861, as the result of a tragic accident, and the poem of Longfellow's which is most successful in conveying the effect of deep emotion, his *Cross of Snow,* resulted from this bereavement. He did not print it; he seems always to have felt that frank expression of his personal feeling was not for the public eye. In 1868 he went to Europe, where he was hailed as a celebrity. Among the honours conferred on him were degrees of LL.D. from Cambridge and D.C.L. from Oxford, and election to membership in the Royal Spanish Academy. He died on March 24, 1882, and in 1884 a memorial to him was unveiled in Westminster Abbey. He was the first American poet to be commemorated there.

His fame in his own day was greater than that attained by any American poet prior to his time. It was based on the extraordinary popularity of his work, which was read not only by all classes in the United States but generally in England, and was translated into many languages to meet the demand for it in other countries. Longfellow's kindliness and charm, his unfailing generosity toward the thousands who visited his house in Cambridge, besieged him with requests for autographs, and heaped his desk with correspondence, contributed toward making him a national hero.

Longfellow's facility in remembering and reproducing what he had read gives an imitative quality and a too bookish flavour to much of his verse, though he was never the downright plagiarist Poe called him. But, though his writing rarely reflects current American concerns and though he cherished the romantic past, he believed definitely that there should be a truly American literature, not distinguished by its mere difference from English but by its authors' willingness to write "naturally, to write from their own feelings and impressions, from the influence of what they see around them." He was a good story-teller, and this has endeared him to children and to beginners in the appreciation of poetry.

Longfellow is still probably as much read as any American poet, even by those who do not come to know his verse in school. Barred from the company of the few great universal poets of the world, his work has virtues which are not ordinarily found in the merely mediocre. Much is summed up in the words of William Dean Howells, who refused to prophesy as to Longfellow's future place in literature, but remarked, "I am sure that with Tennyson and Browning he fully shared in the expression of an age which more completely than any former age got itself said by its poets."

BIBLIOGRAPHY.—*See* the Riverside edition of Longfellow's *Works* (Boston, 1886). The most complete biography is Samuel Longfellow's *Life of Henry Wadsworth Longfellow with Extracts from his Journals and Correspondence* (Boston, 1891). For bibliography *see* L. S. Livingston, *Bibliography of the . . . Writings of Henry Wadsworth Longfellow* (1908). Of the shorter biographies that by T. W. Higginson (1902) is the best; H. S. Gorman's *A Victorian American* (1926), the most recent. P. Morin's *Les Sources de l'Oeuvre de Henry Wadsworth Longfellow* (1913) is a useful study. For a friend's description of the poet, *see* W. D. Howell's *Literary Friends and Acquaintance* (1900). Brief essays and criticisms are numerous; *see,* for example, Paul Elmer More in *Shelburne Essays,* vol. v. (1908); Bliss Perry in *Park Street Papers* (Boston, 1908); and his "Longfellow and Hawthorne" in *Bowdoin College Bulletin* (Sept. 1925); E. C. Stedman in *Poets of America* (Boston, 1885); and W. P. Trent in *Longfellow and Other Essays* (1910). (K. B. M.)

LONG FIVES. This game, though played on a tennis court, bears but a slight resemblance to tennis, but is nevertheless a valuable form of preparatory practice. The game is 8 or 11 points, each stroke won counting one point to the winner. The server gives 3 points in 8, or 4 points in 11 to the striker-out. There are no chases. The winning openings count as at tennis. If a ball be struck into any other gallery or opening, it may be counted, by arrangement, either as a "let" (the rest being annulled) or against the striker; a similar arrangement is made for balls that make any chase on the hazard-side, or a chase of the last gallery on the service-side.

LONGFORD, a county of Eire, bounded northwest by Leitrim, northeast by Cavan, east and south by Westmeath and west by Lough Ree and Roscommon. The area is 257,935 acres, or about 403 sq.mi. Pop. (1936) 37,847.

The Silurian axis of Newry reaches the north of the county, where Lough Gowna lies upon it. Anticlinals bring up Old Red Sandstone at Longford town and Ardagh, above the Carboniferous Limestone plain, in which Lough Ree forms a characteristic lake, with signs of extension by solution along its shores. Marble of fine quality has been raised. In the north indications of iron are abundant, and there are also traces of lead. The principal rivers are the Camlin, which rises near Granard and flows past Longford to the Shannon, and the Inny, which entering the county from Westmeath crosses its southern corner and falls into Lough Ree. Lough Ree is partly included in Longford. The other principal lakes are Lough Gowna, Derrylough, Lough Drum and Lough Bannow.

The early name of Longford was Annaly or Analé, a principality of the O'Farrels. Then included in Meath, it was granted by Henry II. to Hugh de Lacy, who planted an English colony. On the division of Meath into two counties in 1543, Annaly was included in Westmeath, but in 1569 it was made shire ground under the name of Longford.

The chief rath is called the Moat of Granard. There are monastic remains at Ardagh, a former bishopric, Longford, Moydow and on several of the islands of Lough Ree. The principal castles are those of Rathcline near Lanesborough, and Ballymahon on the Inny. Oliver Goldsmith was born at Pallas, a village near Ballymahon, in this county; and at Edgeworthstown lived the family of the novelist Maria Edgeworth.

The climate is moist and cold, and there is much marsh and bog. The soil in the southern districts resting on the limestone is a deep loam well adapted for pasture, but in the north it is often poor. Oats and potatoes are the principal crops. The Great Southern line from Mullingar to Sligo crosses the county by way of the county town of Longford; and the Cavan branch touches the extreme east.

The Royal canal enters the county in the south at Abbeyshrule, and joins the Shannon near Cloondara. The constituency of Longford-Athlone returns three members to Dáil Eireann.

LONGFORD, the county town of Co. Longford, Eire, on the river Camlin, 75 mi. W.N.W. of Dublin by rail. Pop. (1936) 3,807. The principal building is St. Mel's Roman Catholic cathedral for the diocese of Ardagh. Trade is in grain, butter and bacon. There are corn-mills, a spool factory and tanneries. The ancient name of the town was Athfada, and here a monastery is said to have been founded by St. Idus, a disciple of St. Patrick. The town obtained a fair and market from James I. and a charter of incorporation from Charles II.

LONGHI, PIETRO (1702–1785), Venetian painter, celebrated for his little pictures of satiric *genre,* was born in Venice. He was a pupil of Antonio Balestra and Giuseppe Maria Crespi at Bologna. He has very aptly been called the Goldoni of painting, and Mariette said of him "Il devint un autre Watteau." Most of his paintings are in the public collections of Venice. The Brera collection, Milan, owns several examples of his work. They are generally on a small scale, but the staircase of the Palazzo Grassi-Stucky, now Sina, on the Canal Grande in Venice, is decorated by him with seven frescoes, representing carnival scenes. In England the National Gallery owns "The Exhibition of a Rhinoceros in an Arena," a "Domestic Group" and "The Fortune Teller"; two *genre* pictures are at Hampton Court palace. Many of his works have been engraved by Alessandro Longhi, Bartolozzi Cattini, Faldoni and others.

His son, ALESSANDRO LONGHI (1733–1813), was a famous portrait painter and engraver. He studied painting under the Venetian portraitist, Giuseppe Nogari, as he himself states in his book on Venetian painters, *Compendio delle Vite dei Pittori Veneziani Istorici più rinomati del presente secolo, con suoi ritratti dal naturale, delineati ed incisi* (Venice, 1762). Portraits painted by Alessandro have in recent times been attributed to his famous father, who was never mentioned in his own days as a portraitist. In 1766 an academy of painters was founded at Venice. The majority of Venetian painters belonged to it, among them the two Longhi—father and son. In the list of its members Pietro is described as a figure painter only; his son Alessandro, however, is entered as a portrait painter.

See J. P. Richter, *Mond Collection* (1910).

LONGINUS, CASSIUS (*c.* A.D. 213–273), Greek rhetorician and philosophical critic, surnamed PHILOLOGUS. The origin of his gentile name Cassius is unknown; it can only be conjectured that he adopted it from a Roman patron. He was perhaps a native of Emesa (Homs) in Syria, the birthplace of his uncle Fronto the rhetorician. He studied at Alexandria under Origen the heathen, and taught for 30 years at Athens. Longinus upheld, in opposition to Plotinus, the doctrine that the Platonic ideas existed outside the divine Νοῦς (*ὅτι ἔξω τοῦ νοῦ ὑφέστηκε τὰ νοητά*: *see* F. Überweg, *Grundriss der Geschichte der Philosophie,* 9th ed., 1903, i. § 72). Plotinus, after reading his treatise Περὶ ἀρχῶν (*On First Principles*), remarked that Longinus might be a scholar (*φιλόλογος*), but that he was no philosopher (*φιλόσοφος*). The reputation which Longinus acquired by his learning was immense; he is described by Porphyry as "the first of critics," and by Eunapius as "a living library and a walking museum" or encyclopaedia. During a visit to the East he became teacher in Greek, and subsequently chief counsellor in state affairs, to Zenobia, queen of Palmyra. It was by his advice that she endeavoured to regain her independence; Aurelian, however, crushed the attempt, and while Zenobia was led captive to Rome to grace Aurelian's triumph, Longinus paid the forfeit of his life.

Longinus was the author of a large number of works, nearly all of which have perished. Among those mentioned by Suïdas are *Quaestiones Homericae, An Homerus fuerit philosophus, Problemata Homeri et solutiones, Atticorum vocabulorum editiones duae;* the most important of his philological works, Φιλόλογοι ὁμιλίαι (*Philological Discourses*) consisting of at least 21 books, is omitted. A considerable fragment of the Περὶ τέλους (*De finibus, On the Chief End*) is preserved in the *Life of Plotinus* by Porphyry (§ 20). Under his name there are also extant Prolegomena to the *Encheiridion* of Hephaestion on metre (printed in R. Westphal, *Scriptores Metrici Graeci,* i. 1866) and the fragment of a treatise on rhetoric (L. Spengel, *Rhetores Graeci,* i. pp. 299–320), inserted in the middle of a similar treatise by Apsines. It gives brief practical hints on invention, arrangement, style, memory and other things useful to the student.

It is as the reputed author of the well-known and remarkable work Περὶ ὕψους (generally, but inadequately, rendered *On the Sublime*) that Longinus is best known. Modern scholars, however, with few exceptions, are agreed that it cannot with any certainty be ascribed to him, and that the question of authorship cannot be determined (*see* Introduction to Roberts's edition).

The alternative author, Dionysius, of the mss. has been variously identified with the rhetorician and historian Dionysius of Halicarnassus, the Atticist Aelius Dionysius of Halicarnassus, Dionysius Atticus of Pergamum, Dionysius of Miletus. Dr. W. R. Roberts (Class. Ass. Proceedings, 1928) concludes on an unidentified Greek man of letters who probably lived at Rome not more than 30 or 40 years after the birth of Christ. Wilamowitz-Möllendorff also gives his date as about A.D. 40.

The rendering *On the Sublime* implies more than is intended by the Greek Περὶ ὕψους ("impressiveness in style," Jebb). Nothing abnormal, such as is associated with the word "sublime," is the subject of discussion; it is rather a treatise on style. According to the author's own definitions, "sublimity is a certain distinction and excellence in expression," "sublimity consists in elevation," "sublimity is the echo (or expression) of a great soul" (*see* note in Roberts).

The treatise is especially valuable for the numerous quotations from classical authors, above all, for the preservation of the famous fragment of Sappho, the ode to Anactoria, beginning

φαίνεταί μοι κῆνος ἴσος θεοῖσιν,

imitated by Catullus (li.) *Ad Lesbiam,*

"Ille mi par esse deo videtur."

"Its main object is to point out the essential elements of an impressive style which, avoiding all tumidity, puerility, affectation and bad taste, finds its inspiration in grandeur of thought and intensity of feeling, and its expression in nobility of diction and in skilfully ordered composition" (Sandys).

A full bibliography of this subject will be found in the edition by W. Rhys Roberts (2nd ed. 1909), with introduction, analysis, translation and appendices. *See* also W. R. Roberts' introduction to *Demetrius on Style* in *Aristotle: the Poetics* (ed. with Eng. trans. by W. Hamilton Fyfe, 1927); F. Marx, *Wiener Studien* (xx. 1898) and F. Kaikel, *Hermes* (xxxiv., 1899), who respectively advocate and reject the claims of Longinus, and J. E. Sandys, *History of Classical Scholarship* (2nd ed. 1906). The number of translations in all the languages of Europe is large, including the famous one by Boileau. A text and translation was published by A. O. Prickard (1907–08).

LONG ISLAND, a fragment of the North American continent extending 118 m. east-north-east from the mouth of the Hudson river, U.S.A. It roughly parallels the south shore of Connecticut from which it is separated by Long Island sound (115 m. long) and lies south-east of the mainland of New York State of which it is a part. The island is from 12 to 23 m. wide and has an area of 1,682 sq.m. The east end is divided into two narrow peninsulas (the northern culminating in Orient point about 25 m. long, the southern ending in Montauk point, the eastern extremity of the island, about 40 m. long) by three bays, Great Peconic, Little Peconic (in which lies Shelter island) and Gardiners (in which lies Gardiners island). The north shore is broken in its western half by Flushing bay, Little Neck bay, Manhasset bay, Cold Spring Harbor, Huntington bay, Smithtown bay and Port Jefferson. The south shore has Jamaica bay with many low islands and nearly cut off from the ocean by the narrow spit of Rockaway beach; the ill-defined Great South bay, which is separated from the Atlantic by the narrow Long beach, Jones beach and Oak Island beach, and by the long peninsula called Fire island or Great South beach. Still farther east is Shinnecock bay, about 10 m. long and cut off from the ocean by a narrow beach.

Physiography, climate and location have combined to make Long Island one of the richest and most important garden spots in the United States. The hills of glacial moraine and much of the outwash plains of the southern half of the island, covered for centuries with forest mould, offer a rich soil to the husbandman. A mild, maritime climate brings the spring earlier and holds the autumn later than in the continental interior at the same latitude. New York city offers a market without equal in America. Long Island agriculture of the 17th and 18th centuries was characterized by the self-sufficient farm. Toward the end of the 18th century some farmers began selling their surplus crops in New York. Connection with this market was by wagons from the farms at the western end of the island and by small coasting boats from the homesteads of the north shore. Two events in the first half of the 19th century established Long Island agriculture on its modern basis. In 1825 the completion of the Erie canal gave New York city a connection with the continental interior and allowed a swift development which made it the metropolis of North America. In 1844 the Long Island railroad was completed to Greenport.

The growth of New York and the completion of the railroad caused the general farms to be turned into market gardens, cultivated intensively. The change did not come at once. For a time, after the Civil War, Queens and western Suffolk counties comprised an important milk-producing region. As the urban market increased, however, the land became too valuable for grazing, and truck farming became the dominant industry.

In 1935, according to the figures of the farm census for that year, the farming land of Long Island was roughly valued at $90,000,000. Kings county, across the East river from Manhattan, had 42 farms with a total of 117 ac. under cultivation. Queens county had 292 farms with a total acreage of 2,234 where market gardening was conducted with profit. Nassau county, the next political division to the east, had 614 farms with an acreage of 27,895. Suffolk county, covering the remainder of the island to the east, is chiefly agricultural with 2,220 farms with 123,351 ac. The product of the farms and market gardens is sold in New York city.

Fishing Industries.—Whaling was the first important maritime industry. So far as Long Island was concerned the fishery had its origin in the 17th century at East Hampton and Southampton. Early in the 19th century Sag Harbor became the chief Long Island whaling port. The village, dependent almost solely upon whaling, prospered in the golden age of the fishery and suffered heavily when whaling swiftly declined after the middle of the century. Throughout most of the 19th century the menhaden fishery flourished along the southern shore and in Peconic bay. Before the end of the 18th century, the Blue Point oyster bed in Great South bay had been discovered and was being worked, and in 1855 New York State permitted the leasing of sea-bottom, which was not part of a natural bed, for the purpose of establishing oyster farms. Oystering under the new conditions became one of the important industries, not only of Great South bay, but of Peconic bay, and some of the north shore harbours. Scallop fishing is also an enterprise of some importance in Peconic bay. Throughout the history of the island, deep-sea fishing—for cod, mackerel, bluefish, sea bass, weakfish, etc.—has supported many Long Island families.

Manufactures.—The chief manufacturing enterprises of the first half of the 19th century were those supplying the needs of the maritime industries. Cooperages and rope walks characterized Sag Harbor in the whaling days. The building of ships and boats became an important industry at Port Jefferson and other north shore towns located near good timber. The development of oystering on a large scale made a new demand for boats and for repair work. More important was the growth of summer colonies on the shores. The making, repairing, and storing during the winter of pleasure-craft became and has remained an important industry. Here and there, as at Patchogue and Sag Harbor, other manufacturing industries sprang up. Today Brooklyn and Queens boroughs are among the most important industrial centres in the United States. The two boroughs had in 1939, 6,454 industrial establishments, with 187,907 employees and produced goods valued at $1,304,010,119. Among the more important industries were automobile, shoe, silk, candy, printing, rubber, food-stuff, sugar, soap, iron and steel, paint and varnish and motion pictures. The factors causing this great industrial development at the western end of Long Island are not far to seek. Nearly 30% of the buying power of the United States lies within 100 m. of New York city. Land on Long Island is cheaper than in Manhattan, yet it is near the water front and close to the important trans-Atlantic lines.

Long Island as a Playground.—The growth of New York has caused the development of Long Island for recreational purposes. In the first decade of the 19th century Far Rockaway became a watering place for New York's *élite*. After the Civil War, with the increase of railroad facilities great estates began to be developed. Southampton became a second Newport. Camps, like Camp Carey of the New York Boys' Club, appeared. Coney Island, pioneer of American amusement parks, flourished. And all the while the city grew eastward.

Improved transportation made it possible for millions to escape for a few hours or days from the crowded streets to the quiet shore or countryside. Under the leadership of Governor Alfred E. Smith, the development of parks on Long Island began. By 1941, as a result of the activities of the Long Island State Park commission, some 10,000 ac. had been set aside as state parks. Some, like those at Fire island, Montauk, and Wading river, are on the shore. Deer Range park on Great South bay is well stocked with deer and other wild animals. In Nassau county, New York city has turned over more than 2,000 ac. containing lakes no longer used as reservoirs, where boating, bathing and fishing are possible. In 1928 a parkway scheme was undertaken to make it easy for the people to reach their playgrounds. The park commission hopes and plans to bring the area of Long Island State parks up to 40,000 acres. Long Island, on the edge of the largest American city, has become one of the most important of American playgrounds.

Early History.—At the time of the first settlement by the whites, the island was occupied by numerous small tribes of Indians whose former existence is now commemorated by such names as "Montauk" Point, "Shinnecock" hills, "Manhasset" bay, etc. The territory of Long Island was included in the grant of 1620 by James I. to the Plymouth Company and in 1635 was conveyed to William Alexander, earl of Stirling. The conflicting claims of English and Dutch were the subject of the treaty concluded at Hartford, Conn., in 1650, by which the Dutch were to hold everything west of Oyster bay, the English everything east—a provision which failed to settle the boundary dispute. In 1674 by the treaty of Westminster, Long Island became a part of the British colony of New York.

The Dutch settlements on the west end of the island were more important ethnically than historically. The "Five Dutch Towns" were: Nieuw Amersfoord (after 1801 officially called Flatlands) on Jamaica bay, where the first settlement was made about 1623 and the first grant in 1636; Midwout (later Vlackte-Bosch and Flatbush), settled between 1645 and 1650 and having in 1654 the first Dutch church; Nieuw Utrecht, settled soon after 1650 and incorporated in 1660; Breuckelen (now Brooklyn), which was settled a little before its organization as a town in 1646; and Boswijck (Bushwick), first settled by Swedes and Norwegians and incorporated in 1660.

Apparently the earliest English settlement was at Hempstead in 1640 by colonists from Lynn, Mass., but they were immediately driven out by the Dutch. In 1643 another English settlement was made at Hempstead by men from Stamford, Conn., who in 1644 secured a patent from Gov. Keift of New Netherland. In 1645 Keift granted land at Gravesend to Lady Deborah Moody, who had settled there about 1643. The Connecticut towns were as follow: Southampton, settled in 1640 by the Lynn men driven out of Hempstead by the Dutch, and in 1644–64 was under the Connecticut jurisdiction; and Southold (the "South Hold of New Haven"), which had a church and a code of law court based on the "cotton code." The colony joined New Haven in 1648, in which year the colony of Forretts (now Shelter) island also submitted to New Haven. Oyster bay and Easthampton were settled by people from Lynn in 1640 and 1648, respectively. Newton, subsequently named Hastings, was settled in 1652 and was annexed to Connecticut in 1662. Other early settlements were Huntington (1653), Jamaica (1657), Brookhaven (1655) and Smithtown (patented in 1677).

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Battle of Long Island, 1776.—The interest of this battle lies in the fact that it was the first engagement in the campaign of 1776 (*see* AMERICAN REVOLUTION) and was expected in England to be decisive of the contest in the colonies. After the evacuation of Boston (March 1776), Lord Howe moved against New York city, which he thought would afford a better base of operations for the future. The Americans undertook its defence although recognizing the difficulties in the case, as the bay and rivers adjoining would enable the British fleet to co-operate effectively with the army. To protect his left flank Washington was forced to throw a portion of his troops over to the Long Island side of the East river; they fortified themselves there on the site of the present Borough of Brooklyn. Lord Howe, who had encamped on Staten Island at the entrance to the harbour, determined to attack this isolated left wing, and on Aug. 22 landed at Gravesend bay, Long Island, with about 20,000 men. The Americans maintained strong outposts in the wooded hills in advance of their fortified lines. On the morning of the 27th Howe, after four days' reconnaissance, attacked these posts with three columns, the left and centre delivering the holding attack, and the right and strongest column turning the enemy's left by a détour. Howe himself, accompanied by Generals (Sir H.) Clinton and Lord Cornwallis, led the turning movement, which came upon the rear of the enemy at the moment when they were engaged with the two other columns. By noon the Americans had been driven back into the Brooklyn lines in considerable confusion, and with the loss of about half their number. This constituted the battle. The completeness of the British victory was due to the neglect of the Americans in guarding the left of their outposts. Howe has been criticized for not immediately assaulting the American works, which he might have carried on the evening of the battle. In view of the fact that he had only defeated a small portion of the American forces, and that the works were of considerable strength, he decided to make a formal siege, and Washington took advantage of the delay in operations to retreat across the river to New York on the night of the 29th. This successful movement repaired to some extent the bad moral effect of the defeat of the 27th in the American camp. In the engagement of Long Island Washington lost about 1,200 prisoners and 30 guns, and 400 killed and wounded; of the latter the British lost nearly the same number.

See Thomas Warren Field, "The Battle of Long Island," *Long Island Hist. Soc. Memoirs*, vol. ii. (1869); and Charles Francis Adams, "The Battle of Long Island," *Amer. Hist. Rev.*, vol. i., p. 650–670 (1896). (C. F. A.)

LONG ISLAND CITY, formerly a city of Queens county, New York, U.S.A. and since 1898 a part of the Borough of Queens, New York city. It has a river front, on East river and Long Island sound, of 10 miles. The first settlement within the limits of what subsequently became Long Island City was made in 1640 by a Dutch blacksmith, Hendrick Harmensen, who soon afterward was murdered by an Indian. Other settlers, both Dutch and English, soon followed, and established detached villages, which became known at Hunter's Point, Blissville, Astoria, Ravenswood, Dutch Kills, Middleton and Steinway. In 1853 this group of villages, by that time virtually one community, was called Long Island City, and it was formally incorporated under that name in 1870. It is the principal industrial area of Queens borough and ranks in number of plants among the first 20 communities of the United States. The industrial pay roll equals that of San Francisco, Calif. Food products lead and aircraft, shoes, paints, plastics, motion pictures and metal goods are other important products. The Sunnyside yards contain the country's largest Pullman storage space and busiest railway express depot. Astoria is the chief retail and residential section with 130,000 of the 240,000 population.

Railroad and vehicular tunnels and bridges linking it to Manhattan just across the East river, and near by La Guardia airport, enhance its industrial advantages.

See J. S. Kelsey, *History of Long Island City* (Long Island City, 1896); B. F. Thompson, *History of Long Island* (1918); and R. H. Gabriel, *The Evolution of Long Island* (1921).

LONGITUDE, the angle which the terrestrial meridian from the pole through a point on the earth's surface makes with some standard meridian, commonly that of Greenwich. It is equal to the difference between local time on the standard meridian, and at the place defined, one hour of time corresponding to 15° difference of longitude. Formerly each nation took its own capital or principal observatory as the standard meridian from which longitudes were measured. Another system had a meridian passing through or near the island of Ferro, defined as 20° W. of Paris, as the standard. While the system of counting from the capital of the country is still used for some purposes, the meridian of Greenwich has been used for nautical and international calculations since the Washington Meridian Conference of 1884. In astronomy, the longitude of a celestial body is the distance of its projection upon the ecliptic from the vernal equinox, counted in the direction west to east from 0° to 360°.

LONGLEY, CHARLES THOMAS (1794–1868), archbishop of Canterbury, was born at Rochester, and educated at Westminster and Oxford. He was ordained in 1818. He was headmaster of Harrow School (1829–36), bishop of Ripon (1836–56), bishop of Durham (1856–60), archbishop of York (1860–62), and archbishop of Canterbury (1862–68). The chief event of his primacy was the meeting at Lambeth, in 1867, of the first Pan-Anglican conference of British, colonial and foreign bishops (*see* LAMBETH CONFERENCES). He died on Oct. 27, 1868, at Addington Park, near Croydon.

LONGMANS, a firm of English publishers. The founder, Thomas Longman (1) (1699–1755), was the son of Ezekiel Longman, a gentleman of Bristol. Thomas was apprenticed in 1716 to John Osborn, a London bookseller. He married Osborn's daughter, and in 1724 purchased the goods of William Taylor, the first publisher of *Robinson Crusoe,* for £2,282 9s. 6d. Taylor's two shops in Paternoster Row were known respectively as the Black Swan and the Ship. Osborn, who afterwards entered into partnership with his son-in-law, held one-sixth of the shares in Ephraim Chambers's *Cyclopaedia of the Arts and Sciences,* and Thomas Longman was one of the six booksellers who undertook the responsibility of Samuel Johnson's *Dictionary.* In 1754 Thomas Longman took his nephew into partnership, the title of the firm becoming T. and T. Longman.

Upon the death of his uncle in 1755, Thomas Longman (2) became sole proprietor. He had three sons. Of these, Thomas Norton Longman (3) succeeded to the business. In 1794 Owen Rees became a partner, and Thomas Brown, who was for many years after 1811 a partner, entered the house as an apprentice. He published the works of Wordsworth, Coleridge, Southey and Scott. In 1824 the title of the firm was changed to Longman, Hurst, Rees, Orme, Brown & Green. In 1814 arrangements were made with Thomas Moore for the publication of *Lalla Rookh,* for which he received £3,000; and when Archibald Constable failed in 1826, Longmans became the proprietors of the *Edinburgh Review.*

Thomas Norton Longman (3) died on Aug. 29, 1842, leaving his two sons, Thomas (4) and William Longman in control. They first published Macaulay's *Lays of Ancient Rome,* which was followed in 1849 by the issue of the first two volumes of his *History of England,* which in a few years had a sale of 40,000 copies. Both brothers had literary talent; Thomas Longman edited a beautifully illustrated edition of the New Testament, and William Longman wrote a *History of the Three Cathedrals dedicated to St. Paul* (1869) and a work on the *History of the Life and Times of Edward III.* (1873). In 1890 they incorporated all the publications of the firm of Rivington, established in 1711. The family control of the firm (now Longmans, Green & Co.) was continued by Thomas Norton Longman (5), son of Thomas Longman (4).

LONGMONT, a city of Boulder county, Colorado, U.S.A., 35 mi. N. by W. of Denver, and 32 mi. E. of the Rocky Mountain National park; at an altitude of 4,950 ft. Longs peak is visible in the distance. Longmont is on federal highway 87, and is served by the Burlington, the Colorado and Southern, and Great Western railways. Pop., 6,029 in 1930; 7,406 in 1940. It is a trading and shipping point for the fertile irrigated region around it, and has an immense beet-sugar factory, large flour mills and vegetable canneries. Gold and lignite coal are mined near by.

LONGOMONTANUS (or LONGBERG), **CHRISTIAN SEVERIN** (1562–1647), Danish astronomer, was born at Longberg in Jutland, Denmark, on Oct. 4, 1562. The appellation Longomontanus was a Latinized form of the name of his birthplace. In 1577 he ran away to Viborg, where he attended the grammar-school, defraying his expenses by manual labour, and went to Copenhagen in 1588 with a high reputation for learning and ability. Engaged by Tycho Brahe in 1589 as his assistant in his great astronomical observatory of Uraniborg, he rendered him invaluable services there during eight years. He quitted the island of Hveen with his master, but obtained his discharge at Copenhagen on June 1, 1597, for the purpose of studying at some German universities. He rejoined Tycho at Prague in January 1600, and having completed the Tychonic lunar theory, turned homeward again in August. He visited Frauenburg, where Copernicus had made his observations, took a master's degree at Rostock, and at Copenhagen found a patron in Christian Friis, chancellor of Denmark, who gave him employment in his household. Appointed in 1603 rector of the school of Viborg, he was elected two years later to a professorship in the university of Copenhagen, and his promotion to the chair of mathematics ensued in 1607. This post he held till his death, on Oct. 8, 1647.

He inaugurated, at Copenhagen in 1632, the erection of a stately astronomical tower, but did not live to witness its completion. Christian IV. of Denmark, to whom he dedicated his *Astronomia Danica,* an exposition of the Tychonic system of the world, conferred upon him the canonry of Lunden in Schleswig.

The following is a list of his more important works in mathematics and astronomy: *Systematis Mathematici,* etc. (1611); *Cyclometria e Lunulis reciproce demonstrata,* etc. (1612); *Disputatio de Eclipsibus* (1616); *Astronomia Danica,* etc. (1622); *Disputationes quatuor Astrologicae* (1622); *Pentas Problematum Philosophiae* (1623); *De Chronolabio Historico, seu de Tempore Disputationes tres* (1627); *Geometriae quaesita XIII. de Cyclometria rationali et vera* (1631); *Inventio Quadraturae Circuli* (1634); *Disputatio de Matheseos Indole* (1636); *Coronis Problematica ex Mysteriis trium Numerorum* (1637); *Problemata duo Geometrici* (1638); *Problema contra Paulum Guldinum de Circuli Mensura* (1638); *Introductio in Theatrum Astronomicum* (1639); *Rotundi in Plano,* etc. (1644); *Admiranda Operatio trium Numerorum* 6, 7, 8, etc. (1645); *Caput tertium Libri primi de absoluta Mensura Rotundi plani,* etc. (1646).

See J. B. J. Delambre, *Hist. de l'astr. moderne,* i. 262; J. S. Bailly, *Hist. de l'astr. moderne,* ii. 141; J. L. E. Dreyer, *Tycho Brahe,* pp. 126, 259, 288, 299; F. Hoeffer, *Hist. de l'astronomie,* p. 391; J. Mädler, *Geschichte der Himmelskunde,* i. 195; J. F. Weidler, *Hist. Astronomiae,* p. 451.

LONG PRIMER, a printing type, in size larger than bourgeois and smaller than small pica. It is also known as 10-point. The term describes size only, and does not indicate any particular design. The following passage is printed in long primer:

> "Until well into the 19th century types were cast in small hand moulds, the output from which was about 400 letters an hour by a skilled worker."

This size of type is among those most frequently used in book printing. (*See* PRINTING TYPE.)

LONGS PEAK, a peak of the Front Range in Boulder county, Colorado. It is the 14th highest summit in the State, attaining an elevation of 14,255 ft. above sea-level. The peak was named in honour of Major S. H. Long who, in 1820, led an exploring party into the valleys of the South Platte and the Arkansas and made the first official report of the existence of the peak.

LONGSTREET, JAMES (1821–1904), American soldier, lieutenant general in the Confederate army, was born on Jan. 8, 1821, in Edgefield district, S.C., and graduated from West Point in 1842. He was severely wounded in the Mexican war, and received two brevets for gallantry. In 1861, having attained the rank of major, he resigned when his state seceded, and became a brigadier general in the Confederate army. In this rank he fought at the first battle of Bull Run, and at the head of a division in the Peninsular campaign and the Seven Days. This division later became the nucleus of the 1st corps, army of northern Virginia, which was commanded throughout the war by Longstreet, and took part in the second battle of Bull Run, Antietam and Fredericksburg. Most of the corps was absent in North Carolina when the battle of Chancellorsville took place, but Longstreet, now a lieutenant general, returned to Lee in time to take part in the campaign of Gettysburg. In Sept. 1863 he took part in the great battle of Chickamauga. In November he commanded the unsuccessful expedition against Knoxville. In 1864 he rejoined Lee's army in Virginia, and on May 6 arrived upon the field of the Wilderness as the Confederate right had been turned and routed. His attack was a model of impetuosity and skill, and drove the enemy back until their entire force upon that flank was in confusion. At this critical moment, as Longstreet in person, at the head of fresh troops, was pushing the attack in the forest he was fired upon by mistake by his own men and desperately wounded. This mischance stayed the Confederate assault for two hours, and enabled the enemy to provide effective means to meet it. In Oct. 1864 he resumed command of his corps, which he retained until the surrender, although paralyzed in his right arm.

During the period of Reconstruction, Longstreet's attitude toward the political problem, and the discussion of certain military incidents, notably the responsibility for the Gettysburg failure, brought the general into extreme unpopularity. His admiration for General Grant, and his loyalty to the Republican party accentuated the ill-feeling of the southern people. But in time his services in former days were recalled, and he became once more "General Lee's war-horse" to his old soldiers and the people of the south.

He held several civil offices, among them that of minister to Turkey under Grant, and that of commissioner of Pacific railways under Presidents McKinley and Roosevelt. In 1896 he published *From Manassas to Appomattox*, and in his later years he prepared an account of Gettysburg, which was published soon after his death, with notes and reminiscences of his whole military career. He died at Gainesville, Ga., on Jan. 2, 1904.

See Helen D. Longstreet, *Lee and Longstreet at High Tide* (1904), also Sir F. Maurice, *Statesmen and War* and *Robert E. Lee*.

LONGTON, a former market town of Stoke-on-Trent municipal county and parliamentary borough, Staffordshire, England. In 1910 it amalgamated with neighbouring towns to form the municipal borough of Stoke-on-Trent (*q.v.*) which in 1925 became a city.

LONGUEVILLE, ANNE GENEVIEVE, DUCHESSE DE (1619–1679), was the only daughter of Henri de Bourbon, Prince de Condé, and the sister of Louis, the great Condé (*q.v.*). She was the guiding spirit of the first Fronde, (*q.v.*) when she brought over Armand, Prince de Conti, her second brother, and her husband to the malcontents, but she failed to attract Condé himself, whose loyalty to the court overthrew the first Fronde.

The second Fronde was largely her work, and in it she played the most prominent part in attracting to the rebels first Condé and later Turenne. After the war she became more and more Jansenist in opinion.

In her house Antoine Arnauld, Pierre Nicole (*qq.v.*) and De Lane were protected. Her letters to the pope are part of the history of PORT ROYAL (*q.v.*), and as long as she lived the nuns of Port Royal des Champs were left in safety.

As her health failed she hardly ever left the convent of the Carmelites in which she had been educated. On her death in 1679 she was buried with great splendour by her brother Condé, and her heart, as she had directed, was sent to the nuns of Port Royal des Champs.

The chief authority for Madame de Longueville's life is a little book in two volumes by Villefore the Jansenist, published in 1738. Victor Cousin has devoted four volumes to her, which, though immensely diffuse, give a vivid picture of her time. *See* also Sainte-Beuve, *Portraits of Women* (tr. 1891). Her connection with Port Royal should be studied in Arnauld's *Memoirs*, and in the different histories of that institution. *See* also Hugh Noel Williams, *A Princess of Intrigue, Anne Geneviève de Bourbon, Duchesse de Longueville, and her Times* (1908).

LONGUS, Greek romancer, author of *Daphnis and Chloë*. All that can be said about him is that he probably lived at the end of the 2nd or the beginning of the 3rd century A.D. Even the name attributed to the author may be a misreading of the title of the work.

Longus's style is rhetorical, his shepherds and shepherdesses are wholly conventional, but he has imparted human interest to a purely fanciful picture. As an analysis of feeling *Daphnis and Chloë* makes a nearer approach to the modern novel than its chief rival among Greek erotic romances, the *Aethiopica* of Heliodorus, which is remarkable mainly for the ingenious succession of incidents. Daphnis and Chloë, two children found by shepherds, grow up together, nourishing a mutual love which neither suspects. The development of this simple passion forms the chief interest, and the only notable incident is the abduction of Chloë by a pirate. The two lovers eventually discover their parents and marry.

See J. Dunlop, *History of Prose Fiction* (1888), and especially E. Rohde, *Der griechische Roman* (1900). Longus found an incomparable translator in Jacques Amyot, bishop of Auxerre, whose French version, as revised by Paul Louis Courier, is better known than the original. It appeared in 1559, 39 years before the publication of the Greek text at Florence by Columbani. The chief subsequent editions are those by G. Jungermann (1605), J. B. de Villoison (1778, the first standard text with commentary), A. Coraes (Coray) (1802), P. L. Courier (1810, with a newly discovered passage), E. Seiler (1835), R. Hercher (1858), N. Piccolos (Paris, 1866) and Kiefer (Leipzig, 1904), W. D. Lowe (Cambridge, 1908). A. J. Pons's edition (1878) of Courier's version contains an exhaustive bibliography. There are English translations by G. Thorneley (1733, reprinted 1893), C. V. Le Grice (1803); R. Smith (in Bohn's *Classical Library*), and the rare Elizabethan version by Angel Day from Amyot's translation (ed. J. Jacobs in *Tudor Library*, 1890).

LONGVIEW, a city of eastern Texas, on federal highway 80, near the Sabine river; the county seat of Gregg county. It is served by the Santa Fe, the Texas and Pacific and Missouri Pacific railways. Pop. (1930) 5,036; (1940) 13,758. The city was founded in 1871 and incorporated in 1882.

LONGWY, a fortified town of northeastern France in the department of Meurthe-et-Moselle, 89 mi. N.N.W. of Nancy by rail. Pop. (1936) 6,024. It is situated on a plateau overlooking the Chiers, a right-bank affluent of the Meuse, near the frontiers of Belgium and Luxembourg. Longwy (*Longus vicus*) came into the possession of the French in 1678 and was at once fortified by Vauban. It was captured by the Prussians in 1792, 1815 and 1871. It comprises an upper and a lower town; the former, on a hill, 390 ft. above the Chiers valley, commands the Luxembourg road, and is fortified. The 17th-century church has a high square tower and the hôtel de ville dates from 1730.

LÖNNROT, ELIAS (1802–1884), Finnish philologist and discoverer of the *Kalevala*, was born at Nyland, Finland, on April 9, 1802. He entered the university of Åbo in 1822, and qualified as a physician.

As early as 1827, he had begun to publish contributions to the study of the ancient Finnish language, and to collect the national ballads and folk-lore. In 1833 he settled as a doctor in the country district of Kajana, and began to travel throughout Finland and the adjoining Russian provinces, collecting songs and legends. In this way he was able to put together the great epic of Finland, the *Kalevala*, the first edition of which he published in 1835; he continued to add to it, and in 1849 issued a larger and completer text.

Lönnrot also published an important collection (1840) of the *Kanteletar*, or folk-songs of ancient Finland, which he had taken down from oral tradition; and the *Proverbs of Finland* (1842). In 1853 Lönnrot succeeded Castrén as lecturer on the Finnish language and literature at the Helsingfors high school; he retired in 1862. He died on March 19, 1884.

LONSDALE, EARLS OF. This English earldom is held by the ancient family of Lowther, which traces its descent to Sir Hugh Lowther, who flourished in the reign of Edward I. Sir Hugh's descendant Sir Richard Lowther (1529–1607) received Mary queen of Scots on her flight into England in 1568, and in the two following years was concerned with his brother Gerard in attempts to release her from captivity. He was sheriff of

Cumberland and lord warden of the west marches. Sir Richard's eldest son, Sir Christopher Lowther (d. 1617), was the ancestor of the later Lowthers, and another son, Sir Gerard Lowther (d. 1624), was judge of the common pleas in Ireland.

One of Sir Christopher's descendants was Sir John Lowther, Bart. (d. 1706), the founder of the trade of Whitehaven, and another was John Lowther (1655–1700), who was created Viscount Lonsdale in 1696. Before this creation John had succeeded his grandfather, another Sir John Lowther (d. 1675), as a baronet. In 1690 he was first lord of the treasury, and he was lord privy seal from March 1699 until his death in July 1700.

James Lowther, 1st earl of Lonsdale (1736–1802), was descended from Sir Christopher Lowther; through his mother, James was a great-grandson of the 1st Viscount Lonsdale. From 1757 to 1784 he was a member of parliament, exercising enormous influence on elections in the north of England on account of his great wealth, and controlling nine seats in the house of commons, where his nominees were known as "Sir James's ninepins." In 1784 Lowther was created earl of Lonsdale and in 1797 Viscount Lowther with an extended remainder.

The earldom became extinct in 1802, but was revived in 1807, and William Lowther (1757–1844), a cousin of James Lowther, was created the 1st earl of Lonsdale after the earldom was revived. He was succeeded by his eldest son, William Lowther II (1787–1872), upon whose death a nephew, Henry Lowther (1818–76), became the 3rd earl. St. George Henry Lowther (1855–82), son of Henry Lowther, and 4th earl, was succeeded by his brother, Hugh Cecil Lowther, 5th earl of Lonsdale. He died on April 13, 1944.

LONSDALE, WILLIAM (1794–1871), English geologist and palaeontologist, born at Bath on Sept. 9, 1794, was educated for the army, and in 1810 was gazetted as ensign in the 4th (King's Own) regiment. He served in the Peninsular War at the battles of Salamanca and Waterloo, for both of which he received medals; and he retired as lieutenant. At his home at Batheaston he collected a series of rocks and fossils which he presented to the Literary and Scientific Institution of Bath. He became the first honorary curator of the natural history department of the museum.

He was assistant secretary and curator of the Geological society of London at Somerset House from 1829 to 1842. In 1829 Lonsdale read before the society an important paper "On the Oolitic District of Bath" (*Trans. Geol. Soc.* ser. 2, vol. iii), the results of a survey begun in 1827; later he was engaged in a survey of the Oolitic strata of Gloucestershire (1832), and he laid down on the one-inch ordnance maps the boundaries of the various geological formations.

He became the highest authority in England on corals, and he described fossil forms from the Tertiary and Cretaceous strata of North America and from the older strata of Britain and Russia. In 1837 he suggested from a study of the fossils of the South Devon limestones that they would prove to be of an age intermediate between the Carboniferous and Silurian systems. This suggestion was adopted by Sedgwick and Murchison in 1839, and may be regarded as the basis on which they founded the Devonian system.

Lonsdale's paper, "Notes on the Age of the Limestones of South Devonshire" (read 1840), was published in the same volume of the *Transactions of the Geological Society* (ser. 2, vol. v) with Sedgwick and Murchison's famous paper "On the Physical Structure of Devonshire." Lonsdale died at Bristol on Nov. 11, 1871.

LONS-LE-SAUNIER, a town of E. France, capital of the department of Jura, 76 mi. N.N.E. of Lyons on the P.L.M. Ry., on which it is a junction for Chalon-sur-Saône, Dôle, Besançon and Champagnole. Pop. (1936) 14,593. The town is on both sides of the river Vallière and is surrounded by the vine-clad hills of the western Jura.

Lons-le-Saunier, known as *Ledo* in the time of the Gauls, was fortified by the Romans, who added the surname *Salinarius* to the Gallic name. An object of contention owing to the value of its salt, it belonged for a long time during the mediaeval period to the house of Chalon. It was burned in 1364 by the English, and again in 1637, when it was seized by the duke of Longueville for Louis XIII. It became definitely French in 1674. There the meeting between Ney and Napoleon took place, on the latter's return from Elba in 1815.

The town owes its name to the salt mines of Montmorot, its western suburb, which have been used from early times. The church of St. Désiré (12th and 15th centuries), has a huge Romanesque crypt. The town is the seat of a prefect and of a court of assizes, and there are tribunals of first instance and of commerce and a chamber of commerce. There are sodio-chlorinated mineral waters. The principal industry of the place is the manufacture of sparkling wines.

LOO, formerly called "Lanterloo" (Fr. *lanturlu,* the refrain of a popular 17th century song), a game of cards, invariably played for a stake. The players may number from five to about nine, each for himself. The pack of 52 cards is used.

In the simplest form of the game, three cards are dealt to each player, and the next is turned for trump. Eldest hand leads, and one-third of the pool goes to the winner of each trick. The pool is formed by antes before each deal, and may be increased by payments for *loo* (failure to win a trick) and fines for irregularities.

Among the features added to this base are found:

1. Turn of a card for trump is deferred until the first time any hand fails to follow suit. The trump then fixed affects the winning of the current and any subsequent tricks.

2. The first pool is a *single,* three counters put in by dealer alone. The players who are looed pay three counters each to the next pool, making it a *double.*

An extra hand called the *miss* is dealt at the right of the next dealer. Each player in turn, eldest hand first, must *pass, stand* or take the miss if it is still available. The player who takes the miss discards his original hand. After the miss is taken, the remaining players must pass or stand. All who pass throw in their cards; all who stand must play. Dealer must take the miss if no other does, playing for himself or "for the pool" (in which case his winnings if any remain in the next pool). The pool is divided, one-third for each trick. Players looed contribute to the next pool. Whenever the pool is cleared, the next deal is a *single,* otherwise the *doubles* continue.

3. The first dealer (eldest hand of those who stand) must lead the ace of trumps if he has it, or the king if the ace was previously turned for trump. The leader is also bound to lead a trump if he has two. Each player must *head* a trick if able, by playing higher in the suit led, by trumping if void of the suit led, or by playing a higher trump than any previously played to the trick.

4. A player dealt a *flush* wins the pool without play. A flush is three trumps.

5. The penalty for loo is to double the current pool. This variant, unlimited loo, has caused some considerable fortunes to change hands.

6. The hand may be five cards instead of three.

7. The turned trump may be taken up by the dealer in place of a discard.

8. *Pam,* the knave of clubs, is always the highest trump. It may be used as a "wild card" to complete a *flush* or a *blaze.* A flush is five trumps; a blaze is five court cards. The holder of either wins the pool without play.

9. Pam may be withheld on a trump lead, and must be withheld if the leader of the trump ace says, "Pam be civil!"

See J. Warren, *Rules for Three Card Loo* (1820); *The Laws of Loo of the Blenheim Club* (London, 1866).

LOOE, a seaport and market town of Cornwall, England, 17 mi. by sea W. of Plymouth. Pop. (est. 1938) 3,088. It is divided by the river into East Looe and West Looe; and is so sheltered by the surrounding hills that myrtles, geraniums, fuchsias and other delicate plants flourish at all seasons in the open air. Its lanes are narrow, steep and winding; many of the houses are entered by wooden staircases. Area of urban district 2.6 sq.mi.

The harbourage was probably the original cause of settlement. At the time of the Domesday Survey East Looe was assessed under Pendrym, which was of the king's demesne and West Looe under Hamelin's manor of Trelowia. In the 14th century the former manor was held by the family of Bodrugan; the latter by that of Dauney. In 1237 Henry Bodrugan received the grant of a market on Fridays and a fair at Michaelmas in his manor of Pendrym. In 1301 East Looe was granted a market and fair, and other privileges. Otto Bodrugan in 1320 granted the burgesses the privilege of electing their own portreeve and controlling the trade of the town. A charter of incorporation was granted in 1587 under which the common council was to consist of a mayor and 8 chief burgesses. There was to be a court of record, a market on Saturdays and fairs at Michaelmas and Candlemas. In 1685 James II provided that there should be a mayor and 11 aldermen, 36 free burgesses, 4 fairs and a court of pie powder. East Looe was governed under this charter until 1885. West Looe (known also as Porpighan or Porbuan), was constituted a free borough by a charter ratified in 1325. There were to be a market on Wednesdays and a fair at Michaelmas. Upon the attainder of the earl of Devon in 1539 the borough fell to the crown and was annexed to the duchy. In 1574 a charter of incorporation was granted providing for a mayor and 11 burgesses, also for a market on Wednesdays and two fairs. West Looe continued to be administered under this charter until 1869. Looe was second only to Fowey as a port in the 15th century. It furnished 20 ships for the siege of Calais. Of the markets and fairs only the markets on Wednesdays and Saturdays and a fair on May 6 remain.

The parish church of St. Martin, 1 mi. outside the town, has a Norman doorway and font. The ancient chapel of St. Nicholas in West Looe was restored in 1862; in the old town hall is preserved the ancient pillory. A considerable export trade in copper, tin and granite was formerly carried on; grain, granite, fish and clay are now exported; while timber, coal, limestone and manure are imported. There are also thriving fisheries, the Looe fishermen being particularly expert with the seine on a rocky bottom.

LOOFAH: *see* LUFFA.

LOOM. A machine for weaving fabrics by intersecting the longitudinal threads, the "warp," *i.e.,* "that which is thrown across," with the transverse threads, the "weft," *i.e.,* "that which is woven." (*See* WEAVING.)

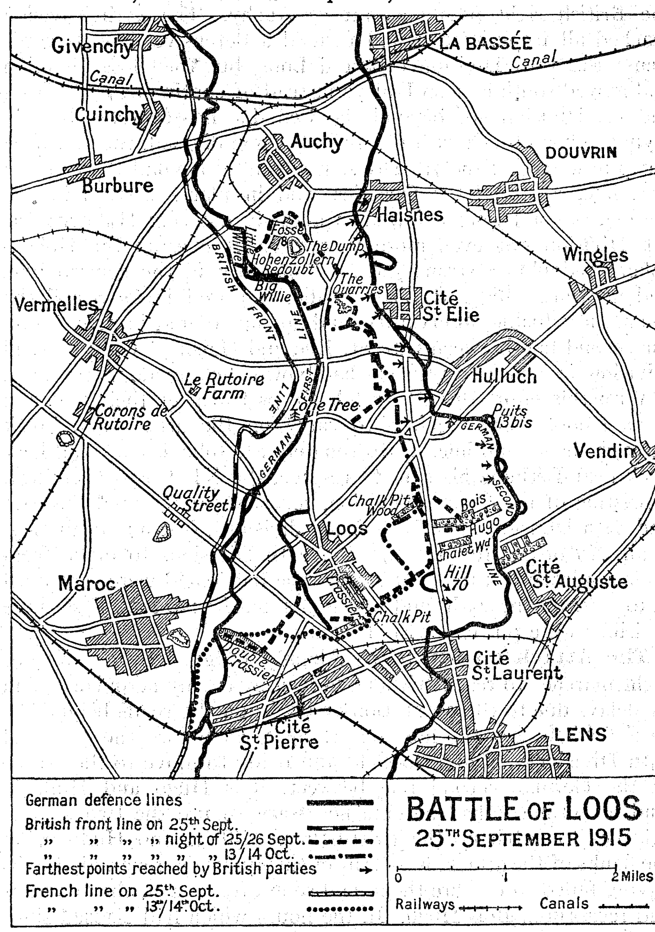
LOON, largest municipality in rank of population of the island and province of Bohol, Philippine Islands, on the extreme west coast. Pop. (1939) 28,799. It is picturesquely situated on the west slope of a hill and is reached from the sea by steps cut in the rocks. The harbour is in a sheltered bay on the north side of the place. Agriculture and livestock raising are the principal industries. The chief products are coconuts, maguey, tobacco, cotton and maize (corn). Cebuano, a dialect of Bisayan, is the principal vernacular. Of the inhabitants aged 6 to 19 inclusive, 26.3% in 1939 attended school; of the population aged 10 years and over, 34.4% was literate.

LOON, any of several primitive, large, fish-eating diving birds constituting the genus *Gavia* and order Gaviiformes, inhabiting circumpolar northern regions. The common loon or great northern diver (*G. immer*), 32 in., occurs from Arctic coasts to northern United States, has an iridescent black head, white-spotted black back and wings and white under parts; the lesser loon (*G. i. elasson*) occurs in the Dakotas and perhaps nearby regions. The smaller European black-throated diver (*G. arctica*) occurs in northern Europe and Scotland, with *G. a. suschkini* in western Siberia, the green-throated loon (*G. a. viridigularis*) on the coast of northeastern Siberia and western Alaska, and the Pacific loon (*G. a. pacifica*) from Point Barrow and the Alaska peninsula east to Southampton Island. The red-throated loon (*G. stellata*) ranges from Arctic coasts to Sweden, northern Russia, Kamchatka, the Aleutians and southern Canada. The yellow-billed loon (*G. adamsii*) is found on Arctic coasts from eastern Siberia to the Mackenzie Delta of northern Canada. The loon dives at the flash of a gun, swims long distances under water, has gooselike flight and is nearly helpless on land because the short powerful legs are so far back at rear end of body. The smooth head and slender, dagger bill distinguish it from near-related water birds. Two mottled olive eggs are laid on a mass of soggy vegetation. (*See* DIVER.) (G. F. Ss.)

LOOS, THE BATTLE OF (Sept. 25–Oct. 19, 1915), is the name given to the actions fought by the British in the great Allied offensive in France in the autumn of 1915.

The French Plan.—The plan elaborated by Gen. Joffre was to attack on both sides the great salient formed by the German front in France: on the right in Champagne with the French II. and IV. Armies, the main effort; and on the left in Artois with the X. Army. He hoped by these two operations to cut off the enemy troops in the salient and get astride their communications. He asked that the British should co-operate by attacking in Artois on the left of the X. Army. This army was commanded by Gen. D'Urbal and in the group of armies under Gen. Foch. Field-Marshal Sir John French was opposed to committing his troops to battle until the spring following, by which time further reinforcements and more guns and ammunition would have arrived. The B.E.F. had suffered very heavy losses at Neuve Chapelle, Second Ypres, Aubers and Festubert earlier in the year; had recently taken over a considerable portion of the French front with the newly-formed III. Army; the Territorial and New Army divisions recently sent to France required more training; and the force possessed very few heavy guns and was woefully short of ammunition and equipment for trench warfare.

In view of the German successes in Russia and the necessity for assisting France to the utmost, the British Government felt compelled to abandon the natural policy of waiting until such time as sufficient munitions could be prepared and the newly raised forces were ready before taking the offensive. Sir John French was therefore given definite orders to co-operate with the French. The I. Army under Gen. Sir. D. Haig, was selected to carry out the attack. Both Sir John French and Gen. Haig were opposed to attacking in the area between Lens and the La Bassée canal, as Gen. Foch required; for it involved advancing



over very unfavourable ground, open, but dotted with coal mines and mining villages: whilst Lens and its suburbs formed one vast industrial town. They suggested an objective further north. This proposal was overruled.

The Employment of Gas.—Whilst the British leaders were doing their best, against their better judgment, to prepare the offensive at a spot not of their own selection and with totally inadequate artillery, the first consignment of chlorine gas arrived, for trial. Its use seemed to promise a chance of surprise and provide a solution of the problem of attack with inadequate means. A sufficient supply of gas was manufactured and preparations were made to employ it. After four days' bombardment, during the later part of which the weather was unsuitable for flying and observation, on Sept. 25 the offensive was begun simultaneously in Champagne (30 French divisions) and Artois (17 French and nine—later 12—British divisions), whilst diversions were made at other parts of the line: by the British near Givenchy, Neuve Chapelle and Hooge; by the Belgians near Nieuport; and by the navy on the coast. On the British front gas and smoke were discharged for 40min. preceding the assault, which took place at 6:30 A.M. The French X. Army did not leave its trenches until 12:45 P.M. and even then the Allied contingents in Artois were not shoulder to shoulder, for between them opposite Lens was left a passive front of 3m. held by a French Territorial division.

The Assault on Sept. 25.—The British assault was made by the 47th (2nd London Territorial), 15th (Scottish, of the New Army), and 1st Divisions of the IV. Corps (Rawlinson), and the 7th, 9th (Scottish, of the New Army) and 2nd Divisions of the I. Corps (Gough). Although the wind was very feeble, and on the front of the 2nd Division unfavourable so that the gas and smoke blew back, considerable success was obtained by the British. The German defences comprised two separate positions (*see* sketch) disposed on the great rolling plain in which the spurs of the Artois plateau sink down. In spite of insufficient bombardment, the German front line position was overrun from the British right nearly as far as Auchy. The 47th Division reached all its objectives and formed a defensive flank towards Lens; the 15th Division captured Loos, but then lost direction and moved south-east on Hill 70 instead of continuing eastwards; the 1st Division got beyond the Lens-La Bassée road, but, in trying to keep touch with the 15th, became divided, thus creating a gap in its front; the 7th Division advanced beyond the German first line, captured the Quarries, and in places arrived at the German second line, a few men actually entering Hulluch; the 9th Division was even more successful: it overran the Hohenzollern redoubt, a strong independent work in the general line, and its wings, Big and Little Willie, captured Fosse 8 and the Dump, a valuable observatory, and got up to, and in places into, the second line between Cité St. Elie and Haisnes. Only the 2nd Division, in whose area the gas had blown back, made no progress.

With this effort the IV. and I. Corps had shot their bolt and fresh troops were required to carry on the attack and break through the second line. Unfortunately Sir John French had kept back near Béthune his general reserve, the XI. Corps (Haking), consisting of the Guards Division, recently formed, and the 21st and 24th Divisions, two New Army divisions, just out from England. No orders for the 21st and 24th Divisions to move from their rendezvous 5 to 8 miles from the battlefield were sent until 9:30 A.M. on the 25th, and it was not until 1:20 P.M. that these divisions were put under Sir D. Haig.

The Attack on Sept. 26.—Already fatigued by a series of night marches to reach Béthune unseen by enemy aeroplanes, and by delays due to the congestion of traffic on the roads behind the battlefield, it was the morning of Sept. 26 before the 21st and 24th Divisions were on the field and ready to move to the attack of the German second line between Bois Hugo and Hulluch. And meantime it had become necessary to use the two leading brigades to patch up the British line. Hill 70 and Hulluch, on the flanks of the attack, were still in enemy hands, renewed attacks having failed to capture them, and soon after 9 A.M. the Germans had recaptured Bois Hugo. In the hours which had elapsed since the original attack, they had recovered from their surprise, brought up reinforcements and strengthened their second line. During the night of the 25th–26th and early morning of the 26th they made counter-attacks on both flanks of the line gained by the British in the first advance and recovered part of the lost ground.

The attack of the four remaining brigades of the two divisions at 11 A.M. against the intact second line was a failure, though some units actually reached the wire entanglement in front of it. Eventually the men, new to war, having done all that was possible, began to stream back. The Guards Division was brought up to fill the gap in the line that their retirement caused, and the 3rd Cavalry Division to stiffen the defence near Loos village. The French X. Army, having no gas, had less success than the British; but its persistent attacks, against the crest of Vimy Ridge by Gen. Foch's orders, caused the Germans to divert the Guard Corps from the British to the French front.

After Sept. 26 the fighting became desultory and degenerated into trench warfare, and on the 30th the French offensives, both in Champagne (where also no success had been achieved) and Artois, were formally stopped in order to prepare for another combined effort. Delays brought about by bad weather, enemy interference with the preparations and enemy counter-attacks, led to postponement after postponement.

The Last Phase.—Finally a renewed French attack in Champagne was made on Nov. 6, a French attack in Artois on Nov. 11, and a British (fresh divisions, the 12th, 28th and 46th having arrived) on the 13th, with no result but heavy casualties. Trench fighting, particularly round the Hohenzollern Redoubt, went on for several days longer, and then both sides settled down to winter conditions. The fighting of the year had but proved that, with the guns and munitions then available, the defence was still stronger than the attack. The British losses in the battle of Loos included three divisional commanders killed (Maj.-Gen. Sir T. Capper, G. H. Thesiger and F. D. V. Wing) and 2,407 officers and 57,985 other ranks killed, wounded and missing, and were probably three times as heavy as those of the enemy.

See *History of the Great War Based on Official Documents,* "Military Operations France and Belgium, 1915," vol. ii. (1928, where there is a bibl.); *Les Armées Françaises dans la Grande Guerre,* tome iii. (1922); M. Schwarte, *Ed., Der grosse Krieg, 1914–1918,* vol. ii. (1921–25). (J. E. E.)

LOOSESTRIFE, the common name of any plant of the genus *Lysimachia* of the family Primulaceae. The Eurasian *L. vulgaris,* an erect plant, 2 to 4 ft. high, is common on river banks in England; the branched stem bears tapering leaves in pairs or whorls, and terminal panicles of rather large deep yellow flowers. *L. nemorum,* yellow pimpernel or wood loosestrife, a low-growing plant with slender spreading stem and yellow flowers standing singly in the leaf-axils, is frequent in England. *L. Nummularia* is the well known creeping jenny or moneywort, a larger plant with widely creeping stem, pairs of shining leaves and large solitary yellow flowers; it is found on banks of rivers and damp woods, and is a common rockery plant. Purple loosestrife, *Lythrum Salicaria,* belongs to a different family, Lythraceae. It is a handsome plant growing 2 to 6 ft. high on river banks and ditches with a branched stem bearing whorls of narrow pointed stalkless leaves and ending in tall tapering spikes of beautiful rose-purple flowers. The flowers are trimorphic, that is to say, exist in three forms which differ in the relative length of the styles and stamens and are known as long-styled, mid-styled and short-styled forms respectively; the size and colour of the pollen also differ. These differences are important in the pollination of the flower, making self-fertilization next to impossible. (*See* POLLINATION.)

LOPE DE VEGA: *see* VEGA CARPIO, LOPE FELIX DE.

LOPES, FERNAO (1380?–1460?) (FERNAM LOPEZ), the patriarch of Portuguese historians, was appointed keeper of the royal archives, then housed in the castle of St. George in Lisbon, by King John I. in Nov. 1418. He acted as private secretary to the Infantes D. Duarte and D. Fernando, and when the former ascended the throne he charged Lopes, by a letter of March 19, 1434, with the work of "putting into chronicles the stories of the kings of old time as well as the great and lofty actions of the most virtuous king my lord and father" (John I.). King Alphonso V. confirmed him in his post by a letter of June 3, 1449, and in 1454, after 36 years' service in the archives and 20 as chronicler he resigned in favour of Gomes Eannes de Zurara. The modern historian Herculano says, "there is not only history in the chronicles of Fernão Lopes, there is poetry and drama as well; there is the middle age with its faith, its enthusiasm, its love of glory." Lopes has been called the Portuguese Froissart, and that rare gift, the power of making their subjects live, is common to the two writers; indeed, had the former written in a better-known language, there can be little doubt that the general opinion of critics would have confirmed that of Robert Southey, who called Lopes "beyond all comparison the best chronicler of any age or nation." He had an excellent subject and his scenes are full of dramatic detail. He is a picturesque chronicler and he is a national historian. Lopes composed a general chronicle of the kingdom, which almost certainly served as a foundation for the chronicles of Ruy de Pina. Lopes prepared himself for his work with care and diligence by a study of the archives belonging to municipalities, monasteries and churches, both in Portugal and Spain. He is usually a trustworthy guide in facts and charms the reader by the naïve simplicity of his style.

BIBLIOGRAPHY.—Extant works of Lopes are: *Chronica de D. João I.* (1644; part 1, ed. Braamcamp Freire, 1915); *Chronica de D. Pedro I.*, in vol. iv. of the *Collecção de Livros Ineditos da Historia Portugueza* (1816); *Chronica de D. Fernando,* published in the same volume.

See Damião de Goes, *Chronica del Rei Dom Manoel,* part 4, ch. xxxviii.; A. F. G. Bell, *Fernam Lopez* (1922); *Fernão Lopes* in *Antologia Portuguesa* (3 vols., 1921–22); E. Prestage, *The Chronicles of Fernão Lopes*, etc. (Watford, 1928). (E. P.; A. B.)

LÓPEZ, CARLOS ANTONIO (1790–1862), ruler of Paraguay, was born at Asunción on Nov. 4, 1790, and was educated in the ecclesiastical seminary of that city. He attracted the hostility of the dictator, Francia, and was forced to keep in hiding for several years. He acquired, however, so unusual a knowledge of law and governmental affairs that, on Francia's death in 1840, he obtained an almost undisputed control of the Paraguayan State, which he maintained uninterruptedly until his death on Sept. 10, 1862. He was successively secretary of the ruling military *junta* (1840–41), one of the two consuls (1841–44) and president with dictatorial powers (1844–62) by successive elections for ten and three years, and in 1857 again for ten years, with power to nominate his own successor. Though nominally a president acting under a republican Constitution, he ruled despotically. His government was in general directed with wise energy towards developing the material resources and strengthening the military power of the country. His jealousy of foreign approach several times involved him in diplomatic disputes with Brazil, England and the United States, which nearly resulted in war, but each time he succeeded in extricating himself by skilful evasions.

LÓPEZ, FRANCISCO SOLANO (1827–1870), dictator of Paraguay, eldest son of Carlos Antonio López, was born near Asunción on July 24, 1827. With very little education he was made commander-in-chief of the Paraguayan army in his 18th year. In 1854 he was sent as Paraguayan minister to Europe, where he spent nearly two years, imbibed much of the militaristic spirit which marked his career, and placed orders for munitions and supplies. On his father's death in 1862 he assumed the government as vice-president and called a congress on Oct. 16 which elected him president, virtually dictator, for ten years. In 1864 he demanded that Brazil abandon her armed interference in a revolution in Uruguay. No attention being paid to his demand, he seized a Brazilian merchant steamer in the harbour of Asunción, and threw into prison the Brazilian governor of the province of Matto Grosso who was on board. In the following month (Dec. 1864) he sent a force to invade Matto Grosso. He next sought to send an army to the relief of the Uruguayan Government against the revolutionary aspirant Flores, who was supported by Brazilian troops. The refusal of the Argentine president, Mitre, to allow this force to cross the intervening province of Corrientes, was seized upon by López as an occasion for war with the Argentine Republic. A congress bestowed upon López the title of marshal, with extraordinary war powers, and on April 13, 1865, he declared war on Argentina and summarily announced the annexation of the provinces of Corrientes and Entre Ríos. Flores, meantime, had been successful in Uruguay, and now Brazil and Uruguay joined Argentina in declaring war on Paraguay on May 1, 1865. The war, known as the War of the Triple Alliance, which lasted until April 1, 1870, was carried on with a swelling tide of disasters to López. (*See* PARAGUAY.) In 1868, conceiving that a conspiracy had been formed against his life in Asunción, he ordered several hundred of the leading citizens to be seized and executed. He suffered defeat after defeat until he was at last driven with a mere handful of troops to the northern frontier of Paraguay where he was killed on April 1, 1870, at the Aquidaban river. López's attempt to make himself arbiter of the La Plata region so nearly destroyed Paraguay that the country has not yet recovered from the shock.

See R. F. Burton, *Letters from the Battlefields of Paraguay* (London, 1870); C. A. Washburn, *History of Paraguay* (Boston, 1871); Cecilio Báez, "La guerra y la tiranía de López," *Revista Chilena,* vol. xvi. (1923); A. Rebaudi, *Un tirano de Sudamerica* (Buenos Aires, 1925); A. Zinny, *Historia de governantes del Paraguay, 1535–1887* (Buenos Aires, 1887). (W. B. P.)

LÓPEZ DE AYALA, DON PEDRO, (1332–1407), Spanish statesman, historian and poet, was born at Vittoria in 1332. He first came into prominence at the court of Pedro the Cruel, whose cause he finally deserted; he greatly distinguished himself in subsequent campaigns, during which he was twice made prisoner, by the Black Prince at Nájera (1367) and by the Portuguese at Aljubarrota (1385). A favourite of Henry II. and John I. of Castile, he was made grand chancellor of the realm by Henry III. in 1398.

Ayala was one of the most cultivated Spaniards of his time, at once historian, translator and poet. Of his many works, the most important are his chronicles of the four kings of Castile during whose reigns he lived; they give a generally accurate account of scenes and events, most of which he had witnessed. In addition, he also wrote a long satirical and didactic poem, interesting as a picture of his personal experiences and of contemporary morality.

The first part of his chronicle, covering only the reign of Pedro the Cruel, was printed at Seville in 1495; the first complete edition was printed in 1779–80 in the collection of *Crónicas Españolas,* under the auspices of the Spanish Royal Academy of History. Ayala died at Calahorra in 1407.

BIBLIOGRAPHY.—*See* Rafael Floranes, "Vida literaria de Pedro López de Ayala," in the *Documentos inéditos para la historia de España,* vol. xix. and xx.; F. W. Schirrmacher, "Über die Glaubwürdigkeit der Chronik Ayalas," in *Geschichte von Spanien* (Berlin, 1902), vol. v. pp. 510–32.

LÓPEZ DE GÓMARA, FRANCISCO (1511–1557), Spanish historian, author of the *Primera y Segunda Parte de la historia general de las Indias* . . . (1552), a panegyric of Cortés written in a pleasing style by a literary artist.

He was educated at the university of Alcalá, where he took orders. Soon after 1540 he entered the household of the famous Cortés who supplied him with most of the material for his *Historia* and also with information which the historian used in his *Crónica de la conquista da Nueva España.* While the novel matter and the attractive style enchanted the Spanish public, the unmeasured laudations of Cortés at the expense of his lieutenants and companions brought about a violent reaction and both works were forbidden on Nov. 17, 1553.

LOPHIODONTIDAE, a family of extinct mammals allied to the tapirs and rhinoceroses (*qq.v.*). They lived in Europe during the Eocene epoch. (*See* PERISSODACTYLA.)

LOP-NOR or **LOB-NOR,** a lake of Central Asia, in the Gobi Desert, between the Astin-tagh (Altyn-tagh) on the south and the Kuruk-tagh on the north. Previous to 1876 it was placed in nearly all maps at 42° 30′ N., a position which agreed with the accounts and the maps of ancient Chinese geographers. In the year mentioned the Russian explorer Przhevalsky discovered two closely connected lake-basins, Kara-buran and Kara-koshun, fully one degree farther south, and considerably east of the site of the old Lop-nor, which lake-basins he nevertheless regarded as being identical with the old Lop-nor of the Chinese. But the water they contained he pronounced to be fresh water. This identification was disputed by von Richthofen, on the ground that the Lop-nor, the "Salt Lake" of the Chinese geographers, could not be filled with fresh water; moreover, being the final gathering basin of the desert stream, the Tarim, it was bound to be salt, more especially as the lake had no outflow. Przhevalsky visited the Lop-nor region again in 1885, and adhered to his opinion. But ten years later it was explored anew by Dr. Sven Hedin, who ascertained that the Tarim empties part of its waters into another lake, or rather string of lakes (Avullu-köl, Kara-köl, Tayek-köl and Arka-köl), which *are* situated in 42° 30′ N., and thus so far justified the views of von Richthofen, and confirmed the Chinese accounts. At the same time he advanced reasons for believing that Przhevalsky's lake-basins, the southern Lop-nor, are of quite recent origin—indeed, he fixed upon 1720 as the probably approximate date of their formation, a date which von Richthofen would alter to 1750. Besides this, Sven Hedin argued that there exists a close inter-relation between the northern Lop-nor lakes and the southern Lop-nor lakes, so that as the water in the one group increases, it decreases to the same proportion and volume in the other. He also argued that the four lakes of northern Lop-nor are slowly moving westwards under the incessant impetus of wind and sandstorm (*buran*). These conclusions were afterwards controverted by the Russian traveller, P. K. Kozlov, who visited the Lop-nor region in 1893–1894—that is, before Dr. Sven Hedin's examination. He practically only reiterated Przhevalsky's contention, that the ancient Chinese maps were erroneously drawn, and that the Kara-koshun, in spite of the freshness of its water, was the old Lop-nor, *the* Salt Lake *par excellence* of the Chinese. Finally, Sven Hedin, following up the course of the Kum-darya, discovered—at the foot of the Kuruk-tagh, and at the E. (lowest) extremity of the now desiccated Kuruk-darya, with traces of dead forest and other vegetation beside it and beside the river bed—the basin of a desiccated salt lake, which he holds to be the true ancient Lop-nor of the Chinese geographers, and at the same time he found that the Kara-koshun or Lop-nor of Przhevalsky had extended towards the north, but shrunk on the south. Thus the old Lop-nor no longer exists, but in place of it there are a number of much smaller lakes of newer formation. It may fairly be inferred that, owing to the uniform level of the region, the sluggish flow of the Tarim, its unceasing tendency to divide and reunite, conjoined with the violence and persistency of the winds (mostly from the east and northeast), and the rapid and dense growth of the reed-beds in the shallow marshes, the drainage waters of the Tarim basin gather now in greater volume in one depression, and now in another. This view derives support from the extreme shallowness of the lakes.

See Delmar Morgan's translation of Przhevalsky's *From Kuja across the Tian-shan to Lop-nor* (London, 1879); Von Richthofen's "Bemerkungen zu den Ergebnissen von Oberst-Leutenant Prjewalskis Reise nach dem Lop-nor" in *Verhandl. der Gesch. f. Erdkunde zu Berlin* (1878), pp. 121 *seq.*; Sven Hedin's *Scientific Results of a Journey in Central Asia, 1899–1902* (vols. i and ii, Stockholm, 1905–06), where Kozlov's share of the controversy is summarized. (*Cf.* ii, 270–280.)

LOQUAT, JAPANESE PLUM or Japanese Medlar, known botanically as *Eriobotrya japonica*, small evergreen tree belonging to the family Rosaceae, with large, thick, oval-oblong leaves borne near the ends of the branches, and dark green above with a felt of rusty hairs on the lower face. The fruit is pear-shaped, yellow, about 1½ in. long and contains large stony seeds; it has an agreeable acid flavour. The plant is a native of China and Japan, but is widely grown for its fruit and as a decorative plant. It is a familiar object in the Mediterranean region, in the southern and Pacific coast states of the U.S.A., as well as many parts of South America. It in no way resembles the European medlar (*Mespilus germanica*). (*See* Medlar.)

LORAIN, a city of Lorain county, Ohio, U.S.A., on Lake Erie, at the mouth of the Black river, 28 mi. W. by S. of Cleveland. It is served by the Baltimore and Ohio, the Lake Terminal, the Lorain and West Virginia and the Nickel Plate railways and by interurban bus lines and lake freighters. The population was 44,512 in 1930, and 44,125 in 1940, 18% foreign-born white, by federal census. It is a port of entry and has a fine harbour. The commerce of the port averages close to 5,000,000 tons (largely incoming iron ore and shipments of coal received by rail) valued at $25,000,000. There is a limited fishing industry. The city has steel works employing 9,000 men, shipbuilding yards employing 900, railroad shops and other important manufacturing industries with an aggregate pay roll of over $25,000,000 a year. Bank clearings in 1940 were $11,716,383 and the assessed valuation of property in 1940 was $74,000,000. A Moravian mission was established here in 1787–88, and a trading post in 1807, but permanent settlement began several years later. In 1836 the village was incorporated as Charleston; in 1874 the present name was adopted; and in 1896 Lorain became a city.

LORALAI, a town and district of Baluchistan, in India. The town, which is situated 4,700 ft. above the sea, 35 mi. by road from the railway station of Harnai, was occupied as a military station in 1886 and still serves as a military cantonment. Pop. (1941) 3,419. The District of Loralai was formed in 1903. It consists of a series of long, narrow valleys, hemmed in by rugged mountains, and bordered E. by Dera Ghazi Khan district of the Punjab. Area 7,375 sq.mi.; pop. (1941) 83,685, of whom the majority are Afghans. The principal crops are wheat and millet; but the chief wealth of the inhabitants is derived from their herds of cattle, sheep and goats.

LORANTHACEAE, the mistletoe family, containing 36 genera and 600 species. All the members of this dicotyledonous family are parasitic plants with green leaves. The only British species is *Viscum album*, the mistletoe (*q.v.*). In the United States the family is represented by about six species of *Phoradendron* (American mistletoe) and some eight species of *Arceuthobium* (pine mistletoe). For a treatment of the genera *see* A. Engler and K. Krause, "Loranthaceae," *Die Natürlichen Pflanzenfamilien*, ed. 2, 16b: 98-203, fig. 48-102. (1935).

LORCA, a town of eastern Spain, in the province of Murcia, on the right bank of the river Sangonera and on the Murcia-Baza railway. Pop. (1940) 24,491 (mun., 69,639). It occupies a height crowned by a mediaeval fortress, among the foothills of the Sierra del Caño.

Lorca is the Roman *Eliocroca* (perhaps also the *Ilorci* of Pliny, *N.H.* iii 3) and the Moorish *Lurka*. It was the key of Murcia during the Moorish wars and was frequently taken and retaken. In 1802, by the bursting of the reservoir known as the Pantano de Puentes, the district adjoining the river, the Barrio de San Cristobal, was completely ruined. In 1810 Lorca suffered greatly from the French invasion. In 1886 the Pantano, which was one of the largest European reservoirs, being formed by a dam 800 ft. long and 160 ft. high, was rebuilt. There is an important trade in agricultural products and livestock, as well as manufactures of woollen stuffs, leather, chemicals and porcelain.

LORCH, a town in the Prussian province of Hesse-Nassau, Germany, on the right bank of the Rhine, 8 mi. below Rüdesheim by the railway Frankfort-on-Main-Wiesbaden-Cologne. Pop. (1933) 2,620. It has a Gothic church—St. Martin's—dating from the 14th century. The slopes of the hills descending to the Rhine are covered with vineyards, which produce excellent wine. In the neighbourhood is the ruined castle of Nollich.

LORCH, a town in the *Land* of Württemberg, Germany, on the Rems, 26 mi. E. of Stuttgart. Pop. (1933) 3,421. It possesses a 12th century Protestant church containing several tombs of the Hohenstaufen family. It manufactures cement, cardboard and furniture. On the Marienberg lying above the town stands the former Benedictine monastery of Lorch, founded about 1108 by Frederick of Hohenstaufen, and in 1563 converted into an Evangelical college, where Schiller passed a portion of his school days. The Roman *limes* began at Lorch and Roman remains have been found in the neighbourhood of the town.

LORD, in its primary sense, the head of a household, the master of those dependent on him for their daily bread; the word frequently occurs in this sense in the Bible, *cf.* Matt. xxiv, 45. As a term implying the ownership of property, "lord" survives in "lord of the manor" and "landlord." The chief applications are due to its use as the equivalent of Lat. *dominus*, Gr. κύριος and Fr. *seigneur;* thus in the Old Testament it represents *Yahweh*, Jehovah, and, in the New Testament κύριος as a title of Jesus Christ. It is not only a general word for a prince or sovereign, but also the common word for a feudal superior, and particularly for a feudal tenant holding directly of the king, a baron (*q.v.*), hence a peer of the realm, a member of the House of Lords, constituted of the lords temporal and the lords spiritual; this is the chief modern usage. The prefix "lord" is ordinarily used as a less formal alternative to the full title, whether held by right or by courtesy, of marquess, earl or viscount, and is always so used in the case of a baron (which in English usage is generally confined to the holder of a foreign title). Where the name is territorial the "of" is dropped, thus the marquess of A., but Lord A. The younger sons of dukes and marquesses have, by courtesy, the title of Lord prefixed to the Christian and surname, *e.g.*, Lord John Russell. In the case of bishops, the full and formal title of address is the Lord Bishop of A., whether he be a spiritual peer or not. Many high officials of the British Government have the word "lord" prefixed to their titles. (*See* CABINET, THE.) In certain cases the members of a board which has taken the place of an office of State are known as lords commissioners or, shortly, lords of the office in question, *e.g.*, lords of the treasury, civil or naval lords of the admiralty.

For lord lieutenant and lord mayor *see* LIEUTENANT and MAYOR. As the proper form of address, "my lord" is used not only to those members of the nobility to whom the title "Lord" is applicable, and to bishops, but also to all judges of the High Court in England, and of the Scottish and Irish Superior Courts, and to lord mayors and lord provosts (*see* also FORMS OF ADDRESS.)

LORD ADVOCATE, or king's advocate, the principal law-officer of the Crown in Scotland. His business is to act as a public prosecutor, and to plead in all causes that concern the Crown. He is the head of the administration of criminal justice, and thus his functions are of a far more extensive character than those of the English law-officers. He is aided by a solicitor-general and advocates-depute. The office seems to have been established about the beginning of the 16th century. Originally he could only prosecute with the concurrence of a private party; but in the year 1597 he was empowered to do so at his own instance. He has the privilege of pleading in court with his hat on.

LORD CHAMBERLAIN, in England, an important officer of the king's household, to be distinguished from the lord great chamberlain (*q.v.*). He is the second dignitary of the court, and is always a member of the government of the day (before 1782 the office carried cabinet rank), a peer and a privy councillor. He carries a white staff, and wears a golden or jewelled key, typical of the key of the palace, which is supposed to be in his charge, as the ensigns of his office. He is responsible for the necessary arrangements connected with State ceremonies, such as coronations and royal marriages, christenings and funerals; he examines the claims of those who desire to be presented at court; all invitations are sent out in his name by command of the sovereign, and at drawing-rooms and levees he stands next to the sovereign and announces the persons who are approaching the throne. It is also part of his duty to conduct the sovereign to and from his carriage. At one time he discharged some important political functions. The bedchamber, privy chamber and presence chamber, the wardrobe, the housekeeper's room, the guardroom and the chapels royal are in the lord chamberlain's department. He is regarded as chief officer of the royal household, and he has charge of a large number of appointments, such as those of the royal physicians, tradesmen and private attendants of the sovereign. All theatres in the cities of London and Westminster (except patent theatres), in certain of the London boroughs and in the towns of Windsor and Brighton, are licensed by him and he is also licenser of plays (*see* THEATRES, LAW RELATING TO).

The vice-chamberlain of the household is the lord chamberlain's assistant and deputy. He also is one of the ministry, a white-staff officer and the bearer of a key; and he is generally a peer or the son of a peer as well as a privy councillor. Next to the vice-chamberlain comes the groom of the stole, an office only in use during the reign of a king. He has the charge of the vestment called the stole worn by the sovereign on State occasions. In the lord chamberlain's department also are the master, assistant master, marshal of the ceremonies and deputy-marshal of the ceremonies, officers whose special function it is to enforce the observance of the *etiquette* of the court. The reception of foreign potentates and ambassadors is under their particular care, and they assist in the ordering of all entertainments and festivities at the palace. The gentleman usher of the black rod—the black rod which he carries being the ensign of his office—is the principal usher of the court and kingdom. He is one of the original functionaries of the order of the Garter, and is in constant attendance on the House of Lords, from whom, either personally or by his deputy, the yeoman usher of the black rod, it is part of his duty to carry messages and summonses to the House of Commons. There are six lords and six grooms "in waiting" who attend on the sovereign throughout the year and whose terms of attendance are of a fortnight's or three weeks' duration at a time. Usually "extra" lords and grooms in waiting are nominated by the sovereign, who, however, are unpaid and have no regular duties. Among the serjeants-at-arms there are two to whom special duties are assigned: the one attending the speaker in the House of Commons, and the other attending the lord chancellor in the House of Lords, carrying their maces and executing their orders. The comptroller and examiner of accounts, the paymaster of the household, the licenser of plays, the dean and subdean of the chapels royal, the clerk and deputy clerks of the closet, the groom of the robes, the pages of the backstairs, of the chamber and of the presence, the poet laureate, the royal physicians and surgeons, chaplains, painters and sculptors, librarians and musicians, etc., are all under the superintendence of the lord chamberlain of the household.

The queen consort's household is also in the department of the lord chamberlain of the household. It comprises a lord chamberlain, a vice-chamberlain and treasurer, equerry and the various ladies of the royal household, a groom and a clerk of the robes. The ladies of the household are the mistress of the robes, the ladies of the bedchamber, the bedchamber women and the maids of honour. The mistress of the robes in some measure occupies the position of the groom of the stole. She is the only lady of the court who comes into office and goes out with the administration. She is always a duchess, and attends the queen consort at all State ceremonies and entertainments, but is never in permanent residence at the palace. Since the great "bedchamber question" of 1839 the settled practice has been for all the ladies of the court except the mistress of the robes to receive and continue in their appointments independently of the political connections of their husbands, fathers and brothers. The ladies of the bedchamber share the personal attendance on the queen consort throughout the year. Of these there are eight, always peeresses, and each is in waiting for a fortnight or three weeks at a time. But the women of the bedchamber, of whom there are also eight, appear only at court ceremonies and entertainments according to a roster annually issued under the authority of the lord chamberlain of the queen consort. They are usually the daughters of peers or the wives of the sons of peers. The eight maids of honour have the same terms of waiting as the ladies of the bedchamber. They are commonly if not always the daughters or granddaughters of peers.

LORD CHIEF JUSTICE OF ENGLAND is the head of the king's bench division of the high court of justice and next in rank to the lord chancellor. He is *ex officio* a member of the court of appeal, and is appointed by the Crown on nomination of the prime minister. This title was conferred upon him by the Judicature Act, 1873, by which the court of queen's bench became one of the divisions of the queen's bench division. It may be traced to that of the first minister of the Crown under the Norman and Angevin kings—*capitalis Angliae justiciarius* (*see* JUSTICIARIUS CAPITALIS ANGLIAE). He is now the only judicial officer entitled to wear the collar of SS, formerly worn by the chief justices of the three common law courts. His salary is £8,000 a year.

LORD GREAT CHAMBERLAIN, in England, a functionary who must be carefully distinguished from the lord chamberlain; he is one of the great officers of State, whose office dates from Norman times; and the only one who still holds it under a creation of that period. As his name implies, he was specially connected by his duties with the king's chamber (*camera curie*); but this phrase was also used to denote the king's privy purse, and the chamberlain may be considered as originally the financial officer of the household. But as he was always a great baron, deputies performed his financial work, and his functions became, as they are now, mainly ceremonial, though the emblem of his office is still a key. The office had been held by Robert Malet, son of a leading companion of the Conqueror, but he was forfeited by Henry I., who, in 1133, gave the great chamberlainship to Aubrey de Vere and his heirs, earls of Oxford, who, with some intermissions, held the office till 1779 when it passed to the coheiresses of Lord Willoughby d'Eresby. The office is now vested jointly in Lord Ancaster, Lord Cholmondeley and Lord Carrington and their heirs.

The lord great chamberlain has charge of the palace of Westminster, especially of the House of Lords, in which he has an office; and when the sovereign opens parliament in person he is responsible for the arrangements. At the opening or closing of the session of parliament by the sovereign in person he disposes of the sword of State to be carried by any peer he may select, and walks himself in the procession on the right of the sword of State, a little before it and next to the sovereign. He issues the tickets of admission on the same occasions. He assists at the introduction of all peers into the House of Lords on their creation, and at the homage of all bishops after their consecration. At coronations he emerges into special importance; he still asserts before the court of claims his archaic right to bring the king his "shirt, stockings and drawers" and to dress him on coronation day and to receive his ancient fees, which include the king's bed and "night robe." He also claims in error to serve the king with water before and after the banquet, which was the function of the "ewry," a distinct office held by the earls of Oxford. At the actual coronation ceremony he takes an active part in investing the king with the royal insignia.

See J. H. Round, "The Lord Great Chamberlain" (*Monthly Review*, June 1902) and "Notes on the Lord Great Chamberlain Case" (*Ancestor*, No. IV.). (J. H. R.)

LORD HIGH CHANCELLOR. The origin and early history of this official will be found under CHANCELLOR. The lord chancellor is not only head of the judiciary in England, but also a minister of State, taking precedence after the archbishop of Canterbury. The close connection of the chancellor and the chancery with all parts of the constitution accounts for the extraordinary range and variety of the chancellor's functions. They were summarized by Bentham as follows:—"He is (1) a single judge controlling in civil matters the several jurisdictions of the 12 great judges; (2) a necessary member of the cabinet, the chief and most constant adviser of the king in all matters of law; (3) the perpetual president of the highest of the two houses of legislature; (4) the absolute proprietor of a prodigious mass of ecclesiastical patronage; (5) the competitor of the minister for almost the whole patronage of the law; (6) the keeper of the great seal, a various, multifarious and indefinable office; (7) the possessor of a multitude of heterogeneous scraps of power too various to be enumerated." Nominated by the prime minister, he goes out of office with the party to which he is attached. As speaker or prolocutor of the House of Lords it is his principal function to put the question; he may take part in the debates, but cannot rule upon points of order. When the house sits for judicial business he is entitled to preside. He is a member of the court of appeal and when present presides. He is also president of the chancery division and a judge of the High Court of Justice. By the Act of Union (1705) one great seal was appointed to be kept for all public acts and so his authority extends to the whole of Britain, and the commissions of the peace for Scotland as well as for England issue from him. He is visitor of all hospitals and colleges of the king's foundation, patron of all the king's livings under the value of 20 marks—this was to enable him to reward the masters in chancery—guardian of all infants, idiots and lunatics, and superintendent of all charitable uses. Many of these functions are now committed to other departments or to the judges (*see* CHARITY; INFANT; INSANITY). His salary is £10,000 and his pension £5,000 per annum.

See Holdsworth, *Hist. Eng. Law* vol. i., ch. v.; Lord Campbell, *Lives of the Chancellors* (1845); J. B. Atlay, *The Victorian Chancellors* (1906). (H. H. L. B.)

LORD HIGH CONSTABLE, in England, the seventh of the great officers of State. His office is now called out of abeyance for coronations alone. The constable was originally the commander of the royal armies and the master of the horse. He was also, with the earl marshal, president of the court of chivalry. In feudal times martial law (*see* MILITARY LAW) was administered in the court of the constable and marshal. The constableship was granted by the empress Maud to Milo of Gloucester, and on the attainder of Edward Stafford, duke of Buckingham, in the reign of Henry VIII. it became merged in the Crown. The Lacys and Verduns were hereditary constables of Ireland from the 12th to the 14th century; and the Hays, earls of Erroll, have been hereditary constables of Scotland from early in the 14th century.

LORD HIGH STEWARD. The lord high steward of England, who must not be confused with the lord steward (*q.v.*), ranks as the first of the great officers of State. Appointments to this office are now made only for special occasions, such as the coronation of a sovereign or the trial of a peer by his peers. The history of the office is noteworthy. The household of the Norman and Angevin kings of England included certain domestics and officials styled dapifers, seneschals or stewards (the prototypes of the lord steward). At coronations, however, and great festivals it became the custom in England and elsewhere to appoint magnates of the first rank to discharge for the occasion these domestic functions. In accordance with this custom Henry II. appointed both Robert II., earl of Leicester, and Hugh Bigod, earl of Norfolk, to be his honorary hereditary stewards; and at the Christmas festival of 1186 the successors in title of these two earls are described as serving the king at the royal banqueting table. Subsequently the earls of Leicester bought out the rights of the earls of Norfolk for ten knights' fees.

The last of these earls of Leicester to inherit the hereditary stewardship was Simon V. de Montfort, upon whose death his forfeited estates were conferred on his son Edmund of Lancaster, who also obtained a grant of the stewardship, but only for life. Edmund was succeeded by Thomas, earl of Lancaster, who, upon his execution for treason, was succeeded in the earldom by his brother Henry. The subsequent earls and dukes of Lancaster were all recognized as stewards of England, the office apparently being treated as annexed to the earldom, or honour, of Leicester. Strictly speaking, none of the Lancasters after Thomas had any clear title either by grant or otherwise; such title as they had merged in the Crown when Henry IV. usurped the throne. Meanwhile the stewardship had increased in importance. On the accession of Edward III., Henry, earl of Lancaster, as president of the council, had superintended the coronation of the infant king; John of Gaunt did the same for the infant Richard II., and, as part of the duties involved, sat in the White Hall of Westminster to hear and determine the claims to perform coronation services. The claims were made by petition, and included, amongst others, the claim of Thomas of Woodstock to act as constable, the rival claims of John Dymock and Baldwin de Frevile to act as champion, and the claim of the barons of the cinque ports to carry a canopy over the king. Minutes of these proceedings, in which the duke is stated to have sat "as steward of England," were enrolled by his order. This is the origin of what is now called the court of claims. The precedent of Richard II. has been followed on all subsequent occasions, except that in modern times it has been the practice to appoint commissioners instead of a steward to superintend this court. In 1397 John of Gaunt created a notable precedent in support of the steward's claim to be supreme judge in parliament by presiding at the trial of the earl of Arundel and others.

When Henry IV. came to the throne he appointed his young son Thomas, afterwards duke of Clarence, to the office of steward. Clarence held the office until his death. He himself never acted as judge in parliament; but in 1415 he was appointed to preside at the judgment of peers delivered in Southampton against Richard, earl of Cambridge, and Lord Scrope of Masham, who had been previously tried by commissioners of oyer and terminer. No permanent steward was ever again created; but a steward was always appointed for coronations to perform the various ceremonial services associated with the office, and, until the court of claims was entrusted to commissioners, to preside over that court. Also, in the 15th century, it gradually became the custom to appoint a steward *pro hac vice* to preside at the trial, or at the proceedings upon the attainder, of a peer in parliament; and later, to preside over a court, called the court of the lord high steward, for the trial of peers when parliament was not sitting. To assist in establishing the latter court a precedent of 1400 appears to have been deliberately forged. This precedent is reported in the printed *Year-Book* of 1400, first published in 1553; it describes the trial of "the earl of H" for participation in the rebellion of that year, and gives details of procedure. John Holand, earl of Huntingdon, is undoubtedly the earl indicated, but the evidence is conclusive that he was murdered in Essex without any trial. The court of the lord high steward seems to have been first definitely instituted in 1499 for the trial of Edward Plantagenet, earl of Warwick; only two years earlier Lord Audley had been condemned by the court of chivalry, a very different and unpopular tribunal. The Warwick trial was most carefully schemed: the procedure, fundamentally dis-similar to that adopted in 1415, follows exactly the forged precedent; but the constitution of the court was plainly derived from the Southampton case. The record of the trial was consigned to a new repository (commonly but wrongly called the *Baga de Secretis*), which thenceforth became the regular place of custody for important state trials. Latterly, and possibly from its inception, this repository consisted of a closet with three locks, of which the keys were entrusted, one to the chief justice of England, another to the attorney-general and the third to the master of the Crown office, or coroner. Notwithstanding the irregular origin of the steward's court, for which Henry VII. must be held responsible, the validity of its jurisdiction cannot be questioned. The Warwick proceedings were confirmed by act of parliament, and ever since this court has been fully recognized as part of the English constitution.

For about a century and a half prior to the reign of James I. the criminal jurisdiction of parliament remained in abeyance, and bills of attainder were the vogue. The practice of appointing a steward on these occasions to execute judgment upon a peer was kept up till 1477—when George, duke of Clarence, was attainted—and then dropped. Under the Stuarts the criminal jurisdiction of parliament was again resorted to, and, when the proceedings against a peer were founded on indictment, the appointment of a steward followed as a matter of settled practice. The proper procedure in cases of impeachment had, on the contrary, never been defined. On the impeachment of Strafford the lords themselves appointed Arundel to be high steward. In Danby's case a commission under the great seal was issued in the common form adopted for the court of the steward; this was recalled, and the rule agreed to by a joint committee of both houses was that a steward for trials of peers upon impeachments was unnecessary. But, as such an office was obviously convenient, the lords petitioned for a steward; and a fresh commission was accordingly issued in an amended form, which recited the petition, and omitted words implying that the appointment was necessary. This precedent has been treated as settling the practice of parliament with regard to impeachments.

Of the proceedings against peers founded upon indictment very few trials antecedent to the revolution took place in parliament. The preference given to the steward's court was largely due to the practice, founded upon the Southampton case, of summoning only a few peers selected by the steward, a practice which made it easy for the king to secure a conviction. This arrangement has been partially abrogated by the Treason Act of William III., which in cases of treason and misprision of treason requires that all peers of parliament shall be summoned 20 days at least before every such trial. The steward's court also differed in certain other particulars from the high court of parliament. For example, it was ruled by Lord Chancellor Jeffreys, as steward at the trial of Lord Delamere, that, in trials of peers which take place during the recess of parliament in the steward's court, the steward is the judge of the court, the court is held before him, his warrant convenes the prisoner to the bar, his summons convenes the peers for the trial, and he is to determine by his sole authority all questions of law that arise in the course of the trial, but that he is to give no vote upon the issue of guilty or not guilty; during a session of parliament, on the contrary, all the peers are both triers and judges, and the steward is only the chairman of the court and gives his vote together with the other lords. Lord Delamere was tried in 1685 in the steward's court; since then all trials of peers have taken place before the lords in parliament. The most recent trial was that of Earl Russell in 1901, when Lord Chancellor Halsbury was made lord high steward. The steward is addressed as "his grace," he has a rod of office, and the commission appointing him is dissolved according to custom by breaking this rod.

A court of claims sat and a steward was appointed for the coronation of Edward VII.; and during the procession in Westminster Abbey the duke of Marlborough, as steward, carried "St. Edward's crown" in front of the bearer of the Bible (the bishop of London), who immediately preceded the king; this function of the steward is of modern origin. The steward's ancient and particular services at coronations are practically obsolete; the full ceremonies, processions from Westminster Hall and banquet in which he figured prominently were abandoned on the accession of William IV.

Bibliography.—For the early history of the steward *see* L. W. Vernon-Harcourt, *His Grace the Steward and Trial of Peers* (1907); for the later history of the office *see* Sir E. Coke, *Institutes* (1797); Cobbett and Howell, *State Trials* (1809, *seq.*); Sir M. Foster, *Crown Law* (1809); J. Hatsell, *Precedents of Proceedings in the House of Commons*, vol. iv. (1818); and S. M. Phillips, *State Trials* (1826). *See* also the various works on *Coronations* for the steward's services on these occasions. (L. W. V.-H.)

LORD HIGH TREASURER, in England, once the third great officer of state. The office was of Norman origin and dated from 1216. The duty of the treasurer originally was to act as keeper of the royal treasure at Winchester, while as officer of the exchequer he sat at Westminster to receive the accounts of the sheriffs, and appoint officers to collect the revenue. From the middle of the reign of Henry III. he became one of the chief officers of the Crown. He took an important part in the equitable jurisdiction of the exchequer, and was now styled lord high treasurer and treasurer of the exchequer. The first office was conferred by delivery of a white staff, the second by patent. On the death of Lord Salisbury in 1612 the office was put in commission; it was filled from time to time until 1714, when the duke of Shrewsbury resigned it; since that time it has always been in commission. (*See* Government Departments.) The Scottish treasury was merged with the English by the Act of Union, but the office of lord high treasurer for Ireland was continued until 1816.

LORD HOWE, an island of the southern Pacific ocean, lying about 31° 36′ S., 159° 5′ E., 436 mi. N.E. of Sydney. Pop. (1933) 161. It was discovered in 1788 and is a dependency of New South Wales. It measures about $5\frac{1}{2}$ mi. by 1 mi. (area, 5 sq.mi.), and is well wooded, reaching 2,840 ft. at the southern end. It is of volcanic formation, while there are coral reefs on the western shore. The palm seed industry is important. The name Lord Howe is given also to an islet of the Santa Cruz group, and to two islands, also known under other names—Mopiha, of the Society group, and Ongtong Java of the Solomon Islands.

LORD JUSTICE CLERK, in Scotland, the judge next in rank to the lord justice-general. He presides in civil cases in the second division of the court of session, and in the absence of the lord justice-general, presides in criminal cases in the court of justiciary. The justice clerk was originally not a judge at all, but simply clerk and legal assessor of the justice court. In course of time he was raised from the clerk's table to the bench, and by custom presided over the court in the absence of the justice-general. Up to 1672 his position was somewhat anomalous, as it was doubtful whether he was a clerk or a judge, but an act of that year, which suppressed the office of justice-depute, confirmed his position as a judge, forming him, with the justice-general and lords commissioners of justiciary, into the court of justiciary. The lord justice clerk is also one of the officers of State for Scotland, and one of the commissioners for keeping the Scottish regalia.

LORD JUSTICE-GENERAL, the highest judge in Scotland, head of the court of justiciary, called also the lord president, and as such head of the court of session and representative of the sovereign. The office of justice-general was for a considerable time a sinecure post held by one of the Scottish nobility, but by the Court of Session Act, 1830, it was enacted that, at the termination of the existing interest, the office should be united with that of lord president of the court of sessions, who then became presiding judge of the court of justiciary.

LORD KEEPER OF THE GREAT SEAL, in England, formerly a great officer of State. The great seal of England, which is affixed on all solemn occasions to documents expressing the pleasure of the sovereign, was first adopted by Edward the Confessor (*see* SEALS), and entrusted to a chancellor for keeping. The office of chancellor from the time of Becket onwards varied much in importance; the holder being an ecclesiastic, he was not only engaged in the business of his diocese, but sometimes was away from England. Consequently, it became not unusual to place the personal custody of the great seal in the hands of a keeper; this, too, was the practice followed during a temporary vacancy in the chancellorship. This office gradually developed into a permanent appointment, and the lord keeper acquired the right of discharging all the duties connected with the great seal. He was usually, though not necessarily, a peer, and held office during the king's pleasure; he was appointed merely by delivery of the seal, and not, like the chancellor, by patent. His status was definitely fixed (in the case of lord keeper Sir Nicholas Bacon) by an act of Elizabeth, which declared him entitled to the same powers and jurisdiction as the lord chancellor. Subsequently he was generally raised to the chancellorship, and retained the custody of the seal. The last lord keeper was Sir Robert Henley (afterwards Lord Northington), made chancellor on the accession of George III.

LORD MAYOR'S DAY, in England, Nov. 9, the date of the inauguration of the lord mayor of London, marked by a pageant known as the Lord Mayor's Show. The first of these pageants was held in 1215. The citizen chosen to be mayor was presented to the king or his justice for approval. The crowd of citizens who accompanied the mayor to Westminster developed into a yearly pageant. Until the 15th century the mayor either rode or walked to Westminster, but in 1453 Sir John Norman appears to have set a fashion of going by water. From 1639 to 1655 the show disappeared owing to Puritan opposition. With the Restoration the city pageant was revived. In 1711 an untoward accident befell the show, the mayor, Sir Gilbert Heathcote, being thrown by his horse. The next year a coach was provided for the chief magistrate. In 1757 this was superseded by a gilded and elaborately decorated equipage which was used till 1896, when a replica of it was built to replace it. The mediaeval procession, long traditional, has been succeeded by pageants illustrative of the empire, of seafaring and many other aspects of life.

LORD PRESIDENT OF THE COUNCIL, in England, one of the great officers of State, and a member of the ministry. It was only in 1679 that the office of lord president became permanent. Previously either the lord chancellor, the lord keeper of the seal, or some particular court official took formal direction of the Privy Council. In the reign of Charles I. a special lord president of the council was appointed, but in the following reign the office was left unfilled. The office was of considerable importance when the powers of the Privy Council, exercised through various committees, were of greater extent than at the present time. (*See* GOVERNMENT DEPARTMENTS.) The duties of the office are to preside on the infrequent meetings of the Privy Council, and to draw up the minutes of council upon subjects which do not belong to any other department of State. The office is very frequently held in conjunction with other ministerial offices. The lord president is appointed by a declaration made in council by the sovereign. He is invariably a member of the House of Lords, and is included in the cabinet.

LORD PRIVY SEAL, the officer in the British government who has custody of the Privy Seal. *See* SEALS.

LORDS JUSTICES OF APPEAL, in England, the ordinary judges of the court of appeal of the supreme court. Their number has been fixed at five and their salary is £5,000 a year. (*See* PRACTICE AND PROCEDURE.)

LORDS OF APPEAL IN ORDINARY, in England, certain persons (limited to seven), who, having held high judicial office or practised at the bar for not less than 15 years, sit as members of the House of Lords to adjudicate in cases before that house in its legal capacity, and also to aid the judicial committee of the Privy Council in hearing appeals. Of the six lords of appeal in ordinary one is usually appointed from the Irish bench or bar and one from Scotland. Their salary is £6,000 a year. They hold office on the same conditions as other judges, and take rank and sit and vote as barons during life. They are life peers only. The patent of a lord of appeal in ordinary differs from that of a baron in that he is not "created" but "nominated and appointed to be a lord of appeal in ordinary by the style of baron."

LORD STEWARD, in England, an important official of the king's household. He is always a member of the Government, a peer and a privy councillor. Up to 1782 the office was one of considerable political importance and carried cabinet rank. The lord steward receives his appointment from the sovereign in person, and bears a white staff. He is the first dignitary of the court. In the *Statutes of Eltham* he is called "the lord great master," but in the *Household Book* of Queen Elizabeth "the lord steward," as before and since. He presides at the Board of Green Cloth, a committee of the king's household, charged with the audit of its accounts. The board had also power to punish all offenders within the verge or jurisdiction of the palace. The name is derived from the green-covered table at which the transactions of the board were originally conducted. Under the lord steward are the treasurer and comptroller of the household, usually peers or the sons of peers and privy councillors, who sit at the Board of Green Cloth, carry white staves, and belong to the Ministry. But the duties which in theory belong to the lord steward, treasurer and comptroller of the household are in practice performed by the master of the household, who is a permanent officer and resides in the palace. He is a white-staff officer and a member of the Board of Green Cloth but not of the Ministry, and among other things he presides at the daily dinners of the suite in waiting on the sovereign. In his case history repeats itself. He is not named in the *Black Book* of Edward IV. or in the *Statutes* of Henry VIII., and is entered as "master of the household and clerk of the green cloth" in the *Household Book* of Queen Elizabeth. But he has superseded the lord steward of the household, as the lord steward of the household at one time superseded the lord high steward of England.

In the lord steward's department are the officials of the Board of Green Cloth, the coroner ("coroner of the verge"), and paymaster of the household, and the officers of the almonry. (*See* ALMONER.) The lord steward had formerly three courts besides the Board of Green Cloth under him. First, the lord steward's court, superseded (1541) by—second—the Marshalsea court, a court of record having jurisdiction, both civil and criminal, within the verge (the area within a radius of 12m. from where the sovereign is resident), and originally held for the purpose of administering justice between the domestic servants of the sovereign, "that they might not be drawn into other courts and their service lost." Its criminal jurisdiction had long fallen into disuse and its civil jurisdiction was abolished in 1849. Third, the palace court, created by letters patent in 1612 and renewed in 1665 with jurisdiction over all personal matters arising between parties within 12m. of Whitehall (the jurisdiction of the Marshalsea court, the City of London and Westminster Hall being excepted). It had no jurisdiction over the sovereign's household; nor were its suitors necessarily of the household. The privilege of practising before the palace court was limited to four counsel. It was abolished in 1849. The lord steward or his deputies formerly administered the oaths to the members of the House of Commons. In certain cases (messages from the sovereign under the sign-manual) "the lords with white staves" are the proper persons to bear communications between the sovereign and the houses of parliament.

BIBLIOGRAPHY.—*See* the *Statutes of Eltham;* the *Household Book* of Queen Elizabeth; Sir E. Coke, *Institutes* (1797); J. Reeves, *History of English Law* (1869); Sir H. J. Stephen, *Commentaries on the Laws of England* (18th ed., 1925); J. H. Hatsell, *Precedents of Proceedings in the House of Commons* (1818); T. E. May, *A Practical Treatise on the Law . . . and Usage of Parliament* (13th ed., 1921).

LORE, instruction, knowledge. The O.E. *lár,* and Ger. *Lehre,* represent the Old Teut. root, meaning to impart or receive knowledge, seen in "to learn." The word is frequently applied to the many traditional beliefs, stories, etc., connected with the body of knowledge concerning some special subject; *e.g.,* bird-lore, folklore (*q.v.*).

LOREBURN, ROBERT THRESHIE REID, 1ST EARL, cr. G.C.M.G. (1899) (1846–1923), British lawyer and politician, was born at Corfu on April 3, 1846, and was educated at Cheltenham and Balliol college, Oxford, where he won the Ireland scholarship in 1868. He was called to the bar in 1871, and in 1880 entered politics as Liberal M.P. for Hereford. In 1882 he became a Q.C. and, having in 1885 lost his seat at Hereford, represented Dumfries Burghs from 1886–1905. In 1894 he was for a few months solicitor-general and was knighted, and during 1894–95 was attorney-general. From 1899 to 1906 he was counsel to the University of Oxford. On the formation of Campbell-Bannerman's Government in 1905, Sir Robert Reid became lord chancellor, and was raised to the peerage as Baron Loreburn. The passage of the Court of Criminal Appeal Act (1907) was largely due to him. In 1912 he resigned on grounds of health. Lord Loreburn, who was created an earl in July 1911, published *Capture at Sea* (1913) and *How the War Came* (1919). He died without issue on Nov. 30, 1923, when the title became extinct.

LOREE, LEONOR FRESNEL (1858–1940), American railway president, son of William Mulford Loree, a millwright, was born in Fulton City, Ill., on April 23, 1858. After graduating at Rutgers college in 1877, he entered the service of the Pennsylvania railroad as a rodman. In 1879 he served in the U.S. army engineering corps and in 1881 as civil engineer for the Mexican National railway. Re-entering the employ of the Pennsylvania railroad in 1883, he served in engineering positions of increasing importance until 1889 when he was made a division superintendent, and in 1896 he rose to the position of general manager. In 1901 he was elected to a vice-presidency but resigned in the same year to become president of the Baltimore and Ohio railroad company, an office held until 1904 when he was chosen president of the Rock Island company. In 1907 he was elected president of the Delaware and Hudson company, a position in which he served for more than 30 years. He served also as a director of several other railways and in 1926 was made chairman of the board of the Missouri-Kansas-Texas railroad company. He invented the upper quadrant system of semaphore signalling, now standard on American railways; built the first high pressure locomotive; and made other improvements. In the effort to consolidate American railways into a limited number of systems in accordance with the policy formulated by Congress in 1920 he took an active and influential part. He also established the first organized railway police force. He wrote *Railroad Freight Transportation* (1922). (E. N. McG.)

LORELEI, a rock in the Rhine near St. Goar, which gives a remarkable echo (O.H.G. *Lur,* connected with modern Ger. *lauern,* "to lurk," "be on the watch for," and equivalent to elf, and *lai,* "a rock"). In the commonest form of the story the Lorelei is a maiden who threw herself into the Rhine in despair over a faithless lover, and became a siren whose voice lured fishermen to destruction. The tale is closely connected with the myth of Holda, queen of the elves. The man who sees her loses sight or reason, he who listens is condemned to wander with her for ever. In the 19th century the legend formed material for a number of songs, dramatic sketches, etc., enumerated by Dr. H. Seeliger in his *Loreleysage in Dichtung und Musik* (Leipzig-Reudnitz, 1898). The favourite poem with composers was Heine's beginning *Ich weiss nicht was soll es bedeuten,* the settings by Friedrich Silcher (from an old folk-song) and by Liszt being the most famous.

LORENTZ, HENDRIK ANTOON (1853–1928), Dutch physicist, was born at Arnheim on July 18, 1853. He studied at Leyden, where he was appointed professor of mathematical physics in 1878. In 1923 he became director of research at the Teyler institute, Haarlem. He remained honorary professor at Leyden, where he gave a weekly lecture on modern physics, which was usually reported for publication by one of the audience. He died at Haarlem on Feb. 4, 1928.

Lorentz's work in physics was very wide in its scope, but its central aim, it appears, was to arrive at some consistent theory for electricity, magnetism and light. He tried to explain these phenomena by assuming an ether which was at rest and had electrons either at rest or moving in it. A number of phenomena were successfully explained on this electron theory, but it failed to give an explanation of the negative result of the Michelson-Morley experiment. To overcome this difficulty Lorentz introduced the idea of "local time" in 1895. The connection between this and the Fitzgerald contraction was pointed out by Larmor, and in 1903 Lorentz extended his work and arrived at the "Lorentz transformation," which formed the basis of the restricted theory of relativity. Lorentz's earlier investigations were originally published in Dutch in the *Archives Néerlandaises* and consequently were not known to English physicists; Lord Rayleigh and Sir Oliver Lodge were largely responsible for the spread of his ideas in England. His first paper, published in 1875, dealt with the reflection and refraction of light by dielectrics and metals. In 1880 he published a memoir on the relation between the refractive index and the density of a medium. This was the first application of Maxwell's theory to a medium consisting of discrete molecules. Lorentz dealt with optical dispersion and tried to give an explanation on the assumption that it was due to resonant vibrations. This work was continued in his two well known memoirs, *La Théorie électromagnétique de Maxwell et son application aux corps mouvants* (1892) and *Versuch einer Theorie der electrischen und optischen Erscheinungen in bewegten Körpern* (1895). In the latter memoir he deals with the electrodynamic field of a system moving with uniform velocity. Lorentz gave an explanation of the Zeeman effect very soon after it was observed and predicted polarization effects which were verified later by experiment. He was also the author of a number of papers on gravitation theory, thermodynamics, radiation and kinetic theory.

Lorentz had a charming personality and kindly disposition. He spoke English, French and German fluently and he had the gift of clear exposition. He travelled and lectured extensively in Europe and America. He was a keen worker in the cause of international science and was chairman of the committee of intellectual co-operation set up by the League of Nations. Lorentz was an honorary or corresponding member of most scientific societies and received many medals and other honours. In 1902 he was awarded, with Zeeman, the Nobel prize for physics. The jubilee of his doctorate was celebrated by a *Festschrift* to which physicists of all countries contributed. The Lorentz Foundation was established to promote the advancement of theoretical physics.

BIBLIOGRAPHY.—Lorentz's works include *Abhandlungen über theoretische Physik* (vol. i., 1907); this contains some of his collected papers with comments and additions of previously unpublished work; *Theory of Electrons* (1909); *Differential and Integral Calculus* (1882); *Visible and Invisible Movements* (1901); *The Einstein Theory of Relativity* (1920); *Clerk Maxwell's Electromagnetic Theory* (1924). His lectures at Leyden university were published from 1919 onwards under his personal supervision with the title of *Lessons on Theoretical Physics.* (E. TR.)

LORENZ, ADOLF (1854–1946), Austrian surgeon, was born of poor parents at Vidnava, Silesia, on April 21, 1854. He studied at Vienna university where he afterward became a demonstrator and professor. He introduced the use of forcible manipulation for congenital dislocation of the hip joint and specialized on clubfoot and flatfoot. Important among his numerous publications are: *Die Lehre vom erebten Plattfusse* and *Über die operative Orthopädie des Klumpfusses.* He died in Vienna on Feb. 12, 1946.

LORENZAN, a small group of tribes of South American Indians, regarded, on very insufficient evidence, as constituting an independent linguistic stock. The Lorenzas live in Peru in the northern portion of the province of Junin, on the Palcazu, Piches and Chuchuras rivers (tributaries of the Pachitea). They are a timid people, going quite naked and are very little known.

See A. F. Chamberlain, "Sur quelques familles linguistiques . . . de l'Amérique du Sud," *J. Soc. Americanistes de Paris* (n.s.), vol. vii., pp. 178–202.

LORENZETTI, the name of two Italian painters of the first half of the 14th century. Their style combined the harmonious colour and expressive design of early Sienese masters with the naturalism of the Pisanos and of Giotto.

Ambrogio Lorenzetti (*c.* 1300–1348) was the younger and the more distinguished of the two brothers. Only five authentic works of his are in existence; they cover a period of 13 years. The frescoes representing scenes from the lives of St. Louis of Toulouse and of Franciscan martyrs, which he painted in 1331, in the chapter-house adjoining the church of San Francesco, are now in one of the choir chapels of that church. Ambrogio then worked in Florence and Cortona. Of an altarpiece, painted for the church of San Procato in Florence, four predella pieces with scenes from the life of St. Nicholas of Bari are in the Florence academy. From 1337–39 he was employed on the decoration of the Sala della Pace in the Palazzo Publico of Siena with four great allegorical pictures representing "Good Government," "Effects of Good Government," "Tyranny" and "Effects of Tyranny." The subject matter shows that the artist was a student of Aristotle's political philosophy, and bears out Vasari's statement that he was a philosopher and a man of distinction, who was interested in the government of his native town. The symbolical figures, especially those representing "Peace" and "Justice," are full of elegance and life, classical in conception. Here Sienese painting reached its climax. Among Ambrogio's later works are a "Presentation in the Temple," signed and dated 1342, painted for the Spedaletto of Mona Agnese and now in the Uffizi, Florence; and an "Annunciation" dated 1344 and also signed, in the Siena academy. As neither he nor his brother is mentioned after 1348 it is assumed that they died of the plague which that year devastated the city.

Pietro Lorenzetti (*c.* 1280–1348) elder brother of Ambrogio, called Pietro Laurati by Vasari, son of Lorenzo Laurati, was probably a pupil of Duccio. According to Vasari he worked in Florence, Pisa, Pistoia and Arezzo, as well as in his native town; he may have visited Assisi. The earliest work of which documentary evidence exists is the altarpiece of 1320 in S. Maria della Pieve at Arezzo. In 1328 he painted the Madonna for S. Ansano at Dofana outside Siena; and one year later the altarpiece for the church of the Carmine, of which the centrepiece is lost, and of which parts of the predella are in the Siena academy and in the Vatican gallery. We know from documentary evidence that in 1333 he painted a Madonna over one of the doors of the cathedral; and that two years later, in co-operation with his brother Ambrogio, he decorated the façade of the hospital of Santa Maria della Scala with scenes from the life of the Virgin. Unfortunately, both of these works have been destroyed. In 1340 he painted the "Madonna with Angels" for the church of San Francesco at Pistoia, which is in the Uffizi at Florence; in 1342 the "Nativity of the Virgin" in the Opera del Duomo, one of his most pleasant works. Both these pictures are signed. This closes the list of authenticated works.

The Siena gallery possesses a number of paintings which have been ascribed to the master on stylistic evidence. Among these the "Assumption" is the most important. To Pietro's early period is ascribed an altarpiece in the Academy of Florence representing St. Humility of Faenza, and scenes from her life. Two panels thereof are in the Berlin museum. This picture was painted for the convent at Vallombrosa in 1316. Moreover, Crowe and Cavalcaselle have attributed to him the frescoes of the Passion in the Lower church of San Francesco at Assisi and of the Crucifixion in San Francesco at Siena, a scene full of dramatic power. This attribution has been generally accepted; and on these works Pietro's fame as a great artist rests, for they are extremely fine and expressive paintings. The famous frescoes representing the "Triumph of Death," the "Last Judgment" and the "Hermits of the Thebaid," in the Campo Santo at Pisa, have also been ascribed to him by some authorities; they are sometimes given to a follower of the Lorenzetti.

See Vasari, *Vite* (edit. Milanesi); Ghiberti, *I Commentari* (1912); Milanesi, *Documenti per la Storia dell Arte Senese* (1854); Crowe and Cavalcaselle, *History of Italian Painting* (edit. L. Douglas, 1911); Langton-Douglas, *History of Siena* (1902); Raimond van Marle, *The Italian Schools of Painting,* ii. (1924). (I. A. R.)

LORENZO, MONACO, also called Don Lorenzo (*c.* 1370–*c.* 1425), Italian painter, was born at Siena. He took the vows of the Camaldolese order in 1391 and lived mostly at the monastery of Santa Maria degli Angeli, in Florence. His name as a layman was Piero di Giovanni del Popolo di San Michele de Bisdomini and a painter of that name was entered in the books of the guild of St. Luke at Florence in 1396. Lorenzo was in some respects an innovator in Florence, for he combined the rhythmic, graceful flow of line and decorative feeling of the Sienese school with the Florentine traditions of the followers of Giotto; in his later work he appears to be influenced by the realistic tendency of the Early Renaissance. The Uffizi in Florence contains a signed work by the master, "Coronation of the Virgin" with many figures, painted in 1413 for his convent, and later removed to a branch establishment near Certaldo. The National Gallery in London has another smaller version of the same subject; one of his most graceful altarpieces is the "Annunciation" in the Bartolini chapel in the church of S. Trinita at Florence. In the same chapel are late frescoes of the "Life of the Virgin," recently rescued from underneath a coat of whitewash. Another late work of the master is the "Adoration of the Magi" in the Uffizi. The master's feeling for decorative composition, his expressive line, and his originality come out well in his small predella pieces, as in the three small fragments at the Florence academy, representing the "Nativity," the "Life of a Hermit" and a stormy seascape, and in the two remarkable illuminations in the Berlin museums of the "Journey of the Three Kings" and the "Visitation."

See Oscar Siren, *Don Lorenzo Monaco* (Strasbourg, 1905).

LORETO, episcopal see and pilgrimage resort of the Marches, Italy, province of Ancona, 15 m. by rail S.S.E of Ancona. Pop. (1936) 3,310 (town), 7,081 (commune). It lies on the right bank of the Musone, on a hill-side commanding splendid views 341 ft. above sea-level. The town is a long narrow street, lined with shops for the sale of locally made cult-objects. The chief festival is held on Sept. 8, the Nativity of the Virgin. The principal buildings in the piazza are the college of the Jesuits, the Palazzo Apostolico (which contains a picture gallery with works of Lorenzo Lotto, Caracci, Magnasco, etc., a collection of majolica and a replica of the famous set of tapestries designed by Raphael for the Sistine chapel) and the cathedral church of the Holy House (Chiesa della Casa Santa), a Late Gothic structure begun under Paul II., and continued by Giuliano da Maiano, Giuliano da Sangallo Bramante and other architects who altered the original plan, which was revived in 1886 by Giuseppe Sacconi. The handsome façade of the church was completed under Sixtus V., who founded the episcopal see; his colossal statue stands in the middle of the flight of steps in front. Over the principal doorway is a life-size bronze statue of the Virgin and Child by Girolamo Lombardo; the three superb bronze doors executed at the latter end of the 16th century and under Paul V. (1605–1621) are also by Lombardo, his sons and his pupils, among them Tiburzio Vergelli, who also made the fine bronze font in the interior. The doors and hanging lamps of the Santa Casa are by the same artists. The richly decorated campanile, by Vanvitelli, is 250 ft. high. The principal bell, presented by Leo X, in 1516, weighs 11 tons. The interior of the church has mosaics by Domenichino and Guido Reni. In the sacristies on each side of the right transept are frescoes, on the right by Melozzo da Forlì, on the left by Luca Signorelli. In both are fine intarsias.

But the chief object of interest is the Holy House itself. It is of plain stone, 28 ft. by 12½ and 13½ ft. in height, with north door and west window; and a niche contains a small black image of the Virgin and Child, in Lebanon cedar, and richly adorned with jewels. St. Luke is alleged to have been the sculptor; its workmanship suggests the latter half of the 15th century. Around the Santa Casa is a lofty marble screen, designed by Bramante, and executed under Popes Leo X., Clement VII. and Paul III., by Andrea Sansovino, Girolamo Lombardo, Bandinelli, Guglielmo della Porta and others. The four sides represent the Annunciation, the Nativity, the Arrival of the Santa Casa at Loreto and the Nativity of the Virgin respectively.

The legend of the Holy House dates from the close of the crusading period. The house of Nazareth in which Mary had been born and brought up, had received the annunciation, and had lived during the childhood of Jesus and after His ascension, was converted into a church by the apostles. In 336 the empress Helena caused a basilica to be erected over it, in which worship continued until the fall of the kingdom of Jerusalem. Threatened with destruction by the Turks, it was carried by angels through the air and deposited (1291) in the first instance on a hill at Tersatto in Dalmatia, where an appearance of the Virgin and miraculous cures attested its sanctity, confirmed by investigations made at Nazareth by messengers from the governor of Dalmatia. In 1294 the angels carried it across the Adriatic to a wood near Recanati; from this wood (*lauretum*), the chapel derived the name which it still retains. From this spot it was afterwards (1295) removed to the present hill. Bulls in favour of the shrine at Loreto were issued by Pope Sixtus IV. in 1491 and by Julius II. in 1507, the last alluding to the translation of the house with some caution ("*ut pie creditur et fama est*"). There is, as a fact, documentary evidence for the existence of a church dedicated to the Virgin on the spot (*in fundo Laureti*) just a century before the date of its supposed translation. In the end of the 17th century Innocent XII. appointed a "*missa cum officio proprio*" for the feast of the Translation of the Holy House, and the feast is still enjoined in the Spanish Breviary as a "greater double" (Dec. 10). Benedict XV. declared the Madonna di Loreto to be the patron of aviators. (T. A.)

See also U. Chevalier, *Notre-Dame de Lorette* (Paris, 1906); A. Colasanti, *Loreto* (Bergamo, 1911, well illustrated).

LORETO, the largest and most easterly department in Peru (approximate area, 124,070 sq.mi., pop. [1940] 321,341), a partly undetermined tract in the level, forest-covered Amazonian plains east of the Andes, averaging 500 ft. above sea level. The territory north of the Amazon and east of the cordillera, long disputed with Ecuador, was involved in the Peru-Ecuador boundary war of 1941. A joint boundary commission was engaged (1943) in delineating the new boundary which will give most of the territory to Peru. Except for a few open areas such as the Pampa del Sacramento, the region is a continuous jungle whose only openings are the great tributaries of the Amazon, Pastaza, Tigre, Napo, Yavarí, Ucayali, Huallaga and Marañón. Indian tribes, speaking many languages, differing greatly in manners and customs, fish and hunt along the rivers of Amazonia and practice primitive agriculture much today as when Orellana first discovered the Amazon (*see* AMAZON). There are thousands of miles of navigable waterways on all the great tributaries with regular steamer or launch service at the few ports of call (*see* PERU). The only port or town of importance is Iquitos (*q.v.*), capital of the department and base for the Peruvian navy's small Amazon flotilla. There are no roads, but two trails from Iquitos to the Pacific coast, the northern, via Yurimaguas to Pacasmayo, the central, via the Pachitea and Chanchamayo rivers to Oroya and the Central railway.

Prior to the development of rubber plantations in the East Indies the chief industry in Loreto was the exploitation of wild rubber. With the outbreak of World War II this activity was revived and was heavily subsidized by the government of the United States.

Loreto abounds in plants used in making fabrics, for dyeing and tanning, oil and wax-bearing plants, food, aromatic, medicinal, narcotic and poisonous plants as well as vegetable ivory. Crops include cotton, tobacco, sugar, coffee, rice, bananas, yuca, *camotes*, cacao, vanilla, vegetables and fruits.

LORICATA, in zoology, a name applied to the order Crocodilian (*q.v.*), and to various other groups of animals, especially the armadillos.

LORIENT, a maritime town of western France, capital of an arrondissement in the department of Morbihan, on the right bank of the Scorff, at its confluence with the Blavet, 34 mi. W. by N. of Vannes by rail. Pop. (1936) 45,761.

Lorient took the place of Port Louis as the port of the Blavet. The latter stands on the site of an ancient hamlet fortified during the wars of the League and handed over by Philip Emmanuel, duke of Morcoeur, to the Spaniards. After the Treaty of Vervins it was restored to France, and received its name of Port Louis under Richelieu. Some Breton merchants trading with the Indies established themselves first at Port Louis, but in 1628 built their warehouses on the other bank. The Compagnie des Indes Orientales, created in 1664, took possession of these, giving them the name of l'Orient. The importance of the Compagnie des Indes waned after the English conquest of India, and in 1770 its property was ceded to the State. In 1782 the town was purchased by Louis XVI from its owners, the Rohan-Guéméné family.

The town is modern and regularly built. It is one of the five maritime prefectures in France and the first port for naval construction in the country. The naval port to the east of the town is formed by the channel of the Scorff, on the right bank of which the chief naval establishments are situated. A floating bridge connects the right bank with the peninsula of Caudan formed by the union of the Scorff and Blavet. Here are the shipbuilding yards. The commercial port to the south of the town consists of an outer tidal port protected by a jetty, and an inner dock, both lined by fine quays planted with trees. It separates the older part of the town, surrounded by fortifications from a newer quarter. The trade in fresh fish, sardines, oysters (which are reared near Lorient) and tinned vegetables is important, and the manufacture of basket-work, rope, nets, etc., tin-boxes and ice, and the preparation of preserved sardines and vegetables are carried on. The roadstead is the estuary of the Blavet accessible to the largest vessels; the entrance is 3 or 4 mi. S. from Lorient. In the middle of the channel is the granite rock of St. Michel, occupied by a powder magazine. Opposite it, on the right bank of the Blavet, is the mouth of the river Ter, with fish and oyster breeding establishments from which 10,000,000 oysters are annually obtained. The roadstead is provided with six lighthouses.

LORIMER, GEORGE HORACE (1868–1937), U.S. editor, was born at Louisville, Ky., Oct. 6, 1868. He attended the Mosely high school in Chicago, Colby college, and Yale university. After a short time in business in Chicago he became a newspaper reporter and correspondent. In 1897 he was literary editor of the *Saturday Evening Post,* and in 1899 editor-in-chief. The remarkable success of this periodical was largely caused by Mr. Lorimer's keen appreciation of the public taste, coupled with his ability to meet it. His *Letters from a Self-made Merchant to His Son* (1902), which attained great popularity, and *Old Gorgon Graham* (1904) are effective and interesting expositions of the philosophy of getting on. He continued his editorship until Jan. 1, 1937. He died at Wyncote, Pa., Oct. 22, 1937.

LORINER or **LORIMER,** one who makes bits and spurs and the metal mountings for saddles and bridles; the term is also applied to a worker in wrought iron and to a maker of small iron-ware. The word is now rarely used except as the name of one of the London livery companies. (*See* LIVERY COMPANIES.)

LORIS, a name applied to the Indo-Malay lemurs (*see* PRIMATES). Their soft fur, huge staring eyes, rudimentary tails and imperfectly developed index-fingers render lorises easy of recognition. The smallest is the slender loris (*Loris tardigradus*) of the forests of Madras and Ceylon, a creature smaller than a squirrel. The slow loris (*Nycticebus coucang*) is a heavier built and larger animal, ranging from eastern Bengal to Cochin China, the Malay Peninsula, Java, Borneo and Mindanao.

LORIS-MELIKOV, MICHAEL TARIELOVICH, COUNT (1826–1888), Russian statesman, son of an Armenian merchant, was born at Tiflis on Jan. 1, 1826, and educated in St. Petersburg, first in the Lazarev School of Oriental Languages, and afterwards in the Guard's Cadet Institute. He joined a hussar regiment, and in 1847 he was sent to the Caucasus, where he spent twenty years. He was governor of the Terek district from 1855 to 1876, and sought to educate the people so as to make possible the transition from military to civil government. In the Russo-Turkish War of 1877–78 he commanded a separate corps d'armée on the Turkish frontier in Asia Minor. After taking the fortress of Ardahan, he was repulsed by Mukhtar Pasha at Zevin, but subsequently defeated his opponent at Aladja Dagh, took Kars by storm, and laid siege to Erzerum. For these services he received the title of Count.

In 1879 he was appointed temporary governor-general of the region of the Lower Volga, to combat an outbreak of the plague. He was then transferred to the provinces of Central Russia to combat the Nihilists and Anarchists, who had adopted a policy of terrorism, and had assassinated the governor of Kharkov. He advocated removing the causes of popular discontent, and for this purpose he recommended to the emperor a large scheme of administrative and economic reforms. Alexander II. thereupon appointed Loris-Melikov minister of the interior with exceptional powers. The proposed scheme of reforms was never carried out. On the very day in March 1881 that the emperor signed an ukáz creating the necessary commissions, he was assassinated; and his successor, Alexander III., adopted a reactionary policy. Loris-Melikov resigned, and lived in retirement until his death (Dec. 22, 1888) at Nice.

LÖRRACH, a town in the *Land* of Baden, Germany, in the valley of the Wiese, 6 mi. N.E. of Basle. Pop. (1939) 20,306. Lörrach received market rights in 1403, but did not obtain municipal privileges until 1682. It is the seat of considerable industry, its manufactures including calico, cloth, silk, chocolate, cotton, ribbons, hardware and cigars and it has a trade in wine, fruit and timber. It is a centre for the transmission of the electric power generated from the Rhine near by. There is a fine view from the neighbouring Schützenhaus, 1,085 ft. high. In the neighbourhood also is the castle of Rötteln, formerly the residence of the counts of Hachberg and of the margraves of Baden; this was destroyed by the French in 1678, but was rebuilt in 1867.

LORRAINE, one of the former provinces of France. The original kingdom of Lorraine was the northern part of the territories allotted by the treaty of Verdun (Aug. 843) to the emperor Lothair I., and in 855 formed the inheritance of his second son, King Lothair, from whom the name Lotharingia is derived. This kingdom was situated between the realms of the East and the West Franks, and originally extended along the North sea between the mouths of the Rhine and the Ems, including the whole or part of Frisia and the cities on the right bank of the Rhine. From Bonn the frontier followed the Rhine as far as its confluence with the Aar, which then became the boundary, receding from the left bank in the neighbourhood of Bingen so as to leave the cities of Worms and Spires to Germany, and embracing the duchy of Alsace. After crossing the Jura, the frontier joined the Saône a little south of its confluence with the Doubs, and followed the Saône for some distance, and finally the valleys of the Meuse and the Scheldt. Thus the kingdom roughly comprised the region watered by the Moselle and the Meuse, together with the dioceses of Cologne, Trier, Metz, Toul, Verdun, Liége and Cambrai, Basel, Strasbourg and Besançon, and corresponded to what is now Holland and Belgium, parts of Rhenish Prussia, of Switzerland, and of the old province of Franche-Comté, and to the district known later as Upper Lorraine, or simply Lorraine. Though apparently of an absolutely artificial character, this kingdom corresponded essentially to the ancient Francia, the cradle of the Carolingian house, and long retained a certain unity.

The reign of King Lothair (*q.v.*), ended on Aug. 8, 869. His inheritance was divided by the treaty of Meersen (Aug. 8, 870), by which Charles the Bald received part of the province of Besançon and some land between the Moselle and the Meuse. Then for a time the emperor Charles the Fat united under his authority the whole of the kingdom of Lorraine with the rest of the Carolingian empire. After his deposition in 888 Rudolph, king of Burgundy, got himself recognized in Lorraine. He was unable to maintain himself there, and succeeded in detaching definitively no more than the province of Besançon. Lorraine remained in the power of the emperor Arnulf, who in 895 constituted it a distinct kingdom in favour of his son Zwentibold. Zwentibold quickly became embroiled with the nobles and the bishops, and especially with Bishop Radbod of Trier. After the death of Arnulf in 899, the Lotharingians appealed to his successor, Louis the Child, to replace Zwentibold, who, on Aug. 13, 900, was killed in battle. In spite of the dissensions which immediately arose between him and the Lotharingian lords, Louis retained the kingdom till his death. The Lotharingians, however, refused to recognize the new German king, Conrad I., and testified their attachment to the Carolingian house by electing as sovereign the king of the West Franks, Charles the Simple. The struggle which followed ended in the treaty of Bonn (921), by which apparently the rights of Charles over Lorraine were recognized. The revolt of the Frankish lords in 922 and the captivity of Charles finally settled the question. After an unsuccessful attack by Rudolph, king of France, the German king Henry I. became master of Lorraine in 925, thanks to the support of Giselbert, son of Regnier count of Hainault, whom he rewarded with the hand of his daughter Gerberga and the title of duke of Lorraine. Giselbert at first remained faithful to Henry's son, Otto the Great, but in 939 he declared open war against him and appealed to Louis d'Outremer, who penetrated into Lorraine and Alsace, but was soon called back to France by the revolt of the count of Vermandois. In the same year Giselbert was defeated and killed near Andernach, and Otto at once made himself recognized in the whole of Lorraine, securing it by a treaty with Louis d'Outremer, who married Giselbert's widow Gerberga, and entrusting the government of it to Count Otto, son of Ricuin, until Giselbert's son Henry should have attained his majority.

Henry and Count Otto died in 944. After attempting unsuccessfully to govern Lorraine through his son-in-law Conrad of Franconia, Otto the Great in 954 gave it to his brother Bruno, archbishop of Cologne. Bruno had to contend against the efforts of the last Carolingians of France to make good their claims on Lorraine, as well as against the spirit of independence exhibited by the Lotharingian nobles; and his attempts to raze certain castles built by brigand lords and to compel them to respect their oath of fidelity resulted in serious sedition. To obviate these difficulties Bruno divided the ducal authority, assigning Lower Lorraine to a certain Duke Godfrey, who was styled *dux Ripuariorum,* and Upper Lorraine to Frederick (d. 959), count of Bar, a member of the house of Ardenne and son-in-law of Hugh the Great, with the title of *dux Mosellanorum.* In 977 the emperor Otto II. gave the government of Lower Lorraine to Charles I., a younger son of Louis d'Outremer, on condition that that prince should acknowledge himself his vassal and should oppose any attempt of his brother Lothair on Lorraine. Charles left two sons, Otto, who succeeded him (*c.* 992) and died without issue, and Henry, who is sometimes regarded as the ancestor of the landgraves of Thuringia. The duchy was then given to Godfrey (d. 1023), son of Count Godfrey of Verdun, and for some time the history of Lorraine is the history of attempts made by his successors to seize Upper Lorraine. Gothelon (d. 1043), son of Duke Godfrey, obtained the whole of Lorraine at the death of Frederick II., duke of Upper Lorraine, in 1027, and victoriously repulsed the incursions of Odo, count of Champagne, who was defeated and killed in a battle near Bar (1037). At Gothelon's death in 1043, his son Godfrey the Bearded received from the emperor only Lower Lorraine, his brother Gothelon II. obtaining Upper Lorraine. Godfrey attempted to seize the upper duchy, but was defeated and imprisoned in 1045. On the death of Gothelon in 1046, Godfrey endeavoured to take Upper Lorraine from Albert of Alsace, to whom it had been granted by the emperor Henry III. The attempt, however, also failed; and Godfrey was for some time deprived of his own duchy of Lower Lorraine in favour of Frederick of Luxemburg. Godfrey took part in the struggles of Pope Leo IX. against the Normans in Italy, and in 1053 married Beatrice, daughter of Duke Frederick of Upper Lorraine and widow of Boniface, margrave of Tuscany. On the death of Frederick of Luxemburg in 1065 the emperor Henry IV. restored the duchy of Lower Lorraine to Godfrey, who retained it till his death in 1069, when he was succeeded by his son Godfrey the Hunchback (d. 1076), after whose death Henry IV. gave the duchy to Godfrey of Bouillon, the hero of the first crusade, son of Eustace, count of Boulogne, and Ida, sister of Godfrey the Hunchback. On his death in 1100 Lower Lorraine was given to Henry, count of Limburg. The new duke supported the emperor Henry IV. in his struggles with his sons, and in consequence was deposed by the emperor Henry V., who gave the duchy in 1106 to Godfrey, count of Louvain, a descendant of the Lotharingian dukes of the beginning of the 10th century. This Godfrey was the first hereditary duke of Brabant, as the dukes of Lower Lorraine came to be called.

Upper Lorraine.—The duchy of Upper Lorraine, or Lorraine *Mosellana,* to which the name of Lorraine was restricted from the 11th century, consisted of a tract of undulating country watered by the upper course of the Meuse and Moselle, and bounded N. by the Ardennes, S. by the table-land of Langres, E. by the Vosges and W. by Champagne. Its principal fiefs were the countship of Bar which Otto the Great gave in 951 to Count Frederick of Ardenne, and which passed in 1093 to the lords of Montbéliard; the countship of Chiny, formed at the end of the 10th century, of which, since the 13th, Montmédy was the capital; the lordship of Commercy, whose rulers bore the special title of *damoiseau,* and which passed in the 13th century to the house of Saarebrücken; and, finally, the three important episcopal lordships of Metz, Toul and Verdun. After having been the object of numerous attempts on the part of the dukes of Lower Lorraine, Upper Lorraine was given by the emperor Henry III. to Albert of Alsace, and passed in 1048 to Albert's brother Gerard, who died by poison in 1069. He was the ancestor of the hereditary house of Lorraine, of which the male line possessed the duchy continuously until the death of Duke Charles the Bold in 1431. By his will Lorraine was to pass to his daughter Isabella, who married René of Anjou, duke of Bar, in 1420. But Anthony of Vaudemont, Charles's nephew and heir male, disputed this succession with René, who was taken prisoner at the battle of Bulgnéville (July 2, 1431). It was not until 1436 that René obtained his liberty by paying a ransom of 200,000 crowns. In 1444 Charles VII. of France and the dauphin Louis went to Lorraine, accompanied by envoys from Henry VI. of England, and procured a treaty, by which Yolande, René's eldest daughter, married Anthony's son, Ferri of Vaudemont, and René's second daughter Margaret became the wife of Henry VI. of England. After his return to Lorraine in 1442, René was seldom in the duchy. Like his successor John, duke of Calabria, who died in 1470, he was continually occupied with expeditions in Italy or in Spain. John's son and successor, Nicholas (d. 1473), died without children, and his heir was René, son of Frederick of Vaudemont. He died in 1508, leaving by his second wife three sons—Anthony, called the Good, who succeeded him; Claude, the ancestor of the house of Guise; and John (d. 1550), known as the cardinal of Lorraine. Anthony had been brought up from the age of 12 at the French court, where he became the friend of Louis XII., whom he accompanied on his Italian expeditions. He succeeded in maintaining a neutral position in the struggle between Francis I. of France and the emperor Charles V. He died on June 14, 1544, and was succeeded by his son Francis I., who died of apoplexy (Aug. 1545) at the very moment when he was negotiating peace between the king of France and the emperor.

Lorraine in Modern Times.—Francis's son Charles, called the Great, succeeded under the tutelage of his mother and Nicholas of Vaudemont, bishop of Metz. Henry II. of France took this opportunity to invade Lorraine, and in 1552 seized the three bishoprics of Metz, Toul and Verdun. In the same year the emperor laid siege to Metz, but was forced to retreat with heavy loss before the energetic resistance of Duke Francis of Guise. On leaving Lorraine, Henry II. took Charles to France, brought him up at the court and married him to his daughter Claude. After the accession of Francis II., the young duke returned to Lorraine, and, while his cousins the Guises endeavoured to make good the claims of the house of Lorraine to the crown of France by virtue of its Carolingian descent, he devoted himself to improving the administration of his duchy. He reconstituted his domain by revoking the alienations irregularly granted by his predecessors, reorganized the working of the mines and saltworks, unified weights and measures and promulgated edicts against vagabonds. His duchy suffered considerably from the passage of German bands on their way to help the Protestants in France, and also from disturbances caused by the progress of Calvinism, especially in the neighbourhood of the three bishoprics. To combat Calvinism Charles established the Jesuits at Pont-à Mousson, and gave over to them the university he had founded in that town in 1572. To this foundation he soon added chairs of medicine and law, the first professor of civil law being the *maître des requêtes,* the Scotsman William Barclay, and the next Gregory of Toulouse, a pupil of the jurist Cujas. Charles died on May 14, 1608, and was succeeded by his eldest son Henry II., called the Good, who died in 1624 without issue.

Henry was succeeded by his brother Francis II., who abdicated on Nov. 26, 1624, in favour of his son Charles IV. or III. He died in 1675, after a life spent in continual, though rarely effective, opposition to the French monarchy. His nephew Charles was recognized as duke of Lorraine by all the Powers except France, but never obtained effective possession of the duchy. He died in 1690. Seven years later Leopold, his son, was restored to his estates by the treaty of Ryswick (1697), but had to dismantle all the fortresses in Lorraine and to disband his army with the exception of his guard. Under his rule Lorraine flourished. While diminishing the taxes, he succeeded in augmenting his revenues by wise economy. The population increased enormously during his reign—that of Nancy, for instance, almost trebling itself between the years 1699 and 1735. Leopold welcomed French immigrants, and devoted himself to the development of commerce and industry, particularly to the manufacture of stuffs and lace, glass and paper. He was responsible, too, for the compilation of a body of law which was known as the "Code Léopold." Some time after his death, which occurred on March 27, 1729, his heir Francis III. was betrothed to Maria Theresa of Austria, the daughter and heiress of the emperor Charles VI. France, however, could not admit the possibility of a union of Lorraine with the empire; and in 1735 Louis XV. negotiated an arrangement by which Francis received the duchy of Tuscany in exchange for Lorraine, and Stanislaus Leszczynski, the dethroned king of Poland and father-in-law of Louis XV., obtained Lorraine, which after his death would pass to his daughter—in other words to France. These arrangements were confirmed by the treaty of Vienna (Nov. 18, 1738). In 1736, by a secret agreement, Stanislaus had abandoned the financial administration of his estates to Louis XV. for a yearly subsidy. The intendant, Chaumont de la Galaizière, was instructed to apply the French system of taxation in Lorraine; but in spite of the severity of the administration Lorraine preserved a grateful memory of the good king Stanislaus, who held his brilliant little court at Lunéville, and founded an academy and several libraries and hospitals. At his death in Feb. 1766 the two duchies of Lorraine and Bar became definitively incorporated in the kingdom of France. The treaties of 1735 and 1736, however, guaranteed their legislation, the privileges enjoyed by the three orders, and their common law and customs tariffs, which they retained until the French Revolution. Lorraine and Barrois formed a large government corresponding, together with the little government of the three bishoprics, to the *intendance* of Lorraine and the *généralité* of Metz. For legal purposes, Metz had been the seat of a parlement since 1633, and the parlement of Nancy was created in 1776. There was, too, a *chambre des comptes* at Metz, and another at Bar-le-duc. (For the later history *see* ALSACE-LORRAINE.)

See Dom. A. Calmet, *Histoire ecclésiastique et civile de Lorraine* (2nd ed., Nancy, 1747–57); Comte D'Haussonville, *Histoire de la réunion de la Lorraine à la France* (2nd ed., 1860); E. Huhn, *Geschichte Lothringens* (1877); A. Digot, *Histoire de Lorraine* (1879–80); E. Bonvalot, *Histoire du droit et des institutions de la Lorraine et des Trois-Évêchés* (1895); R. Parisot, *Le Royaume de Lorraine sous les Carolingiens* (1899); E. Duvernoy, *Les États Généraux des duchés de Lorraine et de Bar jusqu'à la majorité de Charles III.* (1904).

(R. P.)

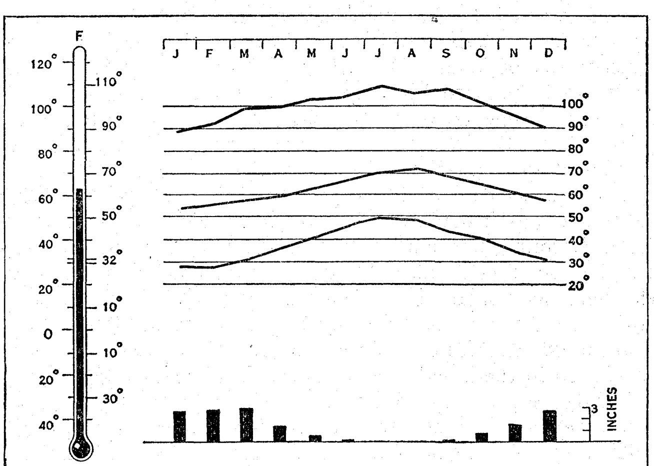
LORTZING, ALBERT (1801–1851), German composer, was born at Berlin on Oct. 23, 1801. His first opera *Ali Pascha von Jannina* appeared in 1824, but his fame rests chiefly upon the two operas *Der Wildschütz* (1842) and *Czar und Zimmermann* (1837). The latter, although now regarded as one of the masterpieces of German comic opera, was received with little enthusiasm on its first performance at Leipzig. It was translated into many European languages. Of his other operas it is only necessary to note *Der Pole und sein Kind,* produced shortly after the Polish insurrection of 1831, and *Undine* (1845). Lortzing died at Berlin on Jan. 21, 1851.

LORY, any of some 60 species of small (mostly 4.5 to 12 in.), brilliantly-coloured (many with bright red) parrots (*q.v.*), with beak less toothed and tongue brush-tipped, constituting the subfamily Loriinae. Some are called lorikeets. Lories are mostly from New Guinea and adjacent islands, though ranging to southeastern Australia, New Caledonia, the Philippines and Marquesas Islands. They fly swiftly in flocks, have shrill voices, and feed mostly on soft fruits and the nectar of flowers, gathered with the bushy tongue. The four or five white eggs are laid in holes in trees. There are about 15 genera, the best known being *Domicella, Trichoglossus, Chalcopsitta, Phigys, Vini* and *Eos*. (G. F. Ss.)

LOS ANDES, a former state of Venezuela under the redivision of 1881, which covered the extreme western part of the republic northwest of Zamora and south of Zulia. The territory is now cut up into three states—Mérida, Táchira and Trujillo.

LOS ANGELES (lōs ăń′gĕl ĕs or los ăng′ jĕ lĕz), a city and the county seat of Los Angeles county, in the southern part of the state of California, U.S.A., is situated in 34° 3′ N. and 118° 14′ W. The situation of the city between the mountains and the sea is attractive. The average altitude is about 275 ft., ranging from sea level to 1,692 ft. at Mt. Hollywood. The city had, on Jan. 1, 1941, an area of 442 square miles. The population within the city limits, according to the United States census bureau, increased from 319,198 in 1910 to 576,673 in 1920, to 1,238,048 in 1930 and to 1,504,277 in 1940, the 5th city in the union.

Geography.—The business section is 16 mi. northeast from the Pacific ocean, on level land, with foothills of the San Gabriel mountains on the north. Fresh water issuing from these hills led



WEATHER GRAPH OF LOS ANGELES. THE MERCURY STANDS AT THE ANNUAL MEAN TEMPERATURE. THE MIDDLE CURVE SHOWS THE NORMAL MONTHLY TEMPERATURE. THOSE ABOVE AND BELOW, THE HIGHEST AND LOWEST EVER RECORDED IN EACH MONTH. THE COLUMNS INDICATE THE NORMAL MONTHLY PRECIPITATION

to choice of the original site. The original town—the "pueblo" of "Our Lady, Queen of the Angels"—was built around a square, or plaza, near the Los Angeles river. With growth, after railways came, the city spread south, east and west over level land, assuming an irregular outline. In the region round about, separate municipalities grew up, of which Pasadena is largest. A high spur of the foothills on the west, which blocked growth in that direction for a time, has been pierced by tunnels and boulevards. On the south a narrow strip of annexed land, about 20 mi. long, known as the "shoestring strip," communicates with Los Angeles harbour. The city touches the ocean in annexed towns, San Pedro, Wilmington and Venice, and entirely surrounds separate municipalities, as Beverly Hills, Vernon and San Fernando.

The height of skyscrapers was limited to 150 ft. by city ordinance, with beneficial results in developing outlying centres. Hollywood, 8 mi. northwest of the business district, and part of Los Angeles municipally through annexation, is such a centre. It retains its original name and character, and is a distinct business and theatrical entity. A large area in the San Fernando valley, likewise annexed, has its distinctive communities.

Climate.—Even quality is the chief characteristic of the climate. Winter is a season of moderate rainfall, 15·23 in. yearly average. There is practically no rain from May to November. Winter days are sunny and warm; the nights are often cold, with occasional frost in December and January.

A 50-year average of the records of the U.S. weather bureau shows the mean temperature to be 62·4°; that there is a 72% possibility of sunshine; and 179 clear days. There are only 37 days per year with more than ·01 in. of rain. Average wind velocity was 6·1 mi. an hour; the highest wind ever recorded, 48 mi. an hour. During nearly half a century, Los Angeles has experienced a moderate earth tremor about once in five years. Since 1781, when the city was founded, there has never been a death or serious accident by earthquake.

Population.—The population of Los Angeles at the past five censuses was 102,479 (1900), 319,198 (1910), 576,673 (1920), 1,238,048 (1930), 1,504,277 (1940). About 1920 began an influx of population to southern California which surpassed even the movement of earlier years. The rapid increase of population, with a corresponding increase of capital and industry, and the discovery, at almost the same time, of rich new oil fields in the vicinity caused a "boom" which accounts for the city's phenomenal growth.

The Latin and Oriental population is about 17%. The census of 1930 showed the foreign-born whites to be 14·7% of the total population. Most of these were Mexicans, many Japanese, some Chinese, and the remainder chiefly Europeans and Canadians.

Natural Resources.—As coal was absent, petroleum and waterpower were the first resources developed by the Americans. Electricity generated in the mountains, for light and power, was brought over long transmission lines. Los Angeles pioneered long-distance transmission and the linking up of large electric networks. Within a radius of 300 mi. are deposits of metals and minerals, as copper, petroleum, soda, salt, potash, silica, infusorial earth, talc, graphite, limestone, building stone, marble and onyx.

Industries.—Manufacturing shows a striking increase since the World War of 1914–18—from $103,500,000 in 1914 to $654,-852,404 (U.S. census) in 1937. Manufacture was chiefly for local needs, as soap, confectionery, beverages and the like, until war made it necessary to meet certain shortages. This encouraged industrial enterprise. Peace brought building activity, increased population and new trade through the Panama canal and to the Orient. These further stimulated industry. The city and environs had during 1937, 4,504 factories. Motion pictures led in value with an output estimated at $171,943,349 yearly. Petroleum products were valued at $228,429,555, but this included recovery as well as refining. Meat packing ranked third with an output of $78,535,538. Other industries with products valued over $10,000,-000 were: printing and publishing, $36,964,886; bakery products, $42,199,182; tires, $65,000,000 (estimated); women's clothing, $34,122,832; machinery and machine shop products, $45,916,045; and furniture and fixtures, $22,805,363. Los Angeles ranks as a fashion centre for sportswear. At the harbour, canneries pack sardines (pilchard) and tuna, the latter a local innovation. Glass, chemicals, cement, paints and food preparations are leading products. Branch plants of eastern concerns are engaged in automobile assembling and the manufacture of rubber tires, furniture, metal articles, glass, tin cans, etc.

Motion Pictures.—Early motion pictures were made in sunlight. Constant sunshine and varied scenery brought this industry to Los Angeles. Hollywood, having at the outset (1910–15) ample land for studios, became famous as a centre; also Universal City and Burbank in the San Fernando valley, and Culver City. At least $95,320,051 were spent in 1940 in production, and 14,151 persons employed.

Agriculture.—Los Angeles county (4,155 sq.mi.) has for two dozen years led all other counties in the United States in value of soil products ($51,863,850 in 1940). The city is a financial and marketing centre for these products. The diversity is wide, including oranges, lemons, apricots, peaches, almonds, walnuts, summer and winter vegetables, figs, avocados, poultry, fur rabbits, grain, alfalfa, livestock, dairying and general farming. About 25,000 carloads of soil products are shipped from Los Angeles county annually. The first outstanding success in co-operative farm marketing was made in this section, by the California Fruit Growers' exchange, in orange distribution. The organization is now in Los Angeles. So is the California Walnut Growers' association.

Communication.—After American occupation (1847) sea trade was established between San Pedro harbour and San Francisco, and mail was carried fortnightly by land between the latter city and Los Angeles. The first freight wagon overland from the east arrived in 1851. In 1860, a ten-day pony express linked Los Angeles with the Missouri river. A railway from Los Angeles to San Pedro harbour was opened in 1869. The Southern Pacific railway from San Francisco to Los Angeles was completed in 1876, and the Santa Fe route connected the city with the east in 1885. Los Angeles by 1928 had three direct railways to the east—the Atchison, Topeka and Santa Fe via Kansas City, the Union Pacific via Ogden and Southern Pacific via New Orleans. The Southern Pacific to San Francisco gives access to other transcontinental routes from that city, and to the northwest. The railway to San Diego connects with still another route east. In a radius of 72 mi., the Pacific Electric railway system runs 3,000 trains daily over 1,106 mi. of track, carrying both passengers and freight. This system is linked to Los Angeles harbour. Los Angeles is a terminal for several national motor highways, and a centre for California highways. Over these roads a large motorbus and motor-truck traffic has developed. By sea, the city has shipping lines to all parts of the globe, as well as coast trade to both Pacific and Atlantic ports. Air service gives quick transportation and communication east and north. The national defence program (1941) made Los Angeles a centre for the aviation industry, with an estimated peak of 150,000 employees.

Harbour and Commerce.—San Pedro bay, in Spanish times, afforded an uncertain roadstead. It was chosen because accessible by a level land route from the city, 24 mi. away. The Americans established a stage route (1852) to the harbour and later a railroad (1869) but San Francisco enjoyed most of the sea trade. A long fight for Los Angeles harbour ended with annexation of two towns, San Pedro and Wilmington (1909), and the building of a breakwater by the U.S. government (1910) and an inner harbour by the city (1912–14). The Panama canal was opened at the same time, but the World War of 1914–18 temporarily disorganized foreign trade.

Growth was immediate when the war ended, rising from 752,513 short tons a year export and import to 5,624,000 short tons in 1940. On the Pacific coast, Los Angeles harbour stands next to that of the San Francisco bay area in water-borne commerce and ranks tenth among all U.S. ports. With 40 mi. water front, and capacity for large ocean vessels, harbour facilities were being enlarged in 1941 in co-operation with the city of Long Beach, which has a separate inner harbour. The chief imports in 1937 were raw silk, crude rubber, newsprint paper, sugar, fish, copra, coffee, tin, liquors, vegetable oil and fibres. Petroleum and petroleum products constituted 11,867,233 tons of the 16,481,646 tons exported, or 85%. The chief exports in 1937 were petroleum products, aircraft, raw cotton, citrus fruits, canned fish, iron and steel manufactures, copper, machinery, chemicals and automobile tires. Over $100,000,000 worth of aircraft flew away under its own power in 1940. Los Angeles harbour is the nearest Pacific terminus for the Panama canal. It is an operating centre for the U.S. navy.

As a Tourist Centre.—Los Angeles is a travel centre for the southwest. Several thousand visitors arrive in the city daily by train, automobile, motorbus, ship and aeroplane. The tourists by automobile (1940) were estimated at 1,580,500. Accommodation for visitors is on a large scale, 1,271 hotels and 5,000 apartment houses having facilities for 524,198 persons. Cottages, boarding and lodging houses, automobile camps, restaurants and cafeterias provide for visitors. At first, travel was limited chiefly to the winter season; but now summer travel slightly exceeds winter, a change brought about by better knowledge of the cool summers, and by activities of the All Year club of Southern California.

Streets and Traffic.—In the business district, streets run chiefly at right angles to diagonal compass points; elsewhere to direct compass points, with winding terraces where hills are built upon. Broad boulevards give access to the ocean, fruitful valleys and mountain wilderness. Motorbus lines operate in both urban and interurban traffic. Traffic congestion, formerly acute, has been relieved by automatic signals governing both vehicles and pedestrians. Steam railways skirt the eastern and northern boundaries of the city; the main area is served by electric street cars, which are operated over 412 mi. of track. With the development of hydroelectricity, Los Angeles became the centre of a network of electric interurban lines.

Water and Power.—Water is an important factor in the growth of a city in a semi-desert region. In 1904, this need was anticipated; William Mulholland, chief engineer of the city's water department, suggested an aqueduct to the east side of the Sierra Nevada mountain range, 250 mi. from the business district, through the Mohave desert. By 1908 bonds had been voted, and work begun. In 1913 the Los Angeles aqueduct was finished, 233 mi. in length, from intake to reservoir, the longest work of its kind in the world. The cost of construction was nearly $25,000,000. In the 233 mi. there are 142 tunnels; 97 mi. of covered conduit; 12 mi. of syphons; 37 mi. of lined canal; and 24 mi. of unlined canal. The capacity, about 280,000,000 gal. daily, is sufficient for 2,000,000 people; 250,000 ac. of land are irrigated with the surplus. For use in construction, 127 mi. of railroad and 215 mi. of highway were built. The giant Colorado river aqueduct, part of a $220,000,000 project which pierces 6 mountain ranges with 38 tunnels totalling 108 mi., will bring an ample water supply to 13 cities (including Los Angeles) in the metropolitan district and is of significance to all southern California. Power is supplied by a remarkable municipal system. The major portion of the electrical energy comes over a transmission line of 266 mi. from Boulder Dam. The four generators completed April 1937 supplied 115,000 horse power each. Five plants in San Francisquito canyon send 175,750 horsepower a distance of 50 miles and two steam plants supply 200,000 horsepower.

Finance.—Los Angeles is important in banking because capital is brought by newcomers, in addition to wealth produced locally. The surrounding country turns to it as the financial centre. Bank deposits grew from $118,000,000 in 1910 to $1,100,000,000 in 1927; yearly clearings increased from less than $1,000,000,000 in 1910 to $5,852,244,000 in 1935. Much capital is invested directly in land, buildings, oil and manufactures. There is also a large, growing investment in securities. The Los Angeles stock exchange transactions for the year 1940 represented a value of approximately $45,000,000.

Buildings.—Los Angeles is a somewhat hurriedly built city, now taking permanent form. Since the World War of 1914–18 (1920–35 inclusive) $1,390,000,000 has gone into building; the number of building permits in 1940 was 40,212, and their value, $74,300,510. This activity has made the city a centre of design and invention. Early builders adapted the bungalow, from India, as most suitable for the climate and the spacious sites then available. With more compact sites, the "California house" of Spanish design has replaced the bungalow. The city had almost no notable public buildings until 1925, but since that date a civic centre has been developed. Other buildings are the City hall, Hollywood police and fire stations, Lincoln Heights jail and Georgia Street hospital.

Theatres, Museums and Libraries.—With visitors seeking diversion, and many stage and screen players among its residents, Los Angeles is an important theatrical centre. Besides numerous theatres in the city and motion picture palaces, it has secondary theatrical centres like Hollywood, and an energetic "little theatre" activity. Grand opera is given in the Shrine Civic auditorium, seating 7,000 persons. Orchestra and other recitals are given in the Philharmonic auditorium. The Mission Play theatre, at San Gabriel, is one of the famous playhouses of the region. As climate makes outdoor entertainment attractive, the city has a number of gathering places like the Los Angeles coliseum, seating 105,000 persons, Hollywood bowl, seating 25,000, the adjoining Pilgrimage Play amphitheatre, and outlying auditoriums, as Pasadena Rose bowl, 84,000. The "symphony under the stars," in Hollywood bowl, during July and August, has become widely known. Easter morning is an occasion for outdoor services in various natural amphitheatres.

The Los Angeles museum of history, science and art has a spacious building in Exposition park. It exhibits mounted skeletons of sabre-toothed tigers, Imperial elephants, American mastodons, camels, wolves and small mammals recovered from La Brea asphalt pits, and has thousands of unmounted specimens. Its pictures, statuary, historical and scientific collections amply cover the field embraced in its title. The Southwest museum, in a building ornamented with cement casts from Mayan sculpture, specializes in the rich civilizations of the southwestern United States, Mexico and Central America, and also has collections of conchology, entomology and ornithology.

The Los Angeles public library, with 1,641,195 books, is housed in a building of monolithic concrete, and has 48 branches, mostly in special buildings. The city has various special libraries, belonging to colleges, professional associations and business concerns, devoted to law, medicine, architecture, mining, petroleum, minerals and industrial subjects. The Henry E. Huntington library and art gallery at San Marino, near Pasadena, is rich in rare books and manuscripts, mostly English and American, with the largest collection of *incunabula* in America. There also is an outstanding collection of the works of the great English painters of the so-called Golden age—Gainsborough, Reynolds, Lawrence, Romney. The Arabella Huntington Memorial, in the same place, includes rare art objects.

Parks.—Among the 130 parks, having an aggregate area of 5,412 ac., are: Griffith park, 3,761 ac. of natural foothill, with golf course; Exposition park, 114 ac., with Los Angeles museum; Elysian park, 599 ac., in natural state, with a motor camp; Sycamore Grove, 15 ac., a natural tract of dry river bed (arroyo); Barnsdall park, 10 ac., for children; Lincoln park, 46 ac., with a museum, zoo and exposition buildings; and Pershing Square, which is the only park in the business section, besides the old Spanish plaza. Many tourists visit Mt. Wilson and Mt. Lowe, northeast of the city, and Santa Catalina island, 23 mi. southwest from San Pedro.

Education.—More than 450,000 pupils were enrolled in 617 public schools in the fall of 1940; 10,283 teachers were giving instruction. Institutions for higher education, in order of the founding, are: (1) the coeducational University of Southern California (1879), Methodist, with students of all denominations. It is composed of 24 schools and colleges and is on large grounds in the central part of the city. Its enrolment in 1940 was 16,000. (2) Occidental college (1887), Presbyterian foundation, nonsectarian. It is coeducational, located on an attractive campus at Eagle Rock, at the northern border of Los Angeles. The college is devoted to the liberal arts; its enrolment in 1940 was about 750. (3) California Institute of Technology (1891), at Pasadena. Its work is confined to scientific and engineering subjects, notably for pure science and research. (4) Loyola university (1912), Catholic, near the beach, gives courses in science, art, engineering, commerce, finance, premedical studies and law. (5) University of California at Los Angeles (1919). It is on a 375 ac. campus at Westwood on the western border of the city. The institution has about 10,000 students, is coeducational and gives complete university training. (6) Other institutions include Chapman college and George Pepperdine college.

Churches and Charities.—The city's 979 churches, increased by about 50 yearly, are almost all new, and are varied in design and setting. Approximate church membership in 1940 was 338,911; of whom 91,046 were Protestant, 179,615 Roman Catholic and 68,250 Jewish. The 194 charitable and welfare organizations of the city secure funds through a yearly community chest solicitation. The contributions for 1940 totalled $2,500,450.

Government.—Los Angeles is governed under a charter adopted in 1924, in operation from July 1, 1925. It provides for the initiative, the referendum, the recall and an executive budget. The mayor (the chief executive, with wide powers of appointment), the city attorney, the controller and the seven members of the board of education are elected at large. The 15 members of the council (the legislative body) are elected by districts for a term of two years. The principal functions of government are entrusted to 16 commissions of 5 members each, appointed by the mayor, serving without salary, which appoint and fix the salary of general managers for their departments. There is also a municipal housing commission consisting of 12 members together with 4 judges and the president of the Chamber of Commerce.

History.—In 1769 an expedition under Gaspar de Portolá, which had been sent to San Diego, marched from that point in July and on Aug. 1 reached an Indian village called "Yang-na," on the present site of Los Angeles. The place was named on the following day, Aug. 2, the day of "Our Lady Queen of the Angels" (*Nuestra Señora la Reina de los Angeles*), by Father Juan Crespi. The pueblo, however, was not founded until Sept. 1781. The Franciscan mission of San Gabriel—still a famous landmark —had been established ten years earlier a few miles eastward. After Mexico's independence from Spain (1822) frequent political disturbances and revolts hampered the little town. In 1835 it was made a city by the Mexican congress, and declared the capital, but the last provision was not enforced and was soon repealed. In 1845–47 it was the actual capital of California. The city was rent by factional quarrels when war broke out between Mexico and the United States, and with the appearance of the United States troops under Commodore Robert F. Stockton and Capt. John C. Frémont, the defenders of Los Angeles fled; the American flag was raised over the city on Aug. 13, 1846. A garrison of 50 men, left in control, was compelled in October to withdraw on account of a revolt of the inhabitants, and Los Angeles was not retaken until Gen. S. W. Kearny and Commodore Stockton entered the city in January 1847. The city was incorporated in 1850, and in 1850 the first English school was opened and the first Protestant church established. Los Angeles continued to grow steadily thereafter until it attained railway connections with San Francisco in 1876, and with the east by the Santa Fe system in 1885. A carload of oranges was sent east by rail in 1877, and then began a new era of horticultural enterprise. A rate war between competing railways and a simultaneous land boom brought thousands of visitors to southern California. A large portion of these travellers became permanent settlers. It is also from this period (about 1890) that the "tourist era" dates. Each succeeding decade showed remarkable increases in population, industry and wealth. In 1914 the city's harbour (San Pedro) was opened, and with the Panama canal open, Los Angeles began to benefit by its position on a new world trade route. The discovery of rich new oil fields and the development of manufacturing enterprises made the decade 1920–30 momentous, and this has continued with the steady success of the cinema, continued public building, and the coming of cheap power.

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LOS ISLANDS (Islas de los Idolos), a group of islands off the coast of French Guinea, West Africa, lying south of Sangarea Bay, between 9° 25′ and 9° 31′ N. and 13° 46′ and 13° 51′

W., and about 80 m. N.N.W. of Freetown, Sierra Leone. There are five principal islands: Tamara, Factory, Crawford, White (or Ruma) and Coral. The two largest islands are Tamara and Factory, Tamara, some 8 m. long by 1 to 2 m. broad, being the largest. These two islands lie parallel to each other, Tamara to the west; they form a sort of basin, in the centre of which is the islet of Crawford. The two other islands are to the south. The archipelago is of volcanic formation, Tamara and Factory islands forming part of a ruined crater, with Crawford Island as the cone. The highest point is a knoll, some 450 ft. above sea-level, in Tamara. All the islands are richly clothed with palm trees and flowering underwood. Tamara has a good harbour, and contains the principal settlement. The inhabitants, about 1,500, are immigrants of the Baga tribe of Senegambian negroes, whose home is the coast land between the Pongo and Nunez rivers. In 1818 Sir Charles McCarthy, governor of Sierra Leone, obtained the cession of the islands to Great Britain from the chiefs of the Baga country, and in 1882 France recognized them to be a British possession. They were then the headquarters of several Sierra Leone traders. By article 6 of the Anglo-French convention of the 8th of April 1904, the islands were ceded to France. They were desired by France because of their geographical position, Konakry, the capital of French Guinea, being built on an islet but 3 m. from Factory Island, and at the mercy of long range artillery planted thereon. The islands derive their name from the sacred images found on them by the early European navigators.

LOSSIEMOUTH, a small burgh, Moray, Scotland. Pop. (1938) 3,984. Area, .8 sq.mi. It embraces the villages of Lossiemouth, Branderburgh and Stotfield, at the mouth of the Lossie, 5½ mi. N.N.E. of Elgin, of which it is the port, by a branch line of the L.N.E. railway. The industries are boat-building and rope-making. Lossiemouth, or the Old Town, dates from 1700; Branderburgh, farther north, grew with the harbour and began about 1830; Stotfield is purely modern. There is a fine golf course and good bathing. The cliffs at Covesea, 2 mi. W., contain caves, one of which was used as a stable in the rebellion of 1745; prehistoric weapons were found in another, and the roof of a third is carved with early Celtic ornamentation. J. Ramsay MacDonald (1866–1937) was born in Lossiemouth.

Kinneddar castle, 1 m. W., was a seat of the bishops of Moray, and Old Duffus castle, 2½ m. S.W., was built in the reign of David II. Nearly midway between Lossiemouth and Elgin stand the massive ruins of the palace of Spynie, formerly a fortified residence of the bishops of Moray. The large tower, with walls 9 ft. thick, was built about 1470.

LOSSING, BENSON JOHN (1813–1891), American historical writer, was born in Beekman, N.Y., Feb. 12, 1813. After editing newspapers in Poughkeepsie he became an engraver on wood, and removed to New York in 1839 for the practice of his profession, to which he added that of drawing illustrations for books and periodicals. He likewise wrote or edited the text of numerous publications. His *Pictorial Field-Book of the Revolution* (first issued in 30 parts, 1850–52, and then in 2 vols.) was a pioneer work of value. Similar but less characteristic and less valuable undertakings were a *Pictorial Field-Book of the War of 1812* (1868), and a *Pictorial History of the Civil War in the United States of America* (1866–69). His other books were numerous: an *Outline History of the Fine Arts;* many illustrated histories, and biographical sketches of celebrated Americans, of which *The Life and Times of Major-General Philip Schuyler* (1860–73) was the most considerable. He died at Dover Plains, N.Y., June 3, 1891. *See* Nathaniel Paine, "A Biographical Notice of Benson John Lossing," *Worcester Society of Antiquity* (1892).

LOSSKI, NIKOLAI ONUFRIEVICH (1870–   ), Russian philosopher, was born at Kreslavka near Vitebsk. He was educated at Kreslavka and at the University of St. Petersburg (Leningrad) where he studied first science and then philology. From 1916 to 1921 he was professor of the same university, but in 1922 he was compelled to leave Russia and went to live in Prague. According to Losski's views, knowledge is immediate contemplation (intuition). His intuitionalism differs from Bergson's in so far as he considers the ideal-rational forms to be elements of realities, intuitively cognisable.

Losski assumes not only concrete real being, but concrete ideal being as well, *i.e.,* supra-temporal and supra-spatial substantial agents with creative force, which are the basis of spatio-temporal being. This doctrine leads Losski to his teaching of the freedom of the will.

Among Losski's most important books are *Die Grundlehre der Psychologie vom Standpunkte des Voluntarismus,* published in Russian (1903), in German (1905); *The Intuitive Bases of Knowledge* (1904; Eng. trans., 1919); and *Handbuch der Logik* (1922), in German (1926). The titles of his principal untranslated Russian works may be given in English as follows: *Introduction to Philosophy; The World as an Organic Whole; Principles of Epistemology; Matter and Life; Freedom of Will.*

LÖSSNITZ, a district in the *Land* of Saxony, Germany, extending for about 5 mi. along the right bank of the Elbe, immediately N.W. of Dresden. Pop. (1933) 7,762.

It lies in a sheltered position and its climate makes it suitable for market-gardening, the produce finding a ready market in Dresden.

LOSSO, a people closely related to the Kabre, inhabiting the Sokode district of Dahomey.

LOSTWITHIEL, a market town and municipal borough of Cornwall, England, on the river Fowey 30½ mi. W. of Plymouth by the G.W. railway. Pop. (1938) 1,925. Lostwithiel probably owed its existence to the neighbouring castle of Restormel, restored somewhat in 1930. The Pipe Rolls (1194–1203) show that Robert de Cardinan, lord of Restormel, paid ten marks yearly for having a market at Lostwithiel. He surrendered to the burgesses all the liberties given them by his predecessors (*anteces-sores*) when they founded the town. By Isolda, granddaughter of Robert de Cardinan, the town was given to Richard, king of the Romans, who granted to the burgesses a gild merchant sac and soc, toll, team and infangenethef, freedom from pontage, lastage, etc., throughout Cornwall, and exemption from the jurisdiction of the hundred and county courts, also a yearly fair and a weekly market. His son Edmund decreed that the coinage of tin should be at Lostwithiel only. In 1609 a charter of incorporation provided for courts of record and pie powder. From 1305 to 1832 two members represented Lostwithiel in parliament, but under the Reform act (1832) the borough became merged in the county. For the victory gained by Charles I. over the earl of Essex in 1644, *see* GREAT REBELLION. St. Bartholomew's church has a fine Early English tower and a Decorated spire. A bridge of the 14th century crosses the river.

The shire hall includes remains of a building, called the Stannary prison, dating from the 13th century. The G.W. railway has workshops here. The boundaries of the borough were further extended in 1934. Area 4·9 sq.mi.

LOT, in the Bible, the legendary ancestor of the two Palestinian peoples, Moab and Ammon (Gen. xix. 30–38; *cf.* Ps. lxxxiii. 8); he appears to have been represented as a Horite or Edomite (*cf.* the name Lotan, Gen. xxxvi. 20, 22). As the son of Haran and grandson of Terah, he was Abraham's nephew (Gen. xi. 31), and he accompanied his uncle in his migration from Haran to Canaan. Near Bethel Lot separated from Abraham, owing to disputes between their shepherds, and being offered the first choice, chose the rich fields of the Jordan valley which were as fertile and well irrigated as the "garden of Yahweh" (*i.e.,* Eden, Gen. xiii. 7 *sqq.*). It was in this district that the cities of Sodom and Gomorrah were situated. He was saved from their fate by two divine messengers who spent the night in his house, and next morning led Lot, his wife, and his two unmarried daughters out of the city. His wife looked back and was changed to a pillar of salt, but Lot with his two daughters escaped first to Zoar and then to the mountains east of the Dead Sea, where the daughters planned and executed an incest by which they became the mothers of Moab and Ben-Ammi (*i.e.,* Ammon; Gen. xix.). The account of Chedorlaomer's invasion and of Lot's rescue by Abraham belongs to an independent source (Gen. xiv.), the age and historical value of which has been much disputed. (*See* further ABRAHAM; MELCHIZEDEK.)

LOT, a department of south-western France, formed in 1790 from the district of Quercy, part of the old province of Guyenne. It is bounded N. by Corrèze, W. by Dordogne and Lot-et-Garonne, S. by Tarn-et-Garonne, and E. by Aveyron and Cantal. Area 2,018 sq.mi. Pop. (1936) 162,572. The department is that part of the south-western slope of the Massif Central which is drained by the river Lot, navigable with the help of locks, while its northern portion is crossed by the parallel Dordogne, both streams flowing west to the Garonne-Gironde. On its eastern side, towards the heights of Cantal, there are hills 2,560 ft. in height. The centre of the department is occupied by a calcareous Jurassic plateau called the Causses, 700–1,300 ft. (Causse de Martel north of the Dordogne, Causse de Gramat or de Rocamadour between Dordogne and Lot, and Causse de Cahors south of Lot). On the west, stream dissection has formed a series of hills fringing the plain of Aquitaine. Water soaks through the porous surface of the causses and vanishes down its many fissures (*igues*) and springs emerge lower down to form large streams in the narrow and beautiful valleys. Temperature varies greatly between the warm valleys and the highlands of impermeable rock in the east; rainfall is somewhat above the average for France. Wheat, oats, maize, buckwheat and rye are the chief cereals. Wines are well known. The north-east cantons produce large quantities of chestnuts, walnuts, truffles, plums, and potatoes are also grown. Sheep abound, but cattle, pigs, horses, mules and goats are also reared, as well as poultry and bees. Some iron and coal are mined, and a little zinc. Limestone is quarried. The three arrondissements are those of Cahors, the capital, Figeac and Gourdon; there are 29 cantons and 331 communes.

Lot belongs to the 17th military district (Toulouse), and to the *académie* of Toulouse, its court of appeal is at Agen, and it is in the province of the archbishop of Albi, bishopric of Cahors. It is served by the Orléans railway. Cahors, Figeac and Rocamadour are the principal places. The fine feudal fortress at Castelnau has an audience hall of the 12th century, the Romanesque abbey-church at Souillac has a finely sculptured entrance. The plateau of Puy d'Issolu, near Vayrac, is believed by most authorities to be the site of the ancient Uxcellodunum, the scene of the last stand of the Gauls against Julius Caesar in 51 B.C. Lot has many dolmens.

LOT, a river of southern France, about 300 m. long, rising in the Hercynian gneisses of the Cévennes on Mt. du Goulet, at a height of 4,918 feet. Its direction is westward through a deep gorge between the Causse of Mende and Aubrac mountains, and the tableland (*causses*) of Sauveterre, Sévérac and Comtal. It passes off the gneisses near Capdenac; hence its sinuous course crosses the plateau of Quercy, of Jurassic limestones, to enter a wider fertile plain, covered with Tertiary deposits and alluvium. Its largest tributary, the Truyère (right), joins it at Entraygues. Lower down it receives the Dourdou (left) and the Célé (right) above Cahors, below which is the town of Villeneuve-sur-Lot. The Lot is canalized and navigable between the Garonne and Bouquiès (160 miles).

LOT-ET-GARONNE, a department of south-western France, formed in 1790 of Agenais and Bazadais, two districts of the old province of Guienne, and of Condomois, Lomagne, Brullois and pays d'Albret, formerly portions of Gascony. It is bounded W. by Gironde, N. by Dordogne, E. by Lot and Tarn-et-Garonne, S. by Gers and S.W. by Landes. Area, 2,079 sq.mi. Pop. (1936) 252,761. The department is that part of the Garonne basin above and below the point at which the Lot joins it. The north-east and the south are hilly, and in the west are the borders of the Landes (*q.v.*). The Garonne, the Lot and the Drot, a right bank tributary of the Garonne, are navigable. The mean temperature of Agen is 56·6° F, or 5° above that of Paris; the annual rainfall, from 20 to 24 in., is nearly the least in France. Of cereals wheat is the chief, with oats and maize. Potatoes, vines and tobacco are important sources of wealth. The best wines are those of Clairac. Vegetables and fruit, especially plums, *prunes d'ente* and apricots, are grown. The chief trees are the pine and the oak; there is a good deal of forest and the cork-oak flourishes in the Landes. Horned cattle are the chief live stock. Poultry and pigs are also reared profitably. There are deposits of iron in the department. The forges, blast furnaces and foundries of Fumel are important; and agricultural implements and other machines are manufactured. The making of lime and cement, of tiles, bricks and pottery, of confectionery and dried plums (*pruneaux d'Agen*) and other delicacies are important. At Tonneins (pop. [1936] 4,506) there is a national tobacco manufactory. Cork cutting, of which the centre is Mézin, candle-making, tanning and paper making are other industries. The arrondissements are three, named from the towns of Agen, Marmande and Villeneuve-sur-Lot, and there are 35 cantons and 326 communes.

Agen, the capital, is the seat of a bishopric under Bordeaux and of the court of appeal. The department belongs to the region of the XVII. army corps (Toulouse), the *académie* of Bordeaux. Lot-et-Garonne is served by the lines of the Southern and the Orléans railways. The department possesses Roman remains at Mas d'Agenais and at Aiguillon. The churches of Layrac, Monsempron, Mas d'Agenais, Moirax, Mézin and Vianne are of interest, as also are the 13th century fortifications of Vianne, and the châteaux of Xaintrailles, Bonaguil, Gavaudun and of the industrial town of Casteljaloux.

LOTHAIR I. (795–855), Roman emperor, was the eldest son of the emperor Louis I., and his wife Irmengarde. Little is known of his early life, which was probably passed at the court of his grandfather Charlemagne, until 815, when he became ruler of Bavaria. When Louis in 817 divided the empire between his sons, Lothair was crowned joint emperor at Aix-la-Chapelle and given a certain superiority over his brothers. In 821 he married Irmengarde (d. 851), daughter of Hugo, count of Tours; in 822 undertook the government of Italy; and, on April 5, 823, was crowned emperor by Pope Paschal I. at Rome. In Nov. 824 he promulgated a statute which reserved the supreme power to the secular potentate, and he afterwards issued ordinances for the good government of Italy. On his return to his father's court his step-mother Judith persuaded him to secure a kingdom for her son Charles, a scheme which was carried out in 829. Lothair, however, soon changed his attitude, and spent the succeeding decade in constant strife over the division of the empire with his father. He was alternately master of the empire, and banished and confined to Italy; at one time taking up arms in alliance with his brothers and at another fighting against them; whilst the bounds of his appointed kingdom were in turn extended and reduced.

When Louis was dying in 840, he sent the imperial *insignia* to Lothair, who, disregarding the various partitions, claimed the whole of the empire. Negotiations with his brother Louis and his half-brother Charles, both of whom armed to resist this claim, were followed by an alliance of the younger brothers against Lothair. A decisive battle was fought at Fontenoy on June 25, 841, when, in spite of his personal gallantry, Lothair was defeated and fled to Aix. With fresh troops he entered upon a war of plunder, but he was compelled to surrender Aix to his brothers. In June 842 the brothers met on an island in the Saône, and agreed to an arrangement which eventually developed into the treaty of Verdun (843).

By this Lothair received Italy and the imperial title, together with a stretch of land between the North and Mediterranean seas lying along the valleys of the Rhine and the Rhône. He abandoned Italy to his eldest son, Louis, and remained in his new kingdom, engaged in alternate quarrels and reconciliations with his brothers, and in efforts to defend his lands from the attacks of the Normans and the Saracens. In 855 he fell ill, and divided his lands between his three sons. On Sept. 23 he entered the monastery of Prüm, where he died six days later.

LOTHAIR II. or **III.** (*c.* 1070–1137), surnamed the "Saxon," Roman emperor, son of Gebhard, count of Supplinburg, succeeded to extensive lands around Helmstadt in Saxony, on his father's death in 1075. Gebhard had been a leading opponent of the emperor Henry IV. in Saxony, and his son, taking the same attitude, assisted Egbert II., margrave of Meissen, in the rising of 1088. His position in Saxony was increased by his marriage (1100) with Richenza, daughter of Henry, count of Nordheim. Having assisted the German king, Henry V., against his father in 1104, Lothair was appointed duke of Saxony by Henry, when Duke Magnus, the last of the Billungs, died in 1106. His independent attitude brought him into collision with Henry V., to whom, however, he was forced to submit after an unsuccessful rising in 1112. In 1112 Lothair supported the claim of Siegfried, count of Ballenstädt to inherit the domains of Ulrich II., count of Weimar and Orlamünde, against the emperor, Henry V. The rebels were defeated, and Siegfried was killed at Warnstädt in 1113, but his son secured possession of the disputed counties. After the defeat by Lothair of Henry's forces at Welfesholz on Feb. 11, 1115, events called Henry to Italy; and Lothair appears to have been undisturbed in Saxony until 1123, when the death of Henry II., margrave of Meissen and Lusatia raised a dispute as to the right of appointment to the vacant margraviates. A struggle ensued, in which victory remained with the duke.

When Henry V. died in 1125, Lothair was chosen German king at Mainz on Aug. 30, 1125. His election was largely owing to the efforts of the papal party. The new king was crowned at Aix-la-Chapelle on Sept. 13, 1125. Lothair requested Frederick of Hohenstaufen to restore to the crown the estates bequeathed to him by the emperor Henry V. Frederick refused, and was placed under the ban. Lothair, unable to capture Nuremberg, gained the support of Henry the Proud, the new duke of Bavaria, by giving him his daughter, Gertrude, in marriage, and that of Conrad, count of Zähringen, by granting him the administration of the kingdom of Burgundy, or Arles. But Conrad of Hohenstaufen, the brother of Frederick, was chosen German king in December 1127, and was quickly recognized in northern Italy. But by the end of 1129 the Hohenstaufen strongholds, Nuremberg and Spires, were in Lothair's possession. This struggle was accompanied by disturbances in Lorraine, Saxony and Thuringia, but order was soon restored after the resistance of the Hohenstaufen had been beaten down. In 1131 the king led an expedition into Denmark; resistance was offered, and the Danish king, Niels, promised to pay tribute to Lothair.

The king's attention at the time was called to Italy where two popes, Innocent II. and Anacletus II., were clamouring for his support. At first Lothair remained heedless and neutral; but in March 1131 he was visited at Liége by Innocent, to whom he promised his assistance. Crossing the Alps with a small army in September 1132, he reached Rome in March 1133, accompanied by Innocent. As St. Peter's was held by Anacletus, Lothair's coronation as emperor took place June 4, 1133 in the church of the Lateran. He then received as papal fiefs the vast estates of Matilda, marchioness of Tuscany, thus securing for his daughter and her Welf husband lands which might otherwise have passed to the Hohenstaufen. He returned to Germany, where he restored order in Bavaria, and on the lower Rhine. Resuming the struggle against the Hohenstaufen, Lothair soon obtained the submission of the brothers, who retained their lands, and a general peace was sworn at Bamberg. The emperor's authority was now generally recognized, and the annalists speak highly of the peace and order of his later years. In 1135, Eric II., king of Denmark, acknowledged himself a vassal of Lothair; Boleslaus III., prince of the Poles, promised tribute and received Pomerania and Rügen as German fiefs; while the eastern emperor, John Comnenus, implored Lothair's aid against Roger II. of Sicily.

The emperor seconded the efforts of his vassals, Albert the Bear, margrave of the Saxon north mark, and Conrad I., margrave of Meissen and Lusatia, to extend the authority of the Germans in the districts east of the Elbe, and assisted Norbert, archbishop of Magdeburg, and Albert I., archbishop of Bremen, to spread Christianity. In Aug. 1136, attended by a large army, Lothair set out upon his second Italian journey. The Lombard cities were either terrified into submission or taken by storm; Roger II. was driven from Apulia; and the imperial power enforced over the whole of southern Italy. A mutiny among the German soldiers and a breach with Innocent concerning the overlordship of Apulia compelled the emperor to retrace his steps. An arrangement was made with regard to Apulia, after which Lothair, returning to Germany, died at Breitenwang, a village in the Tirol, on Dec. 3 or 4, 1137. Lothair has been described as the "imitator and heir of the first Otto." His reign was regarded, especially by Saxons and churchmen, as a golden age for Germany.

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LOTHAIR (941–986), king of France, son of Louis IV., succeeded his father in 954, and was at first under the guardianship of Hugh the Great, duke of the Franks, and then under that of his maternal uncle Bruno, archbishop of Cologne. The beginning of his reign was occupied with wars against the vassals, particularly against the duke of Normandy. Lothair attempted to recover Lorraine by a sudden attack, and in the spring of 978 nearly captured the emperor Otto II. at Aix-la-Chapelle. In the autumn Otto invaded France, penetrating as far as Paris, but was forced to retreat with heavy loss. Peace was concluded in 980 at Margut-sur-Chiers, and in 983 Lothair was even chosen guardian to the young Otto III. Towards 980, however, Lothair quarrelled with Hugh the Great's son, Hugh Capet, who, at the instigation of Adalberon, archbishop of Reims, became reconciled with Otto III. Lothair died on March 2, 986. By his wife Emma, daughter of Lothair, king of Italy, he left a son who succeeded him as Louis V.

See F. Lot, *Les Derniers Carolingiens* (Paris, 1891); and the *Recueil des actes de Lothaire et de Louis V.,* edited by L. Halphen and F. Lot (1908).

LOTHAIR (825–869), king of the district called after him Lotharingia, or Lorraine, was the second son of the emperor Lothair I. On his father's death in 855, he received for his kingdom a district lying west of the Rhine, between the North Sea and the Jura mountains, which was called *Regnum Lotharii* and early in the 10th century became known as Lotharingia or Lorraine. On the death of his brother Charles in 863 he added some lands south of the Jura to this inheritance. The reign was chiefly occupied by efforts on the part of Lothair to obtain a divorce from his wife Teutberga, a sister of Hucbert, abbot of St. Maurice (d. 864); and his relations with his uncles, Charles the Bald and Louis the German, were influenced by his desire to obtain their support to this plan. Louis favoured the divorce, and Charles opposed it, while neither lost sight of the fact that Lothair was without male issue. Lothair put away Teutberga; but Hucbert took up arms on her behalf, and after she had submitted successfully to the ordeal of water, Lothair was compelled to restore her in 858. He then won the support of his brother, the emperor Louis II., by a cession of lands, and obtained the consent of the local clergy to the divorce and to his marriage with Waldrada, which was celebrated in 862. A synod of Frankish bishops confirmed this decision at Metz (863), but Teutberga fled to the court of Charles the Bald, and Pope Nicholas I. declared against the decision of the synod. An attack on Rome by the emperor failed, and in 865 Lothair again took back his wife. Teutberga, however, now expressed her desire for a divorce, and Lothair went to Italy to obtain the assent of the new pope Adrian II. On the return journey he died at Piacenza on Aug. 8, 869. He left, by Waldrada, a son Hugo who was declared illegitimate, and his kingdom was divided between Charles the Bald and Louis the German.

See Hincmar, "Opusculum de divortio Lotharii regis et Tetbergae reginae," in *Cursus completus patrologiae,* tome cxxv., edited by J. P. Migne (Paris, 1857–79); M. Sdralek, *Hinkmars von Rheims Kanonistisches Gutachten über die Ehescheidung des Königs Lothar II.* (Freiburg, 1881); E. Dümmler, *Geschichte des ostfränkischen Reiches* (Leipzig, 1887–88); and E. Mühlbacher, *Die Regenten des Kaiserreichs unter den Karolingern* (Innsbruck, 1881).

LOTHIAN, MARK KERR, First Earl of (d. 1609), the eldest son of Mark Kerr (d. 1584), abbot, and then commendator, of Newbattle, was a member of the famous border family of Ker of Cessford. Mark Kerr was an extraordinary lord of session under the Scottish king James VI; he became Lord Newbattle in 1587, and earl of Lothian in 1606. He died on April 8, 1609, having had, as report says, 31 children by his wife, Margaret (d. 1617), daughter of John Maxwell, 4th Lord Herries.

LOTHIAN, PHILIP HENRY KERR, 11TH MARQUESS OF (1882–1940), British ambassador to the United States, was born April 18, 1882. He was educated at the Oratory school, Birmingham, and at New college, Oxford university. In 1905 he was appointed assistant secretary of the Inter-Colonial Council of Transvaal and Orange River Colony and of the Railway Committee of Central South African Railways, and in those capacities he went to South Africa, where he remained until 1910. In South Africa he edited a magazine, *The State,* which favoured union of the South African colonies. After his return to England, he became editor of *The Round Table,* a journal of government and politics. Lloyd George made Kerr his secretary in 1916, in which capacity he assisted in preparing the Versailles treaty. He resigned in 1921 to direct the United Newspapers, Ltd.; served in the British cabinet as parliamentary under-secretary of the India office (1931–32); was chairman of the Indian Franchise committee (1932); and was secretary of the Rhodes trust, which administers the Rhodes scholarships (1925–39). In 1939 he was appointed British ambassador to the United States, a position he held until his death, Dec. 12, 1940, in Washington, D.C.

In the early 1930s, Kerr was an advocate of appeasing Germany but he abandoned that position after Hitler's seizure of Czechoslovakia. His chief effort as ambassador was to obtain war materials for Britain from the United States.

LOTHIAN. This name was formerly applied to a considerably larger extent of country than the three counties of Linlithgow, Edinburgh and Haddington Roxburghshire and Berwickshire at all events were included in it, probably also the upper part of Tweeddale (at least Selkirk). It would thus embrace the eastern part of the Lowlands from the Forth to the Cheviots, *i.e.,* all the English part of Scotland in the 11th century. This region formed from the 7th century onward part of the kingdoms of Bernicia and Northumbria. It cannot have come into English hands before the last decades of the previous century; for in the *Historia Brittonum* the Bernician king Theodoric, whose traditional date is 572–579, is said to have been engaged in war with four Welsh kings. One of these was Rhydderch Hên who, as we know from Adamnan, reigned at Dumbarton, while another named Urien is said to have besieged Theodoric in Lindisfarne. If this statement is to be believed it is hardly likely that the English had by this time obtained a firm footing beyond the Tweed. Most probably the greater part of Lothian was conquered by the Northumbrian king Aethelfrith, who, according to Bede, ravaged the territory of the Britons more often than any other English king, in some places reducing the natives to dependence, in others exterminating them.

In the time of Oswio the English element became predominant in northern Britain. His supremacy was acknowledged both by the Welsh in the western Lowlands and by the Scots in Argyllshire. On the death of the Pictish king Talorgan, the son of his brother Eanfrith, he seems to have obtained the sovereignty over a considerable part of that nation also. Early in Egfrith's reign an attempt at revolt on the part of the Picts proved unsuccessful. We hear at this time also of the establishment of an English bishopric at Abercorn, which, however, only lasted for a few years. By the disastrous overthrow of Egfrith in 685 the Picts, Scots and some of the Britons also recovered their independence. Yet we find a succession of English bishops at Whithorn from 730 to the 9th century, from which it may be inferred that the southwest coast had already by this time become English. The Northumbrian dominions were again enlarged by Eadberht, who in 750 is said to have annexed Kyle, the central part of Ayrshire, with other districts. In conjunction with Oengus mac Fergus, king of the Picts, he also reduced the whole of the Britons to submission in 756. But this subjugation was not lasting, and the British kingdom, though now reduced to the basin of the Clyde, whence its inhabitants are known as Strathclyde Britons, continued to exist for nearly three centuries. After Eadberht's time we hear little of events in the northern part of Northumbria, and there is some reason for suspecting that English influence in the southwest began to decline before long, as our list of bishops of Whithorn ceases early in the 9th century; the evidence on this point, however, is not so decisive as is commonly stated. About 844 an important revolution took place among the Picts. The throne was acquired by Kenneth mac Alpin, a prince of Scottish family, who soon became formidable to the Northumbrians. He is said to have invaded "Saxonia" six times, and to have burned Dunbar and Melrose. After the disastrous battle at York in 867 the Northumbrians were weakened by the loss of the southern part of their territories, and between 883 and 889 the whole country as far as Lindisfarne was ravaged by the Scots. During the next 50 years the influence of the Scottish kingdom seems to have increased in the south, and in 945 the English king Edmund gave Cumberland, *i.e.,* apparently the British kingdom of Strathclyde, to Malcolm I, king of the Scots, in consideration of his alliance with him. Malcolm's successor Indulph (954–962) succeeded in capturing Edinburgh, which thenceforth remained in possession of the Scots. His successors made repeated attempts to extend their territory southwards, and certain late chroniclers state that Kenneth II in 971–975 obtained a grant of the whole of Lothian from Edgar. Whatever truth this story may contain, the cession of the province was finally effected by Malcolm II by force of arms. At his first attempt in 1006 he seems to have suffered a great defeat from Uhtred, the son of earl Waltheof. Twelve years later, however, he succeeded in conjunction with Eugenius, king of Strathclyde, in annihilating the Northumbrian army at Carham on the Tweed, and Eadulf Cudel, the brother and successor of Uhtred, ceded all his territory to the north of that river as the price of peace. Henceforth in spite of an invasion by Aldred, the son of Uhtred, during the reign of Duncan, Lothian remained permanently in possession of the Scottish kings. (*See* SCOTLAND.)

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(F. G. M. B.)

LOTI, PIERRE (the pen name of Louis Marie Julien Viaud) (1850–1923), French author, was born at Rochefort on Jan. 14, 1850. His education began in Rochefort, but at the age of 17, following the tradition of his family, he entered the navy and began to attend the naval school, Le Borda. He gradually rose in his profession, attaining the rank of captain in 1906, and in 1910 was placed on the reserve list. His pseudonym is said to have been due to his extreme shyness and reserve in early life, which made his comrades call him after *le Loti,* an Indian flower which grows in unfrequented spots. He was never given to books or study, and it was not until 1876 that he was persuaded to write down and publish some curious experiences at Constantinople, in *Aziyadé,* a book which, like so many of Loti's, seems half a romance, half an autobiography. Thereafter he continued to write novels, which were mainly reminiscent of his travels. While taking part as a naval officer in the Tonking war, Loti exposed a series of scandals which followed on the capture of Hué (1883), and was suspended from the service for over a year. He continued silent for some time, but in 1886 published his most famous book, *Pêcheur d'Islande,* a novel of life among the Breton fisher-folk. In May 1891 he was elected a member of the French academy. He died at Hendaye (Basses Pyrénées), June 10, 1923.

Loti's greatest successes were gained in the species of confession, half-way between fact and fiction, of his earlier books. His later books of pure description were rather empty, for in spite of the beauty and melody and fragrance of his works, his mannerisms are likely to pall. With all his limitations, however, he was, in mechanism of style and cadence, one of the most original and talented French writers of the second half of the 19th century.

Among his most important works are: *Rarahu* (1880) republished as *Le Mariage de Loti; Le Roman d'un Spahi* (1881); *Mon frère Yves* (1883); *Propos d'exil* (1887); *Madame Chrysanthème* (1887); *Au Maroc* (1890); *Le Livre de la pitié et de la mort* (1891); *Fantôme d'orient* (1892); *Ramuntcho* (1897); *L'Inde (sans les Anglais)* (1903); *La troisième jeunesse de Mme. Prune* (1905); *Les Désenchantées* (1906; Eng. trans. by C. Bell); *La Mort de Philae* (1908); *Judith Renaudin* (Théâtre Antoine, 1904).

See also P. Loti, *Journal intime, 1878–1881* (1925); P. Loti, *Lettres à Mme. Juliette Adam, 1880–1922* (1924); N. Serban, *Pierre Loti, sa vie et son oeuvre* (1924).

LOTICHIUS or **LOTICH, PETRUS SECUNDUS** (1528–1560), German humanist, was born at Schlüchtern, Hesse-Cassel. He was educated at a number of schools including the one at Wittenberg, where he was a student of Melanchthon's. In 1547 he was a member of the army of the Protestant League of Schamlkalden which was defeated by the forces of the Holy Roman emperor, Charles V, at Mühlberg. He was made professor of medicine at Heidelberg in 1557 and he died in that city three years later. Lotichius is noted for his poems, particularly his elegies, of which he left several volumes. Stylistically they resemble the works of some of the classic Latin poets.

LÖTSCHEN PASS or **LÖTSCHBERG,** an easy glacier pass (8,842 ft.) leading from Kandersteg (Bernese Oberland) to the Lötschen valley (Valais). It is first mentioned in 1352, but was probably crossed earlier by the Valaisans who colonized various parts of the Bernese Oberland. In 1384 and in 1419 battles were fought on it between the Bernese and the Valaisans, while in 1698 a mule path (of which traces still exist) was contructed on the Bernese slope, though not continued beyond. The railway between Berne and Brig passes beneath the pass in the Lötschberg tunnel (9 mi. long and built in 1906–12). The tunnel starts above Kandersteg and enters the Lötschen valley at Goppenstein. This pass is to be distinguished from the Lötschenlücke (10,512 ft.), another glacier pass which leads from the head of the Lötschen valley to the Great Aletsch glacier.

LOTTERIES: *see* GAMING AND WAGERING.

LOTTI, ANTONIO (1667?–1740), Italian musical composer, was born at Venice, the son of Matteo Lotti, Kapellmeister to the court of Hanover. He entered the Doge's chapel as a boy, and in 1689 was engaged as an alto singer, succeeding later to the posts of deputy organist (1690), second organist (1692), first organist (1704), and, finally, in 1736, Maestro di Cappella at St. Mark's church. In 1717 he was invited to Dresden by the crown prince of Saxony. After producing three operas there he returned to his duties at Venice in 1719. He died on Jan. 5, 1740. Like many other Venetian composers he wrote operas for Vienna. Among his pupils were Alberti, Bassani, Galuppi, Gasparini and Marcello. Burney justly praises his church music, which is severe in style, but none the less modern in its grace and pathos. Lotti's greatest work is the *Crucifixus* (for six, eight or ten voices) printed in Rochlitz's collection. A fine setting of the *Dies Irae* is in the Imperial library at Vienna, and some of his masses have been printed in the collections of Proske and Lück.

See C. Spitz, *Antonio Lotti in seiner Bedeutung als opernkomponist* (1918).

LOTTO, LORENZO (*c.* 1480–1556), Italian painter, was born in Venice, but in the earlier years of his life lived at Treviso.

His two earliest authentic pictures, Sir Martin Conway's "Danaë" (about 1498) and the "St. Jerome" of the Louvre, as indeed all the works executed before 1509, have unmistakable quatrocentisque traits in the treatment of the drapery and landscape, and cool gray tonality. To this group belong the Madonnas at Bridgewater House, Villa Borghese, Naples and Sta. Cristina near Treviso, the Recanati altarpiece, the "Assumption of the Virgin" at Asolo, and the portrait of a young man at Hampton Court. He was in Rome between 1508 and 1512, when Raphael was painting in the Stanza della Signatura. A document in the Corsini library mentions that Lotto received 100 ducats as an advance payment for fresco-work in the upper floor of the Vatican, but there is no evidence that this work was ever executed. In the next dated works, the "Entombment" at Jesi (1512), and the "Transfiguration," "St. James" and "St. Vincent" at Recanati, Lotto has abandoned the dryness and cool colour of his earlier style, and adopted a fluid method and a blonde, joyful colouring.

In 1513 we find him at Bergamo, where he had entered into a contract to paint for 500 gold ducats an altarpiece for S. Stefano, completed in 1516, and now at S. Bartolommeo. From the next years, spent mostly at Bergamo, date the Dresden "Madonna," "Christ taking leave of his Mother" at the Berlin gallery, the "Bride and Bridegroom" at Madrid, the National gallery "Family Group" and portrait of the Protonothary Giuliano, several portraits in Berlin, Milan and Vienna, numerous altarpieces in and near Bergamo, the strangely misnamed "Triumph of Chastity" at the Rospigliosi palace in Rome, and the portrait of Andrea Odoni at Hampton Court. To this Bergamask period also belongs the fine series of frescoes in the Oratorio Guardi at Trescorre, near Bergamo (1524), free and original in design. In 1526 or 1527 Lotto returned to Venice, where Titian ruled supreme in the world of art; and it was only natural that the example of the great master should have fired him to emulation. However, even in the Carmine altarpiece, the "St. Nicholas of Bari," which is his nearest approach to Titian, he retained his individualized, as opposed to Titian's generalized, expression of emotion. But it was only a passing phase, and he soon returned to the cooler schemes of his earlier work.

Among his chief pictures executed in Venice between 1529 and 1540 are the "Christ and the Adulteress," now at the Louvre, the "Visitation" at the Jesi library, the "Crucifixion" at Monte S. Giusto, the "Madonna" at the Uffizi, the "Madonna and Saints" at Cingoli, and some portraits at the Berlin and Vienna museums, the Villa Borghese and Doria palace in Rome, and at the National gallery in London. He was at Treviso (1542–45), at Ancona in 1550, the year in which he entirely lost his voice; and in 1552 he "devoted his person and all his property to the Holy Virgin of Loreto" and took up his abode with the monks of that shrine. He died in 1556.

See Vasari (Milanesi ed.) *Vite;* G. Morelli, *Italian Masters in German Galleries* (1883); *Italian Painters in the Borghese and Doria Panfili Galleries* (1892–93); B. Berenson, *Lorenzo Lotto* (1901).

LOTTO (Ital. for "lot"), a gambling game often called *Keno* in America, played by any number of persons upon large boards or cards, each of which is divided into three horizontal rows of nine spaces, four spaces in each row being left blank and the other five marked with numbers up to 90. Each card is designated by a general number. The cards usually lie on the gaming-table, and a player may buy from the bank as many as he cares to use, each card being registered or *pegged* on an exposed table as soon as bought. Ninety small ivory markers, generally balls flattened on one side, numbered from 1 to 90, are placed in a bag and shaken out one by one, or, more usually, in a so-called *keno-goose,* a kind of urn with a spout through which the balls are allowed to roll by means of a spring. When a number falls out, the banker, or *keno-roller,* calls it out distinctly, and each player upon whose card that number occurs places a mark over it. This is repeated until one player has all the numbers in one row of his card covered, upon which he calls out "Keno!" and wins all the money staked excepting a percentage to the bank.

LOTUKO: *see* LOATUKO.

LOTUS, a popular name applied to several plants. The lotus fruits of the Greeks belonged to *Ziziphus lotus,* a bush native in south Europe with fruits as large as sloes, containing a mealy substance which can be used for making bread and also a fermented drink. In ancient times the fruits were an important article of food among the poor. A wine made from the fruit was thought to produce content and forgetfulness; hence the "lotophagi" or lotus-eaters. *Ziziphus* is a member of the family Rhamnaceae. The Egyptian lotus was a water-lily, *Nymphaea lotus;* also the sacred lotus of the Hindus, *Nelumbium nelumbo,* and the American lotus, *N. luteum.* The lotus tree, known to the Romans as the Libyan lotus, was probably *Celtis australis,* the nettle-tree (*q.v.*), a southern European tree, a native of the elm family, with fruits like small cherries, first red and then black. *Lotus* of botanists is a genus of the pea family (*Leguminosae*), containing a large number of species of herbs and undershrubs widely distributed in the temperate regions of the old world. It is represented in Britain by *L. corniculatus,* bird's foot trefoil, a low-growing herb, common in pastures and waste places, with clusters of small bright yellow pea-like flowers, which are often streaked with crimson; the popular name is derived from the pods which when ripe spread like the toes of a bird's foot. (X.)

In decoration, the lotus, through gradual conventionalization, became one of the most prolific ornamental forms. Its universal use in Egypt resulted from its symbolic association with the Nile, the giver of life. The flower itself is represented as a common votive offering and is frequently painted as though tied on to shrines or house pillars. The conventionalized form is not only the origin of the lotus bud capital, and the late lotus flower capital, but also serves in various ways as a basis for borders and all-over patterns. Two conventionalized varieties, the tri-lobe or three-leaved lotus, and the lotus palmette (in which the flower is combined with a semi-circle or semi-ellipse of radiating petals above it), were largely used by the Assyrians and all the peoples along the eastern shore of the Mediterranean. Thus the lotus is at the basis of such varying forms as the Assyrian sacred tree, and those Phoenician stele capitals which were the parents of the Ionic order. Lotus flower bud and palmette forms are also the origin of a great number of Greek, painted ceramic patterns and from them evolved into the egg and dart and into the anthemion (*q.v.*). The Romans not only borrowed and modified these Greek lotus derivatives, but also received further lotus forms from Etruscan art. Lotus derivatives, like many other Roman decorative motives, appear in modified form throughout Byzantine and Romanesque art. Lotus forms or derivatives are common even in the 20th century; thus their influence can be traced continuously back from modern times, through the Renaissance, mediaeval, Roman, Greek and western Asiatic work to its source in Egypt at least 5,000 years ago. For a complete, though not entirely sound discussion, *see* W. H. Goodyear, *Grammar of the Lotus.* (T. F. H.)

LOTUS-EATERS, a people encountered by Odysseus (*q.v.*) (Gr. Λωτοφάγοι); they lived on a plant called *lotos,* which they offered to his men; those who ate of it forgot home and friends and wanted only to remain there and eat of that food (Homer, *Od.* ix., 82 ff.). It should be plain enough that the Lotus-Eaters and their country are situated in fairy-land; but, besides allegorical interpretations, many ancient scholars amused themselves by trying to identify them with some people of Northern Africa, since that continent produces one or two edible plants called λωτὸς by the Greeks. This foolishness has been imitated by some moderns. The phrase "to eat lotus" is used metaphorically by numerous ancient writers to mean "to forget, to be unmindful."

See Roscher's *Lexikon,* art. "Lotophagen."

LOTZE, RUDOLF HERMANN (1817–1881), German philosopher, was born in Bautzen on May 21, 1817, the son of a physician. He studied in the gymnasium of Zittau, and in 1834 entered the university of Leipzig where, four years later, he gained his M.D. and also a doctorate in philosophy. Lotze's studies were governed by two distinct interests. The first was scientific, based upon mathematical and physical studies under the guidance of E. H. Weber, W. Volckmann and G. T. Fechner. The second was his aesthetical and artistic interest, which was developed under the care of C. H. Weisse. His scientific interests led him to condemn the form which Schelling's and Hegel's expositions had adopted, especially the dialectic method of the latter, whilst his love of art and beauty, and his appreciation of moral purposes, revealed to him the existence of a trans-phenomenal world of values into which no exact science could penetrate. His vocation then seemed to be the reconciliation of science with art, literature and religion; and hence the central point of his philosophy has been described as an analysis of the concept of the mechanism of nature with the object of proving that this concept necessarily leads to the assumption of an ideal principle of existence.

Lotze laid the foundation of his system in his *Metaphysik* (1841) and *Logik* (1843), short books published while he was still a junior lecturer at Leipzig, from which university he migrated to Göttingen in 1844, succeeding Herbart in the chair of philosophy. But he first became generally known through his *Allgemeine Pathologie und Therapie als mechanische Naturwissenschaften* (Leipzig, 1842, 2nd ed., 1848), his *Allgemeine Physiologie des Körperlichen Lebens* (Leipzig, 1851), and his *Medizinische Psychologie oder Physiologie der Seele* (Leipzig, 1852). In these he tried to show that the laws which govern particles of matter in the inorganic world govern them if they are joined into an organism. Final causes, vital and mental forces, and even the soul itself can only act through the inexorable mechanism of natural laws. But this mechanical view of nature is not identical with the materialistic. In the last of the above-mentioned works he asserts that mind must be considered as an immaterial principle, though its action on the body and vice versa is purely mechanical. In spite of the fact that Lotze declared that these writings were not intended to solve the origin and meaning of this all-pervading mechanism or to set forth the whole of his conception of Nature, they were counted among the opposition literature which destroyed the phantom of Hegelian wisdom and vindicated the independent position of empirical philosophy.

These misinterpretations induced Lotze to publish his *Streitschriften* (Leipzig, 1857), in which he protested against being counted either as a materialist or as a follower of Herbart. Lotze's next work, the *Mikrokosmos* (3 vols., 1856–64, Eng. trs. 2 vols., 1885) was intended to be a popular expression of his interests in science, aesthetics and religion, and a working out of his belief that the significance of the phenomena of life and mind would only unfold itself if by an exhaustive survey of the entire life of man, individually, socially and historically, we gain the necessary data for deciding what meaning attaches to the existence of this microcosm, or small world of human life, in the macrocosm of the universe. All separate channels of thought lead to the view that everywhere in the wide realm of observation we find three distinct regions—the region of facts, the region of laws and the region of standards of value. The world of facts is the field in which, and laws are the means by which, the higher standards of moral and aesthetical value are being realized; and such a union can again only become intelligible through the idea of a personal Deity, who in the creation and preservation of a world has voluntarily chosen certain forms and laws, through the natural operation of which the ends of His work are gained.

Having published his *Gesch. der Aesthetik in Deutschland* (1868), Lotze proposed to give a systematic exposition of his philosophy. His *Drei Bücher der Logik* appeared in 1874 (Eng. trs. 1888) and his *Drei Bücher der Metaphysik* in 1879 (Eng. trs. 1887), but the third volume which was to include aesthetics, ethics and the philosophy of religion was terminated by the death of Lotze at Berlin on July 1, 1881, three months after he had been called from Göttingen.

REALISTIC IDEALISM

In his exposition of logic he established two points, viz., the existence in our mind of certain laws and forms according to which we connect the material supplied by our senses, and, secondly, the fact that logical thought cannot be usefully employed without the assumption of a further set of connections, not logically necessary, but assumed to exist between the data of experience and observation. These connections handed to us by the sciences and by general culture are represented by such concepts as those of cause and effect, matter and force, end and means, freedom and necessity. It is the business of philosophy firstly to investigate these concepts and to discover the grounds on which the interconnection of phenomena rests, and secondly, to present the departments of knowledge in their true proportion. It follows, then, that any idealistic philosophy must have a realistic basis. Indeed, thought could not constitute reality because it is subjective and represents externals only inadequately, and because it is only one function among others upon which it is dependent *e.g.,* sensation, feeling and volition. All philosophical investigation falls into three parts, the first deals with those necessary forms in which we are obliged to think about things (metaphysics), the second is devoted to facts, and to the application of the results of metaphysics to these, especially to external and mental phenomena (cosmology and psychology), the third is concerned with those standards of value involved in our aesthetical or ethical judgments. We have already mentioned the final conception in which Lotze's speculation culminates, that of a personal Deity, Himself the essence of all that merits existence for its own sake, who in the creation and government of a world has voluntarily chosen certain laws through which His ends are to be realized. According to this view nothing is real but the living spirit of God and the world of living spirits which He has created; the things of this world have reality only in so far as they are the appearance of spiritual substance, which underlies everything.

In his metaphysical treatises, Lotze maintains that the course of things and their connection is only thinkable on the assumption of a plurality of existences, the reality of which can be conceived only as a multitude of relations. The nature of this reality cannot be represented as an unalterable something, but only as a fixed order of recurrence of continually changing events or impressions. Every attempt to think clearly what these relations are, what we really mean, if we talk of a fixed order of events, forces upon us the necessity of thinking also that the different things which stand in relations or the different phases which follow each other cannot be merely strung together or moved by some indefinable external power, in the form of some predestination or inexorable fate. The things themselves which exist and their changing phases must stand in some internal connection; they themselves must be capable of doing or suffering.

The simplest case of reciprocal action presupposes a universal substance, the essence of which we conceive as a system of laws underlying everything but known to us only through the impressions it produces on us, which we call things. Reflection teaches us that the nature of this universal substance can only be imagined as something analogous to our own mental life, where alone we experience the unity of a self preserved in the multitude of its (mental) states. Only where such mental life appears need we assign an independent existence; the purposes of everyday life as well as those of science are equally served if we deprive material things of an independence, and assign to them merely a connected existence through the universal substance by the action of which alone they appear to us.

The universal substance is at this stage of our investigations not endowed with the attributes of a personal Deity, and though Lotze's remarks on the subject are incomplete, in various passages he indicates that the absolute Being must be personal because personality alone possesses independence. In saying that the richness with which the working of the prime Being takes place determines the nature of existences. Lotze passes into his favourite realm of aesthetics.

Though Lotze disclaims being a follower of Herbart, his formal definition of philosophy and his conception of the object of metaphysics are similar to those of Herbart, and he forms with him an opposition to the philosophies of Fichte, Schelling and Hegel, which aimed at objective and absolute knowledge, and also to the criticism of Kant, which aimed at determining the validity of all human knowledge. But Lotze's spirit is more akin to the idealistic school than to the cold formalism of Herbart. What, however, with the idealists was an object of thought alone, the absolute, is to Lotze only inadequately definable in rigorous philosophical language; the aspirations of the human heart, the contents of our feelings and desires, the aims of art and the tenets of religious faith must be grasped in order to fill the empty idea of the absolute with meaning. This conviction of the emptiness of abstract notions, and of the fulness of individual life, has enabled Lotze to combine the two courses into which German philosophical thought had been moving since the death of Leibnitz.

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LOUBET, ÉMILE FRANÇOIS (1838–1929), 7th president of the French republic, was born on Dec. 30, 1838, the son of a peasant proprietor at Marsanne (Drôme), who was more than once mayor of Marsanne. He was admitted to the Parisian bar in 1862, and began to practice at Montélimar, where he married in 1869 Marie Louis Picard. At the crisis of 1870 he became mayor of Montélimar, and thenceforward was a steady supporter of Gambetta's policy. Elected to the Chamber of Deputies in 1876 by Montélimar he was one of the 363 who in June 1877 passed the vote of want of confidence in the ministry of the duc de Broglie. In the Chamber he occupied himself especially with education, fighting the clerical system established by the Loi Falloux, and working for the establishment of free, obligatory and secular primary instruction. In 1880 he became president of the departmental council in Drôme. He had entered the Senate as a member of the moderate republican party in 1885, and he became minister of public works in the Tirard ministry (Dec. 1887 to March 1888). In 1892 President Carnot, who was his personal friend, asked him to form a cabinet. Loubet held the portfolio of the interior with the premiership, and had to deal with the anarchist crimes of that year and with the great strike of Carmaux, in which he acted as arbitrator, giving a decision regarded in many quarters as too favourable to the strikers. He was defeated in November on the question of the Panama scandals, but he retained the ministry of the interior in the next cabinet under Alexandre Ribot, though he resigned on its reconstruction in January. In 1896 he became president of the Senate, and in Feb. 1899 president of the republic in succession to Félix Faure by 483 votes as against 279 recorded by Jules Méline.

Loubet was marked out for fierce opposition and bitter insult as the representative of that section of the Republican party which sought the revision of the Dreyfus case. In June Loubet summoned Waldeck-Rousseau to form a cabinet, and at the same time entreated Republicans of all shades of opinion to rally to the defence of the State. By the reports of Loubet and Waldeck-Rousseau the Dreyfus affair was settled, when Loubet, acting on the advice of Galliffet, minister of war, remitted the ten years' imprisonment to which Dreyfus was condemned at Rennes. Loubet's presidency saw an acute stage of the clerical question, the separation of church and state; serious differences with England at the time of the South African War and the Dreyfus case respectively; and the formation of the Anglo-French *entente*. President Loubet was a typical example of the peasant-proprietor class, and had none of the aristocratic proclivities of President Faure.

His presidency came to an end in Jan. 1906, when he retired into private life, surviving until December 20, 1929, when he died at Montélimar.

LOUCHEUR, LOUIS (1872–1931), French politician, was born at Roubaix on Aug. 12, 1872. After studying at the École Polytechnique he began a highly successful career as an engineer and contractor. When, in Dec. 1916, Briand decided to give certain offices to non-political men of high technical ability, he called upon Loucheur to be an under-secretary of State. In the Clemenceau cabinet of 1917–20 he was minister of munitions, and remained at the head of the department, when it was converted at the end of the World War into a department of industrial reconstruction. In this capacity he was consulted in the drafting of the economic section of the Versailles Treaty. Loucheur entered the Chamber in Nov. 1919 as deputy for the Nord Department, and became minister for the liberated regions in the Briand cabinet in Jan. 1921. In that capacity he negotiated with the German minister of reconstruction, Walter Rathenau, the Wiesbaden Convention for facilitating payment in kind of part of the reparations. During the next two years Loucheur upheld before the Chamber, with great argumentative ingenuity, various schemes for remedying the financial situation. In the second Poincaré cabinet of 1924 he was minister of commerce. On Nov. 28, 1925, Briand appointed him minister of finance in his new cabinet. But he found every group in parliament violently hostile to the seven proposals which he submitted for alleviating the financial crisis, especially to the proposal for the forced consolidation of Government bonds. The finance commission of the Chamber twice rejected five of these proposals and he therefore resigned on Dec. 15, having held his portfolio exactly 17 days. He was one of the French delegates to the League of Nations Assembly in 1924 and 1925.

In the Herriot cabinet of 1926 Loucheur was minister of commerce. On the fall of the Herriot Government he again devoted himself to industry, and was a prime mover in the arrangements made for an international steel cartel. As one of the French delegates at the World Economic Conference at Geneva in 1927, he played an important part in the deliberations, and when Poincaré received a fresh mandate at the elections of 1928 he included Loucheur in his cabinet as minister of labour. Loucheur was proprietor of the *Petit Journal.* He died Nov. 23, 1931.

LOUDON, ERNST GIDEON, FREIHERR VON (1717–1790), Austrian soldier, was born on Feb. 2, 1717, at Tootzen, Livonia, where his family, of Scottish origin, had been settled since before 1400. His father had been in the Swedish service; the boy entered the Russian army as a cadet in 1732, saw service in 1734, 1735, and 1738–39, then resigned (1741), and after vainly applying for employment with Frederick the Great, became a captain in Trenck's corps in Vienna. Soon after the outbreak of the Seven Years' War he became colonel, in 1757 major-general of cavalry, and in 1758 forced Frederick to raise the siege of Olmütz. In 1760 he won a further victory at Kunersdorf, was promoted feldzeugmeister and made commander-in-chief in Bohemia, Moravia and Silesia.

He was successful at Landshut and Glatz, but was defeated by Frederick at Liegnitz (Aug. 15, 1760), which action led to bitter controversy with Daun and Lacy, the commanders of the main army, who, Loudon claimed, had left his corps unsupported. In 1761 he operated again in Silesia, but was hampered by the inactivity of his Russian allies. (*See* SEVEN YEARS' WAR.) His tireless activity continued to the end of the war, in conspicuous contrast with the temporizing strategy of Daun and Lacy, and led in the last three years of the war to ever-increasing friction between the "Fabius" and the "Marcellus," as they were called, of the Austrian army.

After the peace dissensions continued between Loudon and Lacy, and Loudon only remained in the army at the special request of Maria Theresa, acting as commander-in-chief in Bohemia and Moravia 1769–72. In 1776 he settled at Hadersdorf near Vienna, and was made a field-marshal in Feb. 1778.

In the same year he was reconciled with Joseph II. and Lacy and commanded one of the two armies in the field in the war of the Bavarian Succession, but this time with only moderate success. He then retired again to Hadersdorf; but recalled after the reverses of the other generals in the Turkish War, he was made commander-in-chief, and won a last brilliant success by capturing Belgrade in three weeks, 1789. He died on July 14 at Neu-Titschein in Moravia, still on duty. His last appointment was that of commander-in-chief of the armed forces of Austria, which had been created for him by the new emperor Leopold. Loudon was buried in the grounds of Hadersdorf.

See memoir by v. Arneth in *Allgemeine deutsche Biographie, s.v.* "Loudon," and life by G. B. Malleson.

LOUDOUN, JOHN CAMPBELL, 1ST EARL OF (1598–1663), Scottish politician, eldest son of Sir James Campbell of Lawers, became Baron Loudoun in right of his wife Margaret, granddaughter of Hugh Campbell, 1st Baron Loudoun (d. 1622). With John Leslie, 6th earl of Rothes, he took part in the promulgation of the Covenant and in the General Assembly at Glasgow in 1638. He served under Gen. Leslie, and was one of the Scottish commissioners at the Pacification of Berwick in June 1639. In November of that year and again in 1640 the Scottish estates sent Loudoun with Charles Seton, 2nd earl of Dunfermline, to London on an embassy to Charles I. Loudoun intrigued with the French ambassador, and was sent to the Tower. He was released in June, and two months later he re-entered England with the Scottish invading army, and was one of the commissioners at Ripon in October.

In the following August (1641) Loudoun was made lord chancellor of Scotland, and his title of earl of Loudoun (granted in 1633, but stopped in chancery), was allowed. He also became first commissioner of the treasury. He was constantly employed in negotiations in England, and in 1647 was sent to Charles at Carisbrooke castle, but the "engagement" to assist the king there made displeased the extreme Covenanters, and Loudoun was obliged to retract his support of it. He was now entirely on the side of the duke of Argyll and the preachers. He assisted in the capacity of lord chancellor at Charles II.'s coronation at Scone, and was present at Dunbar. He joined in the royalist rising of 1653, but eventually surrendered to Gen. Monk. His estates were forfeited by Cromwell, and a sum of money settled on the countess and her heirs. At the Restoration he was removed from the chancellorship. He died in Edinburgh on March 15, 1663.

LOUD SPEAKER, a device for converting electric energy into sound energy, the strength of sound produced being sufficient to be audible at a distance.

Loud speakers are generally used for the reproduction of speech and music in rooms, halls or the open air. Before 1918 the loud speaker consisted of a form of the ordinary electromagnetic telephone receiver, with a conical horn attached to it to concentrate the sound given out by the vibrating diaphragm.

Since that date considerable research work has been done on loud speakers, particularly in connection with broadcasting, public address work and talking pictures, and the most modern forms can reasonably be classed as musical instruments.

Requirements of a Good Loud Speaker.—Progress has been greatly assisted by the development of satisfactory methods of sound measurement. These have enabled the characteristics of loud speakers to be examined.

The results of such tests have demonstrated that in an electro-acoustic system such as is used in broadcasting from the studio to the listener, the loud speaker is the least satisfactory link in the chain. But these measurements also show the way to the evolution of the perfect loud speaker. Such an instrument from the practical point of view should have the essential characteristics of realism; which means that in listening to the perfect loud speaker connected to its appropriate amplifier and microphone, and reproducing music or speech picked up by that microphone, one would hear exactly the same as if one were placed in the position of the microphone, assuming, of course, that the microphone and amplifier are accurately converting sound pressure variations at the diaphragm of the microphone into similar voltage variations in the amplifier. Then the loud speaker would have to satisfy the following main requirements: (1) An even response for all frequencies. That is to say the sound pressure output for a given voltage input to the loud speaker or loud speaker amplifier must be the same for the whole musical range of frequencies, that is say from 25 to 12,000 cycles per second. Naturalness in reproduction, on the pressure basis, is synonymous with the treatment of all frequencies equally, which means that the frequency characteristic of the instrument is a straight line, having no resonance peaks to indicate that certain frequencies are favoured in comparison with others. (2) The relation between input and output must be linear within the limits of use; that is to say if the electrical input is increased in any proportion, the acoustic output must also be increased in the same proportion. (3) The loud speaker must deal faithfully with transient phenomena; in other words the response to sudden changes must be immediate. (4) The distribution of sound in various directions from the loud speaker must be equal for all frequencies. (5) The loud speaker must be reasonably efficient.

The majority of loud speakers fail to a certain extent on all these points; and a compromise is made in designing loud speakers for any particular purpose. The general uses for modern loud speakers are as follows: (1) For realistic and faithful reproduction of speech and music in a limited space; as for instance in the case of broadcast reception in the home. Frequency characteristic, linearity, and transient response must be good. Equal distribution and efficiency are not so important, but cost and maintenance must not be forgotten. (2) For public address work, efficiency and capability of handling great power are necessary. The remaining characteristics are not so important provided that complete intelligibility is maintained. (3) A purpose now coming into prominence, namely in connection with talking pictures, occupies a half way position between the two given above, and requires the fulfilment of all the above-mentioned points.

Development of the Loud Speaker.—The loud speaker essentially comprises a diaphragm which is set into motion by electrical forces and which by its movement generates sound waves in the neighbouring air. Its motion can be utilised in two ways. The diaphragm may be relatively small and transmit sound to the air by means of a horn; or it may be large and operate direct on the air.

The original electrical sound-producing instrument was the Bell telephone receiver. It consists of a thin iron diaphragm fixed in front of an electromagnetic system, the edges being firmly clamped for mechanical reasons. (*See* TELEPHONE.)

The diaphragm thus has very marked mechanical resonances; in other words it responds more to certain frequencies than to others; and in reproducing music these frequencies are particularly favoured, with a resulting loss of naturalness. The frequency response characteristic for an average telephone earpiece shows these resonance peaks; which are however considerably damped down when the telephone is applied to the ear.

The first loud speaker was developed from the telephone earpiece by placing a conical horn in front of the diaphragm. The air column of the horn acted as a damping on the diaphragm, reduced the effects of the resonance peaks and concentrated the energy of sound coming from the diaphragm. The conical horn however does not deal equally with all frequencies.

The next development was that of a horn which would deal equally with all frequencies. The exponential horn, in which the area of the section perpendicular to the axis varies exponentially with the distance along the axis, is capable of doing this provided that it is sufficiently long.

An exponential horn of medium length is good for high and middle frequencies but fails in the lower frequencies. The longer the horn the lower the cut off frequency. Such a horn acts essentially as an acoustic transformer between the confined area at the diaphragm and the open air condition at the flare of the horn. It is an ideal method of coupling a relatively small diaphragm to the open air to obtain the maximum output from the diaphragm. The subject has been dealt with fully by Hanna and Slepian.

A typical loud speaker exponential horn does not give, in actual practice, uniform characteristics when such a horn is used in conjunction with an electromagnetic unit of the telephone earpiece type. The resonance peaks are still present and there is a noticeable lack of response in the bass frequencies. These are due to the type of unit used where diaphragm resonances are so apparent, and also to the fact that this form of moving iron movement is constrained and asymmetrical, and unable to have the free motion necessary to produce the lower frequencies (the lower the frequency the greater the amplitude necessary for equal pressure radiation).

This restriction does not allow the condition of linearity to be satisfied, and results in the generation of harmonics for pure low frequency input.

These difficulties are overcome by the use of an electrodynamic or moving coil type of movement in the unit. This was developed in one form by Round in 1924, and in another by Wente and Thuras in 1927. In both these cases the diaphragm is non-magnetic, comparatively rigid in itself and flexibly mounted, and driven by a coil attached to it which is suspended in a strong magnetic field.

Such a loud speaker has very much more satisfactory frequency and linearity characteristics. In the Wente type the efficiency is also greatly increased to an average value of 30% which is a great advance beyond that for previous horn or large diaphragm types, the majority of which do not show an efficiency greater than 3%.

For the reproduction of broadcasting the horn type has been somewhat set aside and its place taken by the large diaphragm type, which, operated by some form of electrical movement, communicates the sound direct to the air. Such diaphragms are usually made in the form of paper or card cones, and in some cases these cones are designed to have particular resonances, introduced on purpose to remedy some defective part of the curve.

Where the electrical movements of these types of speakers embody moving iron armatures, lack of linearity exists just as it does for the earpiece type of movement, with consequent absence of pure low frequency reproduction. This fault has been remedied, as in the case of horn type speakers, by the electrodynamic drive. In this type a moving coil is attached to the apex of a lightly suspended paper cone diaphragm and moves in a constant strong magnetic field. The low frequency radiation is preserved by mounting the diaphragm in a baffle.

The baffle is an extension of the mounting, holding the edges of the diaphragm, which serves to lengthen the air path from one face of the diaphragm around to the other. Its function is to limit direct interaction between air pressure changes produced at the two faces of the diaphragm.

The relationship between sound pressure output and input current to the coil can be made more even for the frequency range. Although the acoustic theory for the radiation due to the motion of a circular diaphragm in a baffle was worked out by Rayleigh in 1878, and the moving coil principle was demonstrated by Oliver Lodge in 1898 to vibrate a wooden board to reproduce sounds, it was not until 1925 that the now familiar moving coil type of loud speaker was developed by Rice and Kellogg.

The basis of the design is that the mass of the movement is the controlling factor rather than the elasticity and the damping. On this basis moving coil loud speakers have, comparatively, extremely good frequency characteristics. There is no doubt that the good reproduction which can be obtained has been responsible for a considerable increase of interest by the musical public in broadcast transmission and reception.

The departure from the straight line in the frequency characteristic is due to two factors. A "breaking up" of the cone when vibrating at high frequency is responsible for one main and several subsidiary peaks in the range of frequencies above 1,000 cycles; and mechanical resonance in the suspension of the cone at very low frequency can result in a certain "boominess" in the reproduction. Careful design can however reduce very considerably these two defects.

Another form of electrodynamic large diaphragm type has been developed by Siemens and Halske. The electrical circuit consists of a zig zag metal strip mounted by its edge on a rectangular diaphragm. This is suspended over an electromagnet with parallel gaps, and poles alternately magnetised north and south; each portion of the strip fits into its own magnetic gap with the result that when current passes through the strip the diaphragm moves as a whole and does not tend to break up at certain frequencies. The reproduction is good, and a considerable amount of power can be radiated.

Another type of loud speaker which has not yet attained great success is made in the form of a condenser. One metallic plate is fixed, and the other is made of foil and held close to the fixed one, but insulated from it. The point of interest is that the electrical force is thus applied over the whole of the diaphragm, but the efficiency is not very great and the condenser loud speaker is comparatively insensitive.

Measurement of the Characteristics of Loud Speakers.—It is possible to obtain the frequency characteristic of loud speakers, and this forms a useful basis of comparison. (*See* MICROPHONE for methods used.) The same methods give the contour surfaces of distribution for various frequencies. It is also possible to measure on an oscillograph the degree of departure from linearity. These measurements have already received considerable attention from loud speaker designers.

The importance of response to transient phenomena however has not been fully realised and very little work on the subject has been carried out. There is no doubt however that this requirement is just as necessary for realistic musical reproduction as a good frequency characteristic. There is thus considerable room for improvement in loud speakers, particularly in regard to frequency characteristics, transient response and efficiency. *See* also RADIO; SOUND; TELEPHONE.

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LOUDUN, a town of western France, capital of an arrondissement, in the department of Vienne, 45 mi. by rail S.W. of Tours. Pop. (1936) 4,687. Loudun (*Laudunum*) was a town of importance during the religious wars and gave its name in 1616 to a treaty favourable to the Protestants. Of the old walls a single gateway and two towers remain. A 12th century rectangular donjon of the castle of the counts of Anjou is preserved; at its base traces of Roman constructions have been found, with fragments of porphyry pavement, mosaics and mural paintings. There is a Carmelite convent; the old Romanesque church of Sainte Croix is now used as a market. The Gothic church of St. Pierre-du-Marché has a Renaissance portal and a high stone spire. There are several old houses in the town. The manufacture of farm implements is carried on, and there is a considerable trade in agricultural products, wine, etc.

LOUGHBOROUGH, ALEXANDER WEDDERBURN, 1ST BARON: *see* ROSSLYN, ALEXANDER WEDDERBURN, 1st earl of.

LOUGHBOROUGH (lŭf'brŭ), a town in Leicestershire, England, near the Soar, on the Loughborough canal. Pop. (1938) 30,370. The manor of Loughborough was granted by William the Conqueror to Hugh Lupus, from whom it passed to the Despensers. Edward II visited the manor several times. Among the subsequent lords were Henry, Lord Beaumont and Sir Edward Hastings. The market rights were purchased by the town in 1880. Lace-making was formerly the chief industry, but machines set up by John Heathcote were destroyed by the Luddites in 1816, and the manufacture lost its importance. It is 110 mi. N.N.W. of London by the L.M.S.R. and 113 mi. by the L.N.E.R. The neighbourhood is an agricultural district, and to the S.W. lies Charnwood forest. The grammar school, founded in 1495 by Thomas Burton, occupies modern buildings. The principal industry is hosiery making; there are also engineering, iron and dye works and bell foundries (introduced in 1840). The great bell for St. Paul's cathedral, London, largest in the United Kingdom, was cast here in 1881. Loughborough was incorporated in 1888, and was extended in 1935 and 1936. Area 14.4 sq.mi. Loughborough college is an important engineering school.

LOUGHREA, a picturesque market town of Co. Galway, Eire, on the N. shore of Lough Rea, 116 mi. W. from Dublin by rail. Pop. (1936) 2,891. There are slight remains of an Early English Carmelite friary dating *c.* 1300, which escaped the Dissolution. Loughrea is the seat of the Roman Catholic bishop of Clonfert, and has a cathedral built in 1900–1905. A part of the castle of Richard de Burgh, founder of the friary, still survives, and there are traces of the town fortifications. In the neighbourhood are a cromlech and two ruined towers, and crannogs, or ancient stockaded islands, have been discovered in the lough.

LOUGHTON (low'ton), a parish in the Chigwell urban district, Essex, England, near the Roding, 11½ mi. N.N.E. of Liverpool street station, London, by the L.N.E. railway. Pop. (1931) 7,390. The lordship of the manor was granted to Waltham abbey. In the vicinity are large earthworks, probably of British origin, known as Loughton camp. This is one of the villages near Epping forest, which has become the centre of an important residential district and a resort for Londoners.

LOUHANS, a town of east-central France in the department of Saône-et-Loire, 34 mi. N.N.E. of Mâcon by road. Pop. (1936) 2,781. Its church has a fine 15th-century tower with a carved balustrade. The main street is arcaded. The town is the central market of the agricultural plain of Bresse, with much trade in chickens and horses. It has a sub-prefecture and a tribunal of commerce.

LOUIS I. (778–840), surnamed the "Pious," Roman emperor, third son of the emperor Charlemagne and his wife Hildegarde, was born at Chasseneuil in central France, and crowned king of Aquitaine in 781. His tastes were ecclesiastical rather than military, the government of his kingdom was mainly conducted by his counsellors. In 794 or 795 he married Irmengarde, daughter of Ingram, count of Haspen. After the deaths of his two elder brothers, Louis, at his father's command, crowned himself co-emperor at Aix-la-Chapelle on Sept. 11, 813, and became sole ruler in the following January. He earned the surname of "Pious" by banishing his sisters and others of immoral life from court; by attempting to reform and purify monastic life; and by showing great liberality to the church.

In Oct. 816 he was crowned emperor at Reims by Pope Stephen IV.; and at Aix in July 817, he arranged for a division of his empire among his sons. This was followed by a revolt of his nephew, Bernard, king of Italy; but the rising was easily suppressed, and Bernard was killed, although in 818 Louis pardoned the followers of Bernard and restored their estates. In 819 he married Judith, daughter of Welf I., count of Bavaria, who in 823 bore him a son Charles, afterwards called the Bald. With the support of Judith's eldest step-son Lothair, a district was carved out for Charles in 829. Discontent at this arrangement led to a rebellion in the following year, provoked by Judith's intrigues with her favourite Bernard, count of Barcelona. Lothair and his brother Pippin joined the rebels, and after Judith had been sent into a convent and Bernard had fled to Spain, an assembly was held at Compiègne, when Louis was practically deposed and Lothair became the real ruler of the Empire. But at a second assembly held at Nimwegen in Oct. 830 he was restored to power.

Further trouble between Pippin and his father led to the nominal transfer of Aquitaine from Pippin to his brother Charles in 831. The emperor's plans for a division of his dominions then led to a revolt of his three sons. Louis met them in June 833 near Kolmar, but owing possibly to the influence of Pope Gregory IV., who took part in the negotiations, he found himself deserted by his supporters, and the treachery and falsehood which marked the proceedings gave to the place the name of *Lügenfeld,* or the "field of lies." Judith, charged with infidelity, was again banished; Louis was sent into the monastery of St. Medard at Soissons; and the government of the empire was assumed by his sons. But when the younger Louis had failed to induce Lothair to treat the emperor in a more becoming fashion, he and Pippin took up arms on behalf of their father. The result was that in March 834 Louis was restored to power at St. Denis; Judith returned and the kingdoms of Louis and Pippin were increased. The struggle with Lothair continued until the autumn, when he submitted to the emperor and was confined to Italy. An assembly at Diedenhofen declared the deposition of Louis to have been contrary to law, and a few days later he was publicly restored in the cathedral of Metz. In Dec. 838 Pippin died, and the Empire, except Bavaria, the kingdom of Louis, was now divided between Lothair, reconciled to his father, and Charles. The emperor was returning from suppressing a revolt on the part of his son Louis, when he died on June 20, 840 on an island in the Rhine near Ingelheim. He was buried in the church of St. Arnulf at Metz. Louis, who is also called *Le Débonnaire,* counts as Louis I., king of France.

See *Annales Fuldenses; Annales Bertiniani;* Thegan, *Vita Hludowici;* the *Vita Hludowici* attributed to Astronomus; Ermoldus Nigellus, *In honorem Hludowici imperatoris;* Nithard, *Historiarum libri,* all in the *Monumenta Germaniae historica. Scriptores,* Bände i. and ii. (Hanover and Berlin, 1826 fol.); E. Mühlbacher, *Die Regesten des Kaiserreichs unter den Karolingern* (Innsbruck, 1881); and *Deutsche Geschichte unter den Karolingern* (Stuttgart, 1886); B. Simson, *Jahrbücher des fränkischen Reichs unter Ludwig dem Frommen* (Leipzig, 1874–76); and E. Dümmler, *Geschichte des ostfränkischen Reiches* (Leipzig, 1887–88).

LOUIS II. (825–875), Roman emperor, eldest son of the emperor Lothair I., was designated king of Italy in 839, and was crowned king at Rome by Pope Sergius II. on June 15, 844. In 850 he was crowned joint emperor at Rome by Pope Leo IV., and soon afterwards married his cousin, Engelberga, a daughter of King Louis the German, and undertook the independent government of Italy. On the death of his father in Sept. 855 he became sole emperor. In 857 he allied himself with Louis the German against his brother Lothair, king of Lorraine, and King Charles the Bald, but after he had secured the election of Nicholas I. as pope in 858, he became reconciled with his brother. In 863, on the death of his brother Charles, Louis received the kingdom of Provence. In 864 he quarrelled with Pope Nicholas I. over his brother's divorce, which the pope had declared invalid, and in February reached Rome with an army, but made peace with the pope and left the city.

In 866 he routed the Saracens, but could not follow up his successes owing to the want of a fleet. In 869, with the assistance of his ally, the eastern emperor, Basil I., he captured Bari, the headquarters of the Saracens. He had withdrawn into Benevento to prepare for a further campaign, when he was treacherously robbed and imprisoned by Adelchis, prince of Benevento, in Aug. 871, but was released a month later. Returning to Rome, he was crowned a second time as emperor by Pope Adrian II. on May 18, 872. After further successes against the Saracens, who were driven from Capua, he returned to northern Italy. He died, somewhere in the province of Brescia, on Aug. 12, 875, and was buried in the church of St. Ambrose at Milan, having named as his successor in Italy his cousin Carloman, son of Louis the German.

See *Annales Bertiniani, Chronica S. Benedicti Casinensis,* both in the *Monumenta Germaniae historica. Scriptores,* Bände i. and iii. (Hanover and Berlin, 1826 fol.); E. Mühlbacher, *Die Regesten des Kaiserreichs unter den Karolingern* (Innsbruck, 1881); Th. Sickel, *Acta regum et imperatorum Karolinorum, digesta et enarrata* (Vienna, 1867–68); and E. Dümmler, *Geschichte des ostfränkischen Reiches* (Leipzig, 1887–88).

LOUIS III. (*c.* 880–928), surnamed the "Blind," Roman emperor, was a son of Boso, king of Provence or Lower Burgundy and Irmengarde, daughter of the emperor Louis II. The emperor Charles the Fat took Louis under his protection on the death of Boso in 887; but Louis was not recognized as king of Provence until 890, when Irmengarde had secured the support of the Bavarian king Arnulf and of Pope Stephen V. In 900, after the death of the emperor Arnulf, he went to Italy to obtain the imperial crown. He was chosen king of the Lombards at Pavia, and crowned emperor at Rome in Feb. 901 by Pope Benedict IV. He gained a temporary authority in northern Italy, but was soon compelled by his rival Berengar, margrave of Friuli, to leave the country. In 904, however, he went again to Italy, where he secured the submission of Lombardy; but on July 21, 905, he was surprised at Verona by Berengar, who blinded him and sent him back to Provence, where he remained until his death, at Arles, in Sept. 928. He married Adelaide, possibly a daughter of Rudolph I., king of Upper Burgundy. His eldest son, Charles Constantine, succeeded only to the county of Vienne.

See *Forschungen zur deutschen Geschichte,* Bände ix. and x. (Göttingen, 1862–86); E. Dümmler, *Geschichte des ostfränkischen Reichs* (Leipzig, 1887–88); and *Gesta Berengarii imperatoris* (Halle, 1871); and F. de Gingins-la-Sarra, *Mémoires pour servir à l'histoire de Provence et de Bourgogne Jurane* (Zürich, 1851).

LOUIS IV., or **V.** (*c.* 1287–1347), surnamed the Bavarian, Roman emperor and duke of Upper Bavaria, was the second son of Louis II., duke of Upper Bavaria and count palatine of the Rhine, and Matilda, daughter of the German king Rudolph I. At his father's death in 1294 he inherited, jointly with his elder brother Rudolph, Upper Bavaria and the Palatinate, but passed his time mainly at the court of the Habsburgs in Vienna. In the quarrel with his brother over their joint possessions, Louis was supported by his uncle Albert I., the German king. Rudolph promised in 1301 to admit his brother to a share in the government of Bavaria and the Palatinate. When Albert was murdered in May 1308, Louis became a candidate for the German throne; but his claim was not strongly supported. The new king, Henry VII., was very friendly with Rudolph, and as the promise of 1301 had not been carried out, Louis demanded a partition of their lands, and received the north-western part of Upper Bavaria in 1310, but Rudolph refused to surrender any part of the Palatinate. In 1310, on the death of Stephen I., duke of Lower Bavaria, Louis undertook the guardianship of his two young sons. This led to a war between the brothers, which lasted till June 1313, when peace was made at Munich. Frederick III (the Fair), duke of Austria, called in by the nobles of Lower Bavaria, was defeated at Gammelsdorf on Nov. 9, 1313.

In Aug. 1313 the German throne had again become vacant, and Louis was chosen at Frankfort on Oct. 20, 1314, and crowned at Aix-la-Chapelle on Nov. 25. War followed between Louis and the rival candidate, Frederick of Austria. Louis's embarrassments were complicated by a new dispute with his brother; but in 1317 Rudolph renounced his claims on Upper Bavaria and the Palatinate in consideration of a yearly subsidy and Louis was able to give undivided attention to the war with Frederick. On Sept. 28, 1322, a battle was fought at Mühldorf, which ended in a complete victory for Louis, owing mainly to the timely aid of Frederick IV. of Hohenzollern, burgrave of Nüremburg. Frederick of Austria was taken prisoner, but the struggle was continued by his brother Leopold until the latter's death in 1326. Attempts to enable the two kings to rule Germany jointly failed, and about 1326 Frederick returned to Austria. Supported by Philip V. of France in his desire to free Italy entirely from German influence, Pope John XXII. refused to recognize either Frederick or Louis, and asserted his own right to administer the empire during a vacancy.

After the battle of Mühldorf Louis sent Berthold of Neifen, count of Marstetten, into Italy with an army, which soon compelled the papal troops to raise the siege at Milan. The pope threatened Louis with excommunication unless he resigned his kingdom within three months. The king thereupon appealed to a general council, and was placed under the papal ban on March 23, 1324, a sentence which he answered by publishing his charges against the pope. In the contest Louis was helped by the Minorites, who were upholding against John the principle of clerical poverty, and by the writings of Marsilius of Padua (who dedicated to Louis his *Defensor pacis*), William of Occam, John of Jandun and others. Taking the offensive, Louis met his Ghibelline supporters at Trent and reached Italy in March 1327; and in May he received the Lombard crown at Milan.

Louis compelled Pisa to surrender and on Jan. 17, 1328, he was crowned emperor in St. Peter's by Sciarra Colonna, a Roman noble; he answered the continued attacks of Pope John by pronouncing his deposition, and proclaiming Peter of Corvara pope as Nicholas V. He then undertook an expedition against John's ally, Robert, king of Naples, but, disunion among his troops and scarcity of money and provisions drove him again to Rome, where, finding that his exactions had diminished his popularity, he left the city, and after passing six months at Pisa, returned to Germany in Jan. 1330. The struggle with the pope was renewed in Germany, and a formidable league had been formed against Louis. He was prepared to assent to very humiliating terms, and agreed to abdicate; but negotiations were interrupted by the pope's death in Dec. 1334. John's successor, Benedict XII., was prevented from coming to terms by the influence of Philip VI. of France. Overtures for peace were made to Philip, but without success; and in July 1337 Louis concluded an alliance with Edward III., king of England, and made active preparations for war. During these years his attention was also occupied by a quarrel with John, king of Bohemia, over the possession of Tirol, by a campaign in Lower Bavaria, and a futile expedition against Nicholas I., bishop of Constance. His position was improved when the electors meeting at Rense in July 1338 banded themselves together to defend their elective rights, and when the diet at Frankfort confirmed a decree which declared that the German king did not need the papal approbation to make his election valid.

The heiress of Tirol, Margaret Maultasch, quarrelled with her husband, John Henry, margrave of Moravia, and fled to the protection of Louis, who seized the opportunity to declare her marriage void and to unite her in 1342 with his son Louis. The emperor also increased his possessions by his own marriage. In 1322 his first wife, Beatrice, daughter of Henry III., count of Glogau, had died and by his second marriage with Margaret, daughter of William III., count of Holland, he obtained, at the death of her brother, count William IV., in 1345, possession of Holland, Zealand and Friesland. In 1341 he recovered a portion of the Palatinate, and soon deserted Edward of England and came to terms with Philip of France. In the course of a war between Louis and the enemies made by his policy of acquisition which ensued in Germany he was forced to submit to humiliating terms, though he would not accept the election of Charles, margrave of Moravia (afterwards the emperor Charles IV.) as German king in July 1346. Charles consequently attacked Tirol; but Louis died suddenly at a bear-hunt near Munich on Oct. 11, 1347. He was buried in the Frauenkirche at Munich, where a statue was erected to his memory in 1622 by Maximilian I., elector of Bavaria, and where a second was unveiled in 1905. He had seven sons, three of whom were subsequently electors of Brandenburg, and ten daughters.

As a soldier Louis possessed skill as well as bravery, but he lacked perseverance and decision in his political relations; and the fact that he remained almost undisturbed in the possession of Germany in spite of the utmost efforts of the popes, is due rather to the political and intellectual tendencies of the time than to his good qualities. He encouraged trade and commerce and gave a new system of laws to the duchy.

Bibliography.—Many of the authorities for the life and reign of Louis are found in the *Fontes rerum Germanicarum,* Bände i. and iv., edited by J. F. Böhmer (Stuttgart, 1843–68). Among these is the *Vita Ludovici IV.*, by an unknown author. A number of important documents are found in the *Regesta imperii 1314–1347,* ed. J. F. Böhmer and J. Ficker (Innsbruck, 1865); *Acta imperii selecta,* ed. J. F. Böhmer and J. Ficker (Innsbruck, 1870); *Urkunden zur Geschichte des Römerzuges Königs Ludwigs des Bayern,* ed. J. Ficker (Innsbruck, 1865); *Urkundliche Beiträge zur Geschichte Kaisers Ludwigs IV.*, ed. C. Höfler (Munich, 1839); *Vatikanische Urkunden zur Geschichte Kaisers Ludwigs des Bayern,* Bände v. and vi. (Stuttgart, 1877–88); *Vatikanische Akten zur Deutschen Geschichte in der Zeit Kaisers Ludwigs des Bayern,* ed. S. Riezler (Innsbruck, 1891). In the *Forschungen zur Deutschen Geschichte* (Göttingen, 1862–86), Band. xx., is found *Urkunden zur Bairischen und Deutschen Geschichte 1256–1343,* ed. S. Riezler; and in Band xiii. is C. Häutle's *Beiträge zum Itinerar Kaiser Ludwigs.*

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LOUIS I., king of Bavaria (1786–1868), son of the then prince, afterwards duke and elector, Max Joseph of Zweibrücken and his wife, Princess Augusta of Hesse-Darmstadt, was born at Strasbourg on Aug. 25, 1786. He was educated at home and at the universities of Landshut and Göttingen. Both the classics and contemporary classical poetry took hold upon his receptive mind (he visited Goethe in 1827). As a patron of the arts he proved himself as great as any who had ever occupied a German throne, and he was himself more than a mere dilettante.

The crown prince (his father had become elector in 1799 and king of Bavaria in 1805), became the leader of the small anti-French party in Bavaria. Napoleon sought in vain to win him over, and Louis fell more and more out of favour with him. Their relations continued to be strained, although in the campaigns of 1807 and 1809, in which Bavaria was among the allies of France, Louis won his laurels in the field. He married in 1810 Princess Therese of Saxe-Hildburghausen (1792–1854). Three daughters and four sons were born of this marriage, one of whom succeeded him as Maximilian II., while another, Luitpold, became prince regent of Bavaria on the death of Louis II. Louis resided chiefly at Innsbruck or Salzburg as governor of the circle of the Inn and Salzach. In 1815 he attended the congress of Vienna, where he sought to obtain the restoration of Alsace and Lorraine to Germany; and later in the year he was with the allies in Paris, using his influence to secure the return of the art treasures carried off by the French.

After 1815 also the crown prince maintained his anti-French attitude, and in 1817 his influence secured the fall of Comte Montgelas. Louis took great interest in the work of organizing the Bavarian constitution (1818) and defended it against Metternich and the Carlsbad Decrees (1819); he was also an ardent Philhellene. He succeeded to the crown of Bavaria on Oct. 12, 1825, and at once embarked upon a moderate constitutional policy, in which he found himself in general agreement with the parliament. Although a loyal Catholic he none the less opposed ultramontanism and the Jesuits. He improved the internal administration of the State, and especially that of the finances. He was a warm friend of learning, and in 1826 transferred the University of Landshut to Munich, where he placed it under his special protection. In the course of his visits to Italy he formed friendships with famous artists, notably with Thorwaldsen and Cornelius. He had the assistance of the painter Martin Wagner in procuring works of art for the great Munich collections.

Under the influence of the July revolution of 1830 he began to be drawn into the current of reaction; and though he never took up such a hostile attitude towards constitutional ideas as his brother-in-law, King Frederick William IV., he allowed the reactionary system of surveillance which commended itself to the German Confederation after 1830 to be introduced into Bavaria (*see* Bavaria: *History*). As a follower of the ideas of Friedrich List, he furthered the foundation of the Zollverein in the year 1833 and the making of canals. Of European importance was his enthusiasm for the liberation of Greece from the rule of Turkey, and his generous financial assistance. After his second son Otto (*q.v.*), had become king of Greece in 1832, Greek affairs became the central point of his foreign policy. In 1862 Otto was forced to abdicate. For this unfortunate issue Louis was not without blame; for he had totally misunderstood the national character of the Greeks and the problems involved in the attempts to govern them by bureaucratic methods. After Karl Abel became the head of the ministry in 1837 the strict Catholic party influenced affairs more and more decisively. For a while, indeed, this opposition did not impair the king's popularity, due to his amiable character, his extraordinary services in beautifying his capital at Munich, and to his lavish charity. But his disastrous *liaison,* beginning in 1846, with Lola Montez, the Spanish dancer, brought him into conflict with his people. She used her great influence against the clerical policy of Abel. The ministry protested against her proposed naturalization in the memorandum of Feb. 11, 1847. The king replaced Abel's Clerical ministry by a more accommodating Liberal one under Zu Rhein under which Lola Montez without more difficulty became Countess Landsberg. The revolutionary movement of 1848 and the pressure of the popular opposition compelled Louis to banish the countess. On March 20, 1848 he abdicated in favour of his son Maximilian.

In his retirement Louis continued to play the Maecenas magnificently. His popularity, shaken by the Montez affair, was partially recovered. To him Munich owes her finest art collections and most remarkable buildings, especially the acquisition of the famous Rhenish collection of the Boisserée brothers; also the Walhalla, the Glyptothek, the two Pinakotheken, the Odeon, the University, and many other magnificent buildings. The rôle of Munich as a great art centre would have been impossible without the splendid munificence of Louis I. He died on Feb. 28, 1868 at Nice, and was buried in Munich.

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LOUIS II., king of Bavaria (1845–1886), son of his predecessor Maximilian II. and Maria, daughter of Prince William of Prussia, was born at Nymphenburg on Aug. 25, 1845. With his brother Otto, Louis received a simple and serious education modelled on that of the German *Gymnasien.* Military instruction, physical exercises and sport, in spite of the crown prince's strong physique, received little attention. He developed a taste for solitude, which was combined with the romantic tendencies and musical and theatrical tastes traditional in his family.

Louis succeeded to the throne on March 10, 1864, at the age of eighteen. The early years of his reign were marked by a series of most serious political defeats for Bavaria. In the Schleswig-Holstein question, though he was opposed to Prussia and a friend of Duke Frederick VIII. of Augustenburg, he had not the material forces necessary effectively to resist Bismarck. Again, in the war of 1866, Louis and his minister, von der Pfordten, took the side of Austria, and at the conclusion of peace (Aug. 22) Bavaria had, in addition to the surrender of certain small portions of her territory, to agree to the foundation of the North German Confederation under the leadership of Prussia. The king's Bavarian patriotism, one of the few steadfast ideas underlying his policy, was deeply wounded, but he faced the inevitable, and wrote a letter of reconciliation (Aug. 10) to King William of Prussia. The defeat of Bavaria in 1866 showed the necessity of army reform. Under the new Liberal ministry of Hohenlohe (Dec. 29, 1866–Feb. 13, 1870) and under Prauckh as minister of war, a series of reforms were carried through which prepared for the victories of 1870. In his ecclesiastical policy Louis strove for a greater independence of the Vatican, and maintained friendly relations with Döllinger (*q.v*), but without extending his protection to the anti-Roman movement of the Old Catholics. Early in 1870 Louis formed a more Conservative cabinet under Count Bray-Steinburg. On the outbreak of the Franco-Prussian War he at once took the side of Prussia, and gave orders for mobilization. In 1871 it was he who offered the imperial crown to the king of Prussia; but not on his own initiative. Bismarck not only determined the king of Bavaria to take the decisive step which put an end to a serious diplomatic crisis, but actually drafted the letter to King William which Louis copied and despatched without changing a word.

In the early years of his reign Louis formed an intimate friendship with Richard Wagner, whom from May 1864 to Dec. 1865 he had constantly in his company. He paid 18,000 gulden of debts for him, and granted him a yearly income of 4,000 gulden (afterwards increased to 8,000). A series of performances of the Wagnerian music-dramas was instituted in Munich under the personal patronage of the king, and when the further plan of erecting a great festival theatre in Munich for the performance of Wagner's "music of the future" broke down in the face of the passive resistance of the local circles interested, Louis conceived the idea of building at Bayreuth, according to Wagner's new principles, a theatre worthy of the music-dramas. For a time Louis was entirely under Wagner's influence, and there is extant a series of emotional letters of the king to Wagner. Public opinion in Bavaria turned against Wagner. He was attacked for his foreign origin, his extravagance, his intrigues, his artistic utopias, and last but by no means least, for his unwholesome influence over the king. Louis had to give him up. But in 1866, in the midst of the preparation for war, the king hastened in May to Triebschen, near Lucerne, in order to see Wagner again. In 1868 they were seen together in public for the last time at the festival performances in Munich. In 1876 Wagner's *Ring des Nibelungen* was performed for the first time at Bayreuth in the presence of the king. Later, in 1881, the king formed a brief friendship with Joseph Kainz the actor. In Jan. 1867 he became betrothed to Duchess Sophie of Bavaria (afterwards Duchesse d'Alençon), daughter of Duke Max and sister of the empress of Austria; but the betrothal was dissolved in October of the same year.

Louis presently showed serious signs of an ill-balanced mind, and when ministers sought to check his wild extravagance, which included the building of many magnificent castles, he became violent. The unfortunate king was declared insane on June 8, 1886, and his uncle, Prince Luitpold, assumed the regency. Louis was placed under restraint. On June 13, 1886, he was drowned in the Starnberger See, together with his doctor, von Gudden, who had unwisely gone for a walk alone with his patient, whose physical strength was enormous. Louis's brother Otto, who succeeded him as king of Bavaria, was also incurably insane.

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LOUIS III., king of Bavaria (1845–1921), was born on Jan. 7, 1845, and assumed the regency in succession to his father on Dec. 12, 1912. In accordance with the bill passed by the Bavarian diet he assumed the crown on Nov. 5, 1913. After the proclamation of the republic on Nov. 7, 1918, the king, with the queen and his daughters, left Munich. The royal family resided first at Berchtesgaden, and afterwards at a castle assigned to them on the shores of Chiem See. On Nov. 13 he formally signed his abdication, and relieved all Bavarian officials, officers and soldiers from their oath of allegiance. He died at Sarvar, Hungary, on Oct. 17, 1921.

LOUIS (804–876), surnamed "the German," king of the East Franks, was the third son of the emperor Louis I. When the emperor divided his dominions between his sons in 817, Louis received Bavaria and the neighbouring lands, but did not undertake the government until 825, when he began to fight the Slavs on his eastern frontier. In 827 he married Emma, daughter of Welf I., count of Bavaria, and sister of his stepmother Judith. He interfered in the quarrels arising from Judith's efforts to secure a kingdom for her own son Charles, and the consequent struggles of Louis and his brothers with the emperor Louis I. (*q.v.*). When the elder Louis died in 840 and his eldest son Lothair claimed the whole Empire, Louis in alliance with his half-brother, king Charles the Bald, defeated Lothair at Fontenoy on June 25, 841. By the Treaty of Verdun (August 843), Louis received the bulk of the lands of the Carolingian empire lying east of the Rhine, including a district around Speyer, Worms and Mainz, Bavaria, where he made Regensburg the centre of his government, Thuringia, Franconia and Saxony.

Louis may truly be called the founder of the German kingdom, though his attempts to maintain the unity of the Empire proved futile. In 842 he crushed a rising in Saxony, compelled the Abotrites to own his authority, and undertook campaigns against the Bohemians, the Moravians and other tribes. He did not succeed in freeing his shores from the ravages of Danish pirates. At his instance synods and assemblies were held where laws were decreed for the better government of church and state. From 853 onwards, he attempted to secure the throne of Aquitaine, offered to him by the oppressed subjects of Charles the Bald. But treachery and desertion in his army, and the loyalty of the Aquitanian bishops to Charles prevented success, and Louis renounced his claim by a treaty signed at Coblenz on June 7, 860.

In 855 the emperor Lothair died, and was succeeded in Italy by his eldest son Louis II., and in the northern part of his kingdom by his second son, Lothair. The weakness of these kingdoms afforded opportunities for intrigue by Louis and Charles the Bald, whose interest was increased by the fact that both their nephews were without male issue. Louis supported Lothair in his efforts to divorce his wife Teutberga, for which he received a promise of Alsace, but in 865 Louis and Charles renewed the peace of Coblenz, and doubtless discussed the possibility of dividing Lothair's kingdom. In 868 at Metz they agreed definitely to a partition; but when Lothair died in 869, Louis was ill, and his armies were engaged with the Moravians. Charles the Bald accordingly seized the whole kingdom; but Louis compelled him by a threat of war to agree to the Treaty of Mersen, which divided it between the claimants.

The later years of Louis were troubled by risings on the part of his sons, the eldest of whom, Carloman, revolted in 861 and in 863; an example followed by the second son Louis, who in a further rising was joined by his brother Charles. A report that Louis II. was dead led to peace between father and sons. The emperor, however, was not dead, but a prisoner; and as he was the nephew and son-in-law of Louis, that monarch hoped to secure both the imperial dignity and the Italian kingdom for his son Carloman. Meeting his daughter Engelberga, the wife of Louis II., at Trent in 872, Louis made an alliance with her against Charles the Bald, and in 874 visited Italy on the same errand. The emperor, having named Carloman as his successor, died in August 875, but Charles the Bald reached Italy before his rival, and by persuading Carloman to return, secured the imperial crown. Louis was preparing for war when he died on Sept. 28, 876 at Frankfort. He was in war and peace alike, the most competent of the descendants of Charlemagne. He obtained for his kingdom a certain degree of security against the Normans, Hungarians, Moravians and others. He lived in close alliance with the Church, to which he was very generous, and supported its missionary schemes.

See *Annales Fuldenses; Annales Bertiniani;* Nithard, *Historiarum Libri,* all in the *Monumenta Germaniae historica. Scriptores,* Bde i. and ii. (Hanover and Berlin, 1826 *seq.*); E. Dümmler, *Geschichte des ostfränkischen Reiches* (Leipzig, 1887–88); Th. Sickel, *Die Urkunden Ludwigs des Deutschen* (Vienna, 1861–62); E. Mühlbacher, *Die Regesten des Kaiserreichs unter den Karolingern* (Innsbruck, 1881); and A. Krohn, *Ludwig der Deutsche* (Saarbrücken, 1872); and general bibliography in *Camb. Med. Hist.* (vol. 3, 1922).

LOUIS (893–911), surnamed the "Child," king of the Franks, last of the German Carolingians, son of the emperor Arnulf, was born at Ottingen, designated by Arnulf as his successor in Germany in 897, and crowned on Feb. 4, 900. His chief adviser was Hatto I., archbishop of Mainz; and during his reign the kingdom was ravaged by Hungarians and torn with internal strife. He died in August or September 911 and was buried at Regensburg.

See O. Dietrich, *Beiträge zur Geschichte Arnolfs von Kärnthen und Ludwigs des Kindes* (1890).

LOUIS II. (846–879), king of France, called "le Bègue" or "the Stammerer," a son of Charles II. the Bald, Roman emperor and king of the West Franks, was born on Nov. 1, 846. After the death of his elder brother Charles in 866 he became king of Aquitaine, and in October 877 he succeeded his father as king of the West Franks, but not as emperor. He was crowned king by Hincmar, archbishop of Reims, on Dec. 8, following, and in Sept. 878 he was consecrated afresh by Pope John VIII. After an ineffectual reign of eighteen months Louis died at Compiègne on April 10 or 11, 879. By his first wife, Ansgarde, a Burgundian princess, he had two sons, his successors, Louis III. and Carloman; by his second wife, Adelaide, he had a posthumous son, Charles the Simple, who also became king of France.

The emperor Louis I. is counted as Louis I., king of France.

LOUIS III. (*c.* 863–882), king of France, was a son of Louis II. and with his brother Carloman succeeded his father as king in April 879. In consequence of the doubts cast upon the legitimacy of the young princes, it was proposed to offer the crown to the East Frankish ruler Louis, a son of Louis the German. But in September 879 the brothers were crowned at Ferrières by Ansègisus, archbishop of Sens. A few months later they divided their kingdom, Louis receiving the part of France north of the Loire. They acted together against the Northmen, over whom in August 881 they gained a memorable victory, and against Boso, who claimed sovereignty over Burgundy and Provence. On Aug. 5, 882 Louis died at St. Denis and Carloman became sole king.

LOUIS IV. (921–954), king of France, surnamed "d'Outremer" (*Transmarinus*), was the son of Charles III. the Simple. On his father's imprisonment in 922, his mother Odgiva (Eadgyfu), sister of the English king Aethelstan, fled with him to England—a circumstance to which he owes his surname. But after the death of the usurper Rudolph (Raoul), Ralph of Burgundy, Hugh the Great, count of Paris, and the other French nobles, chose Louis for their king, and the lad was consecrated at Laon on June 19, 936. His reign was marked by a series of rebellions of the French nobles who refused to recognize his authority, and by an irruption of the Hungarians into Burgundy and Aquitaine (937). Backed by the Pope, Louis showed great zeal in quelling these revolts, and by an alliance with Otto the Great, formerly one of his most determined enemies, he gained a temporary success. The powerful vassal, Hugh the Great, was in 948 forced to make submission and to restore Laon to his sovereign; but the last years of the reign were troubled by fresh difficulties with Hugh the Great and also by an irruption of the Hungarians into the south of France. Louis died on Sept. 10, 954, and was succeeded by his son Lothair.

The chief authority for the reign is the chronicler Flodoard. *See* also Ph. Lauer, *La Règne de Louis IV d'Outre-Mer* (1900); and A. Heil, *Die politischen Beziehungen zwischen Otto dem Grossen und Ludwig IV. von Frankreich* (1904).

LOUIS V. (967–987), "le Fainéant" king of France, succeeded his father Lothair in March 986, and finally embroiled the Carolingian dynasty with Hugh Capet and Adalberon, archbishop of Reims. Louis died in May 987, his mother Emma being accused of having poisoned him.

See F. Lot, *Les Derniers Carolingiens* (1891); and the *Recueil des actes de Lothaire et de Louis V.*, ed. L. Halphen and F. Lot (1908).

LOUIS VI. (1081–1137), king of France, surnamed "the Fat," "the Wideawake" or "the Bruiser," was the son of Philip I. and Bertha of Holland. He became associated with his father in the government about 1098, and by his victories over the English and the brigands, he won the support of the army against his step-mother, Bertrada, who tried to poison him. On the death of Philip I., in 1108, Louis was faced by powerful and rebellious barons, but after a hurried coronation at Orleans, he continued his policy of putting down feudal brigands and destroying their strongholds in the Île de France. So strong, however, were his enemies, that 24 years of continuous warfare were needed to root out the robber barons who lived on the plunder of the roads leading to Paris. In his opposition to the English, Louis was equally energetic. He supported William Clito, son of Robert of Normandy, against Henry I., and although worsted in the war which followed he continued to uphold the claims of his protegé. To oppose the forces of the emperor, Henry V., who had become the ally of the king of England, Louis even succeeded in gathering a national army under his flag, and thus temporarily consolidated his realm. Not only did he consolidate France, however, but he extended his power by acquiring control over Flanders.

In all his wars Louis fought in person, and for his prowess gained the reputation of a national hero, the protector of the poor, the Church, the peasants and the towns. He encouraged the communal movement on the fiefs of his vassals, and granted privileges to towns on his domains, but the title of "Father of the Communes," by which he is sometimes known, is not deserved. Neither was Louis the author of the movement for the emancipation of the serfs, his attitude being to favour emancipation only when it promised greater chance of profit. He was a great benefactor to the Church, aided the new, reformed monastic congregations of Cîteau, Prémontré and Fontevrault and chose his two chief ministers, Étienne de Garlande and Suger (*q.v.*) from the clergy. Louis died on Aug. 1, 1137.

See A. Luchaire, *Louis le Gros, annales de sa vie et son règne* (1890); and "Les Premiers Capétiens," in E. Lavisse's *Histoire de France;* Thomson, *Development of the French Monarchy under Louis VI. le Gros* (1895).

LOUIS VII. (*c.* 1121–1180), king of France, son of Louis VI. the Fat, was associated with his father and anointed by Innocent II. in 1131. In 1137 he succeeded his father, and in the same year married at Bordeaux Eleanor, heiress of William II., duke of Aquitaine. In the first part of his reign he was vigorous and jealous of his prerogatives, but after his crusade his religiosity developed to such an extent as to make him utterly inefficient. His accession was marked by no serious disturbances, save the risings of the burgesses of Orleans and of Poitiers, but he came into violent conflict with Pope Innocent II. The archbishopric of Bourges became vacant, and the king supported as candidate the chancellor Cadurc, against the pope's nominee Pierre de la

Châtre, swearing upon relics that so long as he lived Pierre should never enter Bourges. This brought the interdict upon the king's lands. He became involved in a war with Theobald, count of Champagne, which lasted two years (1142–44). The royal army occupied Champagne, and captured Vitry, where many persons perished in the burning of the church. Geoffrey the Handsome, count of Anjou, by his conquest of Normandy threatened the royal domains, and Louis VII. by a clever manoeuvre threw his army on the Norman frontier and gained Gisors, one of the keys of Normandy.

At his court which met in Bourges Louis declared on Christmas Day 1145 his intention of going on a crusade. St. Bernard preached the crusade at Vézelay (Easter 1146), and Louis set out from Metz in June 1147, on the overland route to Syria. The expedition was disastrous, and he regained France in 1149, overcome by humiliation. He caused a council at Beaugency (on the 21st of March 1152) to annul his marriage with Eleanor of Aquitaine, under pretext of kinship. Eleanor married Henry II. of England in the following May, and brought him the duchy of Aquitaine. Louis VII. led a half-hearted war against Henry; but in August 1154 gave up his rights over Aquitaine, and contented himself with an indemnity. In 1154 Louis married Constance, daughter of the king of Castile, and their daughter Marguerite he affianced imprudently by the treaty of Gisors (1158) to Henry, eldest son of the king of England, promising as dowry the Vexin and Gisors. After the death of Constance (1160), Louis VII. married Adèle of Champagne. Louis VII. gave little sign of understanding the danger of the growing Angevin power, though in 1159 he aided Raymond V., count of Toulouse, against Henry II. At the same time the emperor Frederick I. in the east was making good the imperial claims on Arles. When the schism broke out, Louis took the part of the pope Alexander III. He supported Henry's rebellious sons, but acted slowly and feebly, and so contributed to the break up of the coalition (1173–1174).

Finally in 1177 the pope intervened to bring the two kings to terms at Vitry. By his third wife, Adèle, Louis had an heir, the future Philip Augustus, born on the 21st of August 1165. He had him crowned at Reims in 1179, and died on the 18th of September 1180.

See R. Hirsch, *Studien zur Geschichte König Ludwigs VII. von Frankreich* (1892); A. Cartellieri, *Philipp II. August von Frankreich bis zum Tode seines Vaters, 1165–1180* (1891); A. Luchaire, *Études sur les actes de Louis VII.* (1885), and section in E. Lavisse's *Histoire de France,* tome iii. 1st part, pp. 1–81.

LOUIS VIII. (1187–1226), king of France, eldest son of Philip Augustus and of Isabella of Hainaut, was born in Paris on Sept. 5, 1187. Louis left the reputation of a saint, but was also a warrior prince. In 1213 he led the campaign against Ferrand, count of Flanders; in 1214, while Philip Augustus was winning the victory of Bouvines, he held John of England in check, and was victorious at La Roche-aux-Moines. In the autumn of 1215 Louis received from a group of English barons, headed by Geoffrey de Mandeville, a request to "pluck them out of the hand of this tyrant" (John). Louis himself prepared to invade England. The expedition was forbidden by the papal legate, but Louis landed at Stonor on May 22, 1216. (*See* ENGLISH HISTORY.) The pretexts on which he claimed the English crown were set down in a memorandum drawn up by French lawyers in 1215. These claims—that John had forfeited the crown by the murder of his nephew, Arthur of Brittany, and that the English barons had the right to dispose of the vacant throne—lost their plausibility on the death of King John and the accession of his infant son as Henry III. in October 1216. The papal legate, Gualo, arrived in England at the same time as Louis. He excommunicated the French troops and the English rebels, and, after the "Fair of Lincoln," in which his army was defeated, Louis resigned his pretensions, though by a secret article of the treaty of Lambeth (September 1217) he secured a small war indemnity.

Louis had assisted Simon de Montfort in his war against the Albigenses in 1215, and after his return to France he again joined the crusade. With Simon's son and successor, Amauri de Montfort, he directed the brutal massacre which followed the capture of Marmande. Philip Augustus dying on July 14, 1223, Louis VIII. was anointed at Reims on Aug. 6. He continued his father's policy. His reign was taken up with two great designs: to destroy the power of the Plantagenets, and to conquer the heretical south of France. An expedition conquered Poitou and Saintonge (1224); in 1226 he led the crusade against the Albigenses in the south, forced Avignon to capitulate and received the submission of Languedoc. While passing the Auvergne on his return to Paris, he died at Montpensier on Nov. 8, 1226. His reign, short as it was, brought gains both to the royal domains and to the power of the crown over the feudal lords. He had married in 1200 Blanche of Castile, daughter of Alphonso IX. of Castile and granddaughter of Henry II. of England, who bore him twelve children; his eldest surviving son was his successor, Louis IX.

See C. Petit-Dutaillis, *Étude sur la vie et le règne de Louis VIII.* (1894); and E. Lavisse, *Histoire de France,* tome iii. (1901).

LOUIS IX. (1214–1270), king of France, known as Saint Louis, was born on April 25, 1214. His father, Louis VIII., died in 1226, but his mother, Queen Blanche of Castile, secured her son's coronation at Reims on Nov. 29, 1226; and mainly by the aid of the papal legate, Romano Bonaventura, bishop of Porto (d. 1243), and of Thibaut IV., count of Champagne, was able to thwart the rebellious plans of Pierre Mauclerc, duke of Brittany, and Philippe Hurepel, a natural son of Philip Augustus. Mauclerc and Thibaut were both obliged to go on crusade. Louis IX. married Margaret, daughter of Raymond Berenger, count of Provence, in May 1234. The reign was comparatively uneventful. A rising of the nobles of the south-west reached threatening dimensions in 1242, but the king's armies easily overran the lands of the rebel Hugh de Saintonge, and defeated Henry III. of England, who had come to his aid, at Saintes. Raymond VII., count of Toulouse, yielded without resistance upon the advent of two royal armies, and accepted the peace of Lorris in January 1243. This was the last rising of the nobles in Louis's reign.

At the end of 1244, during an illness, Louis took the cross. He had already been much distressed by the plight of John of Brienne, emperor at Constantinople, and bought from him the crown of thorns, parts of the true cross, the holy lance and the holy sponge. The Sainte Chapelle in Paris still stands as a monument to the value of these relics to the saintly king. But the quarrel between the papacy and the emperor Frederick II., in which Louis maintained a watchful neutrality—only interfering to prevent the capture of Innocent IV., at Lyons—and the difficulties of preparation, delayed the embarkation until August 1248. His defeat and capture at Mansura, in February 1250, the next four years spent in Syria in captivity, in diplomatic intrigues, and finally in raising the fortifications of Caesarea and Joppa,—these events belong to the history of the crusades (*q.v.*). His return to France was urgently needed, as Blanche of Castile, whom he had left as regent, had died in November 1252, and upon the removal of her strong hand feudal turbulence had begun to show itself.

This period between his first and second crusades (1254–1269) is the real age of Saint Louis in the history of France. He imposed peace between warring factions of his nobility by mere moral force, backed up by something like an awakened public opinion. His nobles often chafed under his unrelenting justice but never dared rebel. The most famous of his settlements was the treaty of Paris, drawn up in May 1258 and ratified in December 1259, by which the claims of Henry III. of England were adjusted. Henry renounced absolutely Normandy, Anjou, Touraine, Maine and Poitou, and received, on condition of recognizing Louis as liege suzerain, all the fiefs and domains of the king of France in the diocese of Limoges, Cahors and Perigueux, and the expectation of Saintonge south of the Charente, and Agenais, if they should fall to the crown of France by the death of Alphonse of Poitiers. This treaty was unpopular, since the king surrendered a large part of France that Henry had not won; but Louis was satisfied that the absolute sovereignty over the northern provinces more than equalled the loss in the south.

Louis made a similar compromise with the king of Aragon in the treaty of Corbeil, 1258, whereby he gave up the claims of kings of France to Roussillon and Barcelona, which went back to the conquest of Charlemagne. The king of Aragon in his turn gave up his claims to part of Provence and Languedoc, with the exception of Narbonne. Louis's position was strikingly shown in 1264 when the English barons submitted their attempt to bind Henry III. by the Provisions of Oxford to his arbitration. His reply in the "Dit" or Mise of Amiens was a flat denial of all the claims of the barons and failed to avert the civil war. Upon the whole Louis maintained peace with his neighbours, although both Germany and England were torn with civil wars. He sanctioned the conquest of Naples by his brother, Charles, duke of Anjou.

On March 24, 1267, Louis proclaimed his purpose of going on a second crusade. Three years of preparation followed; then on July 1, 1270 they sailed from Aigues Mortes for Tunis, whither the expedition seems to have been directed by the machinations of Charles of Anjou, who, it is claimed, persuaded his brother that the key to Egypt and to Jerusalem was that part of Africa which was his own most dangerous neighbour. After seventeen days' voyage to Carthage, one month of the summer's heat and plague decimated the army, and when Charles of Anjou arrived he found that Louis himself had died of the plague on Aug. 25, 1270.

Saint Louis stands in history as the ideal king of the middle ages. An accomplished knight, physically strong in spite of his ascetic practices, fearless in battle, heroic in adversity, of imperious temperament, unyielding when sure of the justness of his cause, energetic and firm, he was indeed "every inch a king." Joinville says that he was taller by a head than any of his knights. His devotions would have worn out a less robust saint. He fasted much, loved sermons, regularly heard two masses a day and all the offices, dressing at midnight for matins in his chapel, and surrounded even when he travelled by priests on horseback chanting the hours. After his return from the first crusade, he wore only grey woollens in winter, dark silks in summer. He built hospitals, visited and tended the sick himself, gave charity to over a hundred beggars daily. Yet he safeguarded the royal dignity by bringing them in at the back door of the palace, and by a courtly display greater than ever before in France. His naturally cold temperament was somewhat relieved by a sense of humour, which, however, did not prevent his making presents of haircloth shirts to his friends. He had no favourite, nor prime minister. Louis was canonized in 1297.

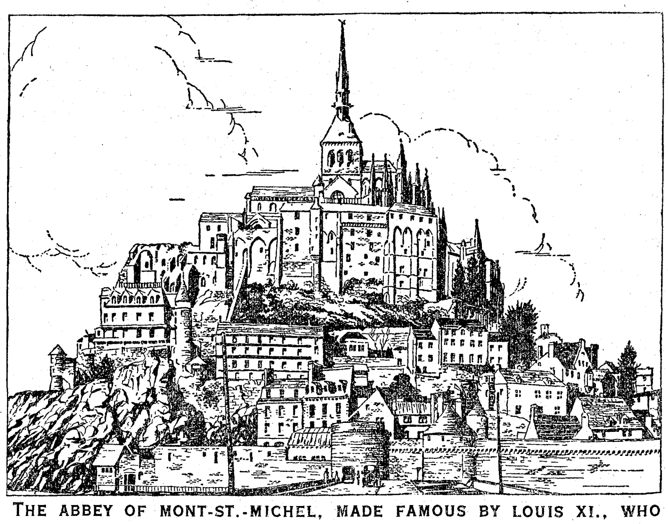
The best contemporary accounts of Louis IX. are the Memoirs of the Sire Jean de Joinville (*q.v.*), published by N. de Wailly for the *Soc. de l'Hist. de France,* under the title *Histoire de Saint Louis* (Paris, 1868), and again with translation (1874); English translation by J. Hutton (1868). *See* also C. V. Langlois in E. Lavisse's *Histoire de France,* tome iii., with references to literature; Frederick Perry, *Saint Louis, the Most Christian King* (New York, 1901); E. J. Davis, *The Invasion of Egypt by Louis IX. of France* (1898); H. A. Wallon, *Saint Louis et son temps* (1875); A. Lecoy de la Marche, *Saint Louis* (Tours, 1891); and E. Berger, *Saint Louis et Innocent IV.* (Paris, 1893), and *Histoire de Blanche de Castille* (1895). *See* also *The Court of a Saint,* by Winifred F. Knox (1909). (J. T. S.; X.)

LOUIS X. (1289–1316), king of France and Navarre, called *le Hutin* or "the Quarreller," was the son of Philip IV. and of Jeanne of Navarre. He was born at Paris on Oct. 4, 1289, took the title king of Navarre on the death of his mother, on April 2, 1305, and succeeded Philip IV. in France on Nov. 29, 1314, being crowned at Reims in August 1315. Louis X. granted to the nobility charters in which he made apparent concessions, but used evasive formulas which in reality ceded nothing. There was a charter to the Normans, one to the Burgundians, one to the Languedocians (1315). Robert de Béthune, count of Flanders, refused to do homage, and his French fiefs were declared confiscate by a court of his peers. Need of money inspired one famous ordinance of this reign; in 1315 the serfs of the royal domains were invited to buy their civil liberty,—an invitation which did not meet with great enthusiasm, as the freedman was merely freed for further exploitation, and Philip V. was obliged to renew it in 1318. Louis X. died suddenly on June 5, 1316. His first wife, Margaret, daughter of Robert II., duke of Burgundy, died a prisoner in the château Gaillard. By her he had one daughter, Jeanne, wife of Philip, count of Evreux and king of Navarre. By his second wife Clémence, daughter of Charles Martel, titular king of Hungary, he left a posthumous son, King John I.

See Ch. Dufayard, "La réaction feodale sous les fils de Philippe le Bel," in *Revue historique* (1894); Paul Lehugeur, *Histoire de Philippe le Long, roi de France* (1897); and Joseph Petit, *Charles de Valois* (1900).

LOUIS XI. (1423–1483), king of France, the son of Charles VII. and his queen, Marie of Anjou, was born on July 3, 1423, at Bourges, where his father, then nicknamed the "King of Bourges," had taken refuge from the English. At the birth of Louis XI. part of France was in English hands; when he was five years old, Joan of Arc appeared; he was just six when his father was crowned at Reims. But his boyhood was spent apart from these stirring events, in the castle of Loches, where he had as tutors Jean Majoris and Bernard of Armagnac. In June 1436, when scarcely thirteen, he was married to Margaret (*c.* 1425–1445), daughter of James I. of Scotland. Three years after this unhappy marriage Louis entered upon his stormy political career. Sent by his father in 1439 to direct the defence of Languedoc against the English, and to put down the brigandage in Poitou, he was induced by the rebellious nobles to place himself at the head of the Praguerie (*q.v.*). Charles VII. pardoned him this rebellion, and in 1440 he was fighting the English, and in 1443 aided his father to suppress the revolt of the count of Armagnac. In 1444 he led an army of from 15,000 to 20,000 mercenaries and brigands,—the product of the Hundred Years' War,—against the Swiss of the canton of Basle. After an ineffective siege, he made peace with the Swiss confederation, and led his robber soldiers into Alsace to ravage the country of the Habsburgs, who refused him the promised winter quarters. Meanwhile his father, making a parallel campaign in Lorraine, had assembled his first brilliant court at Nancy, and when Louis returned he found the king completely under the spell of Agnes Sorel. The death in 1445 of his wife Margaret, who was a great favourite of Charles VII., made the rupture complete. From that year until the death of the king, father and son were enemies. Louis prepared a plot to seize the king and his minister Pierre de Brézé. The plot was revealed to Charles, who banished his son to Dauphiné (1447). He never saw his father again.

Louis dismissed the governor; he determined the boundaries between his state and the territories of the duke of Savoy and of



THE ABBEY OF MONT-ST.-MICHEL, MADE FAMOUS BY LOUIS XI., WHO INSTITUTED THERE THE ORDER OF KNIGHTS OF ST. MICHEL

the papacy; and he enforced his authority over perhaps the most unruly nobility in western Europe, both lay and ecclesiastical. He made a secret treaty with the duke of Savoy which was to give him right of way to Genoa, and made arrangements for a partition of the duchy of Milan. The alliance with Savoy was sealed by the marriage of Louis with Charlotte, daughter of Duke Lodovico, in 1452, in spite of the formal prohibition of Charles VII. The king marched south, but withdrew again leaving his son unsubdued. Four years later, as Charles came to the Bourbonnais, Louis, fearing for his life, fled to Flanders to the court of Philip the Good, duke of Burgundy, leaving Dauphiné to be definitely annexed to the crown of France. The policy of the dauphin was reversed, his ten years' work was undone. Meanwhile he was installed in the castle of Genappe, in Brabant, where he waited impatiently for five years for the death of his father, keeping himself posted by spies on every stage of the king's illness, and thus laying himself open to the unsubstantiated accusation, believed by Charles himself, that he had hastened the end by poison.

On Aug. 15, 1461, Louis was anointed and crowned at Reims. His first act was to strike at the faithful ministers of Charles VII. Pierre de Brézé and Antoine de Chabannes were captured and imprisoned. But the more serviceable of the officers of Charles VII. were for the most part soon reinstated; Louis' advisers were mostly men of the middle class. He drew men of talent from England, Scotland, Italy, Spain and Portugal. Among the most prominent of these men in addition to Brézé, Chevalier and Chabannes, were Tristan Lermite, Jean de Daillon, Olivier le Dain (the barber), and after 1472, Philippe de Commines, drawn from the service of Charles the Bold of Burgundy, who became his most intimate adviser and his biographer. Surrounded by men like these Louis fought the last great battle of French royalty with feudalism.

THE STRUGGLE WITH CHARLES THE BOLD

Louis XI. began his reign with the same high-handed treatment of the nobles which had marked his rule in Dauphiné, going so far as to forbid them to hunt without his permission. He forced the clergy to pay long-neglected feudal dues, and intrigued against the great houses of Anjou and Orleans in Italy. The malcontent nobles soon began to plan revolt. Discharged officers of Charles VII., like Jean Dunois and John II. duke of Bourbon, stirred up hostility to the new men of the king, and Francis II. duke of Brittany was soon embroiled with Louis over an attempt to assert royal control over that practically independent duchy. The dissatisfied nobility found their greatest ally in Charles the Bold, afterwards duke of Burgundy, and in 1465 formed a "league of public welfare" and declared war on their king. The nominal head was the king's brother Charles, duke of Berry, then eighteen years old, a weak character, the tool of the rebels as he was later the dupe of the king. Every great noble in France was in the league, except Gaston de Foix—who kept the south of France for the king—and the counts of Vendôme and Eu.

The whole country seemed on the verge of anarchy. It was saved by the refusal of the lesser gentry to rise, and by the alliance of the king with the citizen class. After a successful campaign in the Bourbonnais, Louis fought an indecisive battle with Burgundians who had marched on Paris at Montlhéry, on July 16, 1465, and then stood a short siege in Paris. On Sept. 28, he made a truce with Charles the Bold, and in October the treaties of Conflans and Saint Maur-les-Fossés ended the war. The king yielded at all points; gave up the "Somme towns" in Picardy, for which he had paid 200,000 gold crowns, to Philip the Good, thus bringing the Burgundians close to Paris and to Normandy. Charles, the king's brother, was given Normandy as an apanage, thus joining the territories of the rebellious duke of Brittany with those of Charles the Bold. The kingdom was plundered both by royal tax gatherers and by unsubdued feudal lords.

Two months after he had granted Normandy to Charles, Louis took advantage of a quarrel between the duke of Brittany and his brother to take it again, sending the duke of Bourbon "to aid" Charles, while Dunois and Chabannes prepared for the struggle with Burgundy. The death of Duke Philip, on June 15, 1467, gave Charles the Bold a free hand. He gained over Edward IV. of England, whose sister Margaret he married; but while he was celebrating the wedding Louis invaded Brittany and detached Duke Francis from alliance with him. Normandy was completely reduced. The king's triumph was followed by his greatest mistake. After an interview between Charles and Louis at Péronne false news of Charles's death was spread, apparently at Louis' instigation. The king was humiliated and renewed intrigues followed. He attempted a diversion by assisting the Lancastrians in England. A new revolt was planned in 1471, but came to nothing. The country was saved a desperate civil war by the death of the king's brother, Charles, the nominal head of the coalition, on May 24, 1472. Charles the Bold, who had again invaded France, was obliged to make a lasting truce. Louis then forced the duke of Brittany to make peace, and turned against John V. count of Armagnac, whose death at the opening of March 1473 ended the power of one of the most dangerous houses of the south. The first period of Louis' reign was closed, and with it closed for ever the danger of dismemberment of France. John of Aragon continued the war in Roussillon and Cerdagne, where the struggle was protracted for two years. After the capture of Perpignan on March 10, 1475, the wise and temperate government of Imbert de Batarnay and Boffile de Juge slowly pacified the new provinces. The death of Gaston IV. count of Foix in 1472 opened up the long diplomatic struggle for Navarre, which was destined to pass to the loyal family of Albret shortly after the death of Louis. His policy had won the line of the Pyrenees for France.

The overthrow of Charles the Bold was the second great task of Louis XI. Charles's ally, Edward IV., invaded France in June 1475, but Louis bought him off on Aug. 29, at Picquigny. In September the invaders recrossed to England. The count of Saint Pol, who had continued to play his double part, was surrendered by Charles to Louis, and executed, as was also Jacques d'Armagnac, duke of Nemours. Louis subsidized the Swiss and René II. of Lorraine in their war upon Charles. The defeat and death of the duke of Burgundy at Nancy on Jan. 5, 1477, was the crowning triumph of Louis' diplomacy. But in his eagerness to seize the whole inheritance of his rival, definite peace was not established until after the death of Mary of Burgundy, Charles's daughter, who had married Maximilian of Austria; but by the treaty of Arras (1482) Louis received Picardy, Artois and the Boulonnais, as well as the duchy of Burgundy and Franche Comté. The Austrians were left in Flanders, a menace and a danger. The unification of France was completed (except for Brittany) and the frontiers enlarged by the acquisition, upon the death of René of Anjou in 1480, of the duchies of Anjou and Bar, and in 1481 of Maine and Provence upon the death of Charles II., count of Maine. Of the inheritance of the house of Anjou only Lorraine escaped the king.

Failure in Spain was compensated for in Italy. Without waging war Louis made himself virtual arbiter of the fate of the principalities in the north, and his court was always besieged by ambassadors from them. After the death of Charles the Bold, Yolande, duchess of Savoy, was obliged to accept the control of Louis, who was her brother. In Milan he helped to place Ludovico il Moro in power in 1479, but he reaped less from this supple tyrant than he had expected. Pope Sixtus IV., the enemy of the Medici, was also the enemy of the king of France. When Sixtus threatened Florence after the Pazzi conspiracy, 1478, Louis aided Lorenzo dei Medici to form an alliance with Naples, which forced the papacy to come to terms.

More than any other king of France, Louis XI. was a "bourgeois king." The upper bourgeois, the aristocracy of his "good cities," were his allies both against the nobles and against the artisan class, whenever they revolted, driven to desperation by the oppressive royal taxes which furnished the money for his wars or diplomacy. He ruled like a modern capitalist; placed his bribes like investments in the courts of his enemies; and, while draining the land of enormous sums, was pitiless toward the two productive portions of his realm, the country population and the artisans. His heartlessness toward the former provoked even an accomplice like Commines to protest. The latter were kept down by numerous edicts, tending to restrict to certain privileged families the rank of master workman in the gilds. There was the paternalism of a Frederick the Great in his encouragement of the silk industry,—"which all idle people ought to be made to work at,"—in his encouragement of commerce through the newly acquired port of Marseilles and opening market places.

Louis even dreamed of a great trading company "of two hundred thousand livres or more," to monopolize the trade of the Mediterranean, and planned to unify the various systems of weights and measures. In 1479 he called a meeting of two burgesses from each "good city" of his realm to consider means for preventing the influx of foreign coin. Impatient of all restraint upon his personal rule, he was continually in violent dispute with the parlement of Paris, and made "justice" another name for arbitrary government; yet he dreamed of a unification of the local customary laws (*coûtumes*) cf France. He was the perfect model of a tyrant. The states-general met but once in his reign, in 1468, and then no talk of grievances was allowed; his object was only to get them to declare Normandy inalienable from the crown. They were informed that the king could raise his revenue without consulting them. Yet his budgets were enormously greater than ever before. In 1481 the *taille* alone brought in 4,600,000 livres, and even at the peaceful close of his reign his whole budget was 4,655,000 livres—as against 1,800,000 livres at the close of his father's reign.

During the last two or three years of his life Louis lived in great isolation, "seeing no one, speaking with no one, except such as he commanded," in the château of Plessis-les-Tours, 2 m. S.W. of Tours, that "spider's nest" bristling with watch towers, and guarded only by the most trusty servitors. A swarm of astrologers and physicians preyed upon his fears—and his purse. But, however foolish in his credulity, he still made his strong hand felt both in France and in Italy, remaining to the last "the terrible king." His fervent prayers were interrupted by instructions for the regency which was to follow. He died on Aug. 30, 1483, and was buried in the church at Cléry, instead of at St. Denis. He left a son, his successor, Charles VIII., and two daughters.

See Charles Petit-Dutaillis in Lavisse's *Histoire de France,* tome iv. pt. ii. (1902), and bibliographical indications given there. Of the original sources for the reign the *Lettres de Louis XI.* (edited by Charavay and Vaesen, 8 vols., 1883–1902), the *Mémoires* of Philippe de Commines and the *Journal* of Jean de Royl come first. *See* further A. Molinier, *Sources de l'histoire de France* (tome v. pp. 1–146); C. Hare, *The Life of Louis XI.* (London, 1907).

LOUIS XII. (1462–1515), king of France, was grandson of Louis of Orleans, the brother of Charles VI., and son of the poet prince, Charles of Orleans, who, after the battle of Agincourt, spent twenty-five years of captivity in England. Louis was duke of Orleans until his accession to the throne. He married at fourteen, Joan, daughter of Louis XI. He revolted against Charles VIII., and for three years (1488–91) was a prisoner. In 1494 he held a command in the invasion of northern Italy. He succeeded Charles VIII. in 1499. He enjoyed a genuine popularity, and in 1506 the estates of Tours conferred on him the surname of *Père du Peuple.* He led in person several armies into Italy, and proved as severe and pitiless towards his enemies as he was gentle and clement towards his subjects. Louis had two daughters. After his accession he divorced Joan, and married, in 1499, Anne of Brittany, the widow of Charles VIII. On her death in January 1514, he married in 1514, for political reasons, Mary Tudor, sister of Henry VIII. of England. (*See* MARY, queen of France.) He died on Jan. 1, 1515.

See Henri Hauser, *Les Sources de l'histoire de France, XVI^e siècle,* vol. 1. (1906). The principal secondary authorities are De Maulde, *Histoire de Louis XII.* (1889–93); Le Roux de Lincy, *Vie de la reine Anne de Bretagne* (1860); H. Lemonnier, *Les Guerres d'Italie* (1903) in the *Histoire de France* by E. Lavisse.

LOUIS XIII. (1601–1643), king of France, was the son of Henry IV. and of Marie de' Medici. He became king on his father's assassination in 1610; but his mother at once seized the full powers of regent. She determined to bring France into alliance with Spain and the Austrian house. Louis was to marry Anne of Austria, daughter of the Spanish king, Philip III., and the Spanish prince, afterwards Philip IV., himself was to marry the Princess Elizabeth, the king's sister. The marriages were concluded in 1615. The next years were full of civil war and political intrigue, during which the queen relied upon the Marshal d'Ancre. Louis XIII. was attached to Charles d'Albert, sieur de Luynes; and with his help he arrested Marshal d'Ancre, and on his resistance had him assassinated. From this time to her death the relation between the king and his mother was one of concealed or open hostility. The article on FRANCE must be consulted for the intricate events of the following years.

The decisive incident for his private life as well as for his reign was the entrance of Cardinal Richelieu (*q.v.*) hitherto the queen's chief adviser, into the king's council in 1624. Henceforth the policy of France was directed by Richelieu, who returned to the policy of Henry IV. abroad, and asserted the power of the crown against all rivals at home. This policy brought Louis into unremitting conflict with the Protestants and the nobles of France, but also made him the enemy of his mother, of his brother Gaston of Orleans, who made himself the champion of the cause of the nobles, and sometimes even of his wife. It is not easy to define his relations to Richelieu. He was convinced of his loyalty and of his genius, and in the end always supported his policy. But he disliked the friction with his family circle which this policy produced. For the most part his share in the great events of the reign was a passive one. There were certain occasions when it seemed as if he would oppose Richelieu. The chief of these was what is known as the "Day of Dupes" (1630). Then the queen-mother and the king's brother passionately attacked the minister, and for a moment it was believed that Richelieu was dismissed and that the queen-mother and a Spanish policy had triumphed. But the minister regained his ascendancy over the king, punished his enemies and forced Marie de' Medici and Gaston of Orleans to sue for pardon. In 1631 Gaston fled to Lorraine and the queen-mother to Brussels. Gaston soon returned, to plot, to fail and to sue for pardon again and again; but Marie de' Medici ended her life in exile.

But the last great effort to overthrow Richelieu was the conspiracy of Cinq-Mars (*q.v.*), one of the king's personal favourites. Cinq-Mars believed himself secure of the king's favour. But Richelieu discovered his treasonous relations with Spain, and defeated his plot. Louis was reconciled to his minister. "We have lived too long together to be separated" he is reported to have said (September 1642). Yet when Richelieu died in December of the same year he allowed himself to speak of him in a jealous and satirical tone. He died himself a few months later (May 1643). (*See* also RICHELIEU, ARMAND JEAN DU PLESSIS DE.)

The chief source of information on Louis XIII.'s life is to be found in the contemporary memoirs, of which the chief are: Bassompierre, Fontenay-Mareuil, Gaston d'Orléans, Montrésor, Omer Talon. Richelieu's own Memoirs are chiefly concerned with politics and diplomacy. Of modern works those most directly bearing on the king's personal life are R. de Beauchamp, *Louis XIII. d'après sa correspondance avec le cardinal de Richelieu;* G. Hanotaux, *Histoire du cardinal de Richelieu* (1893–96); Rossignol, *Louis XIII. avant Richelieu;* M. Topin, *Louis XIII. et Richelieu* (1876). *See* too Professor R. Lodge, *Richelieu;* J. B. H. R. Capefigue, *Richelieu, Mazarin et la Fronde* (1835–36); and Dr. J. H. Bridges, *Richelieu, Mazarin and Colbert* (1866); Aymés, *La France sous Louis XIII.* (1909); *Lettres de la main de Louis XIII.* (2 pt. 1914).

For full bibliography *see* G. Monod, *Bibliographie de l'histoire de France; Cambridge Modern History,* vol. iv. ("The Thirty Years' War"); Lavisse et Rambaud, *Histoire générale,* vol. v. ("Guerres de religion").

LOUIS XIV. (1638–1715), king of France, was born at Saint-Germain-en-Laye on Sept. 5, 1638, the son of Louis XIII. and Anne of Austria. The death of his father made the child of five king on May 14, 1643. Power lay in the hands of the queen-mother and of her minister, Cardinal Mazarin, who had to face the domestic troubles of the Fronde and the last stages of the Thirty Years' War. Twice the court had to flee from Paris; once when there was a rumour of intended flight the populace was admitted to see the king in his bed. The memory of these humiliations played their part in developing later the autocratic ideas of Louis. Mazarin triumphed alike over his domestic and his foreign opponents. The Fronde was at an end by 1653; the peace of Westphalia (1648) and the peace of the Pyrenees (1659) marked the success of the arms and of the diplomacy of France. Louis XIV. was now twenty-one years of age. The peace of the Pyrenees was cemented by the marriage of Louis to his cousin, the Infanta Maria Theresa.

The marriage took place at once, and the king entered Paris in triumph in 1660. Mazarin died in the next year; and the king at once announced his intention of being his own first minister. He built up a thoroughly personal system of government, and presided constantly over the council and many of its committees.

Even the greatest of his ministers found themselves controlled by the king. Fouquet, the finance minister, was overthrown and condemned to perpetual imprisonment. Those who had most of the king's confidence afterwards were Colbert for home affairs; Lionne for diplomacy, Louvois for war; but as his reign proceeded he became more intolerant of independence of judgment in his ministers.

His court was brilliant. In art and in literature, the great period, which is usually called by the king's name, had in some respects passed its zenith when he began to reign. But France was unquestionably the first state in Europe both in arms and arts, and within France the authority of the king was practically undisputed. The nation, proud of its pre-eminence and weary of civil war, saw in the king its true representative and the guarantee of its unity and success. Louis played the rôle of *Grand Monarque* to perfection. His wife Maria Theresa bore him children but there was no community of tastes between them, and the chief influence at court is to be found not in the queen but in the succession of avowed mistresses: Louise de la Vallière, Madame de Montespan and Madame de Maintenon (*q.v.*), who ruled, however, not as mistress but as wife. Through her influence the king was reconciled to his wife, and, when Maria Theresa died in 1683, Madame de Maintenon shortly afterwards (in 1684) became the king's wife, though this was never officially declared. Under her influence the court lost most of its gaiety, and religion came to exercise much control over the life and the policy of the king.

The first years of the king's rule were marked by the great schemes of Colbert for the financial, commercial, industrial and naval reorganization of France, and in these schemes Louis took a deep interest. But in 1667 began the long series of wars, which lasted with little real intermission to the end of the reign. (*See* FRANCE.) The War of Devolution (or the Queen's War) in 1667–68 to enforce the queen's claim to certain districts in the Spanish Netherlands, led to the Dutch War (1672–78), and in both these wars the supremacy of the French armies was clearly apparent. The next decade (1678–88) was the real turning point in the history of the reign, and the strength of France was seriously diminished. The chief cause of this is to be found in the revocation of the Edict of Nantes. The French Huguenots found their privileges decreased, and then, in 1685, the edict was altogether withdrawn. The results were ruinous to France, which lost many thousands of her best citizens and, also, Protestant alliances in Europe which had been in the past her great diplomatic support. The English Revolution of 1688 changed England from a wavering ally into the most determined of the enemies of France.

The war with the Grand Alliance, of which King William III. was the heart and soul, lasted from 1688 to 1697; and the treaty of Ryswick, which brought it to an end, deprived France of certain territories on her frontier. But Louis saw in the Spanish question a chance of more than making up for this loss. The Spanish king Charles II. was dying, and the future of the possessions of Spain was doubtful. The astute diplomacy of Louis succeeded in winning the inheritance for his grandson Philip. But this involved France and Europe in an immense war (1700) and by the peace of Utrecht (1713), though the French prince retained the Spanish crown, France had again to make concessions of territory.

The peace found France burdened with debt; the reforms of Colbert were ruined; and opposition to the king's régime began to make itself felt. Peace brought some relief to France, but the last years of the king's life were gloomy in the extreme. His eldest son, the dauphin, died in April 1711; his eldest grandson the duke of Burgundy in Feb. 1712; and his great-grandson the duke of Brittany in March 1712. The heir to the throne was now the duke of Burgundy's son, the duke of Anjou, afterwards Louis XV. The king died on Sept. 1, 1715, after the longest recorded reign in European history. The judgment of posterity has not repeated the flattering verdict of his contemporaries; but he remains the model of a great king in all that concern the externals of kingship.

The reign Louis XIV. is particularly rich in memoirs describing the life of the court. The chief are Madame de Motteville's memoirs for the period of the Fronde, and the letters of Madame de Sévigné and the memoirs of Saint-Simon for the later period. The king's ideas are best seen in the *Mémoires de Louis XIV. pour l'instruction du dauphin* (edited by Dreyss, 2 vols.). His private life is revealed in the letters of Madame de Maintenon and in those of Madame, Duchesse d'Orléans. *See* also Voltaire, *Siècle de Louis XIV.*; P. Clément, *Histoire de la vie et de l'administration de Colbert;* Blennerhasset, *Louis and Madame de Maintenon* (1910); Martin and Besançon, *Hist. du crédit en France sous le règne de Louis XIV.* (1913); d'Angelo, *Luigi XIV. et la Santa Sede, 1689–93* (1914); M. L. E. Bertrand, *Louis XIV.* (1923); G. Mentz, *Ludwig XIV. Sein Reich und Seine Zeit* (Bonn, 1922), and bibliographies; G. Monod's *Bibliographie de l'histoire de France;* vol. v. ("The Age of Louis XIV.") of the *Cambridge Modern History;* and vol. vi. ("Louis XIV.") of the *Histoire générale* of Lavisse and Rambaud.

LOUIS XV. (1710–1774), king of France, was the great-grandson of Louis XIV. and the third son of Louis, duke of Burgundy, and Marie Adelaide, princess of Savoy. He was five years old when Louis XIV. died. With the help of the parlement of Paris the arrangement for a council of regency made by the late king was set aside, and the duke of Orleans was declared regent with full powers. Fleury, bishop of Fréjus, was appointed the king's tutor. He attained his legal majority at the age of thirteen, shortly before the death of the duke of Orleans. His first minister was the incapable duke of Bourbon, who in 1725 procured his marriage to Maria Leszczynska, daughter of the exiled king of Poland. In 1726 the duke of Bourbon was displaced by the king's tutor, Fleury, who exercised almost absolute power. His administration was successful and peaceful until the year 1734, when France intervened in Poland on behalf of the queen's father. The peace of Vienna (1735) secured to France the possession of Lorraine. In 1740 France drifted into the war of the Austrian Succession as an ally of Frederick of Prussia and the enemy of England, and of Maria Theresa of Austria.

On Fleury's death in 1743 Louis XV. determined to rule alone, but he was not strong enough in will or intellect to rule effectively. The queen for some time seems to have secured his affections, and she bore him seven children. But Louis entertained a series of mistresses. The first to acquire notoriety was the duchess of Châteauroux, the third sister of one family who held this position. He dismissed her in a fit of piety after an illness, but her place was taken in 1745 by Madame de Pompadour, whose influence on public affairs was a fatal one. She had many rivals during her lifetime and on her death in 1764 she was succeeded by Madame du Barry (*q.v.*). To the last Louis maintained the pretence of personal rule, but the machinery of government fell out of gear, and the disorder of the finances was never remedied before the revolution of 1789.

The peace of Aix-la-Chapelle (1748), which ended the war of the Austrian Succession, brought no gains to France in spite of her victories at Fontenoy and Raucoux; and the king was blamed for the diplomatic failure. The interval between this war and the Seven Years' War (1756) saw that great reversal of alliances which is sometimes called the "Diplomatic Revolution"; whereby France repudiated the alliance of Frederick the Great and joined hands with her old enemy Austria. The intrigues of Madame de Pompadour played in this change an important though not a decisive part. It was the cause of immense disasters to France; for after a promising beginning, both by land and sea, France suffered reverses which lost her both India and Canada and deprived her of the leading position which she had so long held in Europe. Her humiliation was declared by the peace of Paris (1763).

The article on the history of France (*q.v.*) shows how there arose during the last years of Louis XV.'s reign a strong reaction against the monarchy and its methods. In the parlements, provincial and Parisian; in religion and in literature, a note of opposition was struck which was never to die until the monarchy was overthrown. France annexed Corsica in 1768, but this was felt to be the work of the minister Chauvelin, and reflected no credit on the king. He died on May 10, 1774.

For the king's life generally *see* the memoirs of Saint-Simon, d'Argenson, Villars and Barbier, and for the details of his private life E. Boutaric, *Correspondance secrète de Louis XV.;* Madame de

Pompadour's *Correspondance* published by P. Malassi; Dietric, *Les Maîtresses de Louis XV.;* and Fleury, *Louis XV. intimes et les petites maîtresses* (1909).

For the system of secret diplomacy and organized espionage, *see* Albert duc de Broglie, *Le Secret du roi, Correspondance secrète de Louis XV. avec ses agents diplomatiques 1752–1774* (1878); Cahen, *Les querelles religieuses et parlementaires sous Louis XV.* (1913); and for a general account of the reign, H. Carré, *La France sous Louis XV.* (Paris, 1891); Mouffle d'Angerville, *The Private Life of Louis XV.* (1924); also C. Saint-André, *Louis XV.* (1921). For other works, general and special, *see* G. Monod, *Bibliographie de la France,* and the bibliography in the *Histoire générale* of Lavisse and Rambaud, vol. vii., and the *Cambridge Modern History,* vol. vi.

LOUIS XVI. (1754–1793), king of France, was the son of Louis, dauphin of France, the son of Louis XV., and of Marie Joseph of Saxony, and was born at Versailles on Aug. 23, 1754, being baptized as Louis Augustus. His father's death in 1765 made him heir to the throne, and in 1770 he married Marie Antoinette (*q.v.*) daughter of the empress Maria Theresa. He was twenty years old when the death of Louis XV. on May 10, 1774, placed him on the throne. He began his reign under good auspices, with Turgot, the greatest living French statesman, in charge of the disorganized finances; but in less than two years he dismissed him. Turgot's successor, Necker, however, continued the régime of reform until 1781, and it was only with Necker's dismissal that the period of reaction began. Marie Antoinette then obtained that ascendancy over her husband which was partly responsible for the extravagance of the ministry of Calonne.

The third part of his reign began with the meeting of the states-general on May 4, 1789, which marked the opening of the Revolution. The revolt of Paris and the taking of the Bastille on July 14 were its results. The suspicion, not without justification, of a second attempt at a *coup d'état* led on Oct. 6, to the "capture" of the king and royal family at Versailles by a mob from Paris, and their transference to the Tuileries. In spite of the growing radicalism of the clubs, however, loyalty to the king remained surprisingly strong. When he swore to maintain the constitution, then in progress of construction, at the festival of the federation on July 14, 1790, he was at the height of his popularity. Even his attempted flight on June 20, 1791, did not entirely turn the nation against him. Arrested at Varennes, he was maintained as a constitutional king, and took his oath on Sept. 13, 1791.

But already a party was forming in Paris which demanded his deposition. This first became noticeable in connection with the affair of the Champ de Mars on July 17, 1791. Crushed for a time the party gained strength through the winter of 1791–1792. The declaration of war against the emperor Francis II., nephew of Marie Antoinette, was forced upon the king by those who wished to discredit him by failure, or to compel him to declare himself openly an enemy to the Revolution. Their policy proved effective. The failure of the war, which intensified popular hatred of the Austrian queen, involved the king; and the invasion of the Tuileries on June 20, 1792, was but the prelude to the conspiracy which resulted on Aug. 10, in the capture of the palace and the "suspension" of royalty by the Legislative Assembly until the convocation of a national convention in September. On Sept. 21, 1792, the Convention declared royalty abolished, and in January it tried the king for his treason against the nation, and condemned him to death. He was executed on Jan. 21, 1793.

Louis XVI. was weak in character and mentally dull. His courage and dignity during his trial and on the scaffold has left him a better reputation than he deserves. His diary shows how little he understood, or cared for, the business of a king. Days on which he had not shot anything at the hunt were blank days for him. The greater part of his time was spent hunting. He also amused himself making locks, and a little at masonry. On one point only, he actively resisted the Revolution. A devoted and sincere Roman Catholic, he refused at first to sanction a constitution for the church in France without the pope's approval, and after he had been compelled to allow the constitution to become law he intrigued feebly against the Revolution. When he gave in, he delayed his acquiescence until it had the air of a surrender.

Having lost his elder son in 1789 Louis left two children, Louis Charles, usually known as Louis XVII. (*q.v.*), and Marie Thérèse Charlotte (1778–1851), duchess of Angoulême. The "orphan of the Temple," as the princess was called, was in prison for three years, during which time she remained ignorant of the fate which had befallen her parents. She died on Oct. 19, 1851. Her life by G. Lênotre has been translated into English by J. L. May (1908).

See the articles French Revolution and Marie Antoinette. F. X. J. Droz, *Histoire du règne de Louis XVI.* (3 vols., 1860), a sane and good history of the period; and Arsène Houssaye, *Louis XVI.* (1891). *See* also the numerous memoirs of the time, and the marquis de Ségur's *Au couchant de la monarchie, Louis XVI. et Turgot* (1910); de Baissière, *La mort du roi, 21 janvier 1793* (1909); Durfel, *La diplomatie de la France sous Louis XVI.* (1919).

For bibliographies *see* G. Monod, *Bibl. de la France;* Lavisse et Rambaud, *Hist. Univ.,* vols. vii. and viii.; and the *Cambridge Modern History,* vol. viii.

LOUIS XVII., Charles (1785–1795?), titular king of France, second son of Louis XVI., and Marie Antoinette, was born at Versailles on March 27, 1785, and given the title of duke of Normandy, becoming dauphin on the death of his elder brother on June 4, 1789. In 1792 his parents and the rest of the royal party were imprisoned in the Temple—at first in the smaller tower; on Oct. 27 they were moved to the larger tower, and Louis was separated from his mother and aunt to be put in his father's charge, except for a few hours daily, but he was restored to the women when Louis was finally isolated at his trial.

On Jan. 21, 1793, Louis became, for the royalists, king of France, and the comte de Provence gave himself the title of regent. Plots were engineered for the escape of the prisoners by the Chevalier de Jarjayes, the baron de Batz (*q.v.*) and Lady Atkyns (*q.v.*). On July 3 the dauphin was given into the charge of Simon, a cobbler who had been named his guardian by the Committee of General Security. Although the Simons were unfit guardians there is little evidence that the child was actually ill-treated. On Oct. 6 Chaumette, Hébert and others visited him, and secured from him admissions of infamous accusations against his mother, and next day he met his sister, Marie Thérèse, for the last time. On Jan. 19 the Simons left the Temple.

Two days after their departure Louis is said by the Restoration historians to have been put in a dark room which was barricaded, while food was passed through the bars; and according to the legend nobody entered the room for six months, till Barras visited him after the 9th Thermidor (July 27, 1794). The child made no complaint to Barras, probably because he feared to do so. After this his condition improved; he was visited during the day by his new attendant, a creole named Jean Jacques Christophe Laurent (1770–1807), who had assistance from a man named Gomin after Nov. 8. From about this time the prisoner was inspected by representatives of the civil committee of the 48 sections of Paris, and on Dec. 19, 1794, he was visited by three commissioners from the Committee of General Security—J. B. Harmand de la Meuse, J. B. C. Mathieu, and J. Reverchon—who extracted no word from him. On Laurent's retirement Étienne Lasne was appointed on March 31, 1795, to be the child's guardian. In May 1795 Louis was seriously ill, and a doctor, P. J. Desault, who had visited him seven months earlier, was summoned. Desault died suddenly, not without suspicion of poison, on June 1, and it was some days before Doctors Pelletan and Dumangin were called. Then it was stated that on the 8th Louis Charles had died. Next day an autopsy was held, at which it was stated that a child apparently about ten years of age "which the commissioners told us was the late Louis Capet's son," had died of a scrofulous affection of long standing. He was buried on the 10th in the cemetery of Ste. Marguerite, but no stone was erected to mark the grave.

Immediately on the announcement of the dauphin's death there arose a rumour that he had escaped. Simien Despréaux, one of Louis XVIII.'s own authors, stated in 1814 that Louis XVII. was living, and Eckard left among his unpublished papers a statement that many members of "an assembly of our wise men" named Louis XVII. as the prince whom they wished to have. The royal family made no serious attempt to ascertain the truth, and the removal of Louis XVII. suited the comte de Provence (now Louis XVIII. for the émigrés) as well as it did the Revolutionary

Government.

The most important of some 40 pretenders under the Restoration were Karl Wilhelm Naundorff (*q.v.*) and the comte de Richemont. According to Naundorff, Barras determined to save the dauphin in order to please Joséphine Beauharnais, the future empress, having conceived the idea of using the dauphin's existence as a means of dominating the comte de Provence in the event of a restoration. The dauphin was concealed in the fourth storey of the Tower, a wooden figure being substituted for him. Laurent, to protect himself from the consequences of the substitution, replaced the wooden figure by a deaf mute, who was presently exchanged for the scrofulous child of the death certificate. The deaf mute was also concealed in the Temple. It was not the dead child but the dauphin who left the prison in the coffin, whence he was extracted by his friends on the way to the cemetery. Richemont's tale is that the woman Simon, who was genuinely attached to him, smuggled him out in a basket. Richemont was in prison in Milan for seven years and began to put forward his claims in Paris in 1828. In 1834, he was condemned to 12 years' imprisonment. He escaped after a few months and left the country, to return in 1840. He died at Gleize on Aug. 10, 1853.

If the dauphin did escape, it seems probable that he perished shortly afterwards or lived in a safe obscurity. The account of the substitution in the Temple is well substantiated, even to the names of the substituted. Lady Atkyns was trying by every possible means to get the dauphin out of his prison when he was apparently already in safe hands, if not outside the Temple walls. A child was in fact delivered to her agents, but he was found to be a deaf mute.

The official version of the dauphin's history as accepted under the Restoration was drawn up by Simien Despréaux in his uncritical *Louis XVII.* (1817), and is found, fortified by documents, in M. Eckard's *Mémoires historiques sur Louis XVII.* (1817) and in A. de Beauchesne's *Louis XVII., sa vie, son agonie, sa mort. Captivité de la famille royale au Temple* (2 vols., 1852, and many subsequent editions), contains copies of original documents. L. de la Sicotière, "Les faux Louis XVII.," in *Revue des questions Historiques* (vol. xxxii., 1882), deals with the pretenders Jean Marie Hervagault, Mathurin Bruneau and the rest; *see* also Dr. Cabanes, *Les Morts mystérieuses de l'histoire* (1901), and revised catalogue of the J. Sanford Saltus collection of Louis XVII. books (New York, 1908); also J. H. Hanson, *The Lost Prince* (1854); E. R. Buckley, *Monsieur Charles, The Tragedy of the True Dauphin* (1927).

For De Richemont see *Mémoires du duc de Normandie, fils de Louis XVI., écrits et publiés par lui-même* (1831), compiled, according to Quérard, by E. T. Bourg, called Saint Edme; Morin de Guérivière, *Quelques souvenirs . . .* (1832); and J. Suvigny, *La Restauration convaincue . . . ou preuves de l'existence du fils de Louis XVI.* (1851).

Since 1905 a monthly periodical has appeared in Paris on this subject, entitled *Revue historique de la question Louis XVII.*

LOUIS XVIII. (Louis le Désiré) (1755–1824). Louis-Stanislas-Xavier, comte de Provence, third son of the dauphin Louis, son of Louis XV. and Maria Josepha of Saxony, was born at Versailles on Nov. 17, 1755. His education was supervised by the devout duc de la Vauguyon, but his own taste was for the writings of Voltaire and the encyclopaedists. On May 14, 1771, took place his marriage with Louise-Marie-Joséphine of Savoy. During the long absence of heirs to Louis XVI., "Monsieur," as heir to the throne, courted popularity and took an active part in politics, but the birth of a dauphin (1781) was a blow to his ambitions. He opposed the revival of the *parlements,* wrote a number of political pamphlets, and at the Assembly of Notables presided, like the other princes of the blood, over a bureau, to which was given the name of the *Comité des sages;* he also advocated the double representation of the *tiers.* At the same time he cultivated literature, entertaining poets and writers both at the Luxembourg and at his château of Brunoy (*see* Dubois-Corneau, *Le Comte de Provence à Brunoy,* 1909), and gaining a reputation for wit by his verses and *mots* in the salon of the charming and witty comtesse de Balbi, one of Madame's ladies, who had become his mistress, and till 1793 exerted considerable influence over him. He did not emigrate after the taking of the Bastille, but, possibly from motives of ambition, remained in Paris. In June 1791, however, at the time of the flight to Varennes, he also fled by a different route, and, in company with the comte d'Avaray—who subsequently replaced Mme. de Balbi as his confidant, and largely influenced his policy—reached Brussels, where he joined the comte d'Artois and proceeded to Coblenz, now the headquarters of the emigration.

Here, living in royal state, he put himself at the head of the counter-revolutionary movement, appointing ambassadors, soliciting the aid of the European sovereigns, and especially of Catherine II. of Russia. Out of touch with affairs in France and surrounded by violent anti-revolutionists, headed by Calonne and the comte d'Artois, he followed an entirely selfish policy, flouting the National Assembly, issuing uncompromising manifestoes (Sept. 1791, Aug. 1792, etc.), and obstructing in every way the representatives of the king and queen. After Valmy he had to retire to Hamm in Westphalia, where, on the death of Louis XVI., he proclaimed himself regent; from here he went south, with the idea of encouraging the royalist feeling in the south of France, and settled at Verona, where on the death of Louis XVII. (June 8, 1795) he took the title of Louis XVIII. From this time onward his life is a record of constant wanderings, negotiations and conspiracies. In April 1796 he joined Condé's army on the German frontier, but was shortly requested to leave the country, and accepted the hospitality of the duke of Brunswick at Blanckenberg till 1797, when, this refuge being no longer open to him, the emperor Paul I. permitted him to settle at Mittau in Courland, where he stayed till 1801. All this time he was in close communication with the royalists in France, but was much embarrassed by the conflicting policy pursued by the comte d'Artois from England, and was largely at the mercy of corrupt and dishonest agents.[1] At Mittau was realized his cherished plan of marrying Madame Royale, daughter of Louis XVI., to the duc d'Angoulême, elder son of the comte d'Artois. From Mittau, too, was sent his well-known letter to Bonaparte (1799) calling upon him to play the part of Monk, a proposal contemptuously refused, though Louis in turn declined to accept a pension from Bonaparte, and later, in 1803, though his fortunes were at their lowest ebb, refused to abdicate at his suggestion and accept an indemnity.

Suddenly expelled from Mittau in 1801 by the capricious Paul I., Louis made his way, in the depth of winter, to Warsaw, where he stayed for three years. All this time he was trying to convert France to the royalist cause, and had a *conseil royal* in Paris, founded at the end of 1799 by Royer-Collard, Montesquiou, and Clermont-Gallerande, but after 1800, and still more after the assumption by Napoleon of the title of emperor (May 1804), the royalist cause appeared hopeless. In Sept. 1804 Louis met the comte d'Artois at Calmar in Sweden, whence they issued a protest against Napoleon's action. Warned that he must not return to Poland, he gained permission from Alexander I. again to retire to Mittau. After Tilsit, however (1807), he was again forced to depart, and took refuge in England, where he stayed first at Gosfield in Essex, and afterwards (1809 onwards) at Hartwell in Buckinghamshire. In 1810 his wife died, and in 1811 d'Avaray died, his place as favourite being taken by the comte de Blacas.[2] After Napoleon's defeats in 1813 the hopes of the royalists revived, and Louis issued a fresh manifesto, in which he promised to recognize the results of the Revolution. Negotiations were also opened with Bernadotte, who seemed willing to support his cause, but was really playing for his own hand.

In March 1814 the allies entered Paris, and thanks to Talleyrand's negotiations the restoration of the Bourbons was effected, Louis XVIII. entering Paris on May 2, 1814, after issuing the declaration of St. Ouen, in which he promised to grant the nation a constitution (*octroyer une charte*). He was now nearly 60, wearied by adversity, and a sufferer from gout and obesity. But though clear-sighted, widely read and a good diplomatist, his impressionable and sentimental nature made him too subject to personal and family influences. His concessions to the reactionary and clerical party of the *émigrés,* headed by the comte d'Artois and the duchess d'Angoulême, aroused suspicions of his loyalty to the constitution, the creation of his *Maison militaire,* alienated

[1]*See* E. Daudet, *La Conjuration de Pichegru* (Paris, 1901).

[2]Pierre-Louis-Casimir, comte (afterwards duc) de Blacas d'Aulps, was as rigidly royalist as d'Avaray, but more able.

the army, and the constant presence of Blacas made the formation of a united ministry impossible. After the Hundred Days, during which the king was forced to flee to Ghent, the dismissal of Blacas was made one of the conditions of his second restoration. On July 8 he again entered Paris, "in the baggage train of the allied armies," as his enemies said, but in spite of this was received with the greatest enthusiasm by a people weary of wars and looking for constitutional government. He was forced to retain Talleyrand and Fouché in his first ministry, but took the first opportunity of ridding himself of them when the elections of 1815 assured him of a strong royalist majority in the chamber (the *chambre introuvable,* a name given it by Louis himself). At this time he came into contact with the young Élie Decazes (*q.v.*), prefect of the police under Fouché, who now became his favourite and gained his entire confidence. Having obtained a ministry in which he could trust, with the duc de Richelieu at its head, and Decazes as minister of police, the king gave it his loyal support and did his best to shield his ministers from the attacks of the royal family. In Sept. 1816, alarmed at the violence of the *chambre introuvable,* he was persuaded by Decazes to dissolve it. An attempt on the part of the Ultras to regain their ascendancy over the king, by conniving at the sudden return of Blacas from Rome to Paris, ended in failure.

The king's policy throughout was one of prudence and common sense. While Decazes, who succeeded Richelieu as president of the council in Dec. 1818, was still in power, the king's policy to a large extent followed his, and was rather liberal and moderate, but after the assassination of the duc de Berry (1820), when he saw that Decazes could no longer carry on the government, he sorrowfully acquiesced in his departure, showered honours upon him, and transferred his support to Richelieu, the head of the new ministry. In the absence of Decazes a new favourite was found to amuse the king's old age, Madame du Cayla (Zoé Talon, comtesse du Cayla), a protégée of the vicomte Sosthène de la Rochefoucauld and consequently a creature of the Ultras. As the king became more and more infirm, his power of resistance to the intrigues of the Ultras became weaker. The birth of a posthumous son to the duc de Berry (Sept. 1820), the death of Napoleon (May 5, 1821) and the resignation of Richelieu, left him entirely in their hands, and after Villèle had formed a ministry of an ultra-royalist character, the comte d'Artois was associated with the government, which passed more and more out of the king's hands. He died on Sept. 16, 1824. Louis XVIII. had the Bourbon characteristics, their love of power, a certain nobility of demeanor, and a consciousness of dignity. But he was cold, unsympathetic and calculating. He had a talent for intrigue, to which was added an excellent memory and a ready wit. An interesting judgment of him is contained in Queen Victoria's *Letters,* vol. i., in a letter by Leopold I., king of the Belgians, dated Nov. 18, 1836, "Poor Charles X. is dead. . . . History will state that Louis XVIII. was a most liberal monarch, reigning with great mildness and justice to his end, but that his brother, from his despotic and harsh disposition, upset all the other had done and lost the throne. Louis XVIII. was a clever, hard-hearted man, shackled by no principle, very proud and false. Charles X. an honest man, a kind friend." As a personal, rather than a political estimate, this is just.

Bibliography.—There is no trustworthy or complete edition of the writings and correspondence of Louis XVIII. From his own hand are *Relation d'un voyage à Bruxelles et à Coblentz, 1791* (1823) and *Journal de Marie-Thérèse de France, duchesse d'Angoulême, corrigé, et annoté par Louis XVIII.,* edit. Imbert de St. Amand (1894). Some of his letters are contained in collections, such as *Lettres et instructions de Louis XVIII. au comte de Saint-Priest,* edit. P. B. de Barante (1845); *Lettres d'Artwel: correspondance politique et privée de Louis XVIII.,* addressed to d'Avaray (1880); *Talleyrand et Louis XVIII. corr. pendant le congrès de Vienne, 1814–1815,* edit. G. Pallain (1881, Eng. trans. 2 vols., 1881); *see* also the correspondence of Castlereagh, Metternich, J. de Maistre, the Wellington Despatches, etc., *Corr. diplomatique de Pozzo di Borgo avec le comte de Nesselrode* (2 vols., 1890–97), the correspondence of C. de Rémusat, Villèle, etc. *See* also E. Daudet, *La Terreur Blanche* (1878), *Hist. de la restauration 1814–1830* (1882), *Louis XVIII. et le duc Decazes* (2 vols., 1899–1903), *Hist. de l'émigration* (3 vols., 1904–07); E. Romberg and A. Malet, *Louis XVIII. et les cent-jours à Gand* (1898). L. de Remâcle, *Bonaparte et les Bourbons* (1899); G. Stenger, *Le Retour des Bourbons* (1908). For various episodes, *see* J. B. H. R. Capefigue, *La Comtesse du Cayla* (1866), J. Turquan, *Souveraines et grandes dames: les favorites de Louis XVIII.* (1900), Vicomte de Reiset, "Anne de Caumont-Laforce, comtesse de Balbe" in *Les Reines de l'émigration,* vol. ii. (1908). *See* also the chief memoires of the period, such as those of Talleyrand, Chateaubriand, Guizot, duc de Broglie, Villèle, Vitrolles, Pasquier, L. F. S. de la Rochefoucauld (15 vols., 1861–64), and of the comtesse de Boigne, edit. C. Nicoullaud (1907).

LOUIS II. (1506–26), king of Hungary and Bohemia, was the only son of Wladislaus II., king of Hungary and Bohemia, and the French princess Anne of Candale. Prematurely born at Buda on July 1, 1506, it required all the resources of medical science to keep the sickly child alive, yet he developed so precociously that at the age of 13 he was well bearded and moustached, while at 18 his hair was silvery white. His parts were good and he could speak and write six languages at a very early age, but the zeal of his guardians and tutors to make a man of him betimes nearly ruined his feeble constitution, while the riotous life led by him and his young consort, Maria of Austria, whom he wedded on Jan. 13, 1522, speedily disqualified him for affairs, so that at last he became an object of ridicule at his own court. He was crowned king of Hungary on June 4, 1508, and king of Bohemia on May 11, 1509, and was declared of age when he succeeded his father on Dec. 11, 1521. But during most of his reign he was the puppet of the magnates and kept in such penury that he was often obliged to pawn his jewels to get proper food and clothing, while his guardians and the Hungarian nobles rent the kingdom with their factions. In the last struggle with the Turks, which was brought on partly by Louis's own folly, the young king was deserted by the nobles who should have helped him. His army was utterly defeated at Mohács, Aug. 29, 1526, and he himself is said to have been drowned in his flight from the field (*see* Hungary: *History*). After his death the Crowns of Hungary and Bohemia passed to the Habsburg dynasty.

See *Rerum Hungaricarum libri* (vol. ii., ed. Ferencz Toldy, Budapest, 1867); and József Podhradczky, *King Louis* (Hung.) (1860).

LOUIS I. (1326–82), called "the great," king of Hungary and Poland, was the third son of Charles Robert, king of Hungary, and Elizabeth, daughter of the Polish king, Ladislaus Lokietek. On July 21, 1362, he was crowned king of Hungary in succession to his father. He engaged in a prolonged struggle against Venice for the Adriatic sea-board. On July 1, 1346, he was defeated by the Venetians at Zara, which had placed itself under the protection of Hungary. The battle has been immortalized by Tintoretto. In 1357, however, Louis formed a league of all the enemies of Venice, including the emperor, the Habsburgs, Genoa and other Italian towns, and forced her to cede most of the Dalmatian towns and renounce the title of duke of Dalmatia and Croatia, hitherto borne by the doge. (Treaty of Zara, Feb. 18, 1358.) In the same year the republic of Ragusa voluntarily submitted to him, Louis undertaking its defence against an annual tribute. The third Venetian War (1378–81), where Louis was again helped by Genoa, was ended by the congress of Turin (1381), Venice virtually surrendering Dalmatia to Louis and undertaking to pay him an annual tribute of 7,000 ducats. The persistent hostility of Venice is partially attributable to her constant fear lest Louis should inherit the crown of Naples and thus threaten her trade and her sea-power from two sides.

Louis's younger brother Andrew had wedded Joanna, granddaughter and heiress of old King Robert of Naples, on whose death, in 1343, she reigned in her own right, and is strongly suspected of having secured her consort's assassination in 1345. Although Louis claimed the throne, and twice occupied Naples, he could never secure the crown. At last in 1378 Joanna, having made the mistake of recognizing the antipope Clement VII., was promptly deposed and excommunicated in favour of Prince Charles of Durazzo, who had been brought up at the Hungarian court. With the Habsburgs, Louis generally maintained friendly relations, and his differences with Rudolph of Habsburg were composed without war at the peace congresses of Nagyszombat (1360) and of Pressburg (1360). On the death of his uncle, the childless Casimir the Great of Poland, who had been Louis's lifelong friend, and had appointed him his successor, Louis was crowned king of Poland (Nov. 17, 1370). This personal union of the two countries was more glorious than profitable. Louis was never able to establish real authority over his Polish subjects although in 1374 he compelled them by force to recognize his daughter Maria and her affianced husband, Count Sigismund of Brandenburg, as their future king and queen. Against the Turks, who were now beginning to threaten Europe, Louis took little or no action. He died suddenly at Nagyszombat, Sept. 10, 1382. He left two daughters Maria and Jadwiga (the latter he destined for the throne of Hungary) under the guardianship of his widow. She was the daughter of the valiant ban of Bosnia, Stephen Kotromanic, and she was married in 1353.

See *Rationes Collectorum Pontif. in Hungaria, 1281–1375* (Budapest, 1887); Dano Gruber, *The Struggle of Louis I. with the Venetians for Dalmatia* (Croat.) (Agram, 1903); Antal Pór, *Life of Louis the Great* (Hung.) (Budapest, 1892); and *History of the Hungarian Nation* (Hung.) (vol. iii., Budapest, 1895).

LOUIS, the name of three kings of Naples.

Louis I., duke of Anjou and count of Maine (1339–1384), was the second son of John II., king of France, and was born at Vincennes on July 23, 1339. As duke of Anjou he led a wing of the French army at the battle of Poitiers. He was a hostage for the treaty of Brétigny in 1360, but he broke his parole in 1363 and so brought about King John's return into captivity. He took part in the war against England which was renewed in 1369, uniting the rival houses of Foix and Armagnac in the common cause, and in other ways rendering good service to his brother, King Charles V. Anjou's entrance into the troubled politics of Italy was one result of the papal schism which opened in 1378. Anxious to secure the support of France, the antipope Clement VII. persuaded the queen of Naples, Joanna I. (*q.v.*), to name Louis as her heir, and about the same time the death of Charles V. (Sept. 1380) placed the duke in the position of regent of France. Neglecting France to prosecute his ambitions in Italy, he collected money and marched on Naples; but although helped by Amadeus VI., count of Savoy, he was unable to drive his rival, Charles, duke of Durazzo, from Naples. His army destroyed by disease, Louis died at Biseglia, near Bari, on Sept. 20, 1384, leaving two sons, his successor, Louis II., and Charles, duke of Calabria.

Louis II., duke of Anjou (1377–1417), born at Toulon on Oct. 7, 1377, took up the struggle for Naples after his father's death and was crowned king by Clement VII. in 1389. After carrying on the contest for some years he took refuge in France. He made other attempts to secure the kingdom of Naples, which was now in the possession of Ladislas, a son of Charles of Durazzo, and he gained a victory at Roccoserra in May 1411. He was again driven back to France, and he died at Angers on April 29, 1417. He married Yolande, a daughter of John I., king of Aragon.

Louis III., duke of Anjou (1403–1434), born on Sept. 25, 1403, son of Louis II., attempted to conquer Naples in 1420; he died at Cosenza on Nov. 15, 1434. In 1424 Louis received from King Charles VII. the duchy of Touraine.

Another titular king of Naples of this name was Louis, a son of Philip, prince of Taranto. In 1346 he became the husband of Joanna I., queen of Naples, and in 1352 he was crowned king. After attempting to conquer Sicily he died on May 26, 1362.

LOUIS or **LEWIS,** a masculine proper name derived from Frankish *Chlodowîch,* Latinized as *Lodhuvicus,* whence O.Fr. *Lodhuwigs, Loys,* and later *Louis; cf.* Ger. *Ludwig.* It means "famous in fight" and was borne by many sovereigns.

The "Louis" or "Louis d'or" was a term applied to the gold coins of France prior to the Revolution. The franc and livre (*qq.v.*) were silver coins which had shrunk in value to such an extent that larger coins were needed, and just as England adopted the guinea so did the French kings have gold coins struck and called after their name. After the Revolution Napoleon continued the practice, but called the coins "Napoleons."

LOUISBURG or Louisbourg, a town and port of entry of Cape Breton, Nova Scotia, Canada, the terminus of the Sydney & Louisburg railway, 39 mi. from Sydney. Pop. (1941) 1,012. Under the French *régime,* Louisburg was second only to Quebec. A fortress was erected at enormous expense, and the city was the centre of the cod-fisheries. The fortress was, however, captured in 1745 by the American colonists, under Sir William Pepperell (1696–1759), assisted by the British fleet, and again in 1758 by a British land and sea force under General Jeffrey Amherst (1717–1797) and Admiral Boscawen. The jealousy of the British settlement of Halifax led to its almost utter destruction, and only a few casemates now remain. Under English rule a fishing village grew up on the other side of the harbour. This harbour is deep, and open save for occasional drift ice in the spring. The site of the fortifications is now the Louisburg National Historic park.

LOUIS OF NASSAU (1538–1574), son of William, count of Nassau, and Juliana von Stolberg, and younger brother of William the Silent, was one of the leaders of the league of nobles who signed the document known as "the Compromise" in 1566, and was a member of the deputation who presented the petition of grievances called "the Request" to the regent, Margaret of Parma. On the arrival of Alva at Brussels, Count Louis, with his brother William, withdrew from the Netherlands and raised a body of troops in defence of the patriot cause. In the spring of 1568 Louis invaded Friesland, and at Heiligerlee, on May 23, completely defeated a Spanish force under Count Aremberg, who was killed. Alva annihilated the levies of Louis at Jemmnigen (July 21), Louis himself escaping by swimming across an arm of the Ems. He now joined William, who had in October to beat a hasty retreat before Alva's superior skill. The brothers then made their way to the camp of Admiral Coligny.

Louis took an active part in the Huguenot campaign, and fought heroically at Jarnac and Moncontour. In 1572 Louis raised a small force in France, and, suddenly entering Hainaut, captured Mons (May 23). Here he was besieged by Don Frederick of Toledo, Alva's natural son, who blockaded all approach to the town. William made an attempt to relieve his brother, but failed, and Mons surrendered (September 17). Louis withdrew to his home, Dillenburg, to raise money and troops for another invasion of the Netherlands. In the hope of diverting the Spaniards from the siege of Leiden, Louis with his brothers John and Henry, at the head of a mixed force, crossed the frontier near Maastricht, and advanced to the Mookerheide near Nijmwegen. Here he was attacked by Sancho d'Avila, and routed. Both Louis and his younger brother Henry were killed.

See P. J. Blok, *Lodewijk von Nassau, 1538–1574* (The Hague, 1689), and the *Cambridge Modern History,* vol. iii. chs. vi. and vii., and bibliography (1904); also A J. Van der Aa, *Biographisch woordenboek der Nederlanden* (22 vols., Haarlem, 1852–78); and Ledderhose, *Graf Ludwig von Nassau* (1877).

LOUIS PHILIPPE I., king of the French (1773–1850), was the eldest son of Louis Philippe Joseph, duke of Orleans (known during the Revolution as Philippe Egalité) and of Louise Marie Adelaide de Bourbon, daughter of the duc de Penthièvre, and was born at the Palais Royal in Paris on Oct. 6, 1773. The legend that he was a supposititious child is dealt with elsewhere. (*See* Maria Stella, countess of Newborough.) The god-parents of the duke of Valois, as he was entitled till 1785, were Louis XVI. and Queen Marie Antoinette; his governess was the famous Madame de Genlis, to whose influence he doubtless owed his wide, if superficial knowledge, his orderliness, and perhaps his parsimony. Known since 1785 as the duc de Chartres, he was 16 at the outbreak of the Revolution, with which, like his father, he at first identified himself. In 1790 he joined the Jacobin club, in which the moderate elements still predominated, and attended the debates of the National Assembly. He thus became a *persona grata* with the party in power; he was already a colonel of dragoons, and in 1792 he was given a command in the army of the north. As a lieutenant-general, at the age of 18, he was present at Valmy (Sept. 20) and Jemappes (Nov. 6).

The republic had meanwhile been proclaimed, and the duc de Chartres, now like his father surnamed *Egalité,* posed as its zealous adherent. Fortunately for him, he was too young to be elected to the Convention, and while his father was voting for the death of Louis XVI. he was serving under Dumouriez in Holland. He shared in the defeat of Neerwinden (March 18, 1793); was implicated with Dumouriez in the plot to overthrow the republic, and on April 5 escaped with him into the Austrian lines. He went first, with his sister Madame Adelaide, to Switzerland where he obtained a situation as professor in the college of Reichenau under the assumed name of M. Chabaud de la Tour, mainly in order to escape from the fury of the *émigrés*. The execution of his father in Nov. 1793 had made him duke of Orleans, and he now became the centre of the intrigues of the Orleanist party. In 1795 he was at Hamburg with Dumouriez, who still hoped to make him king. With characteristic caution Louis Philippe refused to commit himself, and announced his intention of going to America; but in the hope that something might happen in France to his advantage, he postponed his departure, travelling instead through the Scandinavian countries. But in 1796, the Directory having offered to release his mother and his two brothers, who had been kept in prison since the Terror, on condition that he went to America, he set sail for the United States, and in October settled in Philadelphia, where in Feb. 1797 he was joined by his brothers the duc de Montpensier and the comte de Beaujolais. The news of the *coup d'état* of 18 Brumaire decided them to return to Europe. They returned in 1800, only to find Napoleon Bonaparte's power firmly established. Immediately on his arrival, in Feb. 1800, the duke of Orleans, at the suggestion of Dumouriez, sought an interview with the comte d'Artois, through whose instrumentality he was reconciled with the exiled king, Louis XVIII. The duke, however, refused to join the army of Condé and to fight against France, an attitude in which he persisted, while maintaining his loyalty to the king. He settled with his brothers at Twickenham.

On May 18, 1807, the duc de Montpensier died at Christchurch in Hampshire of consumption. The comte de Beaujolais was ill of the same disease and in 1808 the duke took him to Malta, where he died on May 29th. The duke now, in response to an invitation from King Ferdinand IV., visited Palermo where, on Nov. 25, 1809, he married Princess Maria Amelia, the king's daughter. He remained in Sicily until the news of Napoleon's abdication recalled him to France. He was cordially received by Louis XVIII.; his military rank was confirmed, he was named colonel-general of hussars, and such of the vast Orleans estates as had not been sold were restored to him by royal ordinance. This made him enormously rich.

Meanwhile, his sympathy with the Liberal opposition brought him again under suspicion. His attitude in the House of Peers in the autumn of 1815 cost him a two years' exile to Twickenham; he courted popularity by having his children educated *en bourgeois* at the public schools; and the Palais Royal was the rendezvous of that middle-class by which he was to be raised to the throne.

His opportunity came with the revolution of 1830. During the three "July days" the duke kept himself discreetly in the background, retiring first to Neuilly, then to Raincy. Meanwhile, Thiers issued a proclamation pointing out that a Republic would embroil France with all Europe, while the duke of Orleans who was "a prince devoted to the principles of the Revolution" and had "carried the tricolour under fire" would be a "citizen king" such as the country desired. This view was that of the rump of the chamber still sitting at the Palais Bourbon, and a deputation headed by Thiers and Laffitte waited upon the duke to invite him to place himself at the head of affairs. He returned with them to Paris on the 30th, and was elected by the deputies lieutenant-general of the realm. The next day, wrapped in a tricolour scarf, he went on foot to the Hôtel de Ville—the headquarters of the republican party—where he was publicly embraced by Lafayette as a symbol that the republicans acknowledged the impossibility of realizing their own ideals and were prepared to accept a monarchy based on the popular will. Hitherto, in letters to Charles X., he had protested the loyalty of his intentions, and the king now nominated him lieutenant-general and, abdicating in favour of his grandson the comte de Chambord, appointed him regent. On Aug. 7, however, the Chamber by a large majority declared Charles X. deposed, and proclaimed Louis Philippe "king of the French, by the grace of God and the will of the people."

For the trappings of authority he cared little. To conciliate the revolutionary passion for equality he was content to veil his kingship for a while under a middle-class disguise. He erased the royal lilies from the panels of his carriages; and the Palais Royal, like the White House at Washington, stood open to all and sundry who cared to come and shake hands with the head of the State. This pose served to keep the democrats of the capital in a good temper, and so leave him free to consolidate the somewhat unstable foundation of his throne and to persuade his European fellow-sovereigns to acknowledge in him not a revolutionary but a conservative force. But when once his position had been established, it became clear that he possessed all the Bourbon tenaciousness of personal power. When a "party of resistance" came into office with Casimir-Pèrier in March 1831, the speech from the throne proclaimed that "France has desired that the monarchy should become national, it does not desire that it should be powerless"; and the migration of the royal family to the Tuileries symbolized the right of the king not only to reign but to rule. Republican and Socialist agitation, culminating in a series of dangerous risings, strengthened the position of the king as defender of middle-class interests; and since the middle classes alone were represented in Parliament, he came to regard his position as unassailable. Little by little his policy became more purely dynastic. His position in France seeming assured, he sought to strengthen it in Europe by family alliances. The fact that his daughter Louise was the consort of Leopold I., king of the Belgians, had brought him into intimate relations with the English court. Broken in 1840 during the affair of Mohammed Ali, the *entente* with Great Britain was patched up in 1841 by the Straits Convention, and re-cemented by visits paid by Queen Victoria and Prince Albert to the Château d'Eu in 1843 and 1845 and of Louis Philippe to Windsor in 1844, only to be irretrievably wrecked by the affair of the "Spanish marriages," a deliberate attempt to revive the traditional Bourbon policy of French predominance in Spain. If in this matter Louis Philippe had seemed to sacrifice the international position of France to dynastic interests, his attempt to re-establish it by allying himself with the reactionary monarchies against the Liberals of Switzerland finally alienated from him the French Liberal opinion on which his authority was based. When, in Feb. 1848, Paris rose against him, he found that he was isolated.

Charles X., after abdicating, had made a dignified exit from France. Louis Philippe was less happily situated. Escaping with the queen from the Tuileries by a back entrance, he made his way with her in disguise to Honfleur, where the royal couple found refuge in a gardener's cottage. They were smuggled out of the country by the British consul at Havre as Mr. and Mrs. Smith, arriving at Newhaven "unprovided with anything but the clothes they wore." They settled at Claremont, placed at their disposal by Queen Victoria, under the *incognito* of count and countess of Neuilly. Here on Aug. 26, 1850, Louis Philippe died.

Louis Philippe had eight children. His eldest son, the popular Ferdinand Philippe, duke of Orleans (b. 1810), who had married Princess Helena of Mecklenburg, was killed in a carriage accident on July 13, 1842, leaving two sons, the comte de Paris and the duc de Chartres. The other children were Louise, consort of Leopold I., king of the Belgians; Marie, who married Prince Alexander of Württemberg and died in 1839; Louis Charles, duc de Nemours; Clementine, married to the duke of Coburg-Kohary; François Ferdinand, prince de Joinville; Henri Eugène, duc d'Aumale (*q.v.*); Antoine Philippe, duc de Montpensier, who married the younger sister of Queen Isabella of Spain.

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Louis Philippe himself published the *Journal du duc de Chartres, 1790–91; Mon Journal, événements de 1815* (2 vols. 1849); *Discours, allocutions et réponses de S. M. Louis-Philippe, 1830–46;* and after his death was issued his *Correspondance, mémoire et discours inédits* (1863). (W. A. P.)

LOUISE [Auguste Wilhelmine Amalie Luise] (1776–1810), queen of Prussia, was born on March 10, 1776, in Hanover, where her father, Prince Charles of Mecklenburg-Strelitz, was field-marshal of the household brigade. Her mother was a princess of Hesse-Darmstadt. In 1793 Louise met at Frankfort the crown prince of Prussia, afterwards King Frederick William III., whom she married on Dec. 4. As queen of Prussia she commanded universal respect and affection, and won a great name by the dignity and unflinching courage with which she bore the sufferings inflicted on her and her family during the Napoleonic wars. After the battle of Jena she went with her husband to Königsberg, and when the battles of Eylau and Friedland placed Prussia at the mercy of France, she made a personal appeal to Napoleon at his headquarters in Tilsit, but without success. Early in 1808 she accompanied the king from Memel to Königsberg, whence, towards the end of the year, she visited St. Petersburg (Leningrad), returning to Berlin on Dec. 23, 1809. During the war Napoleon attempted to destroy the queen's reputation, but the only effect of his charges in Prussia was to make her more deeply beloved. She died on July 19, 1810, at Strelitz, and was buried in the garden of the palace at Charlottenburg. The Louise Foundation (Luisenstift) for the education of girls was established in her honour, and in 1814 Frederick William III. instituted the Order of Louise (Luisenorden). In 1880 a statue of Queen Louise was erected in the Thiergarten at Berlin.

See Mommsen and Treitschke, *Königin Luise* (1876); Hudson, *Life and Times of Louisa, Queen of Prussia* (1874); A. Lonke, *Königin Luise von Preussen* (Leipzig, 1903); H. von Petersdorff, "Königin Luise," *Frauenleben*, Bd. i. (Bielefeld, 1903, 2nd ed., 1904); F. M. Kircheisen, *Die Königin Luise in der Geschichte und Literatur* (1906); P. Bailleu, *Königin Luise* (1908); and Th. Rehtwisch, *Die Königin, ein Buch aus Preussens schwere Zeit.*

LOUISE OF SAVOY (1476–1531), duchess of Angoulême, mother of Francis I. of France, was daughter of a cadet of the house of Savoy, Philip, count of Bresse, afterwards duke of Savoy, and of Marguerite de Bourbon. At the age of 12 she was married to Charles of Valois, count of Angoulême, great-grandson of King Charles V. The count died in 1496, leaving her the mother of two children, Marguerite (b. 1492) and Francis (b. 1494). The accession of Louis XII., who was childless, made Francis of Angoulême the heir-presumptive to the throne of France. Louise brought her children to the court, and received Amboise as her residence. Finally, her son became king on Jan. 1, 1515, by the death of Louis XII. From 1515 to her death, she took the chief share in the Government. The part she played has been variously judged, and is not yet completely elucidated. It is certain that Louise had a clear head, practical good sense and tenacity. In the critical situation after the battle of Pavia (1525) she maintained order in the kingdom, and manoeuvred very skilfully to detach Henry VIII. of England from the imperial alliance. She died in 1531, and Francis reunited to the crown her domains, which comprised the Bourbonnais, Beaujolais, Auvergne, la Marche, Angoumois, Maine and Anjou.

There is extant a *Journal* of Louise of Savoy, edited by Guichenon in his *Histoire généalogique de la maison de Savoie* (1778–80, vol. iv.).
See *Poésies de François Ier et de Louise de Savoie . . .* , ed. by Champollion-Figeac (1847); De Maulde, *Louise de Savoie et François Ier* (1895); G. Jacqueton, *La Politique extérieure de Louise de Savoie . . .* (1892); H. Hauser, "Étude critique sur le Journal de Louise de Savoie," in the *Revue historique*, vol. 86 (1904).

LOUISIADE ARCHIPELAGO, a chain of islands in the Pacific Ocean, extending south-eastward from the easternmost promontory of New Guinea, and included in the Australian territory of Papua (British New Guinea). The islands number over eighty, and are interspersed with reefs. They are rich in tropical forest products, while gold is also obtained. The islands were probably observed by Torres in 1606, but were named by L. A. de Bougainville in 1768 after Louis XV.

LOUISIANA, popularly known as the "Pelican State," is one of the west South Central States of the United States of America, lying on the north coast of the Gulf of Mexico. It is bounded north by Arkansas along the parallel of 33° N.; east by the Mississippi river to 31°, which separates it in part from the State of Mississippi, eastward on the parallel of 31° to the Pearl river and thence to the Gulf, still with the state of Mississippi on the east; south by the Gulf of Mexico; west by the Sabine river, from the Gulf to 32° N. and thence to the parallel of 33° by a line a little west of (and parallel to) the meridian of 94° W., which separates Louisiana from Texas. The state has an area of 48,523 sq.m., of which 3,346 are water surface (including 1,060 sq.m. of landlocked bays called "lakes"). The length of the coast of the mainland and islands is about 1,700 miles.

Physical Features.—Geologically Louisiana is a very recent creation, and belongs to the "coastal plain province." Most of

MAP OF THE MAIN ROADS IN LOUISIANA

the rocks or soils composing its surface were formed as submarine deposits; the easternmost and southernmost parts are true river deposits. These facts are the key to the State's chorography. The average elevation of the State above the sea is only about 100 ft., and the only parts reaching 400 ft. high are hills in Claiborne parish. The physiographic features are few and very simple. The essential elements are five: "pine-hills," "bluffs," prairies, coastal marshes and alluvial plains. These were successive stages in the geologic process which has created and is still actively modifying the State. They are all seen, spread from north to south, west of the Mississippi, and also, save only the prairies, in the so-called "Florida parishes" east of the Mississippi.

These different elements in the region west of the Mississippi are arranged from north to south in the order of decreasing geologic age and maturity. Beginning with elevations of about 400 ft. near the Arkansas line, there is a gentle slope toward the south-east. The northern part can best be regarded as a low plateau (once marine sediments) sloping southward, traversed by the large diluvial valleys of the Mississippi, Red and Ouachita rivers, and recut by smaller tributaries into smaller plateaus and rather uniform flat-topped hills. The "bluffs" (remnants of an eroded plain formed of alluvion deposits over an old, mature and drowned topography) run through the second tier of parishes west of the Mississippi above the Red river. Below this river prairie areas become increasingly common, constituting the entire southwest corner of the State. They are usually only 20 to 30 ft. above the sea in this district, never above 70, and are generally treeless except for marginal timber along the sluggish, meandering streams. The prairies shade off into the coast marshes. This fringe of wooded swamp and sea marsh is generally 20 to 30 m., but in places even 50 to 60 m. wide. Where the marsh is open and grassy, flooded only at high tide or in rainy seasons, and the ground firm enough to bear cattle, it is used as range. Considerable tracts have also been diked and reclaimed for cotton, sugar and especially for rice culture. The tidal action of the gulf is so slight and the marshes are so low that perfect drainage cannot be obtained through tide gates, which must therefore be supplemented by pumping machinery when rains are heavy or landward winds long prevail. "Trembling prairies"—land that trembles under the tread of man or beast—are common near the coast. The marshes encroach most upon the parishes of St. Charles, Orleans and Plaquemines. In Orleans the city of New Orleans occupies nearly all the high ground and encroaches on the reclaimed swamps. The alluvial lands include the river flood plains.

Each of the larger streams, as well as a large proportion of the smaller ones, is accompanied by a belt of bottom land, of greater or less width, lying low as regards the stream, and liable to overflow at times of high water. These flood plains form collectively what is known as the alluvial region, which extends in a broad belt down the Mississippi, and up the Ouachita and its branches and the Red river to and beyond the limits of the state. Its breadth along the Mississippi within Louisiana ranges from 10 to 50 or 60 mi., and that along the Red river and the Ouachita has an average breadth of 10 miles. Through its great flood plain the Mississippi river winds upon the summit of a ridge formed by its own deposits. In each direction the country falls away in a succession of minor undulations, the summits of the ridges being occupied by the streams and bayous. Nearly all of this vast flood plain lies below the level of high water in the Mississippi, and, but for the protection afforded by the levees, every considerable rise of its waters would inundate vast areas of fertile and cultivated land. The low regions of Louisiana, including the alluvial lands and the coast swamps, comprise about 20,000 sq.mi., or nearly one-half the area of the state. The swamp fringe and much of the swampland proper are reclaimable.

The principal rivers are the Mississippi, which flows nearly 600 mi. through and along the border of the state, the Red river, the Ouachita, Sabine and Pearl; all except the last are navigable at all stages of the water. There are many bayous, several of which are of great importance for navigation, for drainage and for scenic beauty. They may be characterized as secondary outlets of the rivers or flood distributaries. Among them are Bayou Teche, Bayou Plaquemines, Atchafalaya bayou, Bayou Lafourche and Bayou Boeuf. Almost all secondary watercourses, particularly if they have sluggish currents, are known as bayous. The alluvial portion of the state, especially below the mouth of the Red river, is an intricate network of these bayous, which, before their closure by a levee system, served partially, in time of flood, to carry off the escaping surplus of river waters.

The alluvial region of the state is mainly protected against overflow from the Mississippi river by 706 mi. of levee on that river within the state, and by levees on the Mississippi river, Cypress and Amos bayous in Arkansas, forming part of the general system which extends up the Mississippi to the highlands above the junction of the Ohio river. The state and federal government co-operated in the construction and maintenance of this system, but the latter did not give national aid (except the grant of swamplands in 1850) until 1879, when it began acting through a board of engineers, known as the Mississippi River commission. For about a century and a half before that time, levee building had been undertaken in a more or less spasmodic and tentative way, first by riparian interests, and finally by the state, acting through levee districts, advised by a board of engineers. The system of Mississippi river levees, within the state, was built almost entirely after 1866 and represents an expenditure of over $60,000,000 for primary construction alone. Some of the levees, especially those in swampy regions where outlet bayous were closed, are of extraordinary solidity and dimensions, being 30 to 50 ft. high, or even more, across former streams or bayous, with bases of 10 ft. or more to one of height. Levee systems on the interior rivers and bayous, aggregating hundreds of miles, are built and maintained exclusively by the state.

The unprecedented heights of the flood in 1922 led the Mississippi River commission to recommend the raising of the levees along that stream an additional three feet. To carry out this policy congress authorized the expenditure of $60,000,000 on the entire Mississippi system. More than half of this sum had been expended when the deluge of April and May 1927 demonstrated that even the three-ft. margin contemplated would not be sufficient. In 1928 President Coolidge approved the Mississippi Valley Flood Control act, appropriating $325,000,000. Spillways, sluices to relieve the pressure of high water, were built. The Bonnet Carré spillway, in St. Charles parish about 20 mi. above New Orleans, built with federal flood control appropriations, connects the Mississippi river and Lake Pontchartrain. At high stages a vast volume of the waters of the Mississippi is diverted to Lake Pontchartrain through this spillway, thus substantially reducing the river level at New Orleans and its environs, and, in the opinion of engineering experts, making the city practically floodproof under extreme conditions of high water.

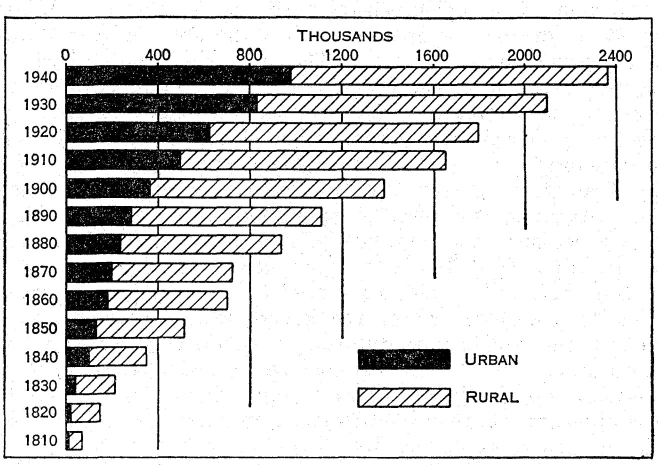
The lakes are mainly in three classes. First come the coast lagoons, many of which are merely landlocked salt-water bays, the waters of which rise and fall with the tides. Of this class are Pontchartrain, Borgne, Maurepas and Sabine. These are simply parts of the sea which have escaped the filling-in process carried on by the great river and the lesser streams. A second class, called "oxbow" lakes, large in number but small in area, includes ordinary cutoff meanders along the Mississippi and Red rivers. A third class, those upon the Red river and its branches, are caused mainly by the partial stoppage of the water above Shreveport by the "raft," a mass of drift such as frequently gathers in western rivers, which for a distance of 45 mi. almost completely closed the channel until it was broken up by government engineers. These lakes are much larger at flood season than at other times and have been much reduced in size by the cutting of a channel through the raft.

Climate.—The climate is semitropical and exceptionally equable over large areas. In the south and southeast the equable temperature is largely the effect of the network of bays, bayous and lakes, and throughout the state the climate is materially influenced by the prevailing southerly winds from the Gulf of Mexico. Some daily variation in the temperature of adjoining localities is caused by a dark soil in the one and a light soil in the other, but the differences of mean annual temperature are almost wholly due to differences of latitude and elevation. The mean annual temperature ranges from 70° F. at Port Eads, in the extreme southeast, to 65° F. at Lake Providence, in the northeast. The mean temperature of July, the hottest month, is comparatively uniform over the state, varying only from 81° to 83°; the mean for January, the coldest month, varies from 46° in the extreme north to 56° in the extreme south. Even in the coldest localities eight or nine months are wholly free from frost, and in the coast parishes frost occurs only a few days in each year. Rainfall is usually heavy in the southeast, but it decreases toward the northwest. As much as 85·6 in. have fallen within a year at New Orleans, but in this locality the average for a year is about 57·4 in.; at Shreveport the average is 46 in., and for the entire state it is 55 inches. Summer is usually the season of heaviest rainfall.

Population.—The population of Louisiana in 1810 was 76,556; in 1830 it was 215,739; in 1850, 517,762; in 1880, 939,946; in 1910, 1,656,388; and in 1940, 2,363,880. This last figure represents an increase of 12·5% over the population in 1930. The population per square mile was 52·3, as compared with 44·2 for the United States as a whole. Of the 1940 population, 980,439, or 41·5%, lived in urban places, that is, in cities and villages of 2,500 or more. The rural population, occupying the remainder of the state, thus constituted 58·5% of the total. The population of the state and of its principal cities is summarized below:

Area	Population			Percent of increase	
	1940	1930	1920	1930–40	1920–30
The State	2,363,880	2,101,593	1,798,509	12·5	16·9
Urban	980,439	833,532	628,163	17·6	32·7
Rural	1,383,441	1,268,061	1,170,346	9·1	8·3
Percent urban	41·5	39·7	34·9	..	..
Principal cities:					
New Orleans	494,537	458,762	387,219	7·8	18·5
Shreveport	98,167	76,655	43,874	28·1	74·7
Baton Rouge	34,719	30,729	21,782	13·0	41·1
Monroe	28,309	26,028	12,675	8·8	105·3
Alexandria	27,066	23,025	17,510	17·6	31·5

The number of occupied dwelling units returned in the housing census of 1940 was 592,595, which is approximately the same as the number of families. The average population per family (occupied dwelling unit) declined from 4·3 in 1930 to 4·0 in 1940. The white population of Louisiana formed 64·0% of the total in 1940, as compared with 62·9% in 1930, practically all the non-white population being Negro. The number of males per 100 females in the entire population of the state was only 98·4, though there was a slight excess of males in the white population, the sex ratio being 100·8 for the white and only 94·3 for the non-white population.



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URBAN AND RURAL POPULATION OF LOUISIANA, 1810–1940

HISTORY

Exploration and Settlement.—The early history of Louisiana belongs to the romance of American history. It is possible that the mouth of the Mississippi was discovered in 1519 by Alonso Alvarez de Piñeda, but this interpretation of his vague manuscript remains conjectural; and that it was discovered by the expedition of Panfilo de Narvaez cannot be established. That Hernando de Soto entered the borders of the present state of Louisiana and that his burial place in the Mississippi was where that river takes the waters of the Red, are probable enough, but incapable of conclusive proof. Survivors of de Soto's expedition, however, descended the Mississippi to its mouth in 1542. Spain set up no claim to the region, and when Robert Cavelier, Sieur de la Salle, came down the river in 1682 from the French possessions to the north, he took possession in the name of France, which thereby gained her first title to the vast drainage basin of the Mississippi. In honour of Louis XIV, the new possession was named "Louisiana"—a name then and until 1812 applied to a much larger area than that of the present state. La Salle attempted to settle a colony in 1684, but missed the Mississippi's mouth and landed in Texas, where he was murdered in 1687 by some of his followers. In 1697, after Ryswick, Pierre Le Moyne d'Iberville (1661–1706) was chosen to lead another colony, which reached the Gulf coast early in 1699. Soon after d'Iberville had built Fort Maurepas (near the present city of Biloxi, Mississippi) in 1699, a fort was erected on the Mississippi river about 40 mi. above the mouth. This was the earliest settlement in what is now the state of Louisiana. It was unhealthy and unprosperous. From 1712 to 1717 "Louisiana," or the French possessions of the Mississippi valley, was held by Antoine Crozat (1655–1738) as a private grant from the king. It proved as great a drain upon his purse as it had proved to the crown, and he willingly parted with it to the so-called "Western Company," afterward incorporated with the great Company of the Indies (*see* LAW, JOHN). The company accomplished much for the colony of Louisiana. Jean Baptiste Le Moyne, Sieur de Bienville (1680–1768), a brother of d'Iberville, was sent out as governor. For 40 years he was the life of the colony. New Orleans was founded in 1717. De Bienville was the founder of the city. In 1718 seven vessels were sent from France with stores and immigrants; eleven followed during the next year. Five hundred Negroes from the Guinea coast were imported in 1719, and many hundreds more soon followed. The Law company eventually came to an end fatal to its creditors in France, but its misfortunes did not check the prosperity of "Louisiana." The company retained its grant of the colony until 1731, when it reverted to the crown. Cotton culture began in 1740, and sugar cane was successfully introduced from Santo Domingo by the Jesuits in 1751. Tafia rum and a waxy, sticky sugar syrup subsequently became important products; but not until the end of the century were the means found to crystallize sugar and so give real prosperity to the industry. Under the French regime 11 governors ruled the province of Louisiana during 14 administrations.

The Spanish Period.—By a secret treaty of Nov. 3, 1762, "Louisiana" was transferred from France to Spain. This treaty was not made known to the people of Louisiana until d'Abbadie, director of Louisiana, issued his proclamation (1764), which was the first example of printing in the province of Louisiana. Spain did not take full possession of the colony until 1769. By a treaty between Spain and France on the one hand and Great Britain and Portugal on the other, signed at Paris in Feb. 1763, all that portion lying east of the Mississippi river, the Iberville river, and lakes Maurepas and Pontchartrain was ceded to Great Britain. The international interests thus created, and others that sprang from them, heavily burdened the diplomacy, and even threatened the safety of the United States after they were placed in possession of the eastern bank of the Mississippi down to 31° in 1783.

The news of the cession of the colony to Spain roused strong discontent among the colonists. Antonio de Ulloa (1716–95), a distinguished Spanish naval officer and scholar, came to New Orleans in 1766 to take possession for his king. An official census taken the same year showed a total population of 5,552. The merchants and civil and military officers refused to support Ulloa who was compelled to continue in an ambiguous and anomalous position—which his lack of military force probably first compelled him to assume—ruling the colony through the French governor, Philippe Aubry, without publicly exhibiting his powers. When the colonists found protests at Paris unavailing, they turned to the idea of independence, but sought in vain the armed support of the British at Pensacola. Nevertheless they compelled Ulloa to leave the colony in Nov. 1768. There is no doubt that the men who led the Creole opposition contemplated independence, and this gives the incident peculiar interest. In the summer of 1769 Alexandro O'Reilly went to New Orleans with a strong military force (3,600 troops). Beginning his rule with an affability that allayed suspicions and securing from Aubry proofs against the popular leaders, he invited them to a reception and arrested them while they were his guests. Five were put to death, one having been previously murdered, and others were imprisoned at Havana. Thus O'Reilly put down the revolution of 1768 with determination and in accord with the instructions of his king. He was, however, liberal and enlightened in his general rule. Among the incidents of these troubled years was the arrival in Louisiana (after 1765) of some hundreds of French exiles from Acadia, who made their homes in the Attakapas country. There their descendants live today, still speaking their soft patois, with somewhat of the glamour thrown over land and people by the "Evangeline" of Longfellow.

On Aug. 18, 1769, Louisiana was formally transferred to Spain. Spanish law and language replaced the French officially, but the colony remained essentially French. Many French Creoles were appointed to office, intermarriages of French and Spanish and even English were encouraged by the highest officials, and in general a liberal and conciliatory policy was followed, which made Louisiana under Spanish rule quiet and prosperous. Bernardo de Galvez (1746–86), a brilliant young officer of twenty-one, when he became the governor of the colony, was one of the most liberal of the Spanish rulers and of all the most popular. During the American Revolution he gave valuable aid to the United States; and when Spain finally joined in the war against Great Britain, Galvez, in a series of energetic and brilliant campaigns (1779–81), captured all the important posts in the British colony of West Florida. The chief interest of the Spanish period lies in the advance of settlement in the western territories of the United States, the international intrigues—British, French and Spanish—involving the future of the valley, the demand of the United States for free navigation on the Mississippi and the growing consciousness of the supreme importance of the river and New Orleans to the union.

In 1794 Spain, hard pressed by Great Britain and France, turned to the United States, and by the treaty of 1794 the Mississippi river was recognized by Spain as the western boundary of the United States, separating it from Louisiana, and free navigation of the Mississippi was granted to citizens of the United States, to whom was granted for three years the right "to deposit their merchandise and effects in the port of New Orleans, and to export them from thence without paying any other duty than a fair price for the hire of the stores." At the expiration of the three years the Spanish governor refused the use of New Orleans as a place of deposit, and contrary to the treaty named no other port in its place. Spanish rule, however, came unexpectedly to an end by the retrocession of Louisiana to France in 1800. Under the Spanish regime 11 governors ruled the province of Louisiana during 10 administrations. French dominion gave way in turn in 1803—as the result of a chain of events even more unexpected, and for the United States fortunate—to the rule of the last-named country. On Nov. 30, 1803, the representatives of the French republic received formal possession from the Spanish governor, and on Dec. 20, lower Louisiana was transferred to the U.S. (*See* LOUISIANA PURCHASE.)

American Control and Statehood.—By an act of Congress, of March 25, 1804, that portion of the Louisiana purchase south of 33° was organized as the territory of Orleans, and was given a government less democratic than might otherwise have been the case, because it was intended to prepare gradually for self-government the French and Spanish inhabitants of the territory, who desired immediate statehood. The foreign slave trade was forbidden by this organic act. English was made the official language. In Nov. 1811 a convention met at New Orleans and framed a constitution under which, on April 30, 1812, the territory of Orleans became the state of Louisiana. A few days later the portion of West Florida between the Mississippi and Pearl rivers (the present "Florida Parishes") was included in its boundaries, making them as they are today. In this same year the first steamboat reached New Orleans. It descended the Ohio and Mississippi from Pittsburgh, whence there had already been a thriving river trade to New Orleans for about 30 years. During the War of 1812 a decisive victory was won by the American forces at Chalmette, near New Orleans, on Jan. 8, 1815. (*See* NEW ORLEANS: *Battle of New Orleans.*) Up to 1860 the development of the state in population, agriculture and commerce was very rapid. Donaldsonville was the (nominal) capital in 1825–31, Baton Rouge in 1849–64 and again after 1882. At other times New Orleans has been the capital, and there too have always been various state offices which, in other states, ordinarily are in the capital.

The Civil War Period.—By an ordinance of secession passed Jan. 26, 1861, Louisiana joined the Confederate states. In the first year there was very little military activity in the state, but in April 1862 Admiral D. G. Farragut, with a powerful fleet, ascended the Mississippi past forts Jackson and St. Philip, which defended the approach to New Orleans, and a military force under Gen. B. F. Butler occupied that city. His administration became a byword for infamy in Louisiana. He was replaced by Gen. N. P. Banks in Dec. 1862. The navigation of the river being secured by this success and by later operations in the north ending in July 1863 with the capture of Vicksburg and Port Hudson, the state was wholly at the mercy of the union armies. Later, in April 1864, the Confederates under Gen. Richard Taylor won a success against the Unionists under Gen. N. P. Banks at Sabine Cross Roads near Mansfield and were themselves repulsed at Pleasant Hill, these battles being incidental to a campaign undertaken by the union forces to crush opposition in western Louisiana.

Reconstruction.—As early as Dec. 1862 the union military government, at President Lincoln's direction, had ordered elections for congress, and the men chosen were admitted in Feb. 1863. In March 1864 also a state government to supersede the military rule was established under the president's auspices. The radicals among the loyal element demanded the calling of a constitutional convention and the abolition of slavery. By a convention that assembled in April 1864 a constitution was framed closely following that of 1852 but repudiating the debt incurred by Louisiana as one of the Confederate states and abolishing slavery. The legislature was ordered to establish free schools for the Negroes and was empowered to give them the suffrage: neither of these provisions, however, was carried out. The extent of the union control is shown by the fact that the legislature of 1864 represented half of the area and two-thirds of the population of the state. The army stood at the back of the new government, and by the end of 1864 Louisiana was apparently "reconstructed." But in 1864 the opposition of congress to presidential reconstruction had clearly developed, so that the electoral votes of Louisiana (like those of Tennessee) for president were not counted. By the spring of 1866 the ex-Confederates had succeeded in gaining possession of most of the local government and most of the state offices, although not of the governorship. The Republican party naturally became extremely radical. The radicals wished to have Negro suffrage in order to get possession of the government. They, therefore, wanted still another constitutional convention. A clause in the constitution of 1864 provided for the reconvening of the convention in certain circumstances, but this clause referred only to necessities prior to the establishment of a government. The radicals, because it was impossible to call a convention through the medium of the state government, took advantage of this clause to reconvoke the old convention at New Orleans. The ex-Confederate party determined to prevent the gathering, but the idea of interference by force seems to have been abandoned. A street riot was precipitated, however, incidental to a procession of armed Negroes; the metropolitan police fired upon the assembled convention; and altogether some 200 persons, mostly Negroes, were killed. This incident raised the crucial question of national politics in 1866: namely, whether the states reconstructed by the president should not again be reconstructed.

This being settled affirmatively, Louisiana was reconstructed with vigour. A constitution of 1868 gave suffrage to the Negroes and disfranchised all whites made ineligible to office under the proposed 14th amendment to the national constitution, and also (practically) those who had by word, pen or vote defended secession. Then the state ratified the 14th amendment and was declared readmitted to the union in July 1868. Probably no other southern state suffered equally with Louisiana from the corruption of "carpetbag," "scalawag," Negro legislatures. For four years (1868–72) the government expenses increased to ten times their normal volume, taxation was enormously increased, and about $57,000,000 of debt was created. But a quarrel broke out among the Republicans (1872), the result of which was the installation of two governors and legislatures, one supported by the Democrats and Liberal Republicans and the other by the radical Republicans, the former being certainly elected by the people. The rivalry of these two state governments, clashes of arms, the recognition by the federal authorities of the radical Republican government (Pinchback and Kellogg, successively governors) followed. One historic clash in New Orleans (Sept. 14, 1874) between the "White League" and the Republican police is commemorated by a monument, and the day is regarded by Louisianans as a sort of state independence day. Finally, in the year 1876, Francis T. Nicholls, a Democrat, was chosen governor, but the Republican candidate, S. B. Packard, claimed the election and with a Republican legislature for a time occupied the state house. In the national election of 1876 there were double returns (Republican: 75,315 for Hayes and 70,508 for Tilden; and Democratic: 83,723 for Tilden and 77,174 for Hayes) from Louisiana, which, as was the case with the double electoral returns from Florida, Oregon and South Carolina, were adjudicated by the electoral commission in favour of the Republican electors voting for Hayes. Civil war being threatened within the state President Hayes sent to Louisiana a commission, composed of Wayne McVeagh, Gen. J. R. Hawley, Charles B. Lawrence, J. M. Harlan and John C. Brown, ex-governor of Tennessee, which was instructed to promote "an acknowledgment of one government within the state." The rival legislatures united, organizing under the Nicholls government, which the commission found was upheld by public opinion. The president ordered the withdrawal of federal troops from the capital on April 20, 1877, and the white party was thus left in control.

Politics and Events.—After 1877 the state prospered in material respects except when floods or the boll weevil destroyed the crops, or some distant factor brought prices down; the fortunate presence of two major crops—cotton and cane sugar—moderated many catastrophes. The most devastating flood of the period occurred in the spring of 1927, inundating 1,300,000 ac., driving 300,000 people from their homes and destroying millions of dollars worth of property. The catastrophe prompted congress to pass its $325,000,000 Mississippi Valley Flood Control act in 1928.

Among early political developments the progressive disfranchisement of the Negro was most significant, but the fight against the Louisiana State Lottery company (1868–93) attracted more attention. Louisiana has been overwhelmingly Democratic since 1877. One section or another has shown a readiness to revolt against specific grievances, as when the sugar-cane area turned against the Democratic low tariff in 1913.

Local politics entered upon a tumultuous era in 1928 with the election of Huey Pierce Long as governor. Leader of the back country, Long soon came into violent conflict with the older party leaders centred in the city. His determination to increase the state expenditures for education under the compulsory education law of 1914 and to build roads and bridges throughout the state frustrated the hopes of many for government economy. The attempts of the opposition to secure Long's impeachment failed in 1929 and his grip on the state became more secure. After his election to the U.S. senate Long refused to vacate the governor's office until the senate convened a year later. In the succeeding election Long's candidate, O. K. Allen, was chosen governor. The Roosevelt campaign of late 1932 and the rigours of the bank crisis of the following year brought a brief lull to the political struggle, but Gov. Allen was soon invoking martial law against the opposition dominant in New Orleans. Four legislative sessions were convened in 1934 and an unprecedented quantity of legislation was rubber-stamped, concentrating in the hands of the governor control over state and local functions.

Continued activity of special sessions during the following year roused local and national concern over the future course of the dictatorship, but in 1935 Long was assassinated by Dr. Carl A. Weiss, Jr., ending a serious third party threat. The political machine abandoned the "Share the Wealth" campaign, returned to the Democratic fold, and carried the state for Roosevelt in 1936. At the death of Gov. O. K. Allen, James A. Noe became governor for 3½ months. Richard Webster Leche was elected to the governorship in 1936 and under him and the "successors" of the Long dynasty serious political and financial scandals resulted in the resignation and trial and conviction in the federal courts of Governor Leche and some of his intimates. Lt. Gov. Earl K. Long became governor on the resignation of Leche. In the gubernatorial contest of 1940 between Earl K. Long and Sam Houston Jones, Jones was elected on a reform ticket. In the 1940 national election Louisiana gave Roosevelt 319,751 votes and Willkie 52,446.

Government.—The "parishes" date from 1807; they were based on an earlier Spanish division for religious purposes—whence the names of saints in parish nomenclature. Since the admission of the state to the union in 1812 there have been 10 state constitutions; the present constitution was adopted June 18, 1921. Under this organic act, sessions of the legislature are biennial (meeting on the second Monday in May in even-numbered years) and are limited to 60 days. The number of senators is fixed by the constitution at 39; the number of representatives is 100. Members of the legislature are elected for four years. Contingent appropriations are forbidden, and the constitution contains a long list of subjects on which special laws may not be passed.

The executive department consists of a governor, lieutenant governor, auditor, treasurer, secretary of state, register of land office, commissioner of agriculture and immigration and commissioner of conservation. The chief executive officers have four-year terms, neither the governor nor the treasurer being eligible for immediate re-election. The attorney general is elected by the voters of the state for a four-year term. The superintendent of public education is similarly elected by the voters of the state and, also, has a four-year term. The governor's power of veto extends to all measures and to individual items in appropriation bills, and any measure so vetoed becomes a law only if passed by a two-thirds vote in each house of the general assembly. In 1940 a reorganization bill was passed co-ordinating all governmental agencies and bureaus under 20 departments.

The judicial powers of the state are vested in a supreme court, courts of appeal, district courts, juvenile courts, justice of the peace court and certain special courts. The supreme court is composed of a chief justice and six associate justices, four of whom shall concur to render a judgment when the court is sitting *en banc.* They are elected for a term of 14 years and receive an annual salary of $12,000. There are three courts of appeal each composed of three judges elected for a term of 12 years. These courts hold terms in Baton Rouge, Shreveport, Alexandria, Monroe, New Iberia, Opelousas and New Orleans, respectively.

Louisiana, outside the parish of Orleans, is divided into 28 judicial districts, each having one or more judges elected for a term of six years. The district courts of the parish of Orleans have both civil and criminal divisions presided over by five judges each; their term of office is 12 years. The New Orleans city court has three judges elected for terms of eight years. The constitution provides that each parish, the parish of Orleans excepted, shall be divided into not less than three nor more than six justice of the peace wards.

Suffrage is granted to every citizen of the state and of the United States not less than 21 years of age, who possesses the following qualifications: (1) Residence in the state two years, in the parish one year and in the precinct three months next preceding the election at which he (or she) offers to vote; (2) legally enrolled as a registered voter on his own personal application; (3) should be of good character, able to understand the duties of citizenship and able to read and write; or if illiterate, of good character and able to interpret the constitution of the state or nation. A general primary election law for the selection by the voters of candidates for state office was in effect after 1906 and was re-enacted in 1940.

Law.—Louisiana has been peculiar among the states of the union in the history of the development of its legal system. In Louisiana alone (as the state is known today), out of all the territory acquired from France as the Louisiana purchase in 1803, was the civil law so established under French and Spanish rule that it persisted under American dominion. In all the other states formed from the purchase, the civil law, never existent practically, was early expressly abrogated, and the common law of England established in its place. After O'Reilly established his power in 1769 (see *History,* above), the Spanish law was supreme. All the old codes of the peninsula, as well as the law of the Indies and special royal decrees and schedules, were in force in the colony. The United States left the task of altering the laws to the people, as far as there was no conflict between them and the constitution of the United States and fundamental American legal customs. In its present form the law shows plainly the Latin and English elements. English law has largely moulded, for example, criminal, commercial law and the law of evidence; the development of the law of corporations, damages, prohibitions and such extraordinary remedies as the mandamus has been very similar to that in other states; while in the fusion of law and equity, and the law of successions, family relations and in the domain of private law generally, the civil law sources of France and Spain, especially much of the text and principles of the Code Napoleon, still prevail.

Finances.—The total assessed valuation of all taxable property in Louisiana for 1940 was $1,370,060,292. The state shared in the Agricultural Adjustment administration crop benefits. The state's chief source of revenue in 1940 was the gasoline taxes, which amounted to $18,151,102. Other important sources of revenue were property taxes, district levee taxes, motor vehicle and business licences, revenue from the port of New Orleans dock board, an inheritance tax, an income tax and a severance tax on natural resources. The total receipts of and disbursements by the state treasury for the year ending Dec. 31, 1940, were $107,-930,488 and $109,495,452, respectively. The chief expenditures were from the following funds: general highway bonds, $10,696,-090; operating, $5,212,069; public schools, $9,152,528; general, $11,879,504. The state debt on Dec. 31, 1940, was $187,970,416, consisting of bonded debt, $183,915,020; notes payable, $3,977,-467; interest accrued, $77,928. The state also acted as guarantor for port improvement, highway and penitentiary bonds.

Education.—Schooling was very scant before the creation of the public schools in 1845. Very little was done for education in the French and Spanish period, although the Spanish governors made commendable efforts in this regard; the first American territorial legislature began the incorporation of feeble "colleges" and "academies." To some of these the state gave financial aid ($1,613,898) before 1845. The public schools were flourishing at the outbreak of the Civil War. War and reconstruction threw upon them the new burden of the Negro children. The constitution of 1879 was illiberal in this respect, but a healthier public opinion soon prevailed. The money given by the state to the public schools is distributed among the parishes according to their school population. The state's part of the public-school fund comes chiefly from a tax of 2½ mills on all properties assessed; sale of public lands granted by the United States; the residue of the severance tax fund; net avails of a ½ cent tax per gallon on motor fuel and appropriations of the legislature. The public-school receipts from all sources, both state and local, for the session 1939–40 were $29,545,533. The public-school expenditures for the same period amounted to $38,042,887. The per caput cost of the public elementary and high schools in 1939–40, based on registration, was white, $61.21; Negro, $14.21. The per caput cost for the total population was $16.10. The total number of pupils enrolled in the public and elementary schools of Louisiana in 1938 was 460,946; there were 60,866 pupils in private and parochial schools, excluding kindergartens. The number of teachers in public schools in 1938 was 14,001; their average annual salary was $982. The total pupil enrolment was divided as follows: white, 294,192; Negro, 166,754. The average attendance per pupil enrolled was 152 days for the white pupils and 124 days for the Negro pupils. According to federal census of 1930, 7·3% of the native white population over ten years of age was illiterate, and 23·3% of the Negro population was illiterate.

State institutions of higher education include: (public) Louisiana state university, Baton Rouge; Louisiana State Normal college, Natchitoches; Southwestern Louisiana institute, Lafayette; Louisiana Polytechnic institute, Ruston; Southeastern Louisiana college, Hammond; Southern university (Negro) Scotlandville. Private institutions are: Tulane university, New Orleans; Loyola university of the South, New Orleans; Centenary college, Shreveport; Louisiana college, Pineville; Mount Carmel college, New Orleans; Normal College of Sacred Heart, Grand Coteau; St. Vincent's academy, Shreveport; Dodd college, Shreveport; De La Salle Normal college, New Orleans; Holy Cross Normal college, New Orleans; Dillard university (Negro), New Orleans; Xavier university (Negro), New Orleans; Leland college (Negro), Baker. The state-approved institutions of higher education with a registration exceeding 500 in 1940–41 were 10 in number.

Agriculture.—Agriculture has always been one of the chief industries of Louisiana. The year 1940 was one of the poorest crop years. Cotton, which is the chief field crop in Louisiana, in 1940 produced 455,000 bales, whereas the output of 1939 was 745,000 bales and in 1937 more than 1,000,000 bales. Indian corn, rice and sugar were similarly affected. In 1940, 9,996,108 ac. were in farms. Of this amount, 4,051,670 ac. of the farm area were classified as cropland. The farm population in 1940 was 857,475 or 36·3% of the total population, as compared with 830,606 or 39·5% of the total population in 1930. In 1940 there were 150,007 farm operators in the state, the farm population being indeterminate. During the years 1935–40 the number of farms decreased from 170,216 to 150,007, and the size of the average farm increased from 61·4 ac. to 66·6. The value of land and buildings increased during the period 1935–40 from $295,-515,197 to $353,873,506. Tenantry decreased during the same period from 63·7% to 59·4%. Of the total number of farmers, 90,423 were white and 59,584 nonwhite. The value of all livestock on farms Jan. 1, 1941, was $61,622,000. The value of farm products in 1940, a poor crop year, was estimated to be $86,227,-000, a figure below the previous five years' average.

Cotton, Indian corn, rice, sugar cane and sweet potatoes, in the order named, constituted the most important field crops. From the 1,126,000 ac. planted in cotton in 1940, 455,000 bales of lint cotton and 203,000 tons of cotton-seed were produced. The total farm value of the cotton crop, lint cotton and seed combined, was $25,733,000 for 1940, a value which gave Louisiana the rank of sixth among the states. The yield of Indian corn, which reached the maximum of 35,022,000 bu. in 1921, was 27,-676,000 bu. in 1935 and had a value of $19,373,000; in 1940 the yield was 24,128,000 bu. valued at $15,924,000. In the production of rice, Louisiana leads all other states, the yield over a period of years averaging nearly one-half the total raised in the United States. The crop in 1940 amounted to 18,040,000 bu., with a value of $12,989,000. Practically all the cane sugar produced in the United States, except for some tonnage from Florida, comes from Louisiana. In 1940, 259,000 ac. yielded 3,335,000 tons of cane for sugar and seed with a value of $9,171,000. From this were produced 242,000 tons of sugar and 21,999,000 gal. of molasses, including blackstrap. About 29,000 ac. were planted in sugar cane for syrup, producing 6,380,000 gal. valued at $2,-424,000. Louisiana ranked fourth among the states of the union in 1939 in the production of sweet potatoes, but first among states producing them as a money crop. The 86,000 ac. devoted to this crop in 1940 yielded 4,988,000 bu. valued at $3,741,000. Rice and sugar cane are the only field crops with restricted areas of production. The sugar-cane region is confined, almost exclusively, to the Mississippi delta and Bayou Teche regions, while the chief area of rice production is the prairie region of the southwest. Irrigation is almost entirely confined to rice farms. The principal sources of water supply are the streams flowing to the Gulf, and wells, from both of which water is pumped. The production of vegetables has not been developed to the extent that the state's climate would warrant; however, the industry has acquired considerable importance in the vicinity of New Orleans. Commercial truck farming, using 30,000 ac., produced crops valued at $2,196,000 in 1940. In addition, 40,000 ac. planted in Irish potatoes yielded 2,280,000 bu. valued at $1,824,000; 4,700 ac. in shallots yielded 596,000 bu. valued at $390,000; and 4,500 ac. in watermelons yielded 1,260,000 melons valued at $156,000. The raising of strawberries has proved profitable on the cutover pine lands of Livingston and Tangipahoa parishes. In 1941 Louisiana stood first among the states of the United States in the production of strawberries with a crop covering 23,000 ac., producing 1,934,000 pt. crates, valued at $3,500,-000. Citrus fruits are grown in considerable quantities along the Mississippi river below New Orleans. In 1940, 224,000 boxes of oranges, valued at $224,000 were produced. Among the nuts the native pecan is exceptionally abundant and is commercially important; the yield for 1940, both improved and wild pecans, was 4,514,000 lb. valued at $423,000. About 10,000,000 lb. of peanuts and 1,500,000 lb. of figs are average crops.

Minerals.—In the value of its mineral products ($168,900,-000) Louisiana, in 1939, ranked seventh among the states of the union. Petroleum, natural gas, natural gasoline, sulphur, sand and gravel and salt, in the order named were the principal products. At first, most of the petroleum produced came from the parishes of Caddo, Red River, De Soto and Claiborne. Now the fields extend throughout various parts of the state to the Gulf of Mexico. The state's output of petroleum in 1940 was 102,037,245 bbl., valued at approximately $100,000,000—a production which gave Louisiana the rank of fourth among the states. In the production of natural gas the state ranked second in 1940, with an output of 325,013,162,000 cu.ft. An important product of natural gas is natural gas gasoline extracted from it, which (1940) amounted to 2,701,858 bbl. Until 1924 Louisiana led all other states in the production of sulphur, but late in that year production in Calcasieu parish was suspended because of the exhaustion of the deposit, after 25 years of production with a total yield of about 10,000,000 tons of sulphur. It was this deposit which made the United States the chief sulphur-producing country in the world, and the product virtually displaced Sicilian sulphur, which at one time held first place in the world's market. The state's sulphur output in 1940 was 512,935 long tons, valued at about $5,500,000, and Louisiana was second only to Texas. In 1940 with 601,935 tons, valued at about $2,000,000, Louisiana ranked fourth among the states of the union as a producer of salt. Sand and gravel (1940) amounting to 4,666,703 tons were dug from the pits, valued at $2,500,000. Limestone, of less importance, is the principal stone product.

Manufactures.—The manufacturing industries of the state are for the most part closely related to the products of the soil, about two-thirds of the value of all manufactures in 1939 being represented by petroleum refining, sugar and molasses refining, food preparations, lumber and timber products, chemicals, paper and pulp mills and rice polishing. The value of all manufactured products in 1939 was $565,265,273, as compared with $674,259,000 in 1929. There were 71,218 wage earners employed in 1,861 establishments. In the production of lumber in 1937, Louisiana ranked fourth in quantity among the states of the union. Petroleum refining, which came first in 1939 in value among the state's products, gave Louisiana the rank of fifth among the states. New Orleans, with industries giving employment to 19,707 wage earners and having an output valued at $126,551,895, was the principal industrial centre in 1939. Second in importance was Shreveport with 2,304 wage earners and products valued at $26,552,090.

The table below shows the chief industries of Louisiana, ranked according to value of product in 1939, and the number of wage earners engaged in each industry.

Industry	Wage Earners	Value of Products
Petroleum refining	2,629	$109,627,341
Sugar refining, cane	3,247	66,673,546
Food and kindred products	4,627	51,985,065
Saw mills, veneer and cooperage mills	16,947	33,319,261
Chemicals	1,269	32,506,506
Paper and paperboard mills	2,536	25,650,456
Rice cleaning and polishing	1,158	17,296,826
Pulp mills	1,787	13,816,560
Bread and bakery products	2,537	12,170,338
Nonalcoholic beverages	614	11,013,503
Textile bags	928	10,741,090
Malt liquors	661	10,662,514
Cotton-seed oil, cake and meal	732	7,823,552
Total	39,672	$403,286,558

Forest Products.—The forests of Louisiana are among the finest in the United States. With a total land area of 28,913,280 ac., the forest area in 1934–35 was 16,211,200 ac. or 56%. In 1937 there were 645 establishments in primary forest industries (*i.e.*, saw mills, pulp mills, veneer and cooperage plants). These gave employment to 29,641 persons and had a product value of $116,472,338. The 1,361,637,000 bd.ft. cut in 1937 ranked Louisiana as fourth among the 48 states. Of this production there were, of softwoods: 738,148,000 bd.ft. of pine and 89,416,000 bd.ft. of cypress; of hardwoods, 534,073,000 bd.ft., making Louisiana the first state as producer of hardwood lumber. Oak, red gum and tupelo constituted 82% of the hardwoods. The state ranked first in the production of oak, red gum, tupelo, ash and magnolia, second in the production of cypress and hickory and third in the production of elm. The work of reforestation proceeded very rapidly during the decade 1931–41. Exclusive of the plantings by the forest service, approximately 10,000,000 trees are planted each year on private lands.

Fisheries and Wild Life.—The coastal fisheries of Louisiana in 1939, according to the U.S. bureau of fisheries, employed 5,362 persons and used vessels and other fishing boats totalling 1,404. The total production of the fisheries amounted to 127,725,200 lb. valued at $4,341,777. The more important species were shrimp, 100,612,500 lb., valued at $3,280,121; oysters, 13,586,400 lb., valued at $719,901; squeteagues or "sea trout," 716,000 lb., valued at $76,294; red drum or redfish, 694,100 lb., valued at $69,056; red snapper, 90,900 lb., valued at $7,863; and sheepshead, 80,400 lb., valued at $4,764. Fish canning and the manufacture of by-products were carried on by 31 establishments, employing 4,934 persons. The total output of these industries was valued at $3,198,560; of this amount canned shrimp represented $2,867,476. Production of dried shrimp was 2,592,997 lb. valued at $453,106. Louisiana ranks first in shrimp production.

Louisiana is a paradise for birds and fowl of infinite variety, with its Russell Sage and Rockefeller game refuge and other sanctuaries in Cameron and Iberia parishes.

The original French settler came to Louisiana for the fur trade. In 1940–41, Louisiana, with a fur crop of $6,084,510, was the greatest fur-producing state, producing more pelts than Canada and Alaska combined. Its yield was 6,235,097 pelts. The muskrat was by far the largest in yield and value, followed in value by mink, raccoons, mice (small muskrats), opossums, otters, foxes and skunks.

Transportation and Commerce.—The steam railway mileage in the state as of Jan. 1941 was 5,020.56; the total in 1915 was 5,729 mi. Electric railways operate only in the cities. There are 34 bus lines, 12 truck lines operated by subsidiaries of railroads and one by the Railway Express agency. Louisiana is showing much progress in the construction of improved highways. On Jan. 1, 1941, there were 19,490 mi. of road in the state highway system, and of this amount 2,579 mi. were concrete, 1,709 asphalt and 12,533 gravel roads. The highway system had 5,925 bridges.

Inland waterways have always been an important factor in Louisiana's transportation system. There are systems of improved bayous, lakes and canals, which, in conjunction with the Mississippi river, afford a total navigable length of waterways amounting to approximately 1,800 mi. Chief among the artificial waterways is the industrial canal (opened Feb. 6, 1923) which connects the Mississippi river at New Orleans with Lake Pontchartrain, thus giving shipping a more direct access to the sea. There is a large, growing and important commerce down the Mississippi to New Orleans. Petroleum and its products comprise its chief item. In 1939 the total of all water-borne imports and exports for the state was 6,780,107 tons; coastwise receipts and shipments 12,059,172 tons; internal (domestic) receipts and shipments 9,936,893 tons; making a total of 28,776,172 tons of water-borne commerce.

In 1940 the port of New Orleans had imports of 2,896,269 tons valued at $101,267,893 and exports of 3,351,177 tons valued at $223,414,336. The grand total of all water-borne traffic through the port of New Orleans including imports and exports and coastwise shipments and receipts (*i.e.*, ocean-going) was 11,613,772 tons; this tonnage, with the internal receipts and shipments, amounted to $19,795,599. The total valuation of imports and exports for 1940 marked a gain of $45,456,889 over 1939. New Orleans is the largest banana port with 11,423,603 bunches, in 1940, valued at $6,167,791. Coffee import in 1940 was 443,838,000 lb., with higher figures shown for 1941. Of sugar 1,267,674 lb. were imported. New Orleans is the second port of the United States. Other ports of entry in the state are Baton Rouge, with foreign imports and exports of 558,005 tons and coastwise receipts and shipments of 3,634,829 tons in 1940, and Lake Charles (in the Sabine customs district).

Three modern steel bridges for railroad, vehicular and pedestrian use span the Mississippi. One is just above New Orleans; the others are at Baton Rouge and Vidalia. All are built to permit the passage of warships.

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For history: the standard work is that of Charles Gayarré, coming down to the Civil War, based on deep and scholarly research, and greatly altered in successive editions (1846–1903). The style is that of the classic school, that of Prescott and Motley, full of colour, characterization and spirit. *See* especially *The French Domination* (1854), *The Spanish Domination* (1854) and *The American Domination* (1867). More important for the later period are Alcée Fortier, *A History of Louisiana* (1904), devoting 2 vol. to American dominations; G. E. King and J. R. Ficklen, *A History of Louisiana* (1902); and H. E. Chambers, *A History of Louisiana* (vol. ii. and iii. biography, 1925); Wm. O. Scroggs, *The Story of Louisiana* (1924), the best textbook; Judge F. X. Martin, *History of Louisiana* (New Orleans 1827–28, later edited by J. F. Condon, continued to 1861, New Orleans, 1882) is also valuable and supplements Gayarré. Baron Marc de Villiers, *Histoire de la Fondation de la Nouvelle-Orléans,* (1717–22) (Paris, 1917) (English tr., New Orleans, 1920) is authoritative. Le Page du Pratz, author of *Histoire de la Louisiane* (Paris, 1758; London, 1763), was the first historian of Louisiana. For the reconstruction period *see* E. Lonn, *Reconstruction in Louisiana after 1868* (1918). The rarest and most valuable of early memoirs and much archive material are embodied in B. F. French's *Historical Collections of Louisiana* (1846–53) and *Historical Collections of Louisiana and Florida* (1869, 1875). Documentary materials on the greater "Louisiana" between the Gulf of Mexico and Canada will be found in the *Jesuit Relations,* edit. by R. G. Thwaites (1896 *et seq.*); and on early voyages in Pierre Margry, *Découvertes et éstablissements des Français* (Paris, 1879–88). *See* also the publications of The Louisiana Historical Society (New Orleans), especially its *Louisiana Historical Quarterly* (1918–41), a mine for the historical researcher; *Reports* of U.S. bureau of the census. (E. A. Ps.)

LOUISIANA, a city of Pike county, Missouri, U.S.A., on the Mississippi river, 94 mi. above St. Louis, at the mouth of the Salt river. It is on federal highway 54 and state highway 79 and is served by the Burlington and the Alton railways, and by river steamers and barges. Pop. (1940), 4,669. Wooded hills and rocky bluffs add charm to the river shores along this stretch. A $1,000,000 highway bridge across the Mississippi was completed in 1928. The city ships large quantities of grain, pork and apples, nursery stock, cotton gloves, pearl buttons, and has various manufacturing industries. It is the home of the largest nursery in the country, which in 1927 took over all of Luther Burbank's experimental farms and all rights in his experiments and in his horticultural creations not yet marketed. From 1818, when the town was laid out, until 1825, Louisiana was the county seat. It was incorporated as a town in 1845 and as a city in 1849.

LOUISIANA PURCHASE, a large portion of the area of the west central section of the United States of America, purchased from the French Republic in 1803. The "Louisiana," to which France held explorer's title, originally included the entire valley of the Mississippi (*see* LOUISIANA); but that part of the territory which was ceded by her to Spain in 1763 (England refusing it, preferring the Floridas), retroceded to France in 1800, and ceded by Napoleon to the United States—in violation of his pledge to Spain that he would not alienate the province—embraced only the portion west of the river and the island of New Orleans on the east (and, as might be claimed with some show of argument, West Florida to the Perdido river).

With the rapid increase of American settlement in the trans-Allegheny region, the freedom of the Mississippi had become of vital importance to the western people, and Spain had recognized these interests in her treaty with the United States of 1794, by guaranteeing freedom of navigation and the privilege of deposit at New Orleans. The transfer of Louisiana from a weak neighbour to so powerful and ambitious a State as France was naturally unwelcome to the United States, and Robert R. Livingston, the American minister in Paris, was instructed by Secretary of State Madison to endeavour to prevent the consummation of the retrocession; or, should that be irrevocable, to endeavour to buy the Floridas (either from France, if they had passed with Louisiana, or through her goodwill from Spain)—or at least West Florida—and if possible New Orleans, so as to give the United States a secure position on the Mississippi, and ensure her commerce.

In his preliminary propositions Livingston lightly suggested to Talleyrand a cession of Louisiana to satisfy certain claims of American merchants for spoliations by French cruisers; following it with the more serious demand that France should pledge observance of the Spanish concession to the Mississippi trade. This pledge Napoleon readily gave. But during these negotiations a suspension by the Spanish governor of the right of deposit aroused extreme apprehension in America and resulted in warlike votes in Congress. Of these, and of London reports of a British expedition against New Orleans preparing in anticipation of the imminent rupture of the peace of Amiens, Livingston made most capable use; and pressed for a cession of West Florida, New Orleans and Louisiana north of the Arkansas river. But without New Orleans Louisiana was of little present worth, and Napoleon—the collapse of whose American colonial schemes seemed involved in his failure in Santo Domingo, and who was persuaded he could not hold Louisiana against Great Britain—suddenly offered to Livingston the whole of the province. Livingston disclaimed wanting the part below the Arkansas. In even mentioning Louisiana he had gone outside his instructions.

At this stage James Monroe became associated with him in the negotiations. They were quickly closed, Barbé-Marbois acting for Napoleon. By three conventions signed on April 30, 1803, the American ministers, without instructions, boldly accepted for their country a territory approximately 1,000,000 sq.m. in area—about five times the area of continental France. For this imperial domain, perhaps the richest agricultural region of the world, the United States paid 60,000,000 francs ($11,250,000) outright, and assumed the claims of her citizens against France to the extent of 20,000,000 francs ($3,750,000) additional; the interest payments incidental to the final settlement raising the total eventually to $27,267,622, or about four cents an acre.

The exact limits of the acquisition were not definitely drawn. The French archives show that Napoleon regarded the Rio Grande as the western boundary of the territory of which he was to take possession, and the United States up to 1819 ably maintained the same claim. She also claimed all West Florida as part of Louisiana—which, in the usage of the second half of the 18th century, it apparently was not. When she acquired the Floridas in 1819–21, the claim to Texas was abandoned. The line then adopted between the American and Spanish possessions on the west followed the Sabine river from the Gulf of Mexico to the parallel of 32° N., ran thence due north to the Red river, followed this to the meridian of 100° W. and this line north to the Arkansas river, thence along this to its source, thence north to the parallel of 42°, and along this line to the Pacific. Such is the accepted description of the western boundary of the Louisiana Purchase—waiving Texas—thus retrospectively determined, except that the original boundary ran with the crest of the Rocky mountains north of its intersection with the parallel of 42°. No portion of the purchase lay west of the mountains, although for some years after 1870 the official maps of the U.S. Government included Oregon as so acquired—an error finally abandoned by 1900.

On Dec. 20, 1803, at New Orleans, the United States took possession of the lower part of the province, and on March 9, 1804, at St. Louis, of the upper. The entire region then contained possibly 80,000 residents. The treaty of cession required the incorporation of Louisiana in the Union, and the admission of its inhabitants, "as soon as possible, according to the principles of the Federal Constitution, to the enjoyment of all the rights, advantages and immunities of citizens of the United States." By act of March 26, 1804, the region below 33° N. was organized as the Territory of Orleans (*see* LOUISIANA), and that above as the District of Louisiana. The region above 33°, renamed in 1805 the Territory of Louisiana, and in 1812 the Territory of Missouri, was divided as time went on into many Indian reservations, Territories and States. Thus were carved from the great domain of the purchase Louisiana, Missouri, Arkansas, Iowa, North and South Dakota, Nebraska and Oklahoma in their entirety and most of Kansas, Colorado, Wyoming, Montana and Minnesota.

The gain of so vast a territory made it possible for the United States to hold a more independent and more dignified position between France and England during the Napoleonic wars; it established for ever in practice the doctrine of implied powers in the interpretation of the Federal Constitution; it gave the new republic a grand basis for material greatness; assured its dominance in North America; afforded the field for a magnificent experiment in expansion and new doctrines of colonization; fed the national land hunger; and accentuated the slavery issue.

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LOUIS STYLES, the French decorative and architectural styles generally current during the reigns of Louis XIII., XIV., XV. and XVI. In all a vacillation between the ideals of classic grandeur and fantastic, imaginative lavishness is observable.

Louis XIII. (1610–1643), a period noteworthy for the gradual change from the extreme Baroque of the Henry IV. style to the classic grandeur of that of Louis XIV. and for the beginning of the use of various scroll and shell-like forms which were used in varying forms throughout the Louis styles. The influence of the contemporary Italian Baroque style was very strong, but in interior work many painted panels, often with curved ends, gave promise of later development.

Louis XIV. (1643–1715).—Classic formality dominated the early years of this period. More and more, as the period progressed, the wish for the most lavish possible decoration led to modifications of the earlier classicism, which, however, continued to dominate exterior design. In interior work, curved headed panels were common, often decorated at the top with shells and complicated, interlaced, rather thin acanthus scrolls. Panel moulds were reduplicated and complex. The fire-place frames were scrolled and bowed, and the use of enormous mirrors was frequent. Classic orders continued to be used, although a growing desire for softness of form led to the imposition of a wide, curved, sweep or cove, usually decorated with a network pattern between the cornice of the order and the ceiling proper. During the end of the period, sometimes differentiated as the Régence (1715–1773) style, a growing love for curves overwhelmed the last remnants of classic dignity. Panel corners were cut off and the custom became universal of surrounding each panel with at least three sets of mouldings and of painting all interiors white, with lavish gilding upon mouldings and carvings. The classic orders gradually disappeared from interior use.

Louis XV. (1750–1774), merely a logical development of the love of fantastic curves which had grown up during the Régence. Exteriors, however, were little affected, except in minor details, and as interiors became richer and more bizarre, exteriors became colder and more restrained. In interior work, the love of curves dominated everything. Panels not only had universally curved tops, but were frequently asymmetrical. The carving at panel heads and bases became continuously richer, more naturalistic, and more involuted, and panel moulds frequently died into, or were combined with, this carving. Definite cornice lines were avoided and wall decoration carried up into the ceiling. Fantasy, combined richness and delicacy, and unbridled imagination were the aims of the developed period.

Louis XVI. (1774–1793), the reaction against the excessive and bizarre fancies of the Louis XV. style. The classic ideal which had been banished to exterior architecture returned and controlled design inside as well as out. Rectangular panels again became universal, although the triple panel mould remained. Cornices came back into use; pilasters occasionally framed mirrors and doors and simple semi-circular or oval arches replaced the broken curves. At times, early Louis XVI. work strongly resembled the early work of the Louis XIV. period, but as the style developed, it attained a new delicacy entirely alien to the taste of the time of the "Sun King." The romanticism which coloured the literature of the period, and fostered a false pastoral sentimentality among the upper classes, found expression in the decorative painting of panels and over doors. *See* PERIODS OF ART.

PAINTING AND SCULPTURE

The same conflict between classic formality and playful fantasy that characterized the architecture dominates the other arts. During the reign of Louis XIII. and the early part of the reign of Louis XIV. a formal and dry classicism was almost universal. Nicholas Poussin (1594–1665) was characteristic; a man of brilliant and basically unconventional genius, he was yet forced by the spirit of the times to paint largely scenes from classic history and mythology.

This dominating classic and academic ideal produced acres of stupid historical, Biblical and classic canvases whose only virtue was their size and a certain soundness in drawing. Two influences were, however, at work, to mitigate this dearth of vitality. The first was a strain of pure naturalism, coming down from an earlier tradition; its master was the great portraitist Philippe de Champaigne (1602–1674), and an allied genius, the landscape painter Claude Lorrain (1600–1682). (*See* PAINTING.)

Similarly, in sculpture, it is the realistic work of Girardon (1628–1715), as in the tomb of Richelieu in the church of the Sorbonne, which seems vital; the fashionable classicisms of the Versailles gardens by Coysevox (1640–1720) are either dry or tortured into over-baroque theatricalness of posture.

To all of this combination of realism, classicism and baroque contortion the close of the reign of Louis XIV. put a definite end; and the development in general from 1715 on was towards graciousness, delicacy, fanciful invention and a continual ever-more facile technique. In the work of Watteau (1684–1721) the transition is already made, and his later pictures show all the freedom and the daintiness of the new style without the superficial prettinesses that occasionally disfigured it.

In sculpture, the demands of the material prevented any such complete debacle. Yet if the architectural sculpture of the period is of a universally high level, the little statuettes which were the most common forms which sculpture took, those of Clodion (1738–1814), for example, paralleled as far as possible the soft nudes the painters loved. Across this movement, and with little relation to it lies the work of the one great sculptor of the period, J. A. Houdon (1741–1828), who profited by the technical advances of his time, and used them to create sculpture, mostly portraiture, which is magnificent in its combination of realistic vision and sculptural sense. (*See* SCULPTURE.)

THE DECORATIVE ARTS

During the reign of Louis XIII., furniture was in a state of transition from the stiff heaviness of the early Renaissance to more free and gracious forms; furniture was taking its modern generic shapes and types. This movement reached the first climax in the lavish and gorgeous period of Louis XIV., who was as generous a patron of the decorators as of the architects. The work of the time is distinguished by solidity, dignity, surface richness. Toward the end of the reign lacquer began to be introduced in imitation of the Chinese and Japanese furniture that was occasionally imported. (*See* INTERIOR DECORATION, *European.*)

Under Louis XV., the rococo style, which dominated interior architecture, was supreme in furniture as well. The heavy richness of Louis XIV. work yielded to the graceful curves, the delicate carving, and suave lines of that of Caffieri (1725–1792) and Slodtz (1655–1726). (*See* ROCOCO.) The reaction to delicate straight-lined classicism during the period of Louis XVI was as marked in furniture as in all interior woodwork. The structural simplicity of the best Louis XIV work returned, and with it there came an additional refinement and delicacy of every line.

In textiles a similar progress is evident. The age of Louis XIV found ample expression for its love of the grandiose in tapestry design, the establishment at the Gobelins in Paris under the direction of Le Brun being especially famous for its large works, and that at Beauvais for smaller pieces. More and more they were reserved for ecclesiastical use; in domestic work brocades and brocatelles usurped their place. Under Louis XVI printed cloths began to assume importance, especially that type of printed cotton known as *toile de Jouy,* which was to gain such importance in the early 19th century. (*See* TEXTILES AND EMBROIDERIES: *Europe and the Near East.*)

In ceramics, the period was distinguished by the founding in 1738 at Vincennes of a great porcelain manufactory, which in 1756 was moved to Sèvres and became the property of the government in 1759. Here, first soft porcelain, and after 1769 hard porcelain resembling Dresden ware was produced, in designs which followed the rococo spirit of the Louis XV period, and then, like the interior architecture and the furniture, reacted to classicism and restraint under Louis XVI. (*See* also POTTERY AND PORCELAIN.)

Throughout the arts there thus runs through the reigns of these four Louis' a continual struggle between academic classicism and the rococo, between restraint and licence, between monumentality and fantastic invention. Richness and luxury dominate all the manifestations. A semiofficial court-supported art could go no further; it was almost as if in the arts, as well as elsewhere, a revolution was inevitable; the last shreds of the Renaissance tradition were thus unravelled, and the old texture of the arts perished along with the *ancien régime.* (T. F. H.)

LOUISVILLE (lo͞o'ĭ-vĭl), the largest city of Kentucky, U.S.A., on the Ohio river, 90 mi. in a beeline S.W. of Cincinnati; a port of entry and the county seat of Jefferson county. It is on federal highways 31E, 31W, 42, 60 and 150; has two airports; and is served by the Baltimore and Ohio, the New York Central, the Chesapeake and Ohio, the Chicago, Indianapolis, and Louisville, the Illinois Central, the Kentucky and Indiana Terminal, the Louisville and Nashville, the Southern and the Pennsylvania railways, by river packets, barge lines and numerous motor truck and bus lines. The population in 1930 was 307,745 (of whom 47,354 were Negroes) and in 1940 it was 319,077.

The city occupies 37.9 sq.mi., in part in a level plain, and in part in the surrounding hills. It has 8 mi. of water front, around a wide curve of the river, which falls in a series of rapids 26 ft. in 2 miles. Canalization of the Ohio was completed from Pittsburgh to Cairo in 1929, providing an all-year 9-foot stage. Highway bridges, one municipally owned, lead to New Albany and Jeffersonville, Indiana, on the north bank of the river. One of these carries railway traffic, and there are two other railway bridges. A hydroelectric power station at the falls (completed in 1927) has a capacity of 108,000 h.p.

The valuation of property for tax purposes in Jefferson county including Louisville in 1940 was $618,502,000. The 34 parks and playgrounds cover 2,177 ac., with 4 municipal golf courses, 33 baseball diamonds and 84 tennis courts. Iroquois amphitheatre in Iroquois park provides a sylvan setting for alfresco musical shows, concerts and pageants. The University of Louisville, said to be the oldest municipal university in the country (founded 1837), occupies a campus of 55 ac. in the southern section of the city. The Southern Baptist theological seminary (established 1859), newly located in a setting known as the Beeches, has a modern well-equipped group of buildings. The Baptist Women's Missionary Union training school adjoins the seminary. The Presbyterian theological seminary of Kentucky (formed in 1901 by the consolidation of two older institutions, dating from 1853 and 1893) has a quadrangle, designed after Balliol college, Oxford. Other higher educational institutions are Nazareth college (for women), Simmons university for Negroes (Baptist), the Jefferson School of Law, the Louisville College of Pharmacy and the Kentucky school for the blind. The public-school system includes 76 schools (1941), with an enrolment of 47,614 pupils. There are 58 parochial schools, with an enrolment of 15,638, and some 16 other private educational institutions of various types, including 7 business colleges. The public library contains 329,965 volumes and maintains 16 branches. There are two newspapers. The *Courier-Journal* (formed in 1868 by the consolidation of three papers and edited from 1868 to 1918 by Henry Watterson) has long been influential.

The United States government maintains at Louisville a marine hospital, a fish hatchery and a coast guard station, the only one in the interior of the country. Bowman field, a municipal airport and an air corps flying field, is on the outskirts of the city to the southeast, and Fort Knox is 33 mi. southwest. The Kentucky state fair, held in the city annually in September on its own spacious grounds, drew an attendance of 168,000 in 1940. At the famous old Churchill Downs, which has 29 days of racing every year, the Kentucky derby, America's foremost horse-racing classic and held annually since 1875, is run in May. It pays $62,575 to the winners and attracts 60,000 people.

Louisville is one of the largest commercial and industrial centres of the south. It is the seat of branches of the federal reserve bank and the farm credit administration. Bank debits to individual accounts in 1940 amounted to $2,057,875,847. The output of the manufacturing establishments within the city in 1937 was valued at $294,210,000, and there are important plants just outside the corporate limits. Widely diversified in character, the 11 leading industries in the order of value of output are: distilled and malt liquors; tobacco products, including cigarettes; food products, including meat packing; railroad repair shops; rolled and extruded aluminium products; lumber and timber products, including furniture; motor vehicles, including motor vehicle parts; printing and publishing, including newspapers and periodicals; textile products, including clothing; chemicals, including petroleum products; paints, varnishes and lacquers.

Wholesale trade in 1939 amounted to $215,936,000, while retail trade grossed $131,004,000 in the same year. As the foremost livestock market of the south, 805,003 of all kinds of stock were received in 1940.

National defence preparations brought an extraordinary stimulus to the Louisville metropolitan district in 1940 and 1941. At Fort Knox, Kentucky, at Bowman field, Louisville's municipal airport, and at the U.S. quartermaster depot at Jeffersonville, Ind., there was an expansion of military forces to more than 40,000 men. Plants for the production of smokeless powder and powder bags sprang up at suburban Charlestown, Ind., a naval gun mounting plant and a carbide plant in Louisville. These national defence industries gave regular employment to around 20,000, increasing the industrial workers in metropolitan Louisville by more than 50%.

In the centre of Fort Knox is the gold vault where the major portion of Uncle Sam's gold supply is stored.

History.—The site of Louisville was probably visited by La Salle in 1669 or 1670. In July 1773, Captain Thomas Bullitt, acting under a commission from the College of William and Mary, surveyed a tract of 2,000 ac. opposite the falls of the Ohio, and laid out a town site. Though the county surveyor refused to approve this survey, Lord Dunmore, the governor of Virginia, conveyed it, in Dec. 1773, to his friend, Dr. John Connolly. There may have been a settlement on Corn island (which has now practically disappeared) at the falls of the Ohio, as early as 1775. In May 1778, Gen. George Rogers Clark, on his way to the Illinois country, landed on this island and built blockhouses for his stores and cabins for some of the colonists who had come with him. Most of these settlers moved to the mainland the following winter and established themselves in a fort within the present limits of Louisville. They organized a town government in April 1779; and on May 14, 1780, the legislature of Virginia, on their petition, declared that Dr. Connolly had forfeited his title (he had been actively pro-British during the Revolution) and incorporated the settlement under the name of Louisville, in recognition of the assistance given by Louis XVI of France to the colonies in the Revolutionary War. In 1828 the town was chartered as a city; in 1851 it received a second charter; in 1870, a third; in 1893, a fourth, and in 1926, a fifth, under which it still operates. The city's growth was greatly stimulated by the introduction of successful steam navigation on the Ohio in 1811, and by the construction (1825–30) of the canal around the falls of the Ohio. The first railway reached it in 1851. In 1922 an area (11,000 ac.) was annexed to the city. On Aug. 6, 1855 ("Bloody Monday"), a riot incited by members of the Know Nothing party resulted in the loss of several lives and considerable damage to property. In March, 1890, a tornado caused great loss of life and property. The city suffered severely during the record Ohio floods of January 1937. Gen. Clark lived in the city after 1779. It was the home of the actress Mary Anderson in her early years, and of J. J. Audubon from 1808 to 1812. Louis Philippe of France, during his American exile, lived for a time a few miles from the city. Five miles east are the homestead and the tomb of Zachary Taylor. At Camp Zachary Taylor, two miles distant, 75,000 men were trained during the war of 1914–18.

LOUISVILLE AND NASHVILLE RAILROAD COMPANY was incorporated in the State of Kentucky on March 5, 1850. Almost from the beginning its undertakings were profitable and with but few reverses it has steadily grown until at the end of 1939 this line operated 4,871·30mi. of road in 13 States of the South, providing service in the territory from Cincinnati to Louisville, Nashville, Birmingham, Montgomery, Pensacola, Mobile and New Orleans on the South; Knoxville and Atlanta on the South-east and to Memphis, St. Louis and Evansville on the West. It also owns a majority of the capital stock of, or is interested jointly with other lines in, other property, including the Nashville, Chattanooga and St. Louis railway; Clinchfield railroad; Chicago, Indianapolis and Louisville railway, and Georgia railroad and Dependencies, aggregating 2,487·24mi., making the total for the L. and N. system 7,358·54 miles. It is itself controlled by the Atlantic Coast Line Railroad Company and is known as one of the Walters Group.

The L. and N. operates through a rich section of the central South-east noted for the production of cotton, although recently this region has been characterized by a marked diversity in agricultural development. The road serves the important iron and steel district near Birmingham, Ala., but its chief source of traffic —about 57%—is bituminous coal, mined from the coal fields of eastern and western Kentucky, Virginia, Tennessee, Alabama and Illinois. About 84% of its traffic originates on its own lines.

The L. and N., at the end of 1939, had a capital stock of $117,000,000 and a funded debt of $221,881,530. Its gross earnings in 1939 approximated $88,300,000 per annum. (J. B. H.)

LOULÉ, a town of southern Portugal, beautifully situated in an inland hilly district, 10 m. N.N.W. of the seaport of Faro and 5 m. from São João da Venda on the Lisbon-Faro railway. Pop. (1940), 7,535. It is surrounded by walls and towers dating from the Moorish period. Basket-making is the principal industry; leather, porcelain and various products of the palm, agave and esparto grass are also manufactured.

LOUNSBURY, THOMAS RAYNESFORD (1838–1915), American scholar, was born at Ovid, N.Y., on Jan. 1, 1838, and educated at Yale university (A.B., 1859; A.M., 1877). He was on the editorial staff of the *American Encyclopaedia* 1860–62, and then enlisted in the 126th N.Y. Volunteers to serve through the Civil War. In 1870 he became instructor and in 1871 professor of English language and literature in the Sheffield Scientific school of Yale university. In 1906 he was retired as professor emeritus. He was also librarian of the Sheffield Scientific school 1873–1906. He won recognition as a scholar in both branches of his subject: study of the English language and study of its literature. His *History of the English Language* (1879) is characterized by Prof. Brander Matthews as "a little masterpiece of carefully controlled information, and of marvellously lucid exposition." He followed this with later studies of pronunciation, usage and spelling no less authoritative: *The Standard of Pronunciation in English* (1904); *The Standard of Usage in English* (1908); *English Spelling and Spelling Reform* (1909). He was one of the most influential of those who advocated spelling reform and was one of the organizers, and later president, of the simplified spelling board. His studies in literature show him a master of his successive subjects. His first was a *Life of James Fenimore Cooper* (1882). *Studies in Chaucer* in three impressive volumes (1891) remains an enduring work. His *Shakespeare as a Dramatic Artist* (1901), *Shakespeare and Voltaire* (1902), and *The Text of Shakespeare* (1906) marked him as one of the foremost writers on Shakespearian subjects. He also wrote *The Early Literary Career of Robert Browning* (1910) and edited the complete works of Charles Dudley Warner. He died on Apr. 9, 1915.

LOURDES, a town of south-western France in the department of Hautes-Pyrénées, at the foot of the Pyrénées, 12 mi. S.S.W. of Tarbes on main line of Southern railway between that town and Pau. Pop. (1936) 10,155. The origin of Lourdes is uncertain. From the 9th century onwards it was the most important place in Bigorre, largely owing to its famous fortress. In 1360 it passed by the treaty of Brétigny from the French to the English, who lost it to the French in 1406. During the religious wars the castle held out successfully against the Protestant troops. From the reign of Louis XIV. to the beginning of the 19th century the castle was used as a state prison. After the visions of Bernadette Soubirous, a peasant girl, in 1858, their authentication by a commission of enquiry appointed by the bishop of Tarbes, and the authorization by the pope of the cult of Our Lady of Lourdes, the quarter on the left bank of the Gave sprang up, and about 600,000 pilgrims annually visit the town, August being the favorite month.

Several religious communities have been named after Our Lady of Lourdes. Of these one, consisting of sisters of the third order of St. Francis, called the Congregation of Our Lady of Lourdes (founded 1877), has its headquarters in Rochester, Minnesota. Another, the Order of Our Lady of Lourdes, was founded in 1883 for work in the archdiocese of New Orleans. Lourdes is divided into an old and a new town by the Gave de Pau, which at this point leaves the valley of Argelès and turns abruptly to the west. The old quarter on the right bank surrounds a scarped rock, on which stands the fortress with its large square 14th century keep. A tower of the 13th or 14th century, surmounting a gateway known as the Tour de Garnabie is part of the old fortifications. The old quarter is united with the new by a bridge which is continued in an esplanade leading to the basilica, the church of the Rosary and the Grotto, with its spring of healing water, where the Virgin Mary is believed in the Roman Catholic world to have revealed herself repeatedly to Bernadette Soubirous. A statue of the Virgin stands on a rock projecting above the grotto, the walls of which are covered with crutches and other votive offerings; the spot is marked by a basilica built in 1876 above the grotto. The Byzantine church of the Rosary was built in front of and below the basilica from 1884 to 1889. Near the grotto are other caves, where prehistoric remains have been found.

Lourdes is the seat of the tribunal of first instance of the arrondissement of Argelès. There are slate quarries and the pastures support a breed of valuable Aquitaine cattle.

LOURENÇO MARQUES, capital of Portuguese East Africa or Mozambique, on the north bank of the Espirito Santo or English river, Delagoa bay, and 396 m. by rail via Pretoria from Johannesburg. A census completed in 1936 gives the population of city and suburbs as 47,392, including 9,000 Europeans, an increase in the European population of 71·88% since 1912. The large majority of non-Europeans are Africans, but there are also 1,364 British Indians. Foreigners numbering 1,588 are employed in the town, which is close to the mouth of the river in 25° 53′ S. and 32° 30′ E., and is built upon a low-lying spit of sand, formerly surrounded by swamps which have now been filled in, providing a large area for business and other occupation, and on the hills behind it. The streets are regularly laid out, and most of them are tar-surfaced; the town and suburbs are lighted by electricity, and adorned by several fine buildings, among which are the railway station, municipal market, post and telegraph offices, the treasury, the residency, the British consulate, offices of the attorney general and the palatial Polana hotel. There are Roman Catholic, Anglican and Wesleyan Methodist churches, and the large church of the Mission Suisse Romande. There are three theatres and many good shops. The handsome Avenida Aguiar, in which are situated the fine municipal gardens, adjacent to which is the municipal museum, leads to the upper town. The electric tram system has been replaced by a municipal bus service, and motor buses ply between the lower and the upper town.

At Ponta Vermelha (Reuben point), which marks the spot where the river enters the bay, are cavalry barracks, the wireless station and many private residences of the wealthier citizens. The town is healthy. The climate is almost ideal in the winter months while sea breezes temper somewhat the summer heat. The mean annual temperature (14 years) was 72° F. There is a large military and civil hospital in the town and also several nursing homes. Water, brought from the Umbeluzi river 18 mi. away, is of excellent quality. Pop. est. (1931) 42,779.

Trade.—There is safe entrance to the harbour, the minimum depth in the Cockburn channel being 29 ft. At its mouth, the river is about 2 mi. across. Lourenço Marques is the nearest port to the Rand gold mines. It is 7,308 mi. from London via Capetown, and 8,460 mi. via the Suez canal. The wharf (cost £500,000), of reinforced concrete, is about a mile long, and can accommodate 12 large steamers at once. There are 11 large warehouses, in addition to the transit shed and national warehouse. Telegraph, telephone and railway booking offices are on the wharf; and a clock gives the official time, a three-hour signalling device giving the time to shipping.

The whole wharf area is enclosed and electrically lighted. There are 38 electric cranes, one 80 ton; and three tugs, one for use on the high seas. There are two docks for small craft, and a dry dock which admits vessels up to 1,400 tons (cost £30,000). In 1936, 1,025 vessels entered the port, unloading 741,858 tons of cargo and loading 588,461 tons of goods and coal. There are regular services of British, Portuguese, German, American, Norwegian and Italian lines. The great bulk of the traffic of the port is that in transit to the Union of South Africa. Over 50% of the import trade of Johannesburg is with Lourenço Marques. (For convention regulating this traffic, *see* PORTUGUESE EAST AFRICA.) Union duties can be paid in Lourenço Marques. The port possesses two coaling plants, capable of handling respectively 400 and 600 tons an hour. The bunkering trade is growing in importance. Great Britain, Portugal and Germany, in this order, have the bulk of the import trade. Most of the imports, being forwarded to the Transvaal, figure also as exports.

A great proportion of the trade of the town, the forwarding trade especially, is in the hands of British firms. The retail trade and the native trade is very largely in the hands of Indians. The chief articles imported are foodstuffs and liquors, iron, mineral oils, inks and dyes, timber and livestock. These all form part of the transit trade. There is little export trade by sea except in coal, chiefly from the collieries at Middelburg, Transvaal. The chief import for local consumption is wine.

History.—In the latter part of 1925 the depreciation of Portuguese currency, and the abolition of the use of sterling currency caused serious difficulties to importers, and led to strikes and other disturbances. The position began to improve in 1926, and by 1928 was stable. For the early history of the town *see* DELAGOA BAY. The existing town dates from about 1850, the previous settlement having been entirely destroyed by natives. In 1871 the town was described as a poor place, with narrow streets, fairly good flat-roofed houses, grass huts, decayed forts and rusty cannon, enclosed by a wall 6 ft. high then recently erected and protected by bastions at intervals. The growing importance of the Transvaal led, however, to greater interest being taken in Portugal in the port. A commission was sent by the Portuguese Government in 1876 to drain the marshy land near the settlement, to plant the blue gum tree, and to build a hospital and a church. It was not, however, until the end of the 19th century that any marked development took place in the town, and up to 1903 cargo had to be discharged in tugs and lighters. Later, a wooden wharf preceded the present reinforced concrete one. The settlement was declared a village in 1876, a corporate town in 1887, and in 1907 became the capital of the Province.

In 1873–77 Mr. Burgers, president of the Transvaal, endeavoured, unsuccessfully, to get a railway built from Pretoria to Delagoa bay. Later, Col. McMurdo organized a company which built a line from the coast to the frontier as marked on maps of 1883, and this railway was opened in 1888. The Portuguese government insisted that the line must be continued another 5 mi. to the frontier as fixed after 1883. This led to disputes, seizure of the line, etc., and a long arbitration. Meantime, however, the railway had been completed and was opened for through traffic to Pretoria on July 8, 1895. In 1906–10 another railway (47 mi. long) was built from Lourenço Marques due west to the Swaziland frontier, being a link in a new line to shorten the distance by rail between the Rand and the sea by some 60 mi.

See also DELAGOA BAY and the authorities there cited. The text of the railway arbitration award was published in French at Berne in 1900. Annual reports on the trade of Lourenço Marques are issued by the British Foreign Office.

LOUSE, a name commonly applied to small wingless insects parasitic upon birds and mammals and belonging to the order Mallophaga and Anoplura. They are dorso-ventrally flattened creatures with short, 3- to 5-segmented antennae, the eyes may be reduced or wanting and the tarsi are 1- or 2-segmented with strongly developed claws for clinging to their hosts. The eggs are attached to the hairs, feathers or clothing, and the young lice are active as soon as they emerge. In structure and habits the immature lice resemble the adults, but they pass through several moults before reaching sexual maturity. When lice are numerous they cause great irritation to the hosts, upon whose bodies their whole life is passed.

The Mallophaga or biting-lice (*see* BIRD-LOUSE) constitute a separate order of insects although they were previously classed as a suborder of the Anoplura. The order Anoplura, also known as the Siphunculata, is restricted to the sucking lice. The sucking lice have extrusible mouth-parts adapted for piercing and sucking, and they live by imbibing the blood or tissue fluids of mammals. None are parasitic on birds or reptiles.

Sucking lice show very distinct host specificity; that is, one species of louse is restricted to a species or a small group of species of hosts, usually within a single genus. Genera of lice are characteristic of certain families or related families of mammals. The louse family Pediculidae is peculiar to the primates, the Echinopthiriidae to the marine carnivores and the Haematopinidae to the rodents, rabbits and ungulates with very few exceptions. Vernon L. Kellogg has suggested that the presence of related lice on related groups of hosts is evidence of parallel evolution of parasites and hosts.

In addition to man and his domestic mammals a wide variety of wild mammals are infested by these insects, each host, genus or species having its own characteristic parasites. A few hosts such as man, the domestic cow and some rodents have two characteristic species of sucking lice, but usually only one species is found on a host. Sucking lice are largely restricted to old world primates, marine carnivores (seals, sea lions and walrus), rodents, rabbits and ungulates. Several species are known from insectivores. The domestic dog is one of the few land carnivores parasitized by sucking lice. No species are known from monotremes, Australian marsupials, bats, elephants or cetaceans. The elephant louse, *Haematomyzus,* is an anomalous insect with a long proboscis and biting mouthparts. It is questionably referred to the order Mallophaga.

The best known species of louse is *Pediculus humanus,* the common louse of man, which infests the human race wherever lousiness has not been eliminated by modern hygiene. Its distribution is almost coextensive with that of the human race and the antiquity of this association is demonstrated by the presence of lice on ancient mummies from Egypt and the southwestern United States. This species has apparently been inherited by man from his remote primate ancestors. There are two varieties of the common human louse, viz., *Pediculus humanus* var. *capitis,* the head louse, and *P. humanus* var. *corporis,* the body louse. The human louse is recognized as the carrier from man to man of the pathogenic agents of epidemic typhus fever, trench fever of World War I and louse-borne relapsing fever (in contrast to tick-borne relapsing fever). The terrible role of these diseases in the history of man is related by Hans Zinsser in *Rats, Lice and History.* Epidemic typhus fever has been a scourge whenever populations have been disrupted or concentrated by war, famine or floods and the attendant insanitary conditions.

The only other louse which infests man is the pubic or crab louse, *Phthirus pubis,* which is occasionally found in the axillae, eyebrows and beard as well as in the pubic regions. It is not known to be an important disease vector.

Related species of lice are *Pediculus schäffi,* of the chimpanzee, and *Phthirus gorillae* of the gorilla. The other lice from old world primates are included in the genus *Pedicinus. Pediculus mjöbergi,* which is almost indistinguishable from the human louse, is recorded from several species of new world monkeys. It is generally considered that these monkeys have acquired the parasite by contact with man, although it may be established on wild monkeys.

Some of the common lice of domestic animals are *Haematopinus suis* of the pig, *H. asini* of the horse, *H. eurysternus* and *Linognathus vituli* of the cow and *L. setosus* of the dog.

Extensive museum collections of lice have been accumulated at Stanford university, United States National museum and the British museum. The Anoplura of the world have been monographed by Gordon F. Ferris of Stanford university in a series of publications entitled *Contributions Toward a Monograph of the Sucking Lice.*

The word louse is also applied in a popular sense to many animals other than the true lice, *e.g.,* wood louse, fish louse (*see* CRUSTACEA), book louse of the insect order Corrodentia, plant louse (*see* APHIDS) and bark louse (*see* SCALE INSECTS). It is also used as a mild epithet indicating small, mean or disgusting.

(W. L. J.)

LOUTH, a maritime county in the province of Leinster, Eire, bounded northeast by Carlingford bay and Co. Down, east by the Irish sea, southwest by Meath, and northwest by Monaghan and Armagh. It is the smallest county in Ireland, its area being 202,814 ac. or about 317 sq.mi. Pop. (1936) 64,339.

Much of the county is occupied by an undulating lowland of much-folded Silurian shales and fine-grained sandstones; but carboniferous limestone overlies these rocks north and east of Dundalk. Igneous rocks form a mountainous promontory, approaching 2,000 ft. in height on the border of Carlingford lough. A raised beach provides a flat terrace at Greenore. As in the adjacent parts of Armagh and Monaghan, lead is worked.

Apart from the promontory of Clogher head, which rises abruptly to 180 ft., the coast is mostly low and sandy. Carlingford lough is navigable beyond the limits of the county, and Carlingford and Greenore are watering places on the Co. Louth shore. The Bay of Dundalk stretches to the town of that name and affords convenient shelter.

The principal rivers, the Fane, the Lagan, the Glyde and the Dee, flow eastward. The Boyne is navigable for large vessels as far as Drogheda.

The territory which afterward became Co. Louth was included in the principality of Uriel, Orgial or Argial, which embraced also the greater part of Meath, Monaghan and Armagh. The chieftain of the district was conquered by John de Courcy in 1183, and Louth or Uriel was among the shires generally considered to have been created by King John, and peopled by English settlers. Until the time of Elizabeth it was included in the province of Ulster. The cromlech of Ballymascanlan lies between Dundalk and Greenore. Danish raths and other forts are numerous. The most interesting monastic ruins are at Monasterboice and Mellifont, both near Drogheda. At the former site are two churches, the larger dating probably from the 9th century, the smaller from the 13th; a round tower, 110 ft. high, and three crosses, two decorated. Ardee, incorporated in 1376, has a 13th century castle. At Dunbar a charter of Charles II (1679) granted the right to elect a sovereign. Louth, $5\frac{1}{2}$ mi. S.W. from Dundalk, gave its name to the county, and contains ruins of an abbey to which was attached one of the most noted early schools in Ireland.

In the lower regions the soil is a rich deep mould, adapted for cereals and green crops. Agriculture generally is in an advanced condition, and the farms are well drained. Oats, barley, flax, potatoes and turnips are cultivated. Cattle, sheep, pigs and poultry represent the bulk of the live stock. Linen manufactures are of some importance. The deep-sea and coast fishery has its headquarters at Dundalk, and the salmon fisheries at Dundalk (Castletown river) and Drogheda (River Boyne). The county is traversed by the Great Northern railway; while Dundalk is connected with Greenore by the L.M.S. railway. From Greenore passenger steamers run regularly to Holyhead. Ardee is served by a branch from the Great Northern line at Dromin. Louth returns three members to Dáil Eireann.

LOUTH, a market town and municipal borough in the Parts of Lindsey and the Louth parliamentary division of Lincolnshire, England, on the River Lud, $141\frac{1}{2}$ mi. N. of London by the L.N.E. Ry. Pop. (1938) 9,747. Area, 4.39 sq.mi. Louth is first mentioned in the Domesday record as a borough held, as it had been in Saxon times, by the bishop of Lincoln who had a market there. The see surrendered the manor to Henry VIII, who granted it to Edward, earl of Lincoln; it was recovered by the crown before 1562. Louth owed its early prosperity to the adjacent Cistercian abbey, founded in 1139 by Alexander, bishop of Lincoln. A manor court under the presidency of the bishop's high steward governed the town, the custom being for the reeve to be elected by 18 exreeves. During the 13th and 14th centuries nine religious guilds were founded in the town. Louth has never been a parliamentary borough. The markets said to have been held from ancient times and the three fairs on the third Sunday after Easter and the feasts of St. Martin and St. James were confirmed in 1551. Louth was a seat of the wool trade as early as 1297. The Perpendicular church of St. James was completed about 1515. The grammar school was refounded and endowed by Edward VI in 1551. The industries include the manufacture of agricultural implements, malting, bone crushing and lime burning.

LOUVAIN (Flem. *Leuven*), a town of Belgium in the province of Brabant, of which it was the capital in the 14th century before the rise of Brussels. Pop. (est. 1939) 36,971. Local tradition attributes the establishment of a camp here to Julius Caesar, but Louvain only became important in the 11th century as a residence for the dukes of Brabant. In 1356 Louvain was the scene of the famous *Joyeuse Entrée* of Wenceslas, the principal charter of Brabant. At that time it had a population of at least 50,000 and was the centre of the wool trade in central Belgium. The guild of weavers numbered 2,400 members. The old walls of Louvain, $4\frac{1}{2}$ mi. in circumference, have been replaced by boulevards, but within them is much cultivated ground. Soon after the *Joyeuse Entrée* a feud began between citizens and patricians, and eventually the duke threw in his lot with the latter. After a struggle of over twenty years' duration the White Hoods, as the citizens called themselves, were crushed. In 1379 they massacred seventeen nobles in the town hall, but this brought the vengeance of the duke, to whom in 1383 they made the most abject surrender. Many weavers fled to Holland and England, the duke took up residence in the strong castle of Vilvorde, and Brussels prospered at the expense of Louvain. What it lost in trade it partially recovered as a seat of learning, for in 1426, Duke John IV of Brabant founded there a university, and ever since Louvain university has enjoyed the first place in Belgium. It has always prided itself most on its theological teaching. In 1432 the university was established in the old Cloth Workers' Hall, a building dating from 1317, with long arcades and graceful pillars supporting the upper stories. In the 16th century there were 6,000 students, and four residential colleges are attached to the university. The aula and the university library were burnt in the German invasion of 1914. A new library was built (1921–28) by gifts from citizens of the United States, and books and fittings came from many nations. The library had more than 600,000 volumes. It was again destroyed by fire during the German attack in May 1940. The town hall is one of the richest examples of pointed Gothic. Mathieu de Layens, master mason, built it (1448 to 1463) in three stories, each with ten pointed windows facing the square.

The church of St. Peter (1425–97), damaged in 1914, was restored. It has seven chapels, in two of which are fine pictures by Dierik Bouts formerly attributed to Memling. Much of the iron and brass work is by Jan Matsys. There are other interesting churches in Louvain, viz., Ste. Gertrude, St. Quentin, St. Michael and St. Jacques, the last with a fine De Crayer (St. Hubert).

LOUVER, LOUVRE or **LUFFER,** in architecture, originally a lantern or cupola built on the ridge of the roof of the great hall of a mediaeval house to let out the smoke; now generally applied to a system of slanting boards, sheets of metal or glass, or other material, so arranged in an opening as to permit the entrance or egress of air without admitting rain. Louvers, usually of copper, are almost universal at exterior vents and intakes of modern ventilating systems; on a much larger scale, and in wood, they are frequent in the arched openings of church belfries.

LOUVET DE COUVRAI, JEAN BAPTISTE (1760–1797), French writer and politician, was born in Paris on June 12, 1760. He became a bookseller's clerk, and published two novels, *Les Amours du chevalier de Faublas* (1787–89), and *Emilie de Varmont,* which attracted some attention. *Paris justifié,* a reply to Mounier's proposal that the court should be established elsewhere (Oct. 1789), led to Louvet's election to the Jacobin club, and he energetically opposed the moderate constitutional royalty advocated by Lafayette and others. On Dec. 25, 1791 he presented at the bar of the assembly his *Pétition contre les princes.*

Louvet was elected deputy to the assembly, and attached himself to the Girondists, publishing, at Roland's expense, a biweekly *journal-affiche* called *La Sentinelle* (March-Nov. 1792). On Aug. 10 he became editor of the *Journal des Débats,* in which he violently attacked Robespierre, Marat and the other Montagnards. His violent invective, coupled with his courageous attitude at the trial of Louis XVI, discredited the Girondists, and he fled after the crisis of May 31, 1793. (*See* GIRONDISTS.)

After Robespierre's fall, Louvet was recalled to the convention and elected a member of the committee of the constitution, president of the assembly, and a member of the committee of public safety. He advocated union among republicans in *La Sentinelle,* which he revived. Under the directory (1795) he was elected member and secretary of the Council of Five Hundred. The bookseller's shop which he had again set up in the Palais Royal was attacked, and Louvet and his wife again fled from Paris. He was appointed consul at Palermo, but died on Aug. 25, 1797, before taking up his post.

Louvet published a part of his memoirs in 1795 under the title *Quelques notices pour l'histoire et le récit de mes périls depuis le 31 mai 1793,* giving a vivid picture of the sufferings of the proscribed Girondists. The first complete edition was published in 1889, ed. F. A. Aulard, *Mémoires de Louvet de Couvrai.*

LOUVIERS, a town of France, in the department of Eure, 17½ mi. S.S.E. of Rouen. Pop. (1936) 9,744. Louviers was originally a *villa* of the dukes of Normandy and in the middle ages belonged to the archbishops of Rouen; its cloth-making industry arose in the beginning of the 13th century. It changed hands many times during the Hundred Years' War, and from Charles VII it received extensive privileges, and the title of Louviers le Franc for the bravery of its inhabitants in driving the English from Pont de l'Arche, Verneuil and Harcourt. It passed through various troubles successively at the period of the League of the Public Weal under Louis XI, in the religious wars (when the parlement of Rouen sat for a time at Louviers) and in the wars of the Fronde. Louviers lies on the Eure. The old part of the town is built of wood; the more modern portions, in brick and hewn stone. The Gothic church of Notre-Dame has a south portal of the 15th century; it contains stained glass of the 15th and 16th centuries. The chief industries are cloth, fancy goods and flannel, leather-work, metal and bell founding.

LOUVOIS, FRANÇOIS MICHEL LE TELLIER, MARQUIS DE (1641–1691), French statesman, war minister of Louis XIV, was born at Paris on Jan. 18, 1641. He was the son of Michel le Tellier, whom he succeeded as war minister in 1666. His talents were perceived by Turenne in the war of Devolution (1667–68), who gave him instruction in the art of providing armies. After the peace of Aix-la-Chapelle, Louvois organized the French army. The work of Louvois in the years 1668–72 is bound up with the historical development of the French army and of armies in general. (*See* ARMY.) Louvois reorganized the military orders of merit, founded the Hôtel des Invalides, and enrolled the nobility and gentry of France for service in the army or at court. The success of his measures is to be seen in the victories of the great war of 1672–78. After the peace of Nijmwegen Louvois was high in favour, his father had been made chancellor, and the influence of Colbert was waning. The surprise of Strassburg in 1681 in time of peace was planned and executed by Louvois and Monclar.

A saving clause in the revocation of the Edict of Nantes, which provided for some liberty of conscience, if not of worship, Louvois sharply annulled. He claimed the credit of inventing the dragonnades, and mitigated their rigour only in so far as licence was prejudicial to discipline. Colbert died in 1683, and Louvois took the ministry for public buildings. Louvois died suddenly on July 16, 1691. Louvois was a war minister only equalled by Carnot. Both organized old armies on a new system, both were admirable contrivers of campaigns, and both devoted themselves to the material well-being of the soldiers. In private life and in the means employed for gaining his ends, Louvois was unscrupulous. His sudden death caused a suspicion of poisoning.

The principal authority for Louvois's life and times is Camille Rousset's *Histoire de Louvois* (1872), a great work founded on the 900 volumes of his despatches at the Depôt de la Guerre. Saint-Simon from his class prejudices is hardly to be trusted, but Madame de Sévigné throws many side lights on his times. *Testament politique de Louvois* (1695) is spurious; L. André, *M. Le Tellier de Louvois et l'organisation de l'armée monarchique* (1906).

LOUYS, PIERRE (1870–1925), French novelist and poet, was born at Paris on Dec. 10, 1870. When he was 19 he founded a review, *La Conque,* which brought him into contact with the leaders of the Parnassians, and counted Swinburne, Maeterlinck, Mallarmé and others among its contributors. He won notoriety by his novel *Aphrodite* (1896), which gave a vivid picture of Alexandrian morals at the beginning of the Christian era. His *Chansons de Bilitis, roman lyrique* (1894), which purported to be a translation from the Greek, is a glorification of Sapphic love, whose delicate decadent prose is typical of a modern French literary school. Some of the "songs" were set to music by Debussy and others. Later books are: *La Femme et le pantin* (1898); *Les Aventures du roi Pausole* (1900); *Sanguines* (1903); *Archipel* (1906). He died on June 4, 1925.

See Gaubert, *Pierre Louys* (1904).

LOVAT, SIMON FRASER, 12TH BARON (*c.* 1667–1747), Scottish chief and Jacobite intriguer, was born about 1667 and was the second son of Thomas Fraser, third son of the 8th Lord Lovat. Young Simon was educated at King's College, Aberdeen, and one of his first acts on leaving college was to recruit 300 men from his clan to form part of a regiment in the service of William and Mary, in which he himself was to hold a command. Among other outrages in which he was engaged about this time was a rape and forced marriage committed on the widow of the 10th Lord Lovat with the view apparently of securing his own succession to the estates. A prosecution having been instituted against him by Lady Lovat's family, Simon retired first to the Highlands, and afterward (1702) to the court of St. Germain.

He planned to land 5,000 French troops at Dundee, where they might reach the northeastern passes of the Highlands in a day's march, and divert the British troops till the Highlands should have time to rise. Immediately afterward 500 men were to land on the west coast, seize Fort William or Inverlóchy, and thus prevent the access of any military force from the south to the central Highlands. His plan was continuously kept in view in all future attempts of the Jacobites, and finally acted on in the outbreak of 1745. Lovat was despatched (1703) on a secret mission to ascertain what forces the chiefs might bring into the field. He found little disposition to rebellion, and he then decided to reveal all that he knew to the government of Queen Anne. He persuaded the duke of Queensberry that his rival, the duke of Atholl, was in the Jacobite plot, and that if Queensberry supported him he could obtain evidence of this at St. Germain. Queensberry foolishly entered into the intrigue with him against Atholl, but when Lovat had gone to France with a pass from Queensberry the affair was betrayed to Atholl by Robert Ferguson, and resulted in Queensberry's discomfiture. The story is obscure, and is complicated by partisanship on either side; but Lovat was certainly playing a double game. Suspicions got afloat as to Lovat's proceedings, and on his return to France he was imprisoned in the castle of Angoulême. He remained nearly ten years under supervision, until in Nov. 1714 he made his escape to England.

For about 25 years after this he was chiefly occupied in lawsuits for the recovery of his estates and the re-establishment of his fortune. The intervals were filled by Jacobite and Anti-Jacobite intrigues, in which he betrayed both parties. When the rebellion of 1745 broke out, Lovat represented to the Jacobites that his weak health and advanced years prevented him from joining the standard of the prince in person, while to the Lord President Forbes he professed his cordial attachment to the house of Hanover, and expressed regret that his son had joined the Pretender and taken with him a strong force from the clan of the Frasers. The truth was that the lad was unwilling to go, but was compelled by his father. After the battle of Culloden he was obliged to retreat to the Highlands. Lovat, after enduring extreme hardships in his wanderings, was at last arrested on an island in Loch Morar. He was conveyed in a litter to London, and after a trial of five days sentence of death was pronounced on March 19, 1747. He was beheaded on April 9.

His son SIMON FRASER, Master of Lovat (1726–1782) (not to be confused with another Simon Fraser who saw somewhat similar service and was killed in 1777 at the battle of Saratoga), was a soldier, who at the beginning of the Seven Years' War raised a corps of Fraser Highlanders for the English service, and at the outbreak of the U.S. War of Independence raised another regiment which took a prominent part in it. He fought under Wolfe in Canada, and also in Portugal, and rose to be a British major-general. The family estates were restored to him, but the title was not revived until 1837.

See *Memoirs of Lord Lovat* (1746 and 1767); J. Hill Burton, *Life of Simon, Lord Lovat* (1847); J. Anderson, *Account of the Family of Frizell or Fraser* (Edinburgh, 1825); A. Mackenzie, *History of the Frasers of Lovat* (Inverness, 1896); Mrs. A. T. Thomson, *Memoirs of the Jacobites* (1845–46); and W. C. Mackenzie, *Simon Fraser, Lord Lovat* (1908); *Papers relating to Simon, Lord Lovat* edited by J. R. N. Macphail (1924).

LOVEBIRD, a name bestowed, chiefly by dealers and their customers, on some of the smaller short-tailed parrots, from the affection which examples of opposite sexes exhibit towards each other. They belong to the genera *Forpus* (5 spp.) and *Agapornis* (9 spp.), the former being South American, the latter African. One of the birds most commonly called lovebird, which, however, bears no near relationship to the above, but is a small, long-tailed parrot, is the budgerigar (*Melopsittacus undulatus*) now familiar throughout the world, being bred by hundreds in aviaries. Its native country is Australia. (*See* BUDGERIGAR.)

LOVEDALE, a mission station in the Victoria East division of the Cape province, South Africa. It lies 1,720 ft. above the sea on the banks of the Tyumie (Chumie) tributary of the Keiskama river, some 2 mi. N. of Alice, a town 88 mi. N.W. by rail of East London. The station was founded in 1824 by the Glasgow Missionary Society and was named after Dr. John Love, one of the leading members of the society.

Until 1841 the missionaries devoted themselves almost entirely to evangelistic work; in that year the Lovedale Missionary Institute was founded by the Rev. W. Govan, who, save for brief intervals, continued at its head until 1870. He was then succeeded by the Rev. James Stewart (1831–1905), who had joined the mission in 1867, having previously (1861–63), and partly in company with David Livingstone, explored the Zambezi regions. To Stewart, who remained at the head of the institute till his death, is due the existing organization at Lovedale. The institute, in addition to its purely church work—in which no sectarian tests are allowed—provides for the education of natives of both sexes in nearly all branches of learning (Stewart discontinued the teaching of Greek and Latin, adopting English as the classic); it also takes European scholars, no colour distinction being allowed in any department of the work.

The institute gives technical training in many subjects and maintains various industries, including such diverse enterprises as farming and printing-works. It also maintains a hospital. The school buildings rival in accommodation and completeness those of the schools in large English cities. The educational and industrial methods initiated at Lovedale have been widely adopted by other missionary bodies. Lovedale is now a branch of the work of the United Free Church of Scotland. The institute had approximately 900 students in 1938.

See R. Young, *African Wastes Reclaimed and Illustrated in the Story of the Lovedale Mission* (1902); J. Stewart, *Lovedale, Past and Present* (1884), and *Dawn in the Dark Continent* (1903); J. Wells, *Stewart of Lovedale* (1908).

LOVEJOY, ELIJAH (1802–1837), U.S. abolitionist, was born at Albion, Me., on Nov. 9, 1802, and graduated at Waterville college in 1826. The following year he moved to St. Louis, Mo., where he established a school and entered journalism. Later he began to publish a religious paper called *The Observer* in which he strongly condemned slavery and recommended gradual emancipation. A letter in 1835 signed by a number of the important men of St. Louis requested him to moderate the tone of his editorials. He replied in an editorial reiterating his views and his right to publish them. Threats of mob violence forced him to move his press across the Mississippi river to Alton, Ill. There his press was destroyed by mobs several times in one year, and on the night of Nov. 7, 1837, when a mob attacked the building, Lovejoy was killed in its defense. The news of his death stirred the people of the north profoundly and led greatly to the strengthening of abolitionist sentiment.

LOVELACE, RICHARD (1618–1658), English poet, was born at Woolwich in 1618. His father, Sir William Lovelace, had served in the Low Countries, received the honour of knighthood from James I, and was killed at Grolle in 1628. His brother, Francis Lovelace, the "Colonel Francis" of *Lucasta,* served on the side of Charles I, and defended Caermarthen in 1644. His mother's family was legal; her grandfather had been chief baron of the exchequer. Richard was educated at the Charterhouse and at Gloucester hall, Oxford. The course of his life gave him more leisure for verse-making than opportunity of soldiering. Before the outbreak of the civil war in 1642 his only active service was in the bloodless expedition which ended in the Pacification of Berwick in 1640. He then inherited the family estates at Bethersden, Canterbury, Chart and Halden in Kent. He was already one of the most distinguished of the courtly poets gathered round Queen Henrietta. When the rupture between king and parliament took place, Lovelace was committed to the Gatehouse at Westminster for presenting to the Commons in 1642 a petition from Kentish royalists in the king's favour. It was then that he wrote his most famous song, "To Althea from Prison." He was liberated, says Wood, on bail of £40,000 (more probably £4,000), and throughout the civil war was a prisoner on parole, with this security in the hands of his enemies. Nevertheless he provided his two brothers with money to raise men for the Royalist army, and befriended many of the king's adherents.

Lovelace was generous to scholars and musicians, and among his associates in London were Henry Lawes and John Gamble, the Cottons, Sir Peter Lely, Andrew Marvell and probably Sir John Suckling. He joined the king at Oxford in 1645, and after the surrender of the city in 1646 he raised a regiment for the service of the French king. He was wounded at the siege of Dunkirk, and with his brother Dudley, who had acted as captain in his brother's command, returned to England in 1648. It is not known whether the brothers took any part in the disturbances in Kent of that year, but both were imprisoned at Petre House in Aldersgate. During this second imprisonment he collected and revised for the press a volume of occasional poems, many if not most of which had previously appeared in various publications.

The volume was published in 1649 under the title of *Lucasta,* his poetical name—contracted from *Lux Casta*—for a lady rashly identified by Wood as Lucy Sacheverell, who, it is said, married another during his absence in France, on a report that he had died of his wounds at Dunkirk. The last ten years of Lovelace's life were passed in obscurity. His fortune had been exhausted in the king's interest, and he is said to have been supported by the generosity of friends. He died in 1658 "in a cellar in Longacre," according to Aubrey, who, however, possibly exaggerates his poverty. A volume of Lovelace's *Posthume Poems* was published in 1659 by his brother Dudley. They are of inferior merit to his own collection.

We have only to compare the version of any poem in *Lucasta* with the form in which it originally appeared to see how fastidious was Lovelace's revision. The expression is often elliptical, the syntax inverted and tortuous, the train of thought intricate and discontinuous. These faults—they are not of course to be found in his two or three popular lyrics, "Going to the Wars," "To Althea from Prison," "The Scrutiny"—are, however, as in the case of his master, Donne, the faults not of haste but of over-elaboration. His thoughts are not the first thoughts of an improvisatore, but thoughts 10 or 20 stages removed from the first, and they are generally as closely packed as they are far-fetched.

His poems were edited by W. C. Hazlitt in 1864. *See* C. H. Hartmann, *The Cavalier Spirit and its influence on the life and work of Richard Lovelace,* 1618–1658 (1925).

LOVELAND, a city of Larimer county, Colorado, U.S.A., 52 mi. N. by W. of Denver, and 33 mi. E. of Estes park and the Rocky Mountain National park, *via* the picturesque cañon of the Big Thompson river. It is on federal highway 285, and is served by the Colorado and Southern and the Great Western railways. The population was 5,065 in 1920 (90% native white), and was 6,145 in 1940 by federal census. Grazing and the cultivation of fruits and sugar-beet are the specialties of the fertile surrounding country. Coal is mined 25 mi. S.E. The city has one of the largest beet-sugar factories in the country, a large flour mill, pea-canning plants and several other manufacturing industries. It was settled about 1869, and incorporated in 1877.

LOVELL, FRANCIS LOVELL, VISCOUNT (1454–?1487), English politician, was a son of John, 8th Baron Lovell. As a young man he served under Richard of Gloucester in the expedition to Scotland in 1480. He had been created a viscount on Jan. 4, 1483, and whilst still Protector Richard made him chief butler. As soon as Richard became king, Lovell was promoted to be lord chamberlain. Lovell helped in the suppression of Buckingham's rebellion, and as one of Richard's most trusted ministers was gibbeted in Collingbourne's couplet with Catesby and Ratcliffe:—

The catte, the ratte and Lovell our dogge
Rulyth all England under a hogge.

He had command of the fleet which was to have stopped Henry Tudor's landing in 1485, but fought for Richard at Bosworth and after the battle fled to sanctuary at Colchester. Thence he escaped next year to organize a revolt in Yorkshire. When that failed he fled to Margaret of Burgundy in Flanders. As a chief leader of the Yorkist party he had a foremost part in Lambert Simnel's enterprise. With John de la Pole, earl of Lincoln, he accompanied the pretender to Ireland and fought for him at Stoke on June 16, 1487. He was seen escaping from the battle, but was never afterward heard of. More than 200 years later, in 1708, the skeleton of a man was found in a secret chamber in the family mansion at Minster Lovell in Oxfordshire. It is supposed that Francis Lovell had hidden himself there and died of starvation.

Collingbourne's couplet is preserved by Fabyan, *Chronicle,* p. 672. For the discovery at Minster Lovell see *Notes and Queries,* 2nd ser. i and 5th ser. x.

LOVER, SAMUEL (1797–1868), Irish novelist, artist, songwriter and musician, was born in Dublin on Feb. 24, 1797. Lover began life as an artist, and was elected in 1828 a member of the Royal Hibernian academy. His love for music showed itself at an early age. At a dinner given to the poet Tom Moore in 1818 Lover sang one of his own songs, which elicited special praise from Moore. One of his best-known portraits was that of Paganini, which was exhibited at the Royal academy. He went to London about 1835, where his gifts rendered him popular in society; and he appeared often at Lady Blessington's evening receptions. There he sang several of his songs, later published as *Songs and Ballads,* 1839. Lover wrote some popular novels, among them *Rory O'More, a National Romance* (1837) and *Handy Andy, an Irish Tale* (1842). In 1844 he began to give entertainments, "Irish Evenings," illustrative of his own works. He died on July 6, 1868.

His *Life* was written in 1874 by Bayle Bernard.

LOVERE, a town of Lombardy, Italy, province of Bergamo, at the north-west end of the Lago d'Iseo, 522 ft. above sea level. Pop. (1936) 4,653 (town), 5,099 (commune). The houses have wooden Swiss roofs with Italian stone arcades; the situation is beautiful, with the lake in front and the semicircle of bold mountains behind. The church of Santa Maria in Valvendra, built in 1474, has frescoes by Floriano Ferramola of Brescia (d. 1528). The Palazzo Tadini contains a gallery of old pictures. Lovere possesses a silk-spinning factory, and the Stablimento Metallurgico Gregorini. Lovere is reached by steamer from Sarnico at the south end of the lake, or from Pisogne at the north, which is a station on the railway from Brescia and Iseo.

LOW, SETH (1850–1916), U.S. municipal and educational administrator, was born in Brooklyn, N.Y., on Jan. 18, 1850. Of New England descent, he displayed on municipal reform and the development of a great university the energy his ancestors had used in conquering the Indians, fighting the British, and building up a fleet of clipper ships in the romantic days of the China trade. After studying at the Polytechnic institute of Brooklyn and at Columbia college, from which he graduated as valedictorian in 1870, he entered his father's tea and silk importing house, but early interested himself in the problem of better government. Twice elected mayor of Brooklyn, he made his terms (1882–85) memorable for efficiency, honesty and strict reliance upon merit. Chosen by his fellow-trustees president of Columbia in 1889, by his broad vision, his business administration and his liberality, he did much to change it from a college to a well-organized university. It was removed to a new site on Morningside Heights, where the central building was the beautiful memorial library given by the president; it added, or became more closely affiliated to, many of the colleges and institutions now within its organization; its curriculum was expanded; it became less local in character. Low resigned to become mayor of greater New York (1901–03), and although defeated for re-election continued to devote himself and his fortune to the service of the public. He was a delegate to The Hague Peace conference in 1899; was prominent as an arbitrator in labour disputes, especially after he became president of the National Civic federation (1907); was president of the New York chamber of commerce (1914), and received many other honours. He died at Bedford Hills, N.Y. on Sept. 17, 1916.

See B. R. C. Low, *Seth Low* (1925), and articles stressing different phases of his career in the *Columbia Alumni News* (vol. 8, Oct. 20, 1916).

LOWBOY, a small table with one or two rows of drawers, so called in contradistinction to the tallboy, or double chest of drawers. Both were favourite pieces of the 18th century, both in England and America; the lowboy was most frequently used as a dressing-table, but sometimes as a side-table. It is usually made of oak, walnut or mahogany, with brass handles and escutcheons. The more elegant examples of the Chippendale period have cabriole legs, claw-and-ball feet and carved knees, and are sometimes sculptured with the favourite shell *mótif* beneath the centre drawer.

LOWDEN, FRANK ORREN (1861–1943), U.S. lawyer, farmer and politician, was born at Sunrise City (Minn.), on Jan. 26, 1861, the son of Lorenzo Orren and Nancy Elizabeth (Breg) Lowden. He was educated at the public schools of Point Pleasant (Ia.), assisting his father with farm work during the summer. At 15 he began teaching in Hardin county (Ia.), while he prepared for college. He graduated from Iowa State university with scholastic honours in 1885 and taught for a year in the high schools of Burlington (Ia.). In July 1886 he began the study of law in Chicago, and at the Union College of Law, from which he graduated, again with honours, in 1887. In 1890 he formed a partnership with Emery S. Walker; in 1892 a second one with William B. Keep. He married Florence, daughter of George M. Pullman of Chicago, on April 29, 1896. In March 1898 he became a member of the firm of Lowden, Estabrook and Davis and continued the practice of law until 1906. After that time he was actively engaged in farming and cattle raising at his home, Sinnissippi Farm, Oregon (Ill.).

He was a delegate to the Republican national convention, 1900–04; a member of the Republican national committee, 1904–12, and a member of the executive committee for the campaigns of 1904 and 1908. He was elected to the 59th congress to fill the unexpired term of R. R. Hitt, on Nov. 6, 1906 and re-elected to the 60th and 61st congresses (1907–11) from the 13th Illinois district.

From 1917 to 1921 he was governor of Illinois. He received 311½ votes for the presidential nomination in the Republican national convention in 1920.

He was president of the Holstein-Friesian Association of America, director of the International Live Stock Exposition, National Dairy association, National Dairy council and other farm organizations, and actively associated with various national welfare movements. He was a lecturer, and contributor to newspapers and magazines on many branches of agriculture, and devoted much time toward the advancement of co-operative marketing of farm products. He was unanimously nominated for vice-president of the United States in the Republican national convention of 1924, and declined the nomination.

He was the author of "Too Much Government," *World's Work,* (Dec. 1926); "Our Governing Machine Halts and Creaks," New York *Times* (Dec. 27, 1925); "The American Farmer's Problem," *Review of Reviews* (July 1927); and a series of articles concerning farm life in Denmark and Sweden, appearing in *The Farmer,* St. Paul (Minn.), Nov.-Dec., 1926, and in numerous standard agricultural publications. He died in Tucson, Ariz., March 20, 1943.

LOWE, SIR HUDSON (1769–1844), English general, was the son of an army surgeon, John Lowe, and was born at Galway on July 28, 1769 and was gazetted ensign in his 12th year. After the outbreak of war with France early in the year 1793, Lowe was almost continuously on active service, holding many important commands, throughout the Napoleonic Wars. Charged with the duties of quartermaster-general of the army in the Netherlands in 1814–15, he was about to take part in the Belgian campaign when he was offered the command of the British troops at Genoa; but while still in the south of France he received (on Aug. 1, 1815) news of his appointment to the position of custodian of Napoleon, who had surrendered to H.M.S. "Bellerophon" off Rochefort. Lowe was to be governor of St. Helena, the place of the ex-emperor's exile.

Friction soon arose between Lowe and his prisoner. The news that rescue expeditions were being planned by the Bonapartists in the United States led to the enforcement of stricter regulations in October 1816, Lowe causing sentries to be posted round Longwood garden at sunset instead of at 9 P.M. He was accused of unnecessary harshness in carrying out his instructions. It may, however, be noted that Lowe recommended that the government allowance of £8,000 a year to the Longwood household should be increased by one-half. After the death of Napoleon in May 1821, Lowe returned to England and received the thanks of George IV. In 1825–30 he commanded the forces in Ceylon, but was not appointed to the governorship when it fell vacant in 1830. In 1842 he became colonel of his old regiment, the 50th; he also received the G.C.M.G. He died in 1844.

See W. Forsyth, *History of the Captivity of Napoleon at St. Helena* (3 vols., London, 1853); Gourgaud, *Journal inédite de Sainte-Hélène* (1815–18; 2 vols., Paris, 1899); R. C. Seaton, *Napoleon's Captivity in relation to Sir Hudson Lowe* (London, 1903); Lieut.-Col. Basil Jackson, *Notes and Reminiscences of a Staff-Officer* (London, 1903); the earl of Rosebery, *Napoleon; the Last Phase* (London, 1900); J. H. Rose, *Napoleonic Studies* (London, 1904); *see* also NAPOLEON I.

LOWELL, ABBOTT LAWRENCE (1856–1943), American educator, was born in Boston, Mass., on Dec. 13, 1856, of an old New England stock in which public service, business enterprise and devotion to civic, intellectual and religious concerns were almost hereditary. He graduated from Harvard college in 1877 with highest honours in mathematics, and Harvard law school in 1880. He practised law 1880–97 in partnership with his cousin, Francis Cabot Lowell, with whom he wrote *The Transfer of Stock in Corporations* (1884). He was a lecturer at Harvard from 1897–99, and became professor of science and government 1900–09. In 1909 he succeeded Charles William Eliot as president of the university. During his 24 years as president, he distinguished himself as administrator, established the Graduate School of Business Administration, and introduced the tutorial system and house plan. Long before retiring from Harvard in 1933 he became a trustee of the Lowell Institute of Boston (1900), president of the American Political Science association for 1909, and of the League to Enforce Peace. President Lowell was a strong supporter of the League of Nations. His books include *Essays on Government* (1889); *Governments and Parties in Continental Europe* (1896; abridged and revised as *The Governments of France, Italy and Germany,* 1914); *Public Opinion in War and Peace* (1923); *Greater European Governments* (1925), and *Public Opinion and Popular Government* (1926). He died in Boston, Mass., Jan. 6, 1943.

LOWELL, AMY (1874–1925), American poet, critic and lecturer, was born on Feb. 9, 1874 in Brookline, Mass., a sister of Abbott L. and Percival Lowell. She came of a line of public-spirited lawyers and men of affairs, who for three generations had been, like herself, lovers and planters of gardens. She received her education from her mother, who was an accomplished musician and linguist, and from private schools. Later she travelled abroad. After her father's death in 1900 she occupied herself with municipal affairs, until "about 1902," she writes, "I discovered that poetry . . . was my natural mode of expression. And from that moment I began to devote myself to it seriously." But she published nothing until 1910, when her first published poem appeared in the *Atlantic Monthly.* Her first volume, *A Dome of Many Coloured Glass,* is dated 1912. Thereafter her books followed each other in rapid succession: *Sword Blades and Poppy Seeds* (1914); *Six French Poets: Studies in Contemporary Literature* (1915); *Men, Women and Ghosts* (1916); *Tendencies in Modern American Poetry* (1917); *Can Grande's Castle* (1918); *Pictures of the Floating World* (1919); *Legends* (1921); *Fir-Flower Tablets* (1921), with Florence Ayscough; *A Critical Fable* (1922); *John Keats* (1925); *What's o'Clock* (1925); *East Wind* (1926) and *Ballads For Sale* (1927). During all this period Miss Lowell contributed critical articles to various magazines and frequently lectured. In 1920 she received the degree of Litt.D. from Baylor university. She had suffered from a serious malady for years, and on the eve of a visit to England, during which she was to have lectured at Oxford, Cambridge, Eton, Edinburgh and elsewhere, it became acute, and she died suddenly on May 12, 1925, at Brookline, Mass.

Miss Lowell, during her later years, was the most striking figure in contemporary American poetry. Her vivid and powerful personality, her intellectual vigour and independence and her zest in life gave her a conspicuous and in some respects a unique position. She was an acknowledged leader of the group in America and England which called itself the Imagists. But through all her radicalism ran a strong conservative strain, and she never abandoned conventional verse forms, nor for some years before her death had she been affiliated with any school. Among her contributions to poetry must be reckoned the perfecting, in her best work, of the technique of "free" verse; her almost unrivalled command of the vocabulary of sensuous impressions; the wide range of the themes to which she has given poetical expression, and the clarity and restrained beauty of many of her shorter poems. Her most important critical work, the result of long and devoted labour, is the biography of Keats, which essays to reinterpret him as "a new generation of poets and critics" regards him.

See biographical and critical accounts exclusive of articles in periodicals, by W. Bryker (1918), H. W. Cook (1923), R. Hunt and R. H. Snow (1921), E. S. Sergeant (1927), C. Wood (1926), S. F. Damon etc.; J. L. Lowes edited *Selected Poems of Amy Lowell* (1928); S. F. Damon, *Amy Lowell* (1935). (J. L. L.)

LOWELL, JAMES RUSSELL (1819–1891), American author and diplomatist, was born at Elmwood, in Cambridge (Mass.), Feb. 22, 1819, the son of Charles and Harriet Lowell. He was brought up near the open country and was early initiated into the reading of poetry and romance—Spenser, Scott, and old ballads. He was a wide reader but a somewhat indifferent student, graduating at Harvard without special honours in 1838. He wrote a number of pieces for the college magazine, and shortly after graduating printed for private circulation his class poem.

After some vacillation he took a course at the Harvard Law School and was admitted to the bar in 1840. He did not care for the law, yet he had little encouragement to trust to writing for self-support. The course of his life was deeply affected by the influence of Maria White, to whom he was betrothed. She was a poet of delicate power, but also possessed a lofty enthusiasm, a high conception of purity and justice, and a practical temper, which led her to concern herself with the temperance and abolition movements. The first-fruit of this passion was a volume of poems, *A Year's Life* (1841), which was inscribed by Lowell in a veiled dedication to his future wife. The betrothal, moreover, stimulated Lowell to new efforts towards self-support, and, though nominally maintaining his law office, he threw his energy into the establishment, with a friend, Robert Carter, of a literary journal, the *Pioneer*. It was to open the way to new ideals in literature and art, and the writers to whom Lowell turned for assistance—Hawthorne, Emerson, Whittier, Poe, Story, and Parsons, none of them then possessing a wide reputation—indicate the acumen of the editor. Lowell himself had already turned his studies in dramatic and early poetic literature to account in another magazine, and continued the series in the *Pioneer*, besides contributing poems; but after the issue of three monthly numbers, beginning in Jan. 1843, the magazine came to an end.

The venture confirmed Lowell in his bent towards literature. At the close of 1843 he published a collection of his poems, and a year later he gathered up certain material which he had printed, sifted and added to it, and produced *Conversations on Some of the Old Poets*. The book reflects Lowell's interest in reform as well as literature, for the conversations relate only partly to the poets and dramatists of the Elizabethan period; a slight suggestion sends the interlocutors off on the discussion of current topics. Just as this book appeared Lowell and Miss White were married. They spent the winter and early spring of 1845 in Philadelphia, where Lowell had a regular engagement as an editorial writer on the *Pennsylvania Freeman*. In the spring of 1845 the Lowells returned to Cambridge and made their home at Elmwood. On the last day of the year their first child, Blanche, was born; but she, like the third, Rose, died in infancy. A second daughter, Mabel, lived to survive her father. His mother's clouded mind and his wife's frail health, together with a narrow income, conspired to make Lowell almost a recluse in these days. Nevertheless he contributed poems to the daily press, called out by the slavery question; he was, early in 1846, a correspondent of the London *Daily News;* and in the spring of 1848 he formed a connection with the *National Anti-Slavery Standard* of New York, by which he agreed to furnish weekly either a poem or a prose article. The poems were most frequently works of art; occasionally they were tracts; but the prose was almost exclusively concerned with the public men and questions of the day, and forms a series of incisive, witty, and sometimes prophetic diatribes. It was a period with him of great mental activity, and is represented by four of his books, which stand as admirable witnesses to the Lowell of 1848, namely, the second series of *Poems,* containing among others "Columbus," "An Indian Summer Reverie," "To the Dandelion," and "The Changeling;" *A Fable for Critics,* in which he characterizes in witty verse and with good-natured satire American contemporary writers, including himself; *The Vision of Sir Launfal,* one of his most popular poems; and finally *The Biglow Papers,* which brought him wide fame. The book was not premeditated; a single poem, called out by the recruiting for the abhorred Mexican War, couched in rustic phrase and sent to the *Boston Courier,* had the inspiriting dash and electrifying rat-tat-tat of this new recruiting sergeant in the little army of anti-slavery reformers. Lowell himself discovered what he had done at the same time that the public did, and he followed the poem with eight others either in the *Courier* or the *Anti-Slavery Standard.* He developed four well-defined characters in the process; and his stinging satire and sly humour are so set forth in the vernacular of New England as to give at once a historic dignity to this form of speech. (Later he wrote an elaborate paper to show the survival in New England of the English of the early 17th century.) He embroidered his verse with an entertaining apparatus of notes and mock criticism. Even his index was spiced with wit. The book, a caustic arraignment of the annexation of Texas and the war with Mexico, made a strong impression, and the political philosophy secreted in its lines became a part of household literature.

The death of Lowell's mother and the fragility of his wife's health led Lowell, with his wife, their daughter Mabel and their infant son Walter, to go to Europe in 1851. The early months of their stay were saddened by the death of Walter in Rome and by the news of the illness of Lowell's father. They returned in Nov. 1852, and Lowell published some recollections of his journey, later collected in *Fireside Travels* (1864). He took some part also in preparing an American edition of the *British Poets,* but the low state of his wife's health kept him in an uneasy condition, and when her death (Oct. 27, 1853) released him from the strain of anxiety, there came with the grief a readjustment of his nature and a new intellectual activity. In the winter of 1855 he delivered a course of lectures on English poets before the Lowell Institute in Boston. This first formal appearance as a critic at once gave him a new standing in the community and was the occasion of his election to the Smith Professorship of Modern Languages in Harvard college, then vacant by the retirement of Longfellow. Lowell accepted the appointment, with the proviso that he should have a year of study abroad. He spent his time mainly in Germany, visiting Italy, and increasing his acquaintance with the French, German, Italian and Spanish tongues. He returned to America in the summer of 1856 and entered upon his college duties, retaining his position for 20 years. In 1856 he married Frances Dunlap, who since his wife's death had had charge of his daughter Mabel.

In the autumn of 1857 the *Atlantic Monthly* was established, and Lowell as its first editor at once gave the magazine the stamp of high literature and of bold speech on public affairs. He held this position only till the spring of 1861, but he continued to make the magazine the vehicle of his poetry (including the second or Civil War series of the *Biglow Papers*) and of some prose. More of his prose, however, especially of a political nature, was contributed to the *North American Review,* in the conduct of which he was associated from 1862 to 1872 with Charles Eliot Norton. Both his collegiate and his editorial duties stimulated his critical powers, and the publication in the two magazines, followed by republication in book form, of a series of studies of great authors gave him an important place as a critic. Shakespeare, Dryden, Lessing, Rousseau, Dante, Spenser, Wordsworth, Milton, Keats, Carlyle, Thoreau, Swinburne, Chaucer, Emerson, Pope, Gray—these are the principal subjects of his prose, and the range of topics indicates the catholicity of his taste. He wrote also a number of essays, such as "My Garden Acquaintance," "A Good Word for Winter," "On a Certain Condescension in Foreigners," which were incursions into the field of nature and society. Although the great bulk of his writing was now in prose, he made after this date some of his most notable ventures in poetry. In 1868 he issued the next collection in *Under the Willows and Other Poems,* but in 1865 he had delivered his "Ode Recited at the Harvard Commemoration," and the successive centennial historical anniversaries drew from him a series of stately odes.

In 1877 Lowell was appointed by President Hayes minister resident at the court of Spain. He had a good knowledge of the Spanish language and literature, and his long-continued studies in history and his quick judgment enabled him speedily to adjust himself to these new relations. Some of his despatches to the home government were published in a posthumous volume, *Impressions of Spain.* In 1880 he was transferred to London as American minister, and he remained there till the close of President Arthur's administration in the spring of 1885. As a man of letters he was already well known in England, and he was in much demand as an orator on public occasions, especially of a literary nature; but he also proved himself a sagacious publicist and made himself a wise interpreter of each country to the other. In 1887 he published *Democracy and Other Addresses,* all of which had been delivered in England. The title-address was an epigrammatic confession of political faith as hopeful as it was wise and keen. The close of his stay in England was saddened by the death of his second wife in 1885. After his return to America he made several visits to England. His public life had made him more of a figure in the world; he was decorated with the highest honours Harvard could pay officially, and with degrees of Oxford, Cambridge, St. Andrews, Edinburgh, and Bologna. He issued *Political Essays* and a volume of poems, *Heartsease and Rue,* in 1888, and occupied himself with revising and rearranging his works, which were published in ten volumes in 1890. The last months of his life were attended by illness, and he died at Elmwood, Aug. 12, 1891. After his death his literary executor, Charles Eliot Norton, besides editing his letters, published his *Latest Literary Essays* (1891), *The Old English Dramatists* (1892), and *Last Poems* (1895).

The spontaneity of Lowell's nature is delightfully disclosed in his personal letters. They are often brilliant, and sometimes very penetrating in their judgment of men and books; but the most constant element is a pervasive humour, and this humour, by turns playful and sentimental, is largely characteristic of his poetry, which sprang from a genial temper, quick in its sympathy with nature and humanity. Through his writings and speech and action Lowell impressed himself deeply upon his generation in America, especially upon the thoughtful and scholarly class, who looked upon him as their representative. He attained a permanent place as one of America's most distinguished critics and a poet of assured power. (H. E. S.)

BIBLIOGRAPHY.—The chief editions of Lowell's *Writings* are: the Riverside edition (1890–92); the Standard Library edition (1891–1902); the Elmwood edition (1904) and, printed from the same plates, the Autograph edition (1904). His *Complete Poetical Works* (1896) were edited by H. E. Scudder. Posthumous volumes are: *The Power of Sound: a Rhymed Lecture* (1896); *Lectures on English Poets* (1897); *Early Prose Writings* (1902); *Anti-Slavery Papers* (1902); *Four Poems* (1906); *The Round Table* (1913). The *Letters of James Russell Lowell* (1894) were edited by C. E. Norton. The chief biographies are by E. E. Hale (1899); H. E. Scudder (1901), and Ferris Greenslet (1905). *A Bibliography of James Russell Lowell* (1906) by G. W. Cooke and the *Bibliography* (1914) by L. S. Livingston are helpful. *See* also J. J. Reilly's *James Russell Lowell as a Critic* (1915) and W. H. Hudson's *Lowell and His Poetry* (1911). Some of the outstanding essays on Lowell may be found in W. D. Howells, *Literary Friends and Acquaintances;* Henry James, *Essays in London;* and Alice Meynell, *The Rhythm of Life and Other Essays.*

LOWELL, JOHN (1743–1802), American jurist, was born in Newburyport (Mass.), on June 17, 1743. He graduated at Harvard in 1760, was admitted to the bar in 1763, represented Newburyport (1776) and Boston (1778) in the Massachusetts assembly, and was a member of the Massachusetts constitutional convention of 1779–80. As a member of the committee appointed to draft a constitution, he secured the insertion of the clause, "all men are born free and equal," which was interpreted by the Supreme Court of the State in 1783 as abolishing slavery in the State. In 1781–83 he was a member of the Continental Congress, which in 1782 made him a judge of the court of appeals for admiralty cases; in 1784 he was a member of the New York-Massachusetts boundary commission; in 1789–1801 he was a judge of the United States district court, Massachusetts; and from 1801 until his death in Roxbury on May 6, 1802, he was a justice of the United States circuit court for the first circuit (Maine, New Hampshire, Massachusetts and Rhode Island).

His son, JOHN LOWELL (1769–1840), graduated at Harvard in 1786, was admitted to the bar in 1790 and retired from active practice in 1803. He opposed French influence and the policies of the Democratic party, writing many spirited pamphlets (some signed "The Boston Rebel," some "The Roxbury Farmer"), including: *The Antigallican* (1797); *Remarks on the Hon. J. Q. Adams's Review of Mr. Ames's Works* (1809); *New England Patriot, being a Candid Comparison of the Principles and Conduct of the Washington and Jefferson Administrations* (1810); *Appeals to the People on the Causes and Consequences of War with Great Britain* (1811), *and Mr. Madison's War* (1812).

Another son of the first John Lowell, FRANCIS CABOT LOWELL (1775–1817), the founder in the United States of cotton manufacturing, was born in Newburyport on April 7, 1775, graduated at Harvard in 1793, became a merchant in Boston, and, during the War of 1812, with his cousin Patrick Tracy Jackson, made use of the knowledge of cotton-spinning gained by him in England and devised a power loom. Experiments were successfully carried on at Waltham in 1814. Lowell worked hard to secure a protective tariff on cotton goods. The city of Lowell (Mass.), was named in his honour. He died in Boston on Aug. 10, 1817.

Francis Cabot Lowell's son, JOHN LOWELL (1799–1836), was born in Boston, travelled in India and the East Indies on business in 1816 and 1817, in 1832 set out on a trip around the world, and on March 4, 1836, died in Bombay. By his will he left $250,000 to establish what is now known as the Lowell institute (*q.v.*).

See the first lecture delivered before the institute, Edward Everett's *A Memoir of Mr. John Lowell, Jr.* (Boston, 1840).

LOWELL, PERCIVAL (1855–1916), American astronomer, was born in Boston, Mass., on March 13, 1855. A member of a brilliant family, he graduated with honours at Harvard in 1876 and after a year of travel returned to Boston where he was active in business. From 1883 to 1893 his energies were chiefly devoted to literature and travel, much of the time in the Far East, which he pictured in *Chosön* (1885), *The Soul of the Far East* (1888), *Noto* (1891) and *Occult Japan* (1895). During part of this period he was counsellor and foreign secretary to the special mission from Korea to the United States. In the '90s, inspired by Schiaparelli's discovery of the *canali* on Mars, he determined to devote his fortune and energy to a study of the planets and after careful scrutiny of desirable sites founded the great observatory which bears his name at Flagstaff, Arizona. The theory which he advanced in his lectures and writings was that the intelligent inhabitants of a dying Mars are struggling to keep alive by a planet-wide system of irrigation from the water of the melting polar snow-caps and that the so-called "canals" are bands of cultivated vegetation dependent on this system of irrigation. His books along this line include *Mars and Its Canals* (1906), *Mars as the Abode of Life* (1908), *The Evolution of Worlds* (1910), *Memoir on a Trans-Neptunian Planet* (1915), and *Memoir on Saturn's Rings* (1915). Although his theory met with opposition, he received numerous scientific honours. He died in Flagstaff, Ariz., on Nov. 12, 1916.

See L. Leonard, *Percival Lowell* (1921); J. A. Peterson, "Percival Lowell—His Life and Work," *Roy. Astr. Soc. Journ.*, vol. xvi. (1922); *Popular Astronomy,* vol. xxv., pp. 219–223 (1917).

LOWELL, a city of Massachusetts, U.S.A., 25 mi. N.W. of Boston, on the Merrimack at the mouth of the Concord; a county seat of Middlesex county, and one of the principal manufacturing centres of the state and the nation. It has an airport, and is served by the Boston and Maine and the New York, New Haven and Hartford railways. The population was 112,759 in 1920 (33·7% foreign-born white) but had fallen to 101,389 in 1940 by the federal census. The city has a beautiful site of 14·1 sq.mi. in a bend on the south bank of the Merrimack, and including some territory on the opposite side of the river. Within its limits are 15·5 mi. of watercourses (rivers, canals and brooks), spanned by 250 bridges. The great textile mills occupy a large tract in the heart of the city, extending for a mile along the river. A monument in front of the city hall commemorates the three Lowell men (Ladd, Whitney and Taylor) who were the first Northerners killed in the Civil War; and a beautiful auditorium seating 4,700 is the memorial to the men and women of the war of 1914–18. The assessed valuation of property in 1940 was $93,642,000. The population has the usual characteristics of a factory centre: a preponderance of women; a high proportion of women and girls at work; and a relatively high, but decreasing, infant mortality. In 1911 the city adopted a commission form of government, but in 1920 it reverted to the mayoralty form.

Lowell is the seat of a state teachers' college, and of the Lowell Textile institute, incorporated in 1895, when the New England mills had begun to feel the effects of the rapid development of the manufacture of the coarser cotton fabrics in the southern states, to promote a wider and more thorough application of the arts and sciences to the production of finer and more varied fabrics.

Cotton fabrics are still Lowell's leading product, but the industries have become increasingly diversified, until the list of articles made by the 400 manufacturing establishments runs through all the letters of the alphabet, from acids, aprons, art gum and ash sifters, to yeast, yarn and "zipper" products.

The aggregate factory output in 1939 was valued at $61,949,-591. Lowell is a shopping centre for the populous adjacent towns of the Merrimack valley.

At the close of the 18th century there was only a small village on the site of the present city of Lowell. A carding mill was built in 1801, and in 1804 the Middlesex canal was completed around the Pawtucket falls, to provide a continuous water thoroughfare from Concord, New Hampshire, to Boston. In 1822 the Merrimack Manufacturing company was incorporated by Patrick Tracy Jackson (1780–1847), Nathan Appleton (1779–1861), Paul Moody (1779–1831), Kirk Boott (1790–1837) and others, to establish cotton mills at this point. They bought the Pawtucket canal, widened and deepened it, constructed a dam, and built a lateral canal to carry the power to the site of their mills. The first cloth was made in 1823. The town was incorporated in 1826, with a population of 2,000, and was named for Francis Cabot Lowell, who in 1814 had introduced the power loom at Waltham and planned the mills there, bringing under one roof all the processes in the converting of cotton into cloth. In 1836, when the town was chartered as a city, it had a population of 18,000 and a property valuation of $5,000,000. Until 1840 the mill hands, except for the English dyers and calico printers, were New England girls, and after 1840 they were only gradually displaced by Irish, French-Canadian, and other immigrants. The corporation provided boarding-houses, and the girls had many improvement circles and literary societies. They published a periodical, *The Lowell Offering,* from 1840 to 1845, edited from 1842 to 1845 by Harriot F. Curtis ("Mina Myrtle"). Among its contributors were Harriet Hanson (b. 1825), who later wrote the valuable records called *Early Factory Labor in New England* (1883) and *Loom and Spindle* (1898); and Lucy Larcom (1824–93), a doffer in the mills, whose mother kept a "corporation" boarding-house, and who described the early life in the mills in *An Idyl of Work* (1875) and *A New England Girlhood* (1889). Dickens visited the city in 1842, and recorded his impressions in the fourth chapter of *American Notes.* A more recent description of conditions is contained in *The Record of a City,* by George F. Kenngott (1912). For the greater part of the 19th century Lowell was the leading producer of cotton fabrics in the United States, and was called "The Spindle City" and "The Manchester of America." By 1850 the population had grown to 33,383, and until 1890 it was the second city of the state in size. Lowell was the birthplace of James McNeill Whistler, whose home has been converted into a museum; and was the home of Humphrey O'Sullivan, the inventor of rubber heels.

LOWELL INSTITUTE, an educational foundation in Boston, Mass. "As the prosperity of my native land, New England, which is sterile and unproductive, must depend hereafter, as it has heretofore depended, first on the moral qualities, and secondly on the intelligence and information of its inhabitants; I am desirous of trying to contribute towards . . ." these objects. Thus John Lowell, Jr., wrote in his will, and provided a fund for public lectures in the city of Boston. He died in 1836. The fund, then, amounted to about $250,000; in 1928 it was over $1,500,000.

He provided for two kinds of lectures, one popular and the other "more erudite and particular"; or, as we should say, more advanced and systematic. The first of these have been given annually for 88 years, many of them by eminent scholars from Europe. The other kind commenced somewhat later, and in one form or another have been regularly maintained. In both cases the Lowell Institute, as the foundation is called, works in conjunction with other institutions; for Lowell, dreading the temptation of costly structures without adequate means of support, provided that no portion of the capital should be used for such buildings. Most of the popular lectures are delivered in a hall of the Massachusetts Institute of Technology; others, of a definitely religious character, in King's Chapel. According to the will, the popular lectures were to be free, while for the more advanced courses a charge for each term of the price of two bushels of wheat was permitted. The courses include: (1) university extension courses, arranged by a committee representing all the institutions of higher learning in and around Boston; (2) a school of engineering, carried on in conjunction with the Massachusetts Institute of Technology, and designed to supply a gap between professional engineers and administrators of industry on the one hand and skilled workmen on the other. At first it was called the School for Industrial Foremen; but as it prepares men for positions well above those of foremen it is now called simply the Lowell Institute school. It fills an important place not covered by any other in the community.

A strange provision was made by the testator for the administration of the fund. He appointed a single trustee, and as visitors the trustees of the library known as the Boston Athenaeum. To them accounts are annually rendered, but they exercise no control over the management. The trustee for the time being he empowered also to designate his successor, enjoining him to choose in preference some competent male descendant of the testator's grandfather, who bears the name of Lowell. As the first incumbent he selected his cousin, John Amory Lowell; and the trusteeships of this kinsman and his son and grandson have now covered nearly a century. Owing to the laws of Massachusetts on exemption from taxation of charitable funds, the trustee of the institute is now by statute a corporation *sole.* (A. L. L.)

LÖWENSTEIN, a town of Germany, in the *Land* of Württemberg on the Löwenstein range, 6 m. from Heilbronn. Pop. (1933) 1,331. It is dominated by the ruined castle of the counts of Löwenstein. The town contains many old houses and a modern palace. Vines are cultivated, and there is a brine spring (Theusserbad).

Löwenstein was founded in 1123 by the counts of Calw, and belonged to the Habsburgs from 1281 to 1441. The county of Löwenstein was purchased by the German king Rudolph I., who presented it to his natural son Albert. In 1441 it was sold to the elector palatine of the Rhine. His descendants inherited the county of Wertheim and other lands by marriage, and then the family divided into two branches. The heads of the two branches, into which the older and Protestant line was afterwards divided, were made princes by the king of Bavaria in 1812 and by the king of Württemberg in 1813; the head of the younger, or Roman Catholic line, was made a prince of the Empire in 1711. The lands of the family were mediatized after the dissolution of the Empire in 1806.

LOWESTOFT, a municipal borough, seaport and watering-place in Suffolk, England, $117\frac{1}{2}$ mi. N.E. from London by the L.N.E.R. Pop. (1938) 44,370. Area 8.8 sq.mi. In 1086 Lowestoft (Lothu Wistoft, Lowistoft, Loistoft) was a hamlet in the demesne of the royal manor of Lothingland. The citizens possessed many privileges, but had no definite burghal rights until 1885. The borough was further extended in 1934. For several centuries before 1740 the fisheries were the cause of constant dispute between Lowestoft and Yarmouth. During the last half of the 18th century the manufacture of china flourished in the town. A weekly market on Wednesdays was granted to John, earl of Richmond, in 1308 together with an eight days' fair, and in 1445 John de la Pole, earl of Suffolk, one of his successors as lord of the manor, received a further grant of the same market and also two yearly fairs, one on the feast of St. Philip and St. James and the other at Michaelmas. The market is still held on

Wednesdays, and in 1792 the Michaelmas fair and another on May day were in existence. Now two yearly fairs for small wares are held on May 13 and Oct. 11. In 1643 Cromwell took Lowestoft. In the war of 1665 the Dutch under Admiral Opdam were defeated off Lowestoft by the English fleet commanded by the duke of York.

It lies on either side of the formerly natural, now artificial outlet of the river Waveney to the North sea, while to the west the river forms Oulton Broad and Lothing lake. The northern bank is the original site. South Lowestoft arose on the completion of harbour improvements, begun in 1844, when the outlet of the Waveney reopened in 1827, was deepened. The old town is situated on a lofty declivity. The church of St. Margaret is Decorated and Perpendicular. South Lowestoft has a fine esplanade, a park (Bellevue) and other adjuncts of a watering-place. Bathing facilities are good. There are two piers enclosing a harbour with a total area of 67 ac., including an inner and outer harbour with a depth of 16 ft. at low water. Extensive improvements have been made for the fishing industry which is very important. Industries include ship and boat building and fitting, and motor engineering, and manufacture of textiles.

LOWIN, JOHN (1576–1659), English actor, was born in London, the son of a carpenter. His name frequently occurs in Henslowe's Diary in 1602, when he was playing at the Rose theatre in the earl of Worcester's company. In 1603 he joined the King's men with whom he remained for many years, until he was superannuated. He played with Shakespeare, Burbage and the others, and owned by 1630 a share and a half of the 20 shares in the Blackfriars theatre. About that time he became one of the managers. He lived in Southwark and later (1623) in Lambeth. Wright says that "Lowin in his latter days kept an inn (the Three Pigeons) at Brentford, where he dyed very old." Two of his favourite parts were Falstaff and Melanteus.

LOWNDES, THOMAS (1692–1748), founder of the Lowndean professorship of astronomy at Cambridge university, England, was born in 1692. In 1725 he was appointed provost marshal of South Carolina, a post he preferred to fill by deputy. In 1727 Lowndes claimed to have taken part in inducing the British government to purchase Carolina, but he surrendered his patent when the transfer of the colony to the crown was completed. His patent was renewed in 1730, but he resigned it in 1733. He then brought various impractical commercial and financial schemes before the government. He died on May 12, 1748. By his will he left his inherited Cheshire properties to the University of Cambridge for the foundation of a chair of astronomy and geometry.

LOWNDES, WILLIAM THOMAS (1798–1843), English bibliographer, was born about 1798, the son of a London bookseller. His principal work, *The Bibliographer's Manual of English Literature*—the first systematic work of the kind—was published in four volumes in 1834. It took Lowndes fourteen years to compile, but, despite its merits, brought him neither fame nor money. Lowndes, reduced to poverty, subsequently became cataloguer to Henry George Bohn, the bookseller and publisher. In 1839 he published the first parts of *The British Librarian*, designed to supplement his early manual, but owing to failing health did not complete the work. Lowndes died on July 31, 1843.

LOW RELIEF: *see* BASSO-RILIEVO.

LOW SUNDAY, the first Sunday after Easter, was also known formerly as Quasimodo Sunday. It is officially termed by the Roman Catholic Church *Dominica in albis* (*depositis*), "Sunday in white garments" (laid aside), in allusion to the white garments anciently worn until this day by those who had been baptized on Easter Eve.

LOW-TEMPERATURE CARBONIZATION. By the low-temperature carbonization of coal is understood its partial coking at temperatures ranging from 500 to 600° C, with the contain oils—obtainable to a much less extent under the high temperatures above those named—as high even as 1,000° C—are sometimes spoken of as "low-temperatures" in this connection.

The late Vivien B. Lewes, in connection with the carbonization of coal regarded—

"Low temperature" as ranging between	400° and 500° C.
"Medium temperature" as ranging between	500° and 900° C.
"High temperature" as above	900° C.

At gas works the coal is carbonized at temperatures ranging between 1,100 and 1,300 degrees C. The original low-temperature process for the manufacture of "coalite" was based on the carbonization of coal at a temperature of 420 degrees C (788° F).

The objects which the low-temperature carbonization of coal aims at securing are mainly the production of—(*a*) a smokeless fuel of high calorific value which can be burned in the domestic hearth or for the raising of steam, and (*b*) the production of certain oils—obtainable to a much less extent under the high temperature carbonization as applied in gas works and in the manufacture of metallurgical coke, in which processes the volatile hydrocarbons are entirely extracted, but only to a small extent in the form of oils, whereas in the semi-coke resulting from low-temperature carbonization upwards to 12% may remain in the coke (*see* COKE, COKING AND HIGH TEMPERATURE CARBONIZATION.)

In order fully to comprehend the difference between low and high temperature carbonization and the character of the respective products obtainable thereunder, it is necessary to study the effects on bituminous coal when treated to a rising temperature in the process of coking. Thus, at 100° C (212° F) the removal of the moisture content of the coal begins and continues up to 260° C (500° F). Intumescence or swelling of the coal takes place at 350° to 400° C. "Intumescence" is a characteristic peculiar to some bituminous coals, being particularly evident in the case of coking coals; steam coals do not intumesce.

In most coals the transformation of a great part of the coal from an insoluble to a soluble condition begins at 232° and continues to 343° C (*i.e.*, such substances as tar are soluble; coke is not): and it is only after such transformation has taken place that the distillation of the oil begins. The extraction of the oils from the coal covers a very short range of temperature. Beyond 426·6° C practically no oil is distilled, but under "oils" are not included tars, pitches, naphthalenes, anthracenes or the phenols, all of which, with similar combinations, are produced beyond this point of temperature. Below 400° C there is very little decomposed tar left in the residual coke, so that, according to Prof. V. B. Lewes, between 400° C and 420° C may be taken as the temperature at which coke forms. The yield of ammonia increases with the more complete gassification of the coal; that is to say, the higher the temperature the more complete the carbonization.

Comparing the results obtained by low-temperature carbonization with those due to high-temperature carbonization—under low-temperature carbonization there is obtained (*a*) a lower volume of gas but a gas which is much richer than that obtained under high-temperature conditions. The calorific value of a "low-temperature" gas as compared with that obtained under high-temperature conditions in gas works with a given coal will be as about 1,000 B.Th.U. to 450 B.Th.U.: (*b*) a higher yield of tar of a lower specific gravity than is obtainable under high-temperature carbonization: (*c*) a low yield of benzene and its homologues, owing to the fact that the tar formed under low-temperature conditions contains a large proportion of paraffin, hydrocarbons and little benzene and toluene: (*d*) a low yield of ammonia compounds: and, (*e*) the tar produced under high-temperature conditions, though rich in the aromatic hydrocarbons (benzene, toluene, etc.), is so poor in the paraffins as to render these practically negligible; consequently, under a process of high-temperature carbonization the light (fuel) oils are in great part lost.

Slow Development.—The development of the low-temperature carbonization industry in Great Britain, America and the continent of Europe has been very slow, in fact it can hardly as yet be termed an industry, though an enormous amount of research work has been carried out in connection therewith, and its literature probably exceeds that bearing on the making of metallurgical coke, which has for a great many years been a prominent branch of industry. The reason is probably due to the fact that whereas in the latter there was ready to hand a market for the coke and for the by-products—sulphate of ammonia, tar, pitch, benzene, etc.—in the case of low-temperature carbonization the markets have in some respects to be created.

In order that low-temperature carbonization processes may be profitable the resultant semi-coke, which constitutes about 70 to 80% of the coal used in the process, must fetch a price at least equivalent to the purchase price of the coal, that is to say, must sell per ton at a higher price than that of the coal purchased, leaving the by-products to pay the cost of working and to provide a profit—a fairly narrow margin. But the British public have been slow to realize the advantages of the semi-coke as a domestic fuel and prefer adhering to the wasteful use of coal to provide them with a cheerful flaming fire instead of paying the higher price for the hotter, smokeless, and almost flameless semi-coke.

Internal and External Heating.—The processes of low-temperature carbonization may be divided into two main classes, namely those dependent on internal heating and those dependent on external heating, the former giving a large production of gas of comparativly low calorific value and consequently a comparatively small production of semi-coke, the latter a comparatively small volume of gas of high calorific value and a large yield of semi-coke. The coal used in most of the processes is in the form of slack, but in others it is in the form of dust. In some of the processes the retort is stationary, in others it rotates; in some the charge is stationary, in others it moves down vertical retorts by gravity, and in others again it moves with the rotation of the retort. In some of the low-temperature processes the through-put, as in the case of the metallurgical coke and the gas-making industries, is intermittent, in others it is continuous.

A process of "double carbonization" *i.e.*, high temperature following on low temperature, has been tried in the United States. In this process, the residual matter from the low-temperature carbonization retort is briquetted and the briquettes subjected to high-temperature carbonization to secure a high yield of ammonia and benzene compounds not available from the low-temperature carbonization. In some few of the processes which have been tested a semi-coke is obtained which is sufficiently hard and compact to allow of its being used in metallurgical processes; but usually it is too soft, though eminently suitable for domestic use both in the open grate, stoves, and for central heating. Of course the make of semi-coke with any given process varies chiefly with the coal used, but may be taken to be from 12·5 to 15cwt. per ton of coal charged. Likewise, the make of tar oil varies in accordance with the chemical composition of the coal. The greater the hydrocarbon content in the coal the greater the yield of tar oil. The make of tar oil, refined oils, tar acids and pitch obtainable therefrom as obtained by the low-temperature treatment in the case of three Yorkshire coals and a mixture of two of them by the Fuel Research Board at their research station near Greenwich and given in the Board's report for the years 1920–21 is of interest. *See* table in previous column.

Washed and refined oils from Tar calculated to gallons per ton of dry coal

Coal, carbonized	Dalton Main 2	Mitchell Main	Ellis-town Main	60% Mitchell Main, 40% Ellistown Main
Original yield of tar	14·00	16·25	12·87	15·51
Fraction 0–170° C				
Original fraction	1·56	2·13	1·22	1·68
Washed spirit	1·39	1·83	1·01	1·49
Washed and refined spirit	1·30	1·63	0·86	1·29
Fraction 170–230° C				
Original fraction	2·90	2·83	2·53	2·78
Washed oil	1·57	1·53	1·11	1·40
Washed and refined oil	1·57	1·46	0·98	1·29
Fraction 230–270° C				
Original fraction	1·85	2·36	1·88	2·24
Washed oil	1·00	1·31	0·84	1·14
Washed and refined oil	0·96	1·23	0·76	1·02
Fraction 270–310° C				
Original fraction	1·66	2·03	2·39	2·39
Washed oil	1·13	1·38	1·39	1·51
Washed and refined oil	1·10	1·25	1·23	1·38
Total of original fraction	7·97	9·35	8·02	9·09
Total washed and refined oil	4·93	5·57	3·83	4·98
Total tar acids, crude	2·49	2·74	3·20	3·07
Total tar acids refined	2·12	2·34	2·58	2·61
Pitch in lb. per ton of dry coal	67·5	75·9	56·9	74·9

The following oils were specially separated from the Dalton Main Tar 2:—

	Sp.gr.,15° C	Per cent by volume of tar	Gals. per ton of dry coal
High naphtha to 160° C	0·829	8·25	1·15
Heavy naphtha 160–200° C	0·870	4·59	0·64
Burning oils 200–270° C.	0·936	11·93	1·67
Gas oil 270–300° C.	0·979	5·46	0·76
Light lubricating oil 300–360° C	1·005	5·10	0·71
Total	..	35·33	4·93

Taking the Mitchell Main Coal the result may be expressed in percentages thus:—

Analysis

Moisture	0·95
Volatile matter less moisture	0·95
Fixed carbon	62·41
Ash	5·21

A high class and very bituminous coal.
Carbonized at 600° C.
Make of *Coke,* 77·88% or 15·58 cwt. per ton of coal carbonized.
Volatiles in Coke, 11·81.
Yield of *Gas,* 3,440 cubic feet; B.T.U. per cu.ft., 1,090.
Therms per ton of coal, 37·56.
Yield of *Tar* (dry), 17·0 gallons per ton of coal.
Yield of *Liquor,* 26·4 gallons per ton of coal.
Ammonia sulphate, lb. per ton of coal, 8·6.
Motor Spirit, 1·63 gallons per ton of coal.

Advantages of Semi-coke.—Great advantages would accrue were the fuel used for raising steam in the production of power and in domestic heating to be the semi-coke procured by the low-temperature distillation of coal instead of the raw coal largely used. The atmosphere of towns would be polluted to a much less degree with consequent improvement in health, and the waste of national resources through the burning of the volatile hydrocarbons contained in coal would be prevented. At least 35 million tons are annually devoted to domestic use, and assuming 15 gallons of fuel oil suitable for naval purposes if there were no fuel to be used for domestic purposes other than low-temperature semi-coke, there would be derivable in the manufacture thereof two million tons of fuel oil per annum for the Navy, which though less than the War requirements is considerably more than the peace requirements; and the motor spirit produced would amount to about 100 million gallons. Incidentally the national output of coal, presuming there to be no saving of fuel effected, would have to be increased by at least 10 million tons per annum.

Reference has already been made to some of the oils of the paraffin group contained in the tar which can be used as fuel oil either for raising steam or for internal combustion or "cracked" to produce petrol and added to the spirit which is derived, chiefly, from stripping the gas, though some of it is available in the tar. This light spirit can, when refined, be used direct in motor cars or as an admixture to petrol; or, as it has "anti-knock" properties, be mixed advantageously with standard petrol. The tar acids—phenols and cresols—are also of value; they can be burned to raise steam, and Dr. Spilker has shown that primary tar distillates of high phenol content can be used successfully in Diesel engines; but they have a use beyond this. Phenol (or carbolic acid) is used in large quantities in the manufacture of fieric acid and other explosives, also in the manufacture of dyes. The cresols (methyl phenols) which are produced in the distillation of coal both by the high-temperature and the low-temperature carbonization processes, are used as a disinfectant, as a sheep dip, for creosoting timber, and in the manufacture of "bakerlite" (an insulating material largely used in electrical transformation and generator construction) and other synthetic resins.

(*See* also Coal and Coal Mining: *Lignite.*) (R. R.)

LOWTH, ROBERT (1710–1787), English divine and Orientalist, was born at Winchester on Nov. 27, 1710. He was educated at Winchester college, and New college, Oxford. In 1741 he was appointed professor of poetry at Oxford, where he delivered the *Praelectiones Academicae de Sacra Poesi Hebraeorum* (printed in 1753). Lowth received numerous preferments, and in 1766 was consecrated bishop of St. David's. He was translated to Oxford in the same year, and in 1777 to London. He died at Fulham palace on Nov. 3, 1787. The *Praelectiones,* translated in 1787 by G. Gregory as *Lectures on the Sacred Poetry of the Hebrews,* had a great influence in England and on the continent. Their chief importance lay in the idea of looking at the sacred poetry as poetry, and examining it by the ordinary standards of literary criticism. He described the typical forms of Hebrew poetry as these occur in the Psalms. Lowth defined the principle of parallelism as the fundamental principle in Hebrew poetry in contrast to the principle of metre which is fundamental in European poetry.

LOXODROME, the line on the earth's surface making a constant angle with the meridian.

LOYALISTS or **TORIES,** in America, the name given to the colonists who were loyal to Great Britain during the War of Independence. In New England and the middle colonies loyalism had a religious as well as a political basis. It represented the Anglican as opposed to the Calvinistic influence. With scarcely an exception the Anglican ministers were ardent Loyalists, the writers and pamphleteers were the ministers and teachers of that faith, and virtually all the military or civil leaders were members of that Church. The Loyalists north of Maryland represented the old Tory traditions. In the southern colonies, where Anglicanism predominated, the division did not follow religious lines so closely. In Virginia and South Carolina the Whig leaders were almost without exception members of the established Church. Although many of the wealthy Anglican planters of the tide-water section fought for the mother country, the Tories derived their chief support from the non-Anglican Germans and Scots in the upper country. The natural leaders in these colonies were members of the same Church as the governor and vied with him in their zeal for the support of that Church. Since religion was not an issue, the disputes over questions purely political in character, such as taxation, distribution of land and appointment of officials, were all the more bitter. The settlers on the frontier were snubbed both socially and politically by the low-country aristocracy, and in North Carolina and South Carolina were denied courts of justice and any adequate representation in the colonial assembly. Naturally they refused to follow such leaders in a war in defence of principles in which they had no material interest. The failure of the British officers to realize that conditions in the south differed from those in the north, and the tendency on their part to treat all Dissenters as rebels, were partly responsible for the ultimate loss of their southern campaign. The Scoto-Irish in the south were mostly in sympathy with the American cause.

Taking the 13 colonies as a whole, loyalism drew its strength largely from the following classes: (1) the official class—men holding positions in the civil, military and naval services, and their immediate families and social connections; (2) the professional classes—lawyers, physicians, teachers and ministers; (3) large landed proprietors and their tenants; (4) the wealthy commercial classes in New York, Albany, Philadelphia, Baltimore and Charleston, whose business interests would be affected by war; (5) natural conservatives and numerous political trimmers and opportunists. Before 1776 the Loyalists may be divided into two groups. There was a minority of extremists led by the Anglican ministers and teachers, who favoured an unquestioning obedience to all British legislation. The moderate majority disapproved of the mother country's unwise colonial policy and advocated opposition to it through legally organized bodies. The aggressive attitude of Congress and the adoption of the Declaration of Independence finally forced them into armed opposition. Very few really sanctioned the British policy as a whole, but all felt that it was their first duty to fight for the preservation of the empire and to leave constitutional questions for a later settlement. John Adams's estimate that one-third of all the people in the 13 States in 1776 were Loyalists was perhaps approximately correct. In New England the number was small, perhaps largest in Connecticut and in the district which afterwards became the State of Vermont. New York was the chief stronghold. The "De Lancey party" or the "Episcopalian party" included the majority of the wealthy farmers, merchants and bankers, and practically all communicants of the Anglican Church. New Jersey, Pennsylvania, Delaware, Maryland and Virginia contained large and influential Loyalist minorities; North Carolina was about equally divided; South Carolina probably, and Georgia certainly, had Loyalist majorities. Some of the Loyalists joined the regular British army, others organized guerrilla bands and with their Indian allies inaugurated a reign of terror on the frontier from New York to Georgia. New York alone furnished about 23,500 Loyalist troops. This was more than any other colony supplied, perhaps more than all the others combined. Johnson's "Loyal Greens" and Butler's "Tory Rangers" served under Gen. St. Leger in the Burgoyne campaign of 1777, and the latter took part in the Wyoming and Cherry Valley massacres of 1778. The strength of these Loyalists in arms was weakened in New York by Gen. Sullivan's success at Newtown (now Elmira) in 1779, and broken in the northwest by George Rogers Clark's victories at Kaskaskia and Vincennes in 1778 and 1779, and in the south by the battles of King's Mountain and Cowpens in 1780.

Severe laws were passed against the Loyalists in all the States. They were in general disfranchised and forbidden to hold office or to practise law. Eight of the States formally banished certain prominent Tories, and the remaining five, Connecticut, New Jersey, Delaware, Maryland and Virginia, did practically the same indirectly. Social and commercial ostracism forced many others to flee. Their property was usually confiscated for the support of the American cause. They went to England, to the West Indies, to the Bahamas, to Canada and to New York, Newport, Charleston and other cities under British control. According to a trustworthy estimate 60,000 persons went into exile during the years from 1775 to 1787. The great majority settled in Nova Scotia and in Upper and Lower Canada, where they and their descendants became known as "United Empire Loyalists." Those who remained in the United States suffered for many years, and all the laws against them were not finally repealed until after the War of 1812. The British Government, however, endeavoured to look after the interests of its loyal colonists. During the war a number of the prominent Loyalists were appointed to lucrative positions, and rations were issued to many Loyalists in the cities held by the British. During the peace negotiations at Paris the treatment of the Loyalists presented a difficult problem. In the treaty, as finally ratified, the United States agreed to recommend to the legislatures of the various States that Loyalists should "have free liberty to go to any part or parts of any of the 13 United States, and therein to remain 12 months, unmolested in their endeavours to obtain the restitution of such of their estates, rights and properties as may have been confiscated," that acts and laws in the premises be reconsidered and revised, and that restitution of estates, etc., should be made. It was also provided "that there shall be no future confiscations made, nor any prosecutions commenced against any person" for having taken part in the war; and that those in confinement on such charges should be liberated. Congress made the promised recommendations, but they were unheeded by the various States. Great Britain, in retaliation, refused until 1796 to evacuate the western posts as the treaty prescribed. Immediately after the war parliament appointed a commission to examine the claims of the Loyalists for compensation for services and losses; and to satisfy these claims and to establish Loyalists in Nova Scotia and Canada the British Government expended fully £6,000,000.

See C. H. van Tyne, *The Loyalists in the American Revolution* (1902), which contains much valuable information but does not explain adequately the causes of loyalism. More useful in this respect is the monograph by A. C. Flick, *Loyalism in New York during the American Revolution* (1901); on the biographical side *see* Lorenzo Sabine, *Biographical Sketches of Loyalists of the American Revolution*

(Boston, 1864); on the literary side, M. C. Tyler, *Literary History of the American Revolution, 1763–1783* (1897); on the economic side, I. S. Harrell, *Loyalism in Virginia* (Durham, N.C., 1926). *See* also J. H. Sterk, *The Loyalists of Massachusetts and the Other Side of the Revolution* (Boston, 1907); Arthur Johnson, *Myths and Facts of the American Revolution* (Toronto, 1908); McLaughlin and Hart (Eds.), *Cyclopaedia of American Government,* vol. ii. (1914); W. H. Siebert, *The Loyalists of Pennsylvania* (Columbus, O., 1920).

LOYALTY ISLANDS (Fr. *Îles Loyalty* or *Loyauté*), a group in the South Pacific Ocean belonging to France, about 60 m. E. of New Caledonia, with a total land area of about 800 sq.m. There are three large islands Uea or Uvéa (the northernmost), Lifu (Lifou) the largest island, with an area of 650 sq.m., Maré or Nengone, and several small islands. They are coral islands of comparatively recent elevation, and in no place rise more than 250 ft. above the level of the sea.

The Loyalty islanders are Melanesians; the several islands have each its separate language, and in Uea one tribe uses a Samoan and another a New Hebridean form of speech. The Loyalty group was discovered at the beginning of the 19th century, and Dumont d'Urville laid down the several islands in his chart. Christianity was introduced into Maré by native teachers from Rarotonga and Samoa. Enough of the rocky surface is covered with a thin coating of soil to enable the natives to grow yams, taro, bananas, etc. Fresh water, rising and falling with the tide, is found in caverns in Lifu, and by sinking to sea-level a supply may be obtained in any part of the island. Coconuts are the chief product; copra and rubber the chief exports.

LOYOLA, ST. IGNATIUS OF [Inigo Lopez de Loyola], (1491–1556), founder of the Society of Jesus, was born in 1491, at the castle of Loyola in the province of Guipuzcoa, Spain. At an early age he was sent as a page to the court of Ferdinand and Isabella; afterwards, until his 26th year, he took service with the duke of Najera, and followed the career of arms. He already gave indications of that courage, constancy, prudence and political ability which marked his after life.

The turning point in his career came in 1521 when he was wounded during the French attack on Pampeluna, the capital of Navarre. During convalescence the reading of a Castilian translation of *The Life of Christ* by Ludolphus of Saxony, and the popular *Flowers of the Saints,* led to an intense mental struggle. Sometimes he would pass hours thinking of a certain illustrious lady, devising means of seeing her and of winning her favour; at other times the spiritual aspirations suggested by the books got the upper hand. During the struggle he began to note his psychological state; and this was the first time that he exercised his reason on spiritual things; the experience thus painfully gained he found of great use afterwards in directing others. One night while he lay awake, he tells us, he saw the likeness of the Blessed Virgin with her divine Son; and immediately a loathing seized him for the former deeds of his life, especially for carnal desires; and he asserts that for the future he never yielded to any such desires. His conversion was now complete, and as soon as he regained strength he went to the great Benedictine abbey of Montserrato, where he made his confession.

He found in use for the pilgrims a translation of the *Spiritual Exercises* of the former abbot, Garcia de Cisneros (d. 1510); and this book evidently gave him the first idea of his more famous work under the same title. Giving away his rich clothes to a beggar, he placed on the Lady altar his sword and dagger, and spent the night before them. In the morning he received the Holy Eucharist and left for a cavern near Manresa. Seven hours a day he spent in prayer and three times a day he scourged his emaciated body. One day, almost overcome with scruples, he was tempted to end his miseries by suicide. At another time, for the same reason, he kept an absolute fast for a week. But he assisted others who came to him for spiritual advice; and seeing the fruit reaped from helping his neighbour, he gave up the extreme severities and began to take more care of his person, so as not needlessly to offend those whom he might influence for good. Having recovered from a severe illness, Ignatius set out in 1523 on his long-planned pilgrimage to Jerusalem via Barcelona, Rome and Venice. On his arrival in September, the Franciscans in charge of the holy places threatened him with excommunication if he remained, for not only had they great difficulty in supporting themselves, but they dreaded an outbreak from the fanatical Turks.

Returning to Barcelona in 1524, he began to learn Latin, and after two years went to Alcalá to begin philosophy. There he gave to some companions his *Spiritual Exercises* in the form they had then taken and certain instructions in Christian doctrine. These discourses brought upon him ecclesiastical suspicion and he was prohibited from instructing others until he had spent four years in study. He incurred similar suspicion at the University of Salamanca, to which he had gone in 1527. By February of the following year he had become a student of the University of Paris. During the term he earned his livelihood by begging, and during his vacations, travelled in Flanders. At Bruges he met the famous Spanish scholar, Juan Luis Vives. In the summer of 1530 he went to London.

At the end of 1529 he came into contact with the men who were to become the first fathers of the Society of Jesus. He won over the Savoyard Pierre Favre (Faber), whose room he shared, and the Navarrese Francis Xavier, who taught philosophy in the college of St. Barbara. Afterwards he met the young Castilian, Diego Laynez, who had heard of him at Alcalá and found him out in Paris. With Laynez came two other young men, the Toledan Alfonso Salmeron and the Portuguese Simon Rodriguez. Nicholas Bobadilla, a poor Spaniard who had finished his studies, was the next to join him. The little company of seven determined to consecrate their union by vows. On Aug. 15, 1534, the Feast of the Assumption, they assembled in the crypt of the church of St. Mary on Montmartre, and Faber, the only one who was a priest, said Mass. They then took the vows of poverty and chastity, and pledged themselves to go to the Holy Land as missionaries or for the purpose of tending the sick; or if this design should prove impracticable, to go to Rome and place themselves at the disposal of the pope for any purpose. But, there was on this occasion no foundation of any society; the vows were individual obligations. A provision was made that if, after waiting a year at Venice, they were unable to go to Jerusalem, they should betake themselves to Rome.

After taking the master's degree in March 1535, ill health required Ignatius to return to Spain a few months later. When he arrived near Loyola he would not go to the castle, but lived at the public hospice at Azpeitia, and began his usual life of teaching Christian doctrine and reforming morals. He then made his way to Venice, where he arrived during the last days of 1535. Here he waited for a year until his companions could join him, and meanwhile occupied himself in his usual good works, gaining several more companions. He was again accused of heresy, and it was said that he had escaped from the Inquisition in Spain and had been burnt in effigy at Paris, but these charges he was able to meet successfully. His companions arrived at Venice in Jan. 1537, and being sent by their leader to Rome, secured abundant alms for their proposed voyage to Palestine from Paul III. who also gave licence for those not yet priests to be ordained by any bishop on the title of poverty. Ignatius and the others had been ordained at Venice in June 1537. Ignatius waited for 18 months before saying Mass, which he did for the first time on Dec. 25, 1538, in the church of Santa Maria Maggiore in Rome.

The year of waiting passed away without any chance of going to the Holy Land. Consequently it was decided that he, Laynez and Faber should go to Rome to place the little band at the disposal of the pope. It was now that the Society began to take some visible form. A common rule was devised and a name adopted. Ignatius declared that having assembled in the name of Jesus, the association should henceforth bear the name of the "Company of Jesus." The word used shows Loyola's military ideal of the duties and methods of the nascent society.

On the road to Rome a famous vision took place. In a certain church near Rome, whilst in prayer, he was aware of a change in his soul; and so openly did he see God the Father associating him with Christ who said "Ego vobis Romae propitius ero," that he could not dare to doubt the reality of his vision. The pope appointed Faber to teach Scripture, and Laynez theology, in the university of the Sapienza. Ignatius was to carry on his spiritual work, which became so strenuous that he was obliged to call his other companions to Rome.

The "Spiritual Exercises."—His life is now mainly identified with the growth of his Society (*see* JESUS, SOCIETY OF), for which he obtained, after difficulty, official recognition from Paul III on Sept. 27, 1540. He was unanimously elected the first general in April 1541; and on the 22nd of that month received the first vows of the Society in the church of San Paolo *fuori le mura*. He was now chiefly occupied with the completion of the *Spiritual Exercises* and the drawing up of the *Constitutions*, which received their final form after his death. For the latter *see* the article JESUS, SOCIETY OF. *The Book of the Spiritual Exercises* has been one of the world-moving books. In its strict conception it is only an application of the Gospel precepts to the individual soul, written to arouse conviction of sin, of justice and of judgment. While taking the title, the idea of division into three periods during which purity of soul, enlightenment and union are to be worked for, and the subjects of most of the meditations from the *Exercitatorio de la vida spiritual* (1500) of Abbot Garcia de Cisneros, Ignatius skilfully adapted it to his own requirements. With his military instinct and views of obedience, Ignatius intervenes between the soul and God with a director who gives the exercises to the person who receives them. The *Spiritual Exercises* have proved their value over and over again, and have received the sincerest form of flattery in countless imitations. The original parts of the book are to be found principally in the meditations; these are *The Reign of Christ,* wherein Christ as an earthly king calls his subjects to war: and *Two Standards,* one of Christ and the other of Lucifer. The practical results of the experiences of Ignatius in the early stages of his conversion, appear in his various methods of prayer; methods of making an election; his series of rules for the discernment of spirits; rules for the distribution of alms and the treatment of scruples; and tests of orthodoxy.

The exercises are divided into four series of meditations technically called "weeks," each of which may last as long as the director considers necessary. The first week is the foundation, and has to do with the consideration of the end of man, sin, death, judgment and hell. After the soul has been purified from sin, the second week treats of the kingdom of Christ, and is meant to lead the soul to make an election of the service of God. The third and fourth weeks are intended to confirm the soul in the new way, to teach how difficulties can be overcome, to inflame it with the love of God and to help it to persevere. Most of the latest critics give 1548 as the date when the book received its final touches. Ignatius wrote originally in Spanish, but the book was twice translated into Latin during his lifetime.

In 1547 Ignatius tried to resign the generalship of his Society and again in 1550, but the fathers unanimously opposed the project. One of his last trials was to see in 1556 the new pope Paul IV., wishing to reform certain points in the Society that Ignatius considered vital. He said: "If this misfortune were to fall upon me, provided it happened without any fault of mine, even if the Society were to melt away like salt in water, I believe that a quarter of an hour's recollection in God would be sufficient to console me and to re-establish peace within me." He never dreamed of putting his Society before the church nor of identifying the two.

In 1556 Ignatius grew very weak and resigned the active government to three fathers, Polanco, Madrid and Natal. Fever laid hold of him, and he died somewhat suddenly at Rome on July 31, 1556, without receiving the last sacraments. He was beatified in 1609 by Paul V. and canonized in 1622 by Gregory XV. His body lies under the altar in the north transept of the Gesù in Rome.

The character of Ignatius was naturally impetuous and enthusiastic, but became marked with great self-control as he gradually brought his will under his reason. He developed a sovereign prudence which nicely adjusted means to the end in view. He impressed on his followers the doctrine that in all things the end was to be considered, but he never countenanced so perverted an idea as that the end justified the means, for with his spiritual light and zeal for God's glory he saw clearly that means in themselves unjust were opposed to the very end he held in view. As a ruler he displayed the same common sense. Obedience he made one of his great instruments, yet he never intended it to be a galling yoke. His doctrine on the subject is found in the well-known letter to the Portuguese Jesuits in 1553, and if this be read carefully together with the *Constitutions* his meaning is clear.

There was in his temperament a peculiar mixture of conservatism and a keen sense of the requirements of the day. In intellectual matters he was not in advance of his contemporaries. While he did not reject any approved learning, he abhorred any intellectual culture that lessened piety. Bartoli, the official biographer of Ignatius, says that he would not permit any innovation in the studies; and that, were he to live 500 years, he would always repeat "no novelties" in theology, in philosophy or in logic—not even in grammar. Ignatius felt that the revival of learning had led many away from Christ; intellectual culture must be used as a means of bringing them back.

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LOYSON, CHARLES (1827–1912), better known as Père Hyacinthe, French preacher, was born at Orléans March 10, 1827, and entered the Carmélite order. He drew large crowds to his Advent sermons in Notre-Dame between 1865 and 1869, but his orthodoxy fell under suspicion, and in 1870 he associated himself with Döllinger (*q.v.*) in his protest against papal infallibility. Being excommunicated he removed first to Geneva and then to London. He married an English lady, Emily Jane Merriman, and settled in Paris in 1877, where he founded an Old Catholic Church. He died in Paris Feb. 9, 1912.

LOZENGE, a figure with four equal sides, having two acute and two obtuse angles, frequently used as a bearing in heraldry or as a shield on which the arms of a widow or spinster are emblazoned. The diamond-shaped facets of a precious stone when cut and the diamond panes of a casement window are called *lozenges*. In the 14th century the "lozenge pattern" was a favourite design for decoration. The word is also applied to a small tablet containing medical drugs, etc. In the reign of James I. of Scotland (1406–37) a Scottish gold coin having a lozenge-shaped shield with the arms of Scotland on the obverse side was called a "lozenge-lion." The origin of the word is obscure, *cf.* Span. *losa,* a stone slab laid on a grave.

LOZÈRE, a department of south-eastern France belonging to the central plateau, composed of almost the whole of Gévaudan and of some portions of the old dioceses of Uzès and Alais, districts all formerly included in the province of Languedoc. Pop.

(1936) 98,480. Area, 2,000 sq.mi. It is bounded N. by Cantal and Haute-Loire, E. by Ardèche and Gard, S. by Gard and Aveyron and W. by Aveyron and Cantal. The north of this mountainous department includes the granitic mountains of La Margeride, reaching 5,098 ft. and wooded on their lower slopes, and the volcanic range of Aubrac (4,826 ft.), both orientated north-north-west and south-south-east. South of these the Lot crosses the department on its way from the Cévennes in the south-east. The south-west of the department is occupied by the arid, calcareous Jurassic plateau (3,000 to 3,300 ft.) called the *causse* de Sauveterre and the *causse* de Méjan, the two *causses* being separated by the beautiful Tarn gorge. On the Mediterranean versant there are 76 in. of rain; in the Garonne basin 46 and in that of the Loire only 28. Sheep- and cattle-rearing and cheese-making are the chief occupations. Bees are kept, and, among the Cévennes, silkworms. Large quantities of chestnuts are exported from the Cévennes, where they form an important article of diet. In the valley of the Lot wheat and fruit are the chief products; elsewhere rye is the chief cereal, and oats, barley, meslin and potatoes are also grown. There is much terrace cultivation. Silver, lead, copper and antimony are found. Saw-milling, wool-spinning, the manufacture of wooden shoes and of woollen goods are carried on. Of mineral springs, those of Bagnols-les-Bains are most frequented. The line of the P.L.M. company from Paris to Nîmes traverses the eastern edge of the department, which is also served by the Midi railway with the line from Neussargues to Béziers via Marvéjols. The arrondissements are Mende and Florac; the cantons number 24, the communes 198. Lozère forms the diocese of Mende and part of the ecclesiastical province of Albi. It falls within the region of the XVI. army corps (Montpellier), the *académie* (educational division) of Montpellier and the appeal court of Nîmes. Mende (*q.v.*) is its most important town. There are many dolmens in the department.

LUANG-PRABANG, Lao state in northwest French Indo-China. Population (1936) 197,000, area 21,467 sq.mi., of which about one-third was ceded to Thailand in 1941. Luang-Prabang town has less than 10,000 population, but is the site of an important airfield. At the head of Mekong river navigation, it has a small trade in rice, silk, wax, sticklac and a wide variety of timbers, gums, resins and other forest products. The Chinese and Shans carry on most of the trade. The Mekong is much less important as a trade artery than other large oriental rivers, for as many as eight transshipments between Saigon and Luang-Prabang are made necessary by the rapids, at low water. The French projected a highway from Saigon to Luang-Prabang, and in 1943 the Japanese broadcast claims to having completed the 1,049-mi. project. For centuries Luang-Prabang was the centre of a great kingdom, covering much of Laos (*q.v.*) and some of Thailand. Thai-Annamite rivalry in the 18th and 19th centuries established the sovereignty of the former, although the king of Luang-Prabang was not deposed. The French took the two-thirds of Luang-Prabang on the Mekong's east bank in 1893, and the remainder in 1904. In 1941 the Thai won back the western part in a border war, re-establishing the Mekong as boundary. (J. R. A.)

LUBAO, a municipality (with 35 *barrios* or districts) in the S.W. part of the province of Pampanga, Luzon, Philippine islands, about 30 mi. N.W. of Manila. Pop. (1939) 29,154. It lies along the Manila-Dagupan railway and has water communication with Manila by tidal streams and Manila bay. It lies in a low fertile plain suitable for the growing of rice and sugar. Thatch and alcohol are made from the nipa palms found in the swamps. Of the inhabitants aged 6 to 19 inclusive, 36.5% in 1939 attended school.

LÜBBEN, a town of Germany, in the Prussian province of Brandenburg, on the Spree, 47 mi. S.S.E. of Berlin. Pop. (1939) 10,778. It is the chief town of the Spreewald, and has saw-mills and is famous for its *gurken,* or small pickling cucumbers.

LUBBER'S POINT, a pointer on a line inside the bowl of a magnetic compass which is used as a reference mark in computing the angle between the ship's course and the geographical meridian. (*See* COMPASS: *The Compass Card.*)

LUBBOCK, a city of northwestern Texas, U.S.A., is the hub city of 15 counties immediately surrounding and commonly known as the south plains of Texas. It is on federal highways 62, 82, 84 and 87 and state highway 290, and is served by the Panhandle Santa Fe railway and Fort Worth and Denver City railway. Altitude is 3,251 ft. County seat of Lubbock county. The population in 1930 was 20,520 (90·7% native white), and in 1940 it was 31,853 by the federal census. It is the geographical, trading, financial, industrial, commercial and educational centre of the South Plains area. Lubbock is the concentration point for all South Plains' cotton and is the third largest inland cotton market in the world. Around 500,000 bales are ginned annually in the territory. Other crops are grain sorghums, sudan grass, corn, wheat, dairy and poultry products. Lubbock manufactures around 4,700,000 lb. of butter annually. Texas Technological college opened for students on Oct. 1, 1925, has an enrolment of 3,797 students and is the third largest college in Texas. The city has a commission-manager form of government.

LÜBECK, a city and former state of Germany. The *province* of Lübeck, north of the *state,* is a constituent part of the *Land* of Oldenburg (*q.v.*). Lübeck is situated on an arm of the Baltic between Holstein and Mecklenburg-Strelitz. It consists of the city of Lübeck, the town of Travemünde, villages and the country districts, embraces 115 sq.mi. of territory, and had a population in 1939 of 153,630, of which more than 100,000 were included in the city and its suburbs. The territory, lying in the Baltic lowlands, is watered by the Trave and its tributaries, the Wakenitz and the Stecknitz.

The constitution of the former state was republican, and by the constitution of 1925 consisted of two assemblies: (1) The House of Burgesses (Bürgerschaft) consisting of 80 members elected by free suffrage. This was the supreme authority and elected (2) the Senate executive which consisted of 12 members. Lübeck was incorporated in the Prussian province of Schleswig in 1937.

At the first rise of the town justice was administered by the *Vogt* (*advocatus*) of the count of Holstein. Simultaneously with its incorporation by Henry the Lion, duke of Saxony, there appears a magistracy of six, chosen probably by the *Vogt* from the *Schöffen.* By the middle of the 13th century the number of magistrates had increased, ranging from 20 to 40 and upwards. In the face of so much self-government the *Vogt* presently disappeared. There were three classes of inhabitants, full freemen, half freemen and guests or foreigners. People of Slav origin being considered unfree, all intermarriage with them tainted the blood; hence nearly all surnames point to Saxon, especially Westphalian, and even Flemish descent. The magistracy was for two centuries almost exclusively in the hands of the merchant aristocracy, who formed companies such as the *Bergen-fahrer, Novgorod-fahrer, Riga-fahrer* and *Stockholm-fahrer*. Tradesmen and handicraftsmen who had settled in the town, though not eligible for the council, shared to a certain extent in the self-government through the aldermen of each corporation or gild, of which some appear as early as the statutes of 1240. Naturally, there arose much jealousy between the gilds and the aristocratic ruling companies.

After an attempt to upset the merchants had been suppressed in 1384, the gilds succeeded in 1408. In 1416, however, owing to the pressure brought to bear by the Hansa, by the emperor Sigismund and by Eric, king of Denmark, there was a restoration. The aristocratic government was again expelled under the dictatorship of Jürgen Wullenweber (*c.* 1492–1537), till the old order was re-established in 1535. In the constitution of 1669, under pressure of debt, the great companies yielded a specified share in the financial administration to the leading gilds of tradesmen. From 1813 the popular representatives had some share in the management of the finances. But the reform committee of 1814, whose object was to obtain an extension of the franchise, had made little progress, when the events of 1848 led to the establishment of a representative assembly of 120 members, elected by universal suffrage, which obtained a place beside the senatorial government. After 1937 Lübeck was governed by the nazi *Gauleiter* of Schleswig-Holstein, Heinrich Lohse.

The City.—Lübeck, the capital of the territory, was formerly the head of the Hanseatic League. It lies between the rivers Trave and Wakenitz, 10 m. S.W. of the mouth of the former in the bay of Lübeck, 40 m. by rail N.E. of Hamburg, at the junction of lines to Eutin, Büchen, Travemünde and Kleinen (in Mecklenburg-Schwerin) and consists of an inner town and three suburbs. Its five chief churches are Gothic. Of them, the *Marienkirche* (13th century), is one of the finest specimens of early Gothic in Germany. The cathedral, or *Domkirche,* founded in 1173, contains some curious sarcophagi and a fine Memling altar-piece. The *Rathaus* (town hall), dating from various epochs during the middle ages, is famous for its staircase, the vaulted wine cellar of the city council beneath and wood carving. There should also be mentioned the *Schiffershaus;* the mediaeval gates (*Holstentor, Burgtor*); and the Hospital of the Holy Ghost.

Its position as the first German emporium of the west end of the Baltic has been impaired by Hamburg and Bremen since the construction of the North Sea and Baltic Canal, and by the growth of Stettin. In order to counterbalance their rivalry, the quays have been extended, a canal was opened in 1900 between the Trave and the Elbe, and the river up to the wharves has been deepened to 25 feet. The river is kept open in winter by ice-breakers. A harbour was made in 1899–1900 on the Wakenitz Canal for boats engaged in inland traffic. Lübeck trades principally with the Baltic states and Scandinavia. In 1938 the tonnage of incoming ships was 1,132,000 and of outgoing 1,130,000, the number of ships being respectively 4,955 and 4,927. The chief imports are coal, grain, timber, copper, steel and wine, and the exports are artificial manures, gypsum and manufactured goods.

HISTORY

Old Lübeck, which stood on the left bank of the Trave where it is joined by the river Schwartau, was destroyed in 1138. Five years later Count Adolphus II. of Holstein founded new Lübeck, a few miles farther up, on the peninsula Buku, where the Trave is joined on the right by the Wakenitz. An excellent harbour, sheltered against pirates, it became almost at once a competitor for the commerce of the Baltic. Henry the Lion, duke of Saxony, who, about 1157, had forced his vassal, the count of Holstein, to give up Lübeck to him, issued the first charter to the citizens and constituted them a free Saxon community. The population grew rapidly in wealth and influence by land and sea, so that, when Henry was attainted by Frederick I., who came in person to besiege Lübeck in 1181, the emperor, "in consideration of its revenues and its situation on the frontier of the Empire," fixed by charter (Sept. 19, 1188) the limits, and enlarged the liberties, of the free town. By the end of the next century the statutes of Lübeck had been adopted by most Baltic towns with a German population: it was the court of appeal for nearly all these cities and even for the German settlement in Novgorod. From the beginning of the 14th century Lübeck presided over a league of cities, including Wisbeck, Rostock, Stralsund and Greifswald. Lübeck was the leading spirit in the nominally federal armament directed against Waldemar IV., the destroyer of Visby, which captured Copenhagen and enforced the peace of Stralsund (May 24, 1370); the burgomaster of Lübeck, Brun Warendorp, commanding the combined naval and land forces and dying on the field of battle. The seal of the city was in 1368 adopted as the common seal of the confederate towns. Though the power of the Hanseatic league was hemmed in at the end of the 15th century by the rise of the power of Burgundy, of Poland and Russia, and of Scandinavia, Lübeck was able to carry on war against Denmark (1501–12) and Sweden (1536–70) and under its democratic burgomaster, Jürgen Wullenweber, was in 1534 and 1535 a powerful force in the north of Europe.

From this time the power of Lübeck began to decline. The herring, a great source of early wealth, had begun to forsake the Baltic as early as 1425. The last Hanseatic diet was held in 1630. Signs of some small recovery began to appear at the end of the 18th century, but the Danes occupied the town in 1801; in 1803 it was sacked by the French and in 1810 annexed to Napoleon's empire. It was declared a free and Hanse town of the German Confederation, after his fall, by the Act of Vienna (June 9, 1815). Lübeck joined the North German Confederation in 1866; its history thenceforward was relatively uneventful until World War II. On March 28, 1942, because of its important naval stores, oil tanks, submarine shipyards and training school, and numerous factories, it was subjected to a heavy British air raid. The effect was catastrophic.

Bombs and fires reduced 40% of the city—about 200 ac.—to rubble and ashes.

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LUBLIN, a province of Poland, bounded N. by Bialystok, E. by Volhynia and Polesie (the Bug forming the boundary), S. by Lemberg, and W. by Kielce (the Vistula separating the two). Area, 12,027 sq.mi. The surface is an undulating plain of Cretaceous deposits, 800 to 900 ft. in altitude, and reaching in one place 1,050 ft. It is largely covered with forests of oak, beech and lime, intersected by ravines and thinly inhabited. A marshy lowland extends between the Vistula and the Wieprz. The government is drained by the Vistula and the Bug, and by their tributaries, the Wieprz, Liwiec and Tanev. Parts of the province, being of black earth, are fertile, but other parts are sandy. Agriculture is in good condition. Many Germans settled in the government before immigration was stopped in 1887; in 1897 they numbered about 26,000. Rye, oats, wheat, barley and potatoes are the chief crops, rye and wheat being exported. Flax, hemp, buckwheat, peas, millet and beetroot are also cultivated. Horses are carefully bred. In 1931 the population was 2,467,000. Industrial establishments consist chiefly of distilleries, sugarworks, steam flour mills, tanneries, sawmills and factories of bentwood furniture. The province is divided into 19 districts, the chief towns of which are Lublin, capital of the province (112,522 in 1931; 122,000 est. in 1939), Siedlce (36,927) and Chelm.

The province was overrun by German troops in the early stages of World War II.

LUBLIN, a town of Poland, capital of the province of the same name, 109 mi. by rail S.E. of Warsaw, on a small tributary of the Wieprz. Pop. (1931) 112,522; (est. 1939) 122,000. It is one of the centres of the manufacture of thread-yarn, linen and hempen goods and woollen stuffs; there is also trade in grain and cattle. It has an old citadel, a university, several palaces of Polish nobles and many interesting churches, and is the see of a Roman Catholic bishop. The cathedral dates from the 16th century. Of the former fortifications nothing remains except the four gates, one dating from 1342.

Lublin was in existence in the 10th century, and has a church which is said to have been built in 986. During the time the Jagellon dynasty ruled over Lithuania and Poland it was the most important city between the Vistula and the Dnieper, having 40,000 inhabitants (70,000 according to other authorities) and all the trade with Podolia, Volhynia and red Russia. Indeed, the present town is surrounded with ruins, which prove that it formerly covered a much larger area. But it was frequently destroyed by the Tatars (*e.g.,* 1240) and Cossacks (*e.g.,* 1477). In 1568–69 the union of Poland and Lithuania was decided there. In 1702 another convention was held in Lublin, in favour of Augustus II and against Charles XII of Sweden, who carried the town by assault.

In 1831 Lublin was taken by the Russians. Returned to Poland in 1918, it was taken by Germany in 1939.

LUBRICANTS. The lubricants are of three classes; solid, semi-solid and liquid. Various forms of graphites or plumbago and soapstone constitute the first class. The second class is composed mainly of the animal fats and of greases that are made of a combination of fats and oils thickened either with a calcium soap or a sodium soap, or with a combination of the two. The third class consists of a great variety of oils that are derived from the animal, vegetable and mineral kingdoms. Animals as well as vegetables secrete a fatty matter which serves as a reserve supply of food for the growing organisms. The fat is generally present in the form of small globules suspended in the cell liquids.

In animals, the fat is in layers and the oil from this fat is rendered by heating or by boiling with water. The most abundant supply of vegetable oil is found in the seeds or the fruits. The oil is rendered by pressing out ("expression") or by solvents such as ether or petroleum naphtha. (*See* OILS, FATS AND WAXES.)

The lubricants are obtained from the minerals through the distillation of brown coal or peat, of shale and of bituminous coal; although lubricants have not been produced to any great extent from these sources. The greatest amounts are obtained from crude petroleum found in many parts of the world and these are the lubricants that are being used to-day on the greatest proportion of the world's machinery. The petroleum lubricants are recovered by distillation of the crude in steam stills or vacuum stills. The lubricants all have a characteristic greasy touch and an individual taste and smell, all subject to some variation through methods of manufacture. The manner in which the lubricant is made also has certain influences upon its greasiness, its cohesion or power of holding together so that it will drag between wedge-like surfaces, and its ability to cling to metal.

PHYSICAL CHARACTERISTICS

All fluid lubricants have certain physical characteristics that can be determined in the laboratory, such as specific gravity, which is the weight of the oil as compared to the weight of a similar amount of distilled water. The flash and the fire points denote the temperature at which vapours are emitted that form a lean mixture with the air and can be ignited to produce a flash. At a higher temperature more vapour is emitted and the mixture burns steadily. The cloud test represents the temperature at which wax begins to form in the paraffin oils. The pour test is determined by the temperature at which the oil ceases to flow. The "fluidity" of the oil at various temperatures is the measure of its viscosity. (*See* VISCOSITY.) The carbon residue (Conradson) test indicates the percentage of residue left after the oil has been completely burned. Saponification and emulsification values, acidity, colour and many other tests are also made.

The foregoing tests have been standardized by the American Society for Testing Materials (*see* A.S.T.M. *Transactions*) and have been adopted by the U.S. Government, by all refiners and by the industries. (*See* the *U.S. Government Master Specifications for Lubricants and Liquid Fuels.*) In the practical work of lubrication, the viscosity, the carbon residue and the tests that indicate the ability of a lubricant to withstand physical change are the most important.

Viscosity.—The fixed lubricants, that is, the animal or vegetable oils, have a viscosity curve that is a characteristic of the oil and indicates its source. The mineral oils can be made of any desired body or viscosity at any temperature by methods of distillation or by blending the heavy-bodied with the light-bodied lubricants. Viscosity is a necessary feature of an oil's ability to support loads; it is also a measure of its internal friction and an indication of its film thickness. The amount of frictional resistance to the motion of machinery is entirely dependent upon the viscosity of the lubricant and its suitability for the conditions under which it has to work. The heat generated in a bearing, if it all could be collected and measured, would be found to be the precise measure of the power lost in overcoming the solid friction of the dry surfaces moving on each other or of the fluid friction of the lubricant between such surfaces. This heat, as it develops, flows out through the metal and is radiated to the air, its rate of flow being dependent upon the construction of the bearing and the kind and location of the machine. (*See* BEARINGS; INTERNAL COMBUSTION ENGINES.)

All oils change in viscosity with the application of heat though not all of them to the same degree at lower temperatures because of the nature of the crudes from which the mineral oils are made, as well as some of the methods of manufacture. The viscosity also increases with the increase of bearing pressure. The varying viscosity of the oils through the effect of heat and pressure is the most important item to be considered in making applications of the lubricants to practical operations. Every bearing requires a certain amount of time to work to a steady temperature above that of the surrounding atmosphere; after that it will remain in equilibrium for that speed and load condition, varying only with the temperature of the surrounding air. The lubricant, when cold, may be of exactly the proper viscosity to keep the surfaces apart. However, the heat generated within the oil itself through fluid friction may be sufficient to lower the viscosity so that actual striking of the high points of the surfaces will take place. It is necessary therefore to use a heavier oil than that theoretically required, depending upon the heat of operation to bring it to the desired viscosity for the machine condition. The frictional resistance of the machine will be high when starting, but the operation will be safe and free from wear at running temperatures. When the heat generated in a bearing equals the heat radiated, the body of the oil remains steady and the power required for the operation is likewise steady.

METHOD OF APPLICATION

The manner of applying the lubricant is an influencing factor; intermittent lubrication, with its flooded and its dry periods, causes considerable losses. Supplying the lubricant to the film at frequent intervals by drop oilers can prevent most solid friction, but the heat is not carried away by the oil to the same extent as obtains in bath lubrication where the heat is conveyed to a reservoir where it can be dissipated over a larger surface.

Effect of Heating and Cooling.—In the case of marine turbine installations where but one oil is used in the circulating force-feed oiling system, it may be necessary to have certain parts of the equipment, such as the reduction gears, lubricated with a higher viscosity oil. This can be done by putting an oil cooler in a by-pass of the system; the oil from this cooler would then be higher in viscosity than the main body of the oil. Heaters and coolers can be put in the system for the purpose of keeping all of the oil at the required viscosity, or a heater can be put in a by-pass to secure as thin an oil as required for some particular high speed condition.

The Hot Bearing.—Undue heating in a bearing is caused by a film of lubricant interrupted by dirt or some unusual stress. The high points of the bearing surfaces then strike and set up local heating. When this continues abrasion takes place, the oil becoming black on account of metal particles and finally charring. As heating continues the film of lubricant becomes thinner, the metal expands and finally the film and surfaces rupture. This situation can be prevented by supplying large quantities of cool oil, which will carry the heat away, allowing the bearing conditions to become normal. The circulating system, either for gravity or for force feed, does this automatically. As the oil heats it flows faster from the bearing and this carries more heat away. The increased flow of cool oil into the bearing reduces the temperature of the metal and keeps the surfaces apart until they are back to normal when the oil feed slows up due to pipe friction induced by the higher viscosity of the cooler oil.

Reduction in Power.—When the lubricant in use in a spindle base is too high in viscosity, the machine starts with difficulty; the spindle will not turn its proper number of revolutions per minute because the belt slippage is excessive. When such an oil has reached its heat and viscosity equilibrium, the fluid friction and power consumption will still be too great and the temperature of the base will be high in consequence. When a condition such as this exists, changing the oil to one more suitable will cause a considerable reduction in the power necessary to operate the machine. At the same time the reduced resistance in the spindle base reduces its temperature and allows the spindle to rotate at a faster speed which may mean greater production. If a lubricant that is too thin is used, the conditions are those approaching solid friction; excessive power is consumed, wear is continuous and the heat produced expands the metals until they seize.

Automotive Engines.—An unbalanced condition exists in regard to the lubricants used in these engines that has never occurred before with the lubrication of any other class of machinery. These engines use petroleum gasolene or petrol for power and certain parts of this fuel find their way to the crankcase of the engines, where they combine with the lubricant.

Certain other parts of the lubricant are thrown up against the hot surfaces, and reach temperatures at which they "crack." This results in carbon being deposited after the liberation of gas and lighter distillates. These also combine with the lubricant. This combined dilution makes the lubricant so low in viscosity that it is consumed at a greater rate than new oil and does not amply protect the surfaces. In consequence of this condition, it has become the custom to use very heavy lubricants for these small high-speed engines, oils that formerly would be selected only for the lubrication of the slowest speeds, highest temperatures and greatest weights in any mechanical machine. These oils place a heavy burden on the engine for the first hours of operation and until they become diluted with fuels, after which the viscosity is under no control whatever. The dirt and dust in the air entering the engine, mixes with the burned oil on top of the cylinders and in the combustion space and forms "carbon" and coke, which has to be removed at stated intervals. Some of this dirt also finds its way to the crankcase where it mixes with the lubricating oil. When the lubricating oil is thin through dilution the abrasives add greatly to the wear of the surfaces.

Air-cleaners and oil-filters are being adopted to correct the dirt situation. Nothing of a permanent nature has so far been accomplished in preventing or removing the fuel dilution and, as a consequence, uncontrolled lubrication of over 25,000,000 automotive engines in the United States is being carried on with unusually heavy lubricating oils contaminated with from 5 to 45% of fuel in the winter and a somewhat less percentage in the summer.

The consumption of oil in the automotive engine is influenced by the engine speed and by the volatility of the oil. With a low priced 6 cylinder car, at 30 m. per hour, a gallon lasted 2,000 miles; at 50 m. per hour the consumption increased to a gallon in 460 m. for a "non-volatile oil" and 320 m. for one more volatile. (Mougey, *National Petroleum News,* Nov. 9, 1927.) Consumption of oil in any automotive engine is also dependent upon the viscosity of the oil while operating in the engine. This is the result of the viscosity of the oil as manufactured, which is subject to control, plus the effect of the heat of the engine, the friction of the oil and plus the mixture of any lighter petroleum products that may dilute the oil. ("Liberty Aero Oil," *Journal American Society of Naval Engineers,* Feb. 1920.)

Modern force-feed systems for the application of the lubricants are very severe in their treatment of all lubricants that are not particularly adapted for the continuous lubrication of the machines to which these systems are attached. Lubricants can be so well made that they will undergo but slight change in such systems, while other lubricants will show the results of much wear. The officers attached to the U.S. naval experimental station at Annapolis, Md., have been making chemical, physical, practical and service tests of lubricants for many years. From the data so assembled a method has developed of grading the lubricants on the basis of the changes that have taken place during use under actual operating conditions, or preferably under conditions which simulate operating conditions as to pressures and temperatures but from which all chance for dilution and contamination is removed. In determining the acceptability of force-feed and motor oils a "work value" formula is used to secure comparisons between the viscosities, neutralization numbers, precipitation numbers and carbon residues on the same oil when new and after 100 hours endurance test. Lubricants that change the least are given the highest value. The lubricants are then graded as to value by applying the following formula:

$$\text{Service cost per gallon} = \frac{\text{Cost per gallon}}{\text{Average work values}}.$$

The lowest service cost per gallon is considered the low bidder. ("Purchase on a Work Factor Basis," p. 697, *Journal of American Society of Naval Engineers,* Nov. 1928.) The methods developed are for the purpose of allowing purchases of lubricants and other materials upon a work factor basis instead of a price basis and the general adoption of this plan by the industries will stimulate the production and use of the finest lubricants for the most modern methods of application to present day machinery. (W. F. P.)

LUBRICATION. An object which slides or rolls upon another generates friction. Unless a solid or a liquid lubricant is placed between the surfaces to hold them apart and allow them to slide on each other with minimum effort, friction ultimately causes abrasion and the destruction of the objects. In nature, the framework of animals comprises many joints which are so perfect mechanically and so well lubricated with a liquid lubricant that they operate for an entire lifetime with an effectiveness that has never been approached in man-made mechanisms. This is due to the suitability of the lubricant provided, which is kept pure and is not allowed to become contaminated. Nature furnishes the greasy lubricant needed to prevent the hair on all animals from cracking and breaking on account of wear, which would thus destroy its usefulness for protection and adornment. Nature does not use the same lubricant for the eyelids as for other parts of the body; she wisely selects and then properly applies what is suitable for each condition of use.

In machines made of parts that move upon each other, lubrication is a necessity; otherwise, the operation could not be continued without destruction of the parts. The degree of lubrication required is entirely dependent upon the degree of development of the machine.

HISTORICAL DEVELOPMENT

In ancient times, the machinery that was needed for the lifting of water or of weights, or for the conveying of loads, consisted of simple pulleys, windlasses and the sleds which afterward were developed and became carts and wagons equipped with wheels and axles. These appliances were made of wood. The bearings were rough and, if lubricated at all, in all probability they were packed with fat taken from the bodies of animals. That lubrication was understood to the degree that certain mechanical conditions require heavy lubricants, while others need lighter-bodied oils, is shown by the following incidents.

The chariot found in the tomb of Yuaa and Thuiu, about 1400 B.C., still had some of the original lubricant on the axle. This was analyzed by Lucas, the official chemist of the Cairo museum, and was described in a report on this tomb by Quibell in *Catalogue Général des Antiquités egyptiennes du Musée du Cairo.* The sample was small, its total weight being 0·59 of a grain. It contained road dirt such as quartz sand, compounds of aluminium, iron and lime. The lubricant was sticky and slightly greasy. It had a melting point of 49·5° C (121·1° F), which suggests its having been mutton or beef tallow, either of which would have proved suitable for axle lubrication in such a warm country.

According to a list prepared by Pliny (A.D. 23–79), the "ancients" of his time had available and in use for various purposes the oils from about the same number and kind of seeds and plants as we have at present. They were also well acquainted with several products from petroleum and had available the fats and oils from animals. Primitive forms of machinery always have been lubricated with occasional applications of whatever lubricant was available, and conditions in this respect have not changed materially since the first simple machines were made.

For many centuries after the beginning of the Christian era these conditions prevailed.

The Age of Steam.—The first of the commercial steam engines that operated early industrial plants were lubricated with melted beef tallow that was fed by means of a tallow cup attached to the steam chest. Tallow was placed in a discarded tea-pot, which was then placed on the steam chest to keep the tallow in liquid form. The oil was supplied at intermittent periods. The guides and main bearings were oiled with castor oil or lard oil. Large open bearings throughout the plant, especially in the case of iron-rolling mills, were packed with beef or mutton tallow, or a side of pork. Hard tallow was mixed with red lead and used to lubricate the gears. Lard oil was the accepted lubricant for the machine-shop engine bearings, line shafting and tools. Lard oil was also used in the lamps and torches, as a cutting oil, and for belt dressing. It was a very practical general-purpose oil and met with much favour in the early machine shops.

Sperm oil and olive oil were used on the machines in the textile industry, as well as upon the leather belts and in the lamps for illumination. Looms also were lubricated with these oils, because they would easily wash out of the finished goods without having stained them. All of these oils were well suited for the mechanical conditions prevailing.

Petroleum.—Petroleum has been known from the earliest times, its antiquity being indicated by the use of bitumen in the cementing of tools by men of the Neolithic, or late Stone age. Herodotus (484–424 B.C.) indicated the ancient method of manufacture of petroleum to produce bitumen and a lighter oil.

Dr. James Young, in 1847 (*Translations* of the Royal Scottish Society of Arts, 1865) found petroleum in Derbyshire, England, from which he obtained a heavy lubricating oil by destructive distillation. The opening of the Pennsylvania oil fields, after Drake, in 1859, had demonstrated that petroleum oil could be secured by sinking wells, provided a new source of crude supply to the American refiners operating under Dr. Young's patents; and refinery practice was adapted to the use of petroleum from which to produce the burning oils then so much in demand. Lubricants were made as a by-product and were being introduced in the manufacturing countries of the world in competition with the established lubricants.

With the primitive and early forms of machinery the lubricant was always applied by hand, the oils being used on the surfaces but once, then dropping on the floor or flying out as mist to be deposited upon the window panes or other cool parts of the machines or buildings which they covered like moist varnish. Oiling by hand is referred to as intermittent lubrication where there is a profuse supply of the lubricant on the surfaces that gradually wears off until the bearing becomes quite dry before the next application. With the flooded bearing, lubrication follows the laws of fluid friction. When the bearings become dry and the surfaces come into contact with each other, the condition changes to that of solid friction, and its attendant dangers of abrasion and stoppage. (*See* FRICTION.)

Beauchamp Tower (see *Proceedings* of the Institution of Mechanical Engineers, Nov. 1883) found that bath lubrication would give the best degree of lubrication when using lard oil, rape-seed oil and sperm oil, as well as a mineral oil and a mineral grease. His first report contained the following data:

Method of lubrication	Coefficient of friction	Comparative friction
Oil-bath	0·00139	1·00
Siphon lubricator	0·00980	7·06
Pad under journal	0·00900	6·48

From this important basic research work Osborne Reynolds (*Philosophical Transactions,* 1886) established the fact mathematically that a well lubricated journal, rotating at a fair speed, becomes automatically separated from its bearing by a film of oil, under pressure, and that the frictional resistance is then due entirely to the viscosity of the oil. John Goodman, reviewing the results of Tower and other tests of oil on the friction machines of Thurston and Stroudley stated (*Transactions,* Institute of Civil Engineers, 1886) that the coefficient of friction with the surfaces efficiently lubricated is one-tenth that for dry or scantily lubricated surfaces.

This combined work of these eminent engineers established rules for the construction of machine bearings and for their efficient lubrication, the result being that machine builders had before them the following knowledge regarding the evolution of the method of applying the lubricants.

(1) *Hand-oiling.*—The poorest results in regard to lubrication were attributed to this primitive method, in which the oil is applied at irregular intervals and where the bearing is alternately flooded and then dry.

(2) *Pad-lubrication.*—This method gave better results. The pad was located under the journal, opposite the point of greatest pressure; it carried the lubricant to the bearing surfaces continuously by capillary attraction.

(3) *Siphon Wick-feed or Drop-oilers.*—Slightly better results were obtained because these oilers supplied oil to the film in small amount at frequent intervals.

(4) *Bath Lubrication.*—The best results were obtained with bath lubrication, only one-tenth the power being required as compared to hand oiling.

With the rapid introduction of the improved methods of lubrication and of machine bearing design, suggested by the foregoing basic work, the limit of the economic use of the animal and vegetable oils had about been reached. Further advances in machine construction and operation were possible only through the rapid development and use of the mineral lubricants, because these do not oxidize and form free fatty acids, gums and compounds, and, in consequence, can be used satisfactorily in continous lubricating systems for long periods of time without undergoing detrimental changes. Finally, as the mineral oils came into successful use, there was created a branch of mechanical research engineering now known as lubrication engineering.

With the improvements in machinery and in the art of the application of the lubricants, marked improvements in the methods of refining the lubricants have naturally followed. New laboratory methods for determining and standardizing the features of the lubricant that modern requirements demand have been established.

As a result of the intensive study given to the subject of application two further general improvements since Tower's work have been made in the methods of applying the lubricants.

(5) *Gravity-feed Circulating System.*—In this method, the oil is carried in a tank higher than the bearing, to which it flows in a slightly restricted stream, and is then splashed around the parts in the crankcase. Bearings are continuously flooded with cool oil. Better results are obtained than with bath lubrication.

(6) *Force-feed Lubrication System.*—In this system, profuse quantities of lubricant are fed under pressures that can be made as high as may be desired to assure the complete flooding of the surfaces. Coolers, heaters, filters and various other refinements have been added to this system of lubrication that have brought it to the highest engineering level.

These successive steps in the development of oiling equipment and in lubricants, from the primitive to the present highly developed stages, have shown progressively increased general economy one over the other. It follows that here is a method of classifying the status of the lubrication of various groups of transportation, farm and industrial machinery.

The great fields of lubrication are as follows:—

Farming Machinery.—Aside from general automotive machinery, this field includes practically all general equipment in the primitive or first (1) class for lubrication.

Steam Railroads.—Comprising locomotives using solid lubricants (1); packed or pad lubrication (2); siphon or drop-oilers (3); with some modern roller-bearings.

Electric Railways.—Including power-house machinery, modern equipment in (5) or (6) classifications; motors and axles on cars using pad or packed lubrication (2); ring-oiling bearings (4); some roller and ball-bearings.

Marine Machinery.—Steam engines, in the primitive or (1) for all hand-oiling; wick or drop-oilers (3); Diesel engines (6).

Heavy Machinery.—Steel and iron mills. A combination of (1) primitive and bath or ring-oilers in the (4). Circulating and force-feed systems for production machines in rolling and paper mills (6); with some power equipment in (5).

Medium-weight Machinery.—General manufacturing plants. Ring and bath lubrication (4). Very little (1) and (2) lubrication, and that difficult to displace.

Light Machinery.—Textile mills constituting the best-lubricated industrial machinery. Bath and ring lubrication (4); power-plants (5).

Automotive.—All types. Bath systems (4); gravity-feed (5); force-feed (6); and various combinations except that provisions are not always made for removing dirt and fuel contaminations from the lubricant.

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combe, *Chemistry of the Oil Industries* (1913); T. C. Thomsen, *Practice of Lubrication* (1920); Archbutt and Deeley, *Lubrication and Lubricants* (1912); R. H. Thurston, *Friction and Lost Work* (1894). *See* also *Industrial and Engineering Chemistry; S.A.E. Journal; Mechanical Engineering; Journal* of The American Society of Naval Engineers; *Journal* of The Institution of Petroleum Technologists; Publications of U.S. Bureau of Standards and U.S. Bureau of Mines.
(W. F. P.)

LUBU, a tribe inhabiting central Celebes, partly tree-dwelling in habit, nomad, but cultivating a little rice and maize. Medicine-men act as chiefs, combining spiritual and temporal functions. (*See* Ratzel, *History of Mankind.*)

LUCAN (MARCUS ANNAEUS LUCANUS) (A.D. 39–65), Latin poet, born at Corduba (Cordova), son of M. A. Mela and grandson of the elder, nephew of the younger, Seneca (Mart. i., 61, 7, "Of the two Senecas and the one Lucan eloquent Corduba tells"), was brought as an infant to Rome, where he was carefully educated, among his teachers being the Stoic Cornutus and among his fellow-pupils under that preceptor the Satirist Persius (Sueton. *Vit. Pers.*). While still young he visited Athens, whence he was recalled by Nero, who bestowed upon him a quaestorship (Sueton. *Vit. Lucan*). His friendship with Nero did not last, and in A.D. 65 he was "almost the standard-bearer" (*paene signifer,* Sueton. *l.c.*) in Piso's conspiracy to murder Nero, moved thereto, it is said, by literary jealousy, Nero having forbidden him to give public recitations of his poetry (Tac. *Ann.,* xv., 49). When the conspiracy was discovered, he attempted on a promise of immunity to save himself by denouncing his mother Acilia (Tac. *Ann.,* xv., 86), but was compelled to commit suicide by opening a vein, April 30, A.D. 65. Tacitus, *Ann.,* xv., 70, says, "Thereafter he (Nero) ordered the death of Annaeus Lucanus. As his blood flowed, when he perceived that his feet and hands were growing cold and life ebbing gradually from his extremities, while his breast was still warm and retained intelligence, remembering a poem composed by himself" (*Pharsal.,* iii., 635–646, and ix., 808–815, have been suggested), "in which he had told of a wounded soldier dying by the same form of death, he repeated the lines, and that was his last utterance."

Lucan wrote a variety of works (Stat. *Silv.* ii., 7 [*Lucan's Birthday*], 54 *seq.*), in prose as well as verse (Stat. *ibid.,* 22, "Et vinctae pede vocis et solutae"). With the exception of a few fragments his works are lost save the single poem on which his fame now rests. This is called in the mss. *Bellum Civile* or *De Bello Civili,* and such a title is supported by a poem of his contemporary Petronius as well as by Joannes Lydus (6th cent. A.D.), *De Magistratibus,* iii., 46, who writes: "the Roman Lucan in the 2nd Bk. of his Civil War (τῶν ἐμφυλίων) says" and then refers to Lucan ii., 610 f. (*cf. ibid.* ἐμφυλίου συγγραφῆς). The name *Pharsalia,* by which it is generally known, seems to be an inference from Lucan's words in ix., 985, *Pharsalia nostra Vivet et a nullo tenebris damnabimur aevo.* The poem, an epic (heroic hexameters) in ten books, which was left unfinished at his death, carries the story of the civil war between Caesar and Pompey down to the arrival of Caesar in Egypt after Pompey's death. Corresponding with the change in the relations of Lucan and Nero there is a marked change of tone as the poem proceeds. At first friendly to the empire—Bk. i., 33–66, is a fulsome eulogy of Nero—it becomes increasingly anti-imperial. The poet is clearly on the side of Pompey and the Senate, whose cause is held to be one (v., 12, "For who would call so many axes drawn in justice, so many *fasces,* a camp? The venerable order taught the peoples that it was not the party of Magnus, but that Magnus was their partisan"). and is identified with the liberty of the Roman people (vii., 578, "He [Caesar] forbids their hands to assail the common people and points out the Senate; he knows what is the blood of empire, what the vitals of the state, whence he is to attack Rome, where stands to be stricken the ultimate liberty of the world").

"Lucan," says Quintilian (x., 1., 90), "is ardent and passionate, brilliant in epigram, and, to speak frankly, a model rather for the orator than for the poet." His rhetorical quality pleased the taste of his time (Martial, xiv., 194, puts in Lucan's mouth the epigram: "There are those who say I am not a poet; but the bookseller who sells me thinks I am"). as that taste was pleased also by the learned allusion, the recondite expression for the simple thing, of which Lucan is so full, *e.g.,* v. 3, "Now had midwinter sprinkled the snows on Haemus and the daughter of Atlas setting on chill Olympus, and the day was at hand which gives new names to the Calendar and first worships Janus who leads the seasons" merely indicates the end of the year. Nothing is harder than to determine the legitimate and the illegitimate use of the learned allusion, but at any rate in this kind Lucan was neither better nor worse than his neighbours and his employment of it was as monotonous as his metre. It is quite otherwise with his gift of epigram and memorable phrase: *Nil actum credens cum quid superesset agendum* (ii., 657); *Victrix causa deis placuit sed victa Catoni* (i., 128); *Stat magni nominis umbra* (i., 135).

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(A. W. MA.)

LUCANIA, formerly Basilicata, a territorial division of southern Italy, comprising the provinces of Matera and Potenza, part of the ancient Lucania. It is bounded on the north by the province of Foggia, northeast by those of Bari and Lecce, east by the Gulf of Taranto (for a distance of 24 mi.), south by the province of Cosenza, and west by the Mediterranean and the provinces of Salerno and Avellino. Area 3,855 sq.mi. The province is mountainous, with Mt. Pollino (7,325 ft.), the highest peak in the southern Apennines, on the boundary of Cosenza, while Mt. Vulture (4,365 ft.) at the northwestern extremity, is an extinct volcano. The mountains descend by a gradual slope to the coastal plane of the Gulf of Taranto. Five rivers, the Bradano (anc. Bradanus), Basento (Casuentus), Cavone or Salandrella, Agri (Aciris) and the Sinni (Siris) run southeast or east into the gulf. The railway from Naples to Taranto and Brindisi passes through Potenza and meets the east coast line from Taranto to Reggio di Calabria at Metaponto. Branch lines from this road run elsewhere through Lucania. The mountains are still to some extent clothed with forests; in places the soil is fertile, especially along the Gulf of Taranto. Olive oil is the most important product. Pop. (1936) 543,262. There are no large towns.

The ancient Lucania extended from the Tyrrhenian sea on the west to the Gulf of Tarentum on the east. To the north it adjoined Campania, Samnium and Apulia and to the south it was separated by a narrow isthmus from the district of Brutii. It thus comprised almost all the area of the modern Lucania together with the greater part of the province of Salerno and a part of Cosenza. As in the modern province, almost the whole of ancient Lucania was occupied by the Apennines. Two important rivers of the ancient province, the Crathis (mod. Crati), forming its southern limit and the Silarus (Sele), constituting its northern boundary, are not included in the smaller modern Lucania.

Lucania was so-called from the Lucani (Lucanians) who conquered it about the middle of the 5th century B.C. Before that it was included under the general name of Oenotria, applied by the Greeks to southernmost Italy. The mountainous interior was occupied by Oenotrians and Chones, while on the coasts on both sides were powerful Greek colonies which doubtless exercised a protectorate over the interior (*see* MAGNA GRAECIA). The Lucanians were a southern branch of the Samnite or Sabelline race, who spoke Oscan (*q.v.*) After much inter-tribal conflict we find them fighting the Tarentines and Alexander, king of Epirus, who was called in by that people to their assistance, 326 B.C. In 298 B.C. they made alliance with Rome, and Roman influence was extended by the colonies of Venusia (291 B.C.), Paestum (273), and above all Tarentum (272). On the landing of Pyrrhus in Italy (281 B.C.) they were among the first to declare in his favour, and found themselves exposed to the resentment of Rome when the departure of Pyrrhus left his allies at the mercy of the Romans. After several campaigns they were reduced to subjection (272 B.C.). They sided with Hannibal during the Second Punic

War (216 B.C.), and their territory during several campaigns was ravaged by both armies. The country never recovered from these disasters, and under the Roman government fell into decay, to which the Social War, in which the Lucanians took part with the Samnites against Rome (90–88 B.C.) gave the finishing stroke.

For administrative purposes under the Roman empire, Lucania was always united with the district of the Bruttii. The two together constituted the third region of Augustus.

The towns on the east coast were—Metapontum, a few miles south of the Bradanus; Heraclea, at the mouth of the Aciris; and Siris, on the river of the same name. Close to its southern frontier stood Sybaris, destroyed in 510 B.C., but subsequently replaced by Thurii. On the west coast stood Posidonia, known under the Romans as Paestum; below came Elea or Velia, Pyxus, called by the Romans Buxentum, and Laus, near the frontier of the province towards Bruttium. Of the towns of the interior the most considerable was Potentia, still called Potenza. To the north, near the frontier of Apulia, was Bantia; while due south from Potentia was Grumentum, and still farther in that direction were Nerulum and Muranum. In the upland valley of the Tanagrus, a tributary of the Silarus, were Atina, Forum Popilii and Consilinum; Eburi (Eboli) and Volceii (Buccino), though to the north of the Silarus, were also included in Lucania. The Via Popillia traversed the district from north to south, entering it at the northwest extremity; the Via Herculia, coming southwards from the Via Appia and passing through Potentia and Grumentum joined the Via Popillia near the southwest of the district: while another nameless road followed the east coast. (T. A.; X.)

LUCARIS, CYRILLOS (1572–1637), Greek prelate and theologian, was a native of Crete. In youth he travelled, studying at Venice and Padua, and at Geneva coming under the influence of the reformed faith as represented by Calvin. In 1602 he was elected patriarch of Alexandria, and in 1621 patriarch of Constantinople. He was the first great name in the Orthodox Eastern Church since 1453, and dominates its history in the 17th century. The great aim of his life was to reform the church on Calvinistic lines, and to this end he sent many young Greek theologians to the universities of Switzerland, Holland and England. In 1629 he published his famous *Confessio,* Calvinistic in doctrine, but as far as possible accommodated to the language and creeds of the Orthodox Church. It appeared the same year in two Latin editions, four French, one German and one English, and in the Eastern Church started a controversy which culminated in 1691 in the convocation by Dositheos, patriarch of Jerusalem, of a synod by which the Calvinistic doctrines were condemned. Lucaris was several times temporarily deposed and banished at the instigation of his orthodox opponents and of the Jesuits, who were his bitterest enemies. Finally, when Sultan Murad was about to set out for the Persian War, the patriarch was accused of a design to stir up the Cossacks, and to avoid trouble during his absence the sultan had him killed by the Janissaries (June 1637).

See the article "Lukaris" by Ph. Meyer in Herzog-Hauck, *Realencyklop.* (3rd ed., Leipzig, 1902), which gives further authorities.

LUCARNE, a French architectural term for a dormer window; in English usage, applied to the dormer windows of spires.

LUCAS, SIR CHARLES (d. 1648), English soldier, was the son of Sir Thomas Lucas of Colchester, Essex. As a young man he saw service in the Netherlands under the command of his brother, and in the "Bishops' War" he commanded a troop of horse in King Charles I.'s army. At the outbreak of the Civil War Lucas took the king's side, and at the first cavalry fight, Powick Bridge, he was wounded. Early in 1643 he raised a regiment of horse, with which he defeated Middleton at Padbury on July 1. In 1644 he was made lieutenant-general of Newcastle's Northern army. At Marston Moor Lucas swept Fairfax's Yorkshire horse before him, but later in the day he was taken prisoner. Exchanged during the winter, he defended Berkeley Castle for a short time against Rainsborough, but was soon in the field again. As lieutenant-general of all the horse he accompanied Lord Astley in the last campaign of the first war, and, taken prisoner at Stow-on-the-Wold, he engaged not to bear arms against parliament in the future. This parole he broke at Colchester which fell to Fairfax's army on Aug. 27, 1648. Lucas and Sir George Lisle were immediately tried by court martial and sentenced to death. They were shot the same evening in the Castle of Colchester.

See Lloyd, *Memoirs of Excellent Personages* (1669); and Earl de Grey, *A Memoir of the Life of Sir Charles Lucas* (1845).

LUCAS, CHARLES (1713–71), Irish physician and politician, was an apothecary in Dublin. He issued in 1748–49 a series of political addresses; the House of Commons voted him an enemy to the country, and issued a proclamation for his arrest. Lucas escaped to the continent, and qualified in medicine at Leiden in 1752. In 1753 he started practice in London. He was elected member for the city of Dublin in 1761, his colleague in the representation being the recorder, Henry Grattan's father. On the appointment of Lord Halifax as lord lieutenant in the same year Lucas wrote him a long letter (Sept. 19, 1761, mss. Irish State Paper office) setting forth the grievances which Ireland had suffered in the past. His contributions to the press, and his *Addresses to the Lord Mayor* and other political pamphlets made him one of the most popular writers in Ireland. He died on Nov. 4, 1771.

See R. R. Madden, *Hist. of Irish Periodical Literature from the End of the 17th to the Middle of the 19th Century* (2 vols., 1867); Francis Hardy, *Memoirs of the Earl of Charlemont* (2 vols., 1812); W. E. H. Lecky, *History of Ireland in the Eighteenth Century,* vols. i. and ii. (1892).

LUCAS, EDWARD VERRALL (1868–1938), British man of letters, was born at Brighton and educated at University college, London. He then started journalism, working first on a Sussex newspaper, then in London with *The Globe,* and became a frequent contributor to *Punch* and later its assistant editor. He acted for many years as publisher's reader to the firm of Methuen, and became head of this company after the death of its founder (1925). He is best known as a light essayist. His edition of the *Letters of Charles and Mary Lamb* (1903–05) and his *Life of Lamb* (1905) showed how congenial was his talent with that of Elia. He wrote many charming books of travel impressions, among these being *A Wanderer in Holland* (1905), *A Wanderer in London* (1906) and *A Wanderer in Paris* (1909), and his books on art showed powers of wide appreciation, as in *The British School* (1913), *Vermeer of Delft* (1922), *John Constable* (1924), *Vermeer the Magical* (1929).

LUCAS, JOHN SEYMOUR (1849–1923), English painter, was born in London, and was a student in the Royal Academy Schools. He was elected A.R.A. in 1886 and R.A. in 1898, and was a constant exhibitor of pictures of historical and domestic incidents, notably of the Tudor and Stuart periods. One of his most important works is a panel in the Royal Exchange, presented by the corporation of London, representing William the Conqueror granting the first charter to the city; and one of his earlier pictures, "After Culloden: Rebel Hunting," is in the National Gallery of British Art. He died at Southwold on May 8, 1923.

LUCAS VAN LEYDEN (*c.* 1494–1533), Dutch painter, was born at Leiden, where his father Huig Jacobsz gave him the first lessons in art. He then entered the painting-room of Cornelis Engelbrechtszen of Leiden. According to van Mander he was born in 1494, and painted at the age of 12 a "Legend of St. Hubert," for which he was paid a dozen florins. He was only 14 when he finished a plate representing Mohammed taking the life of Sergius, the monk, and at 15 he produced a series of nine plates for a "Passion," a "Temptation of St. Anthony," and a "Conversion of St. Paul." The list of his engravings in 1510 includes subjects as various as a celebrated "Ecce Homo," "Adam and Eve expelled from Paradise," a herdsman and a milkmaid with three cows and a "Woman with a Dog."

In Dürer's diary kept during his travels in the Low Countries, we find that at Antwerp he met Lucas, who asked him to dinner. He exchanged the Dutchman's prints for his own and drew his portrait (British Museum). The effect of this contact with the great German artist is traceable in Lucas' drawings. In 1527 he made a tour of the Netherlands, giving dinners to the painters of the gilds of Middleburg, Ghent, Malines and Antwerp. The journey ruined his health; after a long illness he died in 1533.

After Dürer, Lucas was the most important engraver of his time. Existing engravings ascribed to him number 172. He also designed a number of woodcuts, and some 20 pictures by him are in public and private collections. Early works are "The Chess Players" in the Berlin museum; the "Death of John the Baptist" in the Johnson collection, Philadelphia. These are works of a beginner. Then follow the paintings in a more fluent style:—"St. Jerome" and "The Virgin Enthroned" in Berlin; the "Card Players" at Wilton House and a portrait in the National Gallery.

In 1522 he painted the "Virgin and Child with the Magdalen and a Kneeling Donor," now in the gallery of Munich. His manner was then akin to that of Mabuse. The "Last Judgment" in the town-gallery of Leiden is composed on the traditional lines yet some of the heads are painted with great delicacy and modelled with exquisite feeling. His last important work was a triptych now at the Hermitage at Leningrad (St. Petersburg), executed, according to van Mander, in 1531, representing the "Blind Man of Jericho healed by Jesus Christ." Here may be observed great finish and warm flesh-tints with a gaudy scale of colours. It has been said that Lucas van Leyden was the greatest of the Dutch artists who laid the foundation of the 17th century Dutch painting.

See Sir Martin Conway, *The Van Eycks and their Followers* (1921); M. Freidländer, *Lucas van Leyden* (1924); and *Van Eyck bis Brueghel* (1921).

LUCCA, town and archiepiscopal see of Tuscany, Italy, (anc. *Luca*), capital of the province of Lucca, 13 m. by rail N.E. of Pisa. Pop. (1936) 32,896 (town), 82,302 (commune). It is 62 ft. above sea-level, in the fertile valley of the Serchio, and looks out for the most part on a horizon of hills and mountains. The fortifications, pierced by four gates, begun in 1504 and completed in 1645, are still well-preserved and picturesque, with projecting bastions planted with trees.

The city is well-built and has numerous churches, mainly of well-marked basilican type, having richly decorated exteriors, fine apsidal ends and quadrangular campaniles, in some cases with battlemented summits, and windows increasing in number as they ascend. They follow Pisan style. The cathedral of St. Martin was begun in 1060 by Bishop Anselm (later Pope Alexander II.); but the apse with its tall columnar arcades and the campanile are probably the only remnants of the early edifice, nave and transepts having been rebuilt in Gothic style (14th cent.), while the west front is by Guidetto (identified with Guido Bigarelli of Como) (1204) and "consists of a vast portico of three magnificent arches, and above them three ranges of open galleries." The ground plan is a Latin cross, the nave being 273 ft. in length and 84 ft. in width, and the transepts 144 ft. in length. In the nave is a little octagonal shrine for the most precious of the relics of Lucca, a cedar-wood crucifix, carved, according to legend, by Nicodemus, and miraculously conveyed to Lucca in 782. The Sacred Countenance (*Volto Santo*) of the Saviour is shown thrice a year. The chapel was built in 1484 by Matteo Civitali, a local sculptor (1436–1501). The cathedral contains several other works by him—the tomb of P. da Noceto, and the altar of S. Regulus as well as the tomb of Ilaria del Caretto by Jacopo della Quercia of Siena. In the cathedral choir is good stained glass of 1485. The church of St. Michael, founded in the 8th century, and built of marble within and without, has a magnificent western façade (12th–13th cent. like that of the cathedral)—an architectural screen rising much above the roof of the church. The interior is good but rather bare. The basilican church of S. Martino at Arliano near Lucca belongs to the first half of the 8th century. S. Frediano or Frigidian dates originally from the 7th century, but was built in Romanesque style in 1112–1147, though the interior, originally with four aisles and nave, shows traces of the earliest structure; the front occupies the site of the ancient apse; in one of its chapels is the tomb of Santa Zita, patroness of servants and of Lucca itself. In S. Francesco, a fine Gothic church, is the tomb of Castruccio Castracane (d. 1328). San Giovanni (originally of the 12th century), S. Cristoforo, S. Giusto, San Romano (rebuilt in the 17th century, by Vincenzo Buonamici), and Santa Maria Forisportam (of the 12th century) also deserve mention.

Among secular buildings are the old ducal palace, begun in 1578 by Ammanati, and now the residence of the prefect and seat of the provincial officers and the public picture gallery; the early Renaissance Palazzo Pretorio, or former residence of the podestà, now the seat of the civil and correctional courts; the palace, erected in the 15th century by a member of the Guinigi family, of brick, in Italian Gothic, the 16th-century palace of the marquis Guidiccioni, now a depository for the archives, the earliest documents going back to A.D. 790. The Palazzo Mansi contains a collection of Dutch pictures. There are several other fine late 16th-century palaces. The principal market-place in the city has taken possession of the arena of the ancient amphitheatre, the outer arches of which can still be seen in surrounding buildings. The whole building, belonging probably to the early Empire, measured 135 by 105 yd., and the arena $87\frac{1}{2}$ by 58 yards. The outline of the ancient theatre can be traced in the Piazza delle Grazie, and some substructure walls are preserved. The ancient forum was on the site of the Piazza S. Michele. Remains of the city walls have also been found. The rectangular disposition of the streets in the centre of the town is a survival of Roman times. The archiepiscopal library and archives are also important, while the treasury contains some fine goldsmith's work, including the 14th-century Croce dei Pisani, made by the Pisans for the cathedral.

The river Serchio affords water-power for numerous factories. The most important industries are the manufacture of jute goods (carried on at Ponte a Moriano in the Serchio valley, 6 m. N. of Lucca), tobacco, silks and cottons. The silk manufacture was introduced about the close of the 11th century, and in the early 16th formed the means of subsistence for 30,000 of its inhabitants. The bulk of the population is engaged in agriculture. The water supply is maintained from the Pisan mountains by an aqueduct built in 1823–32 with 459 arches.

The ancient Luca, commanding the valley of the Serchio, is first mentioned as the place to which Sempronius retired in 218 B.C. before Hannibal, after his defeat at the Trebia (*q.v.*). It was here that Julius Caesar in 56 B.C. held his famous conference with Pompey and Crassus, Luca then being still in Liguria, not in Etruria. In the Augustan division of Italy Luca was assigned to the 7th region (Etruria); it was a meeting-point of roads—to Florentia (*see* CLODIA, VIA), Parma, Luna and Pisae. Though plundered and deprived of part of its territory by Odoacer, Luca appears as an important city and fortress at the time of Narses, who besieged it for three months in A.D. 553, and under the Lombards it was the residence of a duke or marquis and had the privilege of a mint. The dukes gradually extended their power over all Tuscany, but after the death of the famous Matilda the city began to constitute itself an independent community, and in 1160 it obtained from Welf VI., duke of Bavaria and marquis of Tuscany, the lordship of all the country for 5 m. round, on payment of an annual tribute. Occupied by the troops of Louis of Bavaria, sold to a rich Genoese Gherardino Spinola, seized by John, king of Bohemia, pawned to the Rossi of Parma, by them ceded to Martino della Scala of Verona, sold to the Florentines, surrendered to the Pisans, nominally liberated by the emperor Charles IV. and governed by his vicar, Lucca managed, at first as a democracy, and after 1628 as an oligarchy, to maintain "its independence alongside of Venice and Genoa, and painted the word Libertas on its banner till the French Revolution." In 1546 Francesco Burlamacchi, made a noble attempt to give political cohesion to Italy, but perished on the scaffold (1548); his statue by Ulisse Cambi was erected on the Piazza San Michele in 1863. As a principality formed in 1805 by Napoleon in favour of his sister Elisa and her husband Felice Baciocchi, Lucca was for a few years wonderfully prosperous. It was occupied by the Neapolitans in 1814; from 1817 to 1847 it was governed as a duchy by Maria Luisa, queen of Etruria, and her son Charles Louis; and it afterwards formed one of the divisions of Tuscany.

(T. A.)

LUCCA, BAGNI DI (Baths of Lucca), commune, Tuscany, Italy, province of Lucca, containing a number of famous watering-places in the valley of the Lima, a tributary of the Serchio. Pop. (1936) 1,116 (town), 12,064 (commune). Ponte a Serraglio (16 mi. north of Lucca by rail) is the principal village, but there are warm springs and baths also at Villa, Bagni Caldi, etc. The springs do not seem to have been known to the Romans. The temperature of the water varies from 98° to 130°; in all cases it gives off carbonic acid gas and contains lime, magnesium and sodium products. In the valley of the Serchio, 3 mi. below Ponte a Serraglio, is the mediaeval Ponte del Diavolo (1322), with its lofty central arch.

LUCCEIUS, LUCIUS, Roman orator and historian, friend and correspondent of Cicero. Disgusted at his failure to become consul in 60, he retired from public life and devoted himself to writing a history of the social and civil wars. Cicero wrote to him asking him to write a history of his (Cicero's) consulship and offering to supply the material.

Nothing remains of any such work or of his history. In the civil war he took the side of Pompey but was pardoned by Caesar and returned to Rome.

See Cicero's *Letters* (ed. Tyrrell and Purser), especially *Ad Fam.* v. 12; and Orelli, *Onomasticon Tullianum.*

LUCCHESI, ANDREA (1741–*c.* 1800), Italian musician and composer, was born in Motta, Venice, on May 28, 1741. In his youth he studied under Paolucci, Seratelli and Cocchi. In 1771 he went to Bonn, Germany, and in 1774 he succeeded the grandfather of Ludwig van Beethoven as conductor of the court orchestra. Under him Beethoven, then only a boy, played the viola in the orchestra. Lucchesi composed eight operas, two symphonies, six sonatas for violin and cembalo, four piano quartets and some church music.

LUCCHESINI, GIROLAMO (1751–1825), Prussian diplomatist, was born at Lucca on May 7, 1751, the eldest son of Marquis Lucchesini. In 1779 he entered the service of Frederick the Great in Berlin. Frederick William II sent him in 1787 to Rome to obtain the papal sanction for the appointment of a coadjutor to the bishop of Mainz, with a view to strengthening the German Fürstenbund.

In 1788 he was sent to Warsaw and brought about a rapprochement with Prussia and a diminution of Russian influence at Warsaw. Frederick William was at that time intriguing with Turkey, then at war with Austria and Russia. Lucchesini was to rouse Polish feeling against Russia and to secure for Prussia the concourse of Poland in the event of war with Austria and Russia. He concluded a Prusso-Polish alliance in March, 1790, and in the autumn of that year was sent to Sistova, where the terms of peace between Austria and Turkey were being discussed. Before he returned to Warsaw his treaty was a dead letter, and Prussia was contemplating the second partition of Poland. Lucchesini was recalled and was employed on the Rhine in liquidating the intervention in the French Revolution.

In 1793 he was appointed ambassador to Vienna, with the ostensible object of securing financial assistance for the Rhenish campaign. His anti-Austrian bias made him extremely unpopular with the Austrian court, which began asking for his recall in 1795. The request was granted in 1797.

In 1800 he was sent by Frederick William III on a special mission to Paris. Napoleon too sought his recall but eventually (in 1802) accepted him as regular ambassador. He consistently sought friendly relations between France and Prussia but was unsuccessful and was superseded as ambassador just before the outbreak of war between the two countries in 1806. After the Prussian defeat at Jena he tried to negotiate terms of peace, but his first draft was refused by Napoleon and his second by Frederick William.

He was dismissed from the Prussian service and joined the court of Elisa, grand duchess of Tuscany and after Napoleon's fall devoted himself to writing.

He died on October 20, 1825.

He published in 1819 three volumes, *Sulle cause et gli effetti della confederazione rhenana,* at Florence. His memoirs remained in ms. His dispatches were edited by Bailleu in *Preussen und Frankreich* (Leipzig, 1887, *Publikationen aus den preussischen Staatsarchiven*).

LUCE, CLARE BOOTHE (1903–), U.S. playwright and member of Congress, was born in New York, N.Y., April 10, 1903. She was associate editor of the magazine *Vogue* in 1930 and associate editor and managing editor of the magazine *Vanity Fair* from 1930 to 1934. In 1935 she married Henry R. Luce, magazine publisher. She wrote a number of plays, including *The Women* (1937) and *Kiss the Boys Goodbye* (1938), satires on two phases of American life, and *Margin for Error* (1939), an anti-nazi play. She was also the author of two books, *Stuffed Shirts* (1933) and *Europe in the Spring* (1940). On Nov. 3, 1942, she was elected Republican congresswoman from the 4th district of the state of Connecticut.

LUCE, JOHN (1870–1932), British admiral, was born Feb. 4, 1870, in England.

In the Battle of Falkland Islands in World War I, he commanded the light cruiser H.M.S. "Glasgow," which, with the help of another British ship, sank the German cruiser "Leipzig." From 1921 to 1924, he was admiral superintendent of the Malta dockyard. In 1925 he was retired and in 1930–31 he served as high sheriff of Wiltshire.

He died Sept. 22, 1932.

LUCE, STEPHEN BLEECKER (1827–1917), U.S. naval officer, was born in Albany, N.Y., on March 25, 1827. When he was only 14 years old he received his appointment as midshipman from New York.

The next 19 years of his life, until 1860, were spent largely on ship or at naval stations in all parts of the world. In 1860, by this time a lieutenant, he was made assistant to the commandant of the naval academy.

In 1862 he was promoted to lieutenant commander and made head of the department of seamanship at the academy. During the Civil War he went on sea duty again, commanding the monitor "Nantucket" and the "Pontiac," both of the North Atlantic squadron, and he commanded the "Pontiac" when it gave naval support on the Savannah river to the crossing of General Slocum's division into South Carolina.

After the Civil War, he remained on active sea duty most of the time until 1884. For many years before that time, he had been concerned with the problem of education of naval officers, which he felt was inadequate, especially in the more advanced branches. In 1884 his campaign for improvement of the educational system came to a successful conclusion with the foundation of the Naval War college, the first school of its kind in the world. Luce, by now a commodore, was first president.

The Naval War college came to have an influence not only on American naval officers but on those of many other countries; England, Japan, Germany and France later founded schools based on Luce's ideas. In 1886, Luce was commissioned a rear admiral and went on active duty in the North Atlantic, where he remained until his retirement in 1889.

He died July 28, 1917.

LUCENA, a municipality (with administrative centre and 15 *barrios* or districts) and capital of Tayabas (the second largest province in Luzon), Philippine Islands, located near Tayabas bay along the route of the Manila-Hondagua railway line, and 133 mi. from Manila. Pop. (1939) 21,675, of whom 11,278 were males and 17 whites.

Lumbering is an important industry, and a planing and sawmill are there. Good automobile roads lead to other towns, and Lucena is a commercial centre. The inhabitants represent various Malay strains and some of the aboriginal negritos are found in the adjacent region. Tagalog and Bikol are the leading vernaculars, but other dialects are used. Of the inhabitants aged 6 to 19 inclusive, 47.5% in 1939 attended school; 74.3% of the population 10 years old and over was literate.

LUCENA, a town of Spain, in the province of Córdova, 37 mi. S.S.E. of Córdova, on the Madrid-Algeciras railway. Pop. (1940) 22,659 (mun., 32,687). Lucena is situated on the Cascajar, a minor tributary of the Genil. The parish church dates from the beginning of the 16th century.

The chief industries are the manufacture of matches, brandy and pottery, especially the large earthenware jars (*tinajas*) used throughout Spain for the storage of oil and wine. There is considerable trade in agricultural produce, and the horse fair is famous throughout Andalusia. Lucena was taken from the Moors early in the 14th century. King Boabdil of Granada was taken prisoner in 1483 in the attempt to recapture it.

LUCERA, town and episcopal see, Apulia, Italy, province of Foggia $12\frac{1}{2}$ mi. W.N.W. of the town of Foggia by rail. Pop. (1936) 17,472 (town), 18,447 (commune). It is upon a lofty plateau, the highest point of which (823 ft.), projecting west, was the ancient citadel, which is occupied by the immense and well-preserved castle of Frederick II (1233), who lived there in oriental splendour. It was later enlarged by Charles I of Anjou. It is the largest mediaeval fortress in Apulia, and within it was the palace, the treasury, the mint, the harem and a menagerie of wild beasts. The cathedral, originally Romanesque but restored after 1300, is in the Gothic style. The interior was restored in 1882. The town occupies the site of the ancient Luceria, the key of the whole country. According to tradition the temple of Minerva, founded by Diomede, contained the Trojan Palladium, but in history it is first heard of as on the Roman side in the Samnite Wars (321 B.C.), and in 315 or 314 B.C. a Latin colony was sent there. It is mentioned in subsequent military history, and its position on the road from Beneventum, via Aecae (mod. Troja) to Sipontum, gave it some importance.

Its wool was also renowned. It contains no ancient remains above ground, though mosaic pavements have been found and there are traces of the foundations of an amphitheatre outside the town on the east. The town hall contains a statue of Venus, a mosaic and some inscriptions.

In 663 it was destroyed by Constans II and was only restored in 1223 by Frederick II, who transported 20,000 Saracens thither from Sicily. They were at first allowed religious freedom, but many were slaughtered and the rest became Christians under compulsion in 1300. Up to 1806 Lucera was the capital of the provinces of Basilicata and Molise.

See A. Haseloff, *Bauten der Hohenstaufen in Unteritalien,* i (Leipzig, 1914), 97 *sqq.*

LUCERNE (Ger. *Luzern*), a canton of Switzerland. Its total area is 575 sq.mi., of which about 90% is classed as "productive" (forests covering nearly one-fifth of the total). It contains no glaciers or eternal snows, its highest points being the Brienzer Rothhorn (7,714 ft.) and Pilatus (6,995 ft.), the Rothstock summit (5,453 ft.) and the Kaltbad inn, both on the Rigi. The northern portion of the Lake of Lucerne, the lakes of Sempach and Baldegg and small portions of those of Hallwil and of Zug are in the canton.

Its chief river is the Reuss, which flows through it for a short distance only, receiving the Kleine Emme that flows down through the Entlebuch. In the northern part the Wigger, the Suhr and the Wynen streams flow through shallow valleys, separated by low hills. The canton is fairly well supplied with railways. (For the city of Lucerne, *see* LUZERN.)

In 1941 the population numbered 206,400 of which the great majority were German-speaking Roman Catholics. Its capital is Luzern; the other towns are Kriens, Willisau, Ruswil, Littau, Emmen and Escholzmatt.

The density of the population is 360 per sq.mi. The peasants, outside the chief centres for foreign visitors, have retained many local customs.

The canton ranks officially third in the Swiss confederation, next after Zürich and Berne. It was formerly in the diocese of Constance and is now in that of Basle. It contains 5 administrative districts and 107 communes. By existing cantonal constitution, the legislature or *Grossrath* is elected on a proportional basis by universal suffrage, while the executive is elected by a popular vote.

The canton every three years elects nine members to the Conseil National and sends two members to the Conseil des États (federal council). Citizens have the right of "initiative" as to constitutional amendments or legislative projects.

The canton is composed of the various districts which the town acquired, the dates being those at which the particular region was finally secured—Weggis (1380), Rothenburg, Kriens, Horw, Sempach and Hochdorf (all in 1394), Wolhusen and the Entlebuch (1405), the so-called "Habsburger region" to the N.E. of the town of Luzern (1406), Willisau (1407), Sursee and Beromünster (1415), Malters (1477) and Littau (1481), while in 1803, in exchange for Hitzkirch, Merenschwand (held since 1397) was given up.

LUCERNE, LAKE OF, the name usually given by foreigners to the principal lake of central Switzerland. In French it is called the *Lac des Quatre Cantons,* and in German the *Vierwaldstättersee,* the cantons being Lucerne, Unterwalden, Uri and Schwyz. It is named after Lucerne, at the west end, where the Reuss issues from the lake, after having entered it at Flüelen at the east end; the Muota enters the lake at Brunnen (north) and two mountain streams, the Engelberg and the Sarnen Aa, at Buochs and Alpnachstad respectively (south). The lake is most beautifully situated between steep limestone mountains, the best known being the Rigi (north) and Pilatus (southwest), and great promontories thrust themselves into its waters, such as Horw (south), Bürgenstock (south), Meggenhorn (north) and Seelisberg (south), giving it a romantic irregularity. It occupies an old terminal basin of a glacier and along its shores are evidence of damming by moraines.

It is composed of four main basins (with two side basins), which represent four different valleys, orographically distinct, and connected only by narrow and tortuous channels. There is, first, the most easterly basin, the Bay of Uri, extending from Flüelen (south) to Brunnen (north). At Brunnen the delta of the Muota forces the lake west, so that it forms the Bay of Gersau or the Gulf of Buochs, from the promontory of Seelisberg (east) to that of Bürgenstock (west). Another narrow strait between the two "Noses" (*Nasen*) leads west to the Basin of Weggis, between the Rigi (north) and the Bürgenstock promontory (south). This bay forms the eastern arm of the "Cross of Lucerne," the western arm being the Bay of Lucerne, the northern arm the Bay of Küssnacht and the southern arm that of Hergiswil, prolonged southwestward by the Bay of Alpnach, with which it is joined by a narrow channel, spanned by the Acher iron bridge. The Bay of Uri offers the sternest scenery, and at Brunnen the Everlasting league of 1315 was made, while the legendary place of meeting of the founders of Swiss freedom was the meadow of the Rütli (purchased by the Confederation in 1859), and the site of Tell's leap is marked by the Chapel of Tell (east).

In the Bay of Gersau is the village of Gersau (north), an independent republic (1390–1798), and now in Schwyz (1818 onward). In the next basin to the west is Weggis (north), and on the northern shore of the lake is Vitznau, whence a rack railway leads up to the top of the Rigi ($4\frac{1}{4}$ mi.), while on the southern shore of the lake is Kehrsiten, with electric railway to the Bürgenstock promontory. The town of Lucerne is connected with Flüelen by the St. Gotthard railway. On the promontory between Lucerne and Küssnacht stands the castle of New Habsburg, while from Küssnacht a motor road leads through the "Hollow Way" (*Hohle Gasse*), the scene of the legendary murder of Gessler by William Tell.

The western shore of the southern arm is traversed from Horw to Alpnachstad by the Brünig railway ($5\frac{1}{2}$ mi.), which continues toward Sarnen (Obwalden) and the Bernese Oberland, and southwest from Alpnachstad, whence a rack railway leads northwest up Pilatus ($2\frac{3}{4}$ mi.).

Lucerne is the only town of importance, but several spots serve as ports for neighbouring villages (Brunnen for Schwyz, Flüelen for Altdorf, Stanstad for Stans, Alpnachstad for Sarnen). Most of the villages are summer resorts (Gersau also in winter), especially Hertenstein, Weggis, Gersau, Brunnen, Beckenried and Hergiswil, while hotels have been built on heights above, as well as on the Rigi, Pilatus and the Stanserhorn. The area of the lake is about $44\frac{1}{2}$ sq.mi., it is about 24 mi. long, its greatest width only 2 mi. and its greatest depth 702 ft., while the surface of the water is 1,434 ft. above sea level.

Parts of the lake are in the cantons of Lucerne ($15\frac{1}{2}$ sq.mi.), Nidwalden (13 sq.mi.), Uri ($7\frac{1}{2}$ sq.mi.), Schwyz ($7\frac{1}{2}$ sq.mi.) and 1 sq.mi. in Obwalden.

LUCERNE, PURPLE MEDICK or **ALFALFA:** *see* ALFALFA.

LUCHAIRE, ACHILLE (1846–1908), French historian, was born in Paris on Oct. 24, 1846, and died on Nov. 4, 1908. In 1879 he became a professor at Bordeaux and in 1889 professor of mediaeval history at the Sorbonne; in 1895 he became a member of the Académie des sciences morales et politiques. The most important of Achille Luchaire's works are *Histoire des institutions monarchiques de la France sous les premiers Capétiens* (1883 and again 1891); *Manuel des institutions françaises: période des Capétiens directs* (1892); *Louis VI. le Gros, annales de sa vie et de son règne* (1890); *Etude sur les actes de Louis VII.* (1885); *Innocent III.* (6 vols., 1904–08); and contributions to Lavisse's great history of France.

His son JULIEN (b. 1876) became an official of the department of education, and in 1926 director of the Institute of International Intellectual Co-operation in Paris, in connection with the League of Nations.

LUCHU: *see* RYŪKYŪ ARCHIPELAGO.

LUCIA (or LUCY), **ST.,** virgin and martyr of Syracuse, whose name figures in the canon of the mass, and whose festival is celebrated on Dec. 13. According to the legend, she lived in the reign of Diocletian. Lucia was threatened with outrage, but it was found that no force which could be applied was able to move her from the spot on which she stood; even boiling oil and burning pitch had no power to hurt her, until at last she was slain with the sword. The most important documents concerning St. Lucy are the mention in the *Martyrologium Hieronymianum* and the ancient inscription discovered at Syracuse.

See O. Caietanus, *Vitae sanctorum Siculorum,* i. 114–121 (Palermo, 1657); Ioannes de Ioanne, *Acta sincera sanctae Luciae* (Palermo, 1758); *Analecta Bollandiana,* xxii. 492; Cahier, *Caractéristiques des saints,* i. 105 (1867).

LUCIAN (d. 312), Christian martyr, was born, like the famous heathen writer of the same name, at Samosata. His parents, who were Christians, died when he was twelve. In his youth he studied under Macarius of Edessa, and after receiving baptism he adopted a strictly ascetic life. Settling at Antioch when Malchion was master of the Greek school he became a presbyter, and is regarded as the founder of the theological school of Antioch. He is represented as the connecting link between Paul of Samosata and Arius. Indeed, on the deposition of the former (A.D. 268) he was excluded from ecclesiastical fellowship by three successive bishops of Antioch, while Arius seems to have been among his pupils (Theodoret, *Hist. Eccl.* i. 3, 4). He was, however, restored before the outbreak of persecution, and the reputation won by his high character and learning was confirmed by his courageous martyrdom.

Lucian was carried to Nicomedia before Maximin Daza, and persisting in his faith perished on Jan. 7, 312, under torture and hunger, which he refused to satisfy with food offered to idols. His defence is preserved by Rufinus (ix. 6; on Eusebius, *Hist. Eccl.* ix. 9). His remains were conveyed to Drepanum in Bithynia, and under Constantine the town was founded anew in his honour with the name of Helenopolis, and exempted from taxes by the emperor (A.D. 327) (see *Chron. Pasch.,* Bonn ed., p. 527). Here in 387, on the anniversary of his death, Chrysostom delivered the panegyrical homily from which, with notices in Eusebius, Theodoret and the other ecclesiastical historians, the life by Jerome (*Vir. Ill.* cap. 77), but especially from the account by S. Metaphrastes (cited at length in Bernhardy's notes to Suidas, *s.v.* *νοθεύει*), the facts above given are derived. See also, for the celebration of his day in the Syriac churches, Wright, *Cat. of Syr. MSS.* p. 283.

Jerome says that Lucian wrote *Libelli de fide* and several letters, but only a short fragment of one epistle remains (*Chron. Pasch.,* ed. Dindorf, i. 516). The authorship of a confession of faith ascribed to Lucian and put forth at the semi-Arian synod of Antioch (A.D. 341) is questioned. Lucian's most important literary labour was his edition of the Greek Old Testament corrected by the Hebrew text, which, according to Jerome (*Adv. Ruf.* ii. 77), was in current use from Constantinople to Antioch. That the edition of Lucian is represented by the text used by Chrysostom and Theodoret, as well as by certain extant mss., such as the Arundelian of the British Museum, was proved by F. Field (*Prol. ad Origenis Hexapla,* cap. ix.).

See generally, A. Harnack's art. in Hauck-Herzog, *Realencyk.* vol. xi., and for "remains" Routh, *Rel. Sac.* iv. 3–17.

LUCIAN (Λουκιανός) (*c.* A.D. 125–*c.* 190), Greek sophist and satirist, was born at Samosata (*Hist.* 24), the chief town of Commagene in Syria, on the west bank of the Euphrates (*Pisc.* 19). The precise dates of his birth and death are uncertain, and the little that is known of his life is derived from his own works, supplemented by the notice in Suidas: "Lucian of Samosata, surnamed 'the blasphemer,' because in his dialogues he alleges that the things told of the gods are absurd. . . . He was at first an advocate in Antioch, but, having ill success in that, he turned to the composition of discourses, and his writings are innumerable. He is said to have been killed by dogs, he having been rabid against the truth. For in his 'Life of Peregrinus' he attacks Christianity and, wicked man, blasphemes against Christ himself. Wherefore for his madness he suffered meet punishment in this life, and hereafter with Satan he will be inheritor of the everlasting fire." First apprenticed to his uncle, a sculptor (*Somn.* 2), he soon abandoned sculpture for the study of rhetoric, in particular forensic oratory. After practising as an advocate in Antioch he adopted the profession of a sophistic rhetorician, and in this capacity he travelled widely, visiting various parts of Asia Minor, Macedonia, Greece, Italy and Gaul (*Alex.* 57, *Bis accus.* 27, *Apol.* 15, *De electo* 2). In Rome he made the acquaintance of the Platonist Nigrinus, as he describes in the dialogue of that name. About A.D. 165 he settled in Athens, where he made his home for the next 20 years. Here he devoted himself to writing dialogues of a satiric character. Towards the end of his life he accepted an official post in Egypt, defending himself in the *Apologia* against the charge of inconsistency to which he thus exposed himself, he having in his earlier *De mercede conductis* denounced the practice of serving for hire. In this post he seems to have died, but nothing is known as to the date or circumstances.

Under the name of Lucian we have some 79 prose works, and, in addition, two mock tragedies (the theme being gout) and a collection of 53 epigrams. Neither of the tragedies, *Tragodopodagra* and *Ocypus,* is now considered genuine (the latter having apparently been written by the 4th century rhetorician, Acacius, the correspondent of Libanius), nor is much confidence to be placed in the authenticity of the epigrams, which in any case contain nothing notable, save perhaps No. 17 Ἕξ *ὧραι μόχθοις ἱκανώταται, αἱ δὲ μετ' αὐτὰς γράμμασι δεικνύμεναι "ζῆθι" λέγουσι βροτοῖς, i.e.,* Six hours are enough for work; the next four, expressed in letters (ζ', η', θ', ι'), say to men "Live" (in the emphatic sense of "enjoy life" as in Martial's *sera nimis vita est crastina: vive hodie*).

Several of the prose writings are considered spurious on grounds of varying certainty—*Lucius or the Ass, Nero Macrobii, Philopatris* (written in the 10th century), *Halcyon, De sacrificiis, De Syria dea, De astrologia, De parasito, De saltatione, Calumniae non temere credendum, Hippias, Charidemus, Demosthenis encomium, Amores.* The chronological order of his writings is uncertain, but in general the rhetorical works may be regarded as mainly belonging to his earlier period, the satirical dialogues as the work of his maturity, written for the most part during his residence in Athens.

1. **Rhetorical Declamations.**—As typical of these may be named the *Tyrannicide* (a man goes to slay a tyrant but, finding not him but his son, slays the latter, leaving his sword in the wound. The tyrant finds his son slain, takes the sword, and kills himself. The man claims the reward of a tyrannicide); *Phalaris* I. and II. (in I., Phalaris, sending the brazen bull to Delphi, transmits therewith a defence of his own life and conduct; in II., a Delphian priest advises acceptance of the offering); *The Disinherited,* *Ἀποκηρυττόμενος* (a disinherited son learns medicine and, curing his father's madness, is received again into his family, but refusing to cure his step-mother is again disinherited. He pleads against this sentence); *Praise of the Fly; The Trial of the Vowels* (an action is brought by the letter sigma [s] against

tau [τ] for the encroachments of the latter in the case of Attic ττ for σσ, etc., the vowels forming the jury).

2. **Literary Criticism.**—Representative of this type are the *Teacher of Orators,* ironical advice how to become a successful rhetorician by means of claptrap and impudence; *Pseudo-sophist,* a dialogue in which the interlocutors are Lucinus (*i.e.,* Lucian) and a Solecist, and the discussion is of certain solecisms and the distinction of similar words and phrases; *Lexiphanes,* in which the interlocutors are Lucinus and Lexiphanes. The latter recites a *Symposium* composed by himself and packed with far-fetched phraseology and recondite words. Meeting a doctor he receives an emetic, which cures his distemper by causing him to disgorge a flood of abstruse vocables. There are interesting references to the *Altar* of Dosiades and the *Alexandra* of Lycophron. But the best specimen of his literary criticism is contained in the essay *How History Should be Written,* which belongs probably to an early period of his residence in Athens, and which contains sound, if not particularly profound, criticism. The description of the ideal orator (*Hist.* 41) may be quoted: "I would have the historian to be fearless and incorruptible, independent, a lover of frankness and truth, one who, as the comic poet says, will call a fig a fig and a spade a spade; indulging neither hate nor affection, unsparing and unpitying, not shy nor shamefast, an impartial judge, benevolent towards both sides but giving neither more than its due; knowing in his writing no land and no city, bowing to no authority and, acknowledging no king, not considering what this man or that will think, but stating facts as they occurred." His remarks on the style appropriate to the historian are also admirable.

3. **Biographical Works.**—These include *On the Dream,* which is autobiographical; the *Life of Demonax,* an account of Demonax of Cyprus, a cynic philosopher whose society Lucian enjoyed at Athens (*Vit.* Demon. 1); *Alexander, or the False Prophet,* an indictment of the Paphlagonian religious impostor of that name—written after A.D. 180, since in sec. 48 θεὸς Μάρκος, i.e., *divus Marcus,* implies that M. Aurelius (died March 17, 180) was already dead; *On the Death of Peregrinus,* written about 166, an account of the death of Peregrinus (Proteus) of Parium, who, after professing Christianity, became a cynic and finally committed suicide by publicly burning himself at Harpina near Olympia in A.D. 165, Lucian being an eye-witness (*Peregr.* 2). The references to Christianity in this dialogue (11 *seq.*) and in the *Alexander* (25 and 38) are of interest, particularly the references to Christ, "that great man who was crucified in Palestine because he introduced this religion into life" (*Peregr.* 11), to the unsparing devotion of the Christians, and to their beliefs: "for these unhappy men have persuaded themselves that they will be immortal and live for ever; wherefore they despise death and willingly sacrifice themselves. Further, their first lawgiver has persuaded them that they are all brothers one of another, when once they renounce the gods of the Greeks and worship that crucified sophist and live in accordance with his laws" (*Peregr.* 13).

4. **Romances.**—*Lucius* or the *Ass* seems not to be genuine. The story is that of one Lucius who, visiting Thessaly, sees his hostess transform herself by a drug into a bird. Trying the same experiment, but using the wrong drug, he turns himself into an ass and goes through various adventures before he is able to procure roses (the antidote to the drug), which he eats and regains human form. The same theme seems to have been used by Lucius of Patrae in the 1st century A.D. (Phot. cod. 129) as it was again by Apuleius in his *Metamorphoses* in the 2nd century. The *True History,* in two books, is a novel of adventure, describing the marvellous experiences of certain voyagers who, setting sail from the Pillars of Hercules, are caught up into the air, fight for the men of the moon against the men of the sun over the colonization of the morning star, are swallowed, ship and all, by a huge sea-monster, from which they at last escape and voyage to the islands of the blest, etc. The writer warns the reader at the start: "I write of things which I have neither seen nor suffered nor learned from another, things which are not and never could have been, and therefore my readers should by no means believe them" (*V.H.* i. 4).

5. **Satirical Dialogues.**—The satirical dialogues may be taken as the most mature and characteristic work of Lucian. In the *Twice Accused* Lucian is arraigned by Rhetoric on a charge of desertion (κάκωσις). Rhetoric tells how she found him quite a youth, "still a barbarian in speech and all but dressed in the Assyrian fashion, wandering about Ionia and not knowing what to do with himself," and how she educated him in the art of speaking and made him famous, travelling with him not merely in Ionia and Greece but even so far afield as Italy and Gaul (*Bis accus.* 27). Lucian in his reply admits the benefits which he received from Rhetoric, but he pleads that it was only when he found her abandoning the Demosthenic style of oratory for a more meretricious fashion, "decking herself and wearing her hair in the manner of a courtesan, using paint and pencilling her eyes," that he resolved to desert her for Dialogue: "In any case it was well for me, a man of some 40 years of age, to be done with those tumults and lawsuits and to leave 'gentlemen of the jury' alone; to escape from tirades against tyrants and praise of princes, and to go to the Academy or the Lyceum and walk with this most excellent Dialogue, conversing quietly and requiring no praise or applause" (*Bis accus.* 32). On the other hand, Dialogue arraigns Lucian in an action for insult (ὕβρις), complaining that whereas he (Dialogue) had previously held high discourse of the gods and nature and the universe, soaring high above the clouds, where Zeus drives his winged car, Lucian had dragged him down to earth and broken his wings, robbing him of his mask of tragedy and wisdom and substituting for it a mask of another sort, comic and satyric and almost ridiculous, associating him with jest and lampoon and cynicism and Eupolis and Aristophanes, "scoffers at serious things and mockers of what is well ordered," and finally Menippus, "a terrible dog who bit while he laughed" (*Bis accus.* 33). Lucian in reply substantially admits the accusation, but pleads that by abandoning the subtleties of philosophy and introducing comic relief he had caused Dialogue to "walk upon the earth after the manner of men" and thus to become more generally attractive.

In the *Nigrinus* Lucian makes that philosopher describe himself as "sitting as it were aloft in a crowded theatre surveying the actions of men, some capable of affording amusement and laughter, others calculated to try the firmest heart" (*Nigrin.* 18). If the function of the chorus in Greek tragedy as the κηδευτὴς ἄπρακτος (an interested party who takes no part in the action) is comparable to that of the Wedding Guest, Lucian in his rôle of the laughing philosopher may be compared to the Casual Spectator, for whom in his detachment and unconcern all the world's a stage and all the men and women merely players. This is a notion to which Lucian again and again recurs, e.g., *Menippus* 16: "You have often seen, I imagine, on the stage those tragic actors who, according to the exigencies of the play, appear now as Creon and now as Priam or Agamemnon, and the same person, who a little before had with great dignity represented Cecrops or Erechtheus, comes forth at the bidding of the poet as a menial; and, when the drama is ended, each doffs his gold-bespangled dress and lays aside his mask and stepping down from his still-boots walks about, a poor and humble man, no longer Agamemnon the son of Atreus, or Creon the son of Menoeceus, but Polus son of Charicles of Sunium, or Satyrus son of Theogeiton of Marathon." This detached and external point of view is obtained in the *Menippus* by a descent to Hades; and so, too, in the *Dialogues of the Dead* (with which may be classed the *Cataplus*) the theme is the contemplation of the fugitive vanities of human life from the point of view of those for whom "what comes after life" (τὰ μετὰ τὸν βίον, *Mort. Dialog.* i. 1) is no longer a matter of speculation but a present reality. In the *Icaromenippus,* on the other hand, the vantage-ground is got by an ascent to Heaven; in the *Charon* by piling upon Ossa Pelion, then Oeta, then Parnassus, whence Charon with his guide Hermes contemplates a series of celebrities, and, beholding the futility of human endeavour, is moved to cry "O foolish men! Wherefore are ye so busied about these things? Cease from your labours, for ye will not live for ever. None of those earthly dignities is abiding, and a man can carry none of them with him when he dies, but must depart naked, while his house and lands and gold will own one master after another" (*Charon* 20). In the *Anacharsis* we have Greek institutions as they present themselves to the eye of a barbarian, and a justification of them against his criticisms.

Besides the dialogues already referred to may be mentioned the *Hermotimus* (written when Lucian was 40 years of age, *Herm.* 13), the upshot of which is that all philosophy is vanity; the *Ship,* emphasizing the vanity of human wishes; the *Symposium,* describing a riotous banquet at which the philosophers behave rather worse than others; the *Sale of Lives,* in which the lives of various philosophers are auctioned at market value; the *Timon,* in which the Athenian misanthrope (whose tower was seen by Pausanias, i. 30) is restored to wealth to find himself once more the centre of a crowd of flatterers.

The English writer whom Lucian most recalls is Swift, who, as he probably took the idea of *Gulliver's Travels* from the *True History,* may have found the inspiration for the *Letter of Advice to a Young Poet* in the *Teacher of Orators.* In ease and lucidity of style Lucian's Greek (founded on the best Attic models and only in some minute details aberrant from them) is not inferior; and if he suggests less of the *saeva indignatio* of the conventional satirist, that may well mean not any lack of personal conviction and moral earnestness but a stricter fidelity to what he conceived to be the function of the satirist—*ridentem dicere verum.*

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LUCIFER (d. 371), bishop of Cagliari (hence called *Caralitanus*), an ardent supporter of the cause of Athanasius. After the unfavourable result of the synod of Arles in 353 he volunteered to endeavour to obtain a new and impartial council. He was accordingly sent by Pope Liberius, with Pancratius the presbyter and Hilarius the deacon, but could not prevent the condemnation of Athanasius, which was renewed at Milan in 355. For his own persistent adherence to the orthodox creed he was banished to Germanicia in Commagene; he afterwards lived at Eleutheropolis in Palestine, and finally in the upper Thebaid. His exile came to an end with the publication of Julian's edict in 362. From 363 until his death in 371 he lived at Cagliari in a state of voluntary separation from ecclesiastical fellowship with his former friends Eusebius of Vercelli, Athanasius and the rest, on account of their mild decision at the synod of Alexandria in 362 with reference to the treatment of those who had unwillingly Arianized under the persecutions of Constantius. The sect which Lucifer thus founded did not continue long after his death. It is doubtful whether it ever formulated any distinctive doctrine; certainly it developed none of any importance. The memory of Lucifer is still cherished in Sardinia; but, although popularly regarded there as a saint, he has never been canonized.

Bibliography.—The controversial writings of Lucifer, dating from his exile, are chiefly remarkable for their passionate zeal, and for the boldness and violence of the language addressed to the reigning emperor. Their quotations of Scripture are of considerable value to the critical student of the Latin text before Jerome. They were first collected and edited by Tilius (Paris, 1568); the best edition is that of W. Hartel in the Vienna *Corpus, Script. Eccl. Lat.* (1886). *See* also G. Krüger, *Lucifer Bischof von Cagliari und das Schisma der Luciferianer* (Leipzig, 1886); F. G. Kenyon, *Textual Criticism,* pp. 181, 221.

LUCIFER, meaning "light-bringer," is a name given to the planet Venus when it appears above the eastern horizon before sunrise. It is used in Isaiah xiv. 12 (A.V.; but R.V. "day-star") to translate the Hebrew epithet "shining one," applied to the king of Babylon, fallen from his high estate to Sheol. The Fathers interpreted the words of Jesus, Luke x. 18, "I beheld Satan fallen as lightning from heaven," as a reference to this passage in Isaiah, so that Lucifer came to be regarded as the name of Satan before his fall. It is so used by Milton in *Paradise Lost,* and the idea underlies the proverbial phrase "as proud as Lucifer."

LUCILIUS, GAIUS (*c.* 180–103 B.C.), the earliest Roman satirist, of whose writings only fragments remain, was born at Suessa Aurunca in Campania. The dates assigned by Jerome for his birth and death are 148 and 103 or 102 B.C. But it is impossible to reconcile the first of these dates with other facts recorded of him, and the date given by Jerome must be due to an error, the true date being about 180 B.C. He served under Scipio at the siege of Numantia in 134, was an intimate friend of Scipio and Laelius, and devoted some of his satires to the praises of Scipio. He spent the greater part of his life at Rome, and died, according to Jerome, at Naples. Lucilius belonged to the equestrian order, a fact indicated by Horace's notice of himself as "infra Lucili censum." His satires are another expression of the revolutionary forces behind the Gracchan movement.

He may be regarded as the inventor of poetical satire, as he was the first to give to the formless Roman *satura* that distinctive character of critical comment on manners, politics and literature which the word satire still denotes. Unlike other forms of Roman literature, it owes nothing to Greek, being a legitimate development of a native form of entertainment, originally of a dramatic nature. In his style and his choice of subject Lucilius was equally original. His early work was directed to ridiculing the conventional language of epic and tragic poetry, and he used the style of familiar speech, even to the point of frequently employing Greek, which was then beginning to be fashionable in educated circles, while for his subjects he abandoned the hackneyed ground of Greek and Roman mythology, and treated of the politics and wars, the business and pleasure, the scandals and vices of his own day. These he handled, not in Juvenal's spirit of rhetorical stoicism, but, like Horace, from the standpoint of a man of the world, and the associate of men of affairs. But he differed from Horace in being a thoroughly good hater, and also in a savage outspokenness of attack characteristic of the public life of his age.

The fragments of Lucilius number about 1,100, mostly unconnected lines, most of them preserved by late grammarians, as illustrative of peculiar verbal usages. He was, for his time, a voluminous as well as a very discursive writer. He left behind him 30 books of satires, mostly written in hexameters, but, so far as an opinion can be formed from a number of unconnected fragments, he seems to have written the trochaic tetrameter with a smoothness, clearness and simplicity which he never attained in handling the hexameter. The longer fragments produce the impression of great discursiveness and carelessness, but at the same time of considerable force.

Editions by F. D. Gerlach (1846), L. Müller (1872), C. Lachmann (1876, posthumous), F. Marx (1905); *see* also L. Müller, *Leben und Werke des Lucilius* (1876); "Luciliana," by H. A. J. Munro, in the *Journal of Philology,* vii. (1877); Mommsen, *Hist. of Rome,* bk. 4 ch. xiii.; "Luciliana," by A. E. Housman, in *Classical Quarterly* (April, 1907); C. Cichorius, *Untersuchungen zu Lucilius* (1908). (W. Y. S.; X.)

LUCILIUS JUNIOR, a friend and correspondent of the younger Seneca, probably the author of *Aetna,* a poem on the origin of volcanic activity. As the author appears to have known and made use of the *Quaestiones Naturales* of Seneca (written A.D. 65), and no mention is made of the great eruption of Vesuvius (A.D. 79), the time of its composition seems to lie between these two dates. *See* Aetna.

LUCINA, the Roman goddess or spirit who brings children to birth (*ad lucem, cf.* Fr. *mettre un enfant au jour*). It is commonly found as an epithet of Juno, as Terence, *Andria,* 473; occasionally of other goddesses, as Diana (Hor., *Carm. Saec.,* 15), but not in pure Roman cult.

LUCIUS, the name of three popes.

Lucius I., pope for eight months (253–254), spent a short period of his pontificate in exile. He is referred to in several letters of Cyprian (see *Epist.* lxviii. 5) as agreeing with his predecessor Cornelius in preferring the milder treatment of the lapsed penitent. He is commemorated on March 4. (L. D.)

Lucius II. (Gherardo Caccianemici dal Orso), pope from March 12, 1144, to Feb. 15, 1145, a Bolognese, successively canon at his native city, cardinal priest of Sta Croce in Gerusalemme, treasurer of the Roman Church, papal legate in Germany for Honorius II., chancellor and librarian under Innocent II., was the successor of Celestine II. His stormy pontificate was marked by the erection of a revolutionary republic at Rome which sought to deprive the pope of his temporal power, and by the recognition of papal suzerainty over Portugal. He was succeeded by Eugenius III.

His letters are in J. P. Migne, *Patrol. Lat.* vol. 179. A single unreliable writer, Godfrey of Viterbo (in J. M. Watterich, *Pontif. Roman. Vitae*), is authority for the statement that Lucius II. perished in an attempt to storm the Capitol. *See* Jaffé-Wattenbach, *Regesta pontif. Roman.* (1885–88); J. Langen, *Geschichte der römischen Kirche von Gregor VII. bis Innocenz III.* (Bonn, 1893); F. Gregorovius, *Rome in the Middle Ages,* vol. 4, trans. by Mrs. G. W. Hamilton (1896).

LUCIUS III. (Ubaldo Allucingoli), pope from Sept. 1, 1181, to Nov. 25, 1185, a native of Lucca and a Cistercian monk, named cardinal-priest of Sta Prassede by Innocent II. and cardinal-bishop of Ostia and Velletri by Adrian IV., succeeded Alexander III. He lived at Rome from Nov. 1181 to March 1182, but dissensions in the city compelled him to pass the remainder of his pontificate in exile, mainly at Velletri, Anagni and Verona. He disputed with the emperor Frederick I. the disposal of the territories of the Countess Matilda. In Nov. 1184 he held a synod at Verona which condemned the Cathari, Paterines, Waldensians and Arnoldists, and anathematized all heretics and their abettors. Lucius died in the midst of preparations for a crusade in answer to appeals of Baldwin IV. of Jerusalem. His successor was Urban III.

His letters are in J. P. Migne, *Patrol. Lat.* vol. 201. Consult J. M. Watterich, *Pontif. Roman. Vitae,* vol. 2 (Leipzig, 1862); and Jaffé-Wattenbach, *Regesta Pontif. Roman.* (1885–88). *See* J. Langen, *Geschichte der römischen Kirche von Gregor VII. bis Innocenz III.* (Bonn, 1893); P. Scheffer-Boichorst, "Zu den mathildinischen Schenkungen," in *Mittheilungen des österreichen Instituts* (1888).

(C. H. H.)

ŁUCK or **LUTSK,** a town of Poland, in the province of Volhynia, on the Styr, 51 mi. by rail N.W. of Kovel. Pop. 35,700. In the 11th century it was known as Luchesk, and was the chief town of an independent principality. In the 15th century it was the seat of a bishop and became wealthy, but during the wars between Russia and Poland in the second half of the 16th century, and especially after the extermination of its 40,000 inhabitants, it lost its importance. In 1791 it was taken by Russia. Among its buildings is a 16th-century castle. Luck is the seat of a Roman Catholic bishop. It was occupied by the Russians in 1939 and fell to the Germans in 1941.

ŁUCK or **LUTSK, BATTLES OF.** Under this heading are described the Russian attacks on their south-western front, which extended from the Pinsk marshes to the northern frontier of Rumania, during the summer and autumn of 1916. These attacks are generally known as "the Brusilov offensive." The original break-through of the Austrian front occurred near the town of Łuck (Lutsk), in Volhynia, on the river Styr, which thus gives its name to the whole series of operations.

The general situation in May 1916 was such that despite the failure of the attacks in March which it had launched, the Russian supreme command had set to work to prepare a large scale offensive on the front west of Molodeczno as its contribution to the great general Allied offensive which was to open on all fronts on July 1. Since the great offensive of the Central Powers against Russia had come to an end in the autumn of 1915, their forces on the Eastern front had been considerably reduced. The Germans had taken troops for their Verdun offensive, and the Austrians during the spring had withdrawn formations for an offensive against Italy. The Russians, on the other hand, had recovered rapidly from their disasters of the previous year; the ranks were full and munitions more plentiful than they had been formerly.

Preparation of Brusilov's Offensive.—Gen. Brusilov succeeded Ivanov as Commander-in-Chief of the south-western front in March. He was a cavalry soldier and had commanded the 8th Army since the commencement of the war with conspicuous success. He received instructions to prepare attacks on the south-western front to distract the enemy's attention from the main Russian effort at Molodeczno. The four armies under Brusilov were: the 8th (Kaledin) from the Kowel-Kiev railway near Rafalowka to about Kremenets, 11 divisions and four cavalry divisions; the 11th (Sakharov) from Kremenets to near Tarnupol, eight divisions and one cavalry division; the 7th (Shcherbachev) from near Tarnupol to Potok, seven divisions and $3\frac{1}{2}$ cavalry divisions; and the 9th (Lechitski) from Potok to the Rumanian frontier, ten divisions and three cavalry divisions. There was one corps (two divisions) in reserve.

The Austrian 4th Army (Archduke Joseph Ferdinand), from near Rafalowka to Dubno, with $10\frac{1}{2}$ divisions and one cavalry division, and the 2nd Army (Böhm-Ermolli), from Dubno to near Kremenets, with eight infantry and two cavalry divisions, were opposed to Kaledin; the German Southern Army (von Bothmer) with one German and nine Austrian divisions and two cavalry divisions, held a long front, corresponding approximately with those held by the Russian 11th and 7th Armies; while the Austrian 7th Army (Pflanzer-Baltin), with $8\frac{1}{2}$ divisions and four cavalry divisions, opposed Lechitski. In the actual number of divisions there was little disparity between the total forces at the disposal of either side; the Russians had 38 divisions and 12 cavalry divisions to the Austro-German 37 divisions and nine cavalry divisions; but the Russian divisions were larger. The Austrian front had been strongly fortified and organized, and in spite of the removal of some of their most reliable divisions and much heavy artillery to the Italian front the Austrians were confident of being able to hold their ground.

About the middle of April, Brusilov had ordered each of his army commanders to select a sector of attack and to make preparations with the resources at his disposal within his own army to penetrate the enemy's front in that sector. Preparations were to be complete before the middle of May. These attacks were designed simply as aids to the main Russian offensive in the north, timed for July 1. On May 14, however, the Austrians began an offensive in the Trentino against Italy. The Italians appealed to the Russians to relieve the pressure by attacking the Austrians on their front. Brusilov accordingly launched his attacks on all four army fronts on June 4, without any expectation of a decisive break-through or arrangements for exploitation of success on a large scale.

The Break-through at Łuck.—The sector of attack chosen by Kaledin, commander of the 8th Army, centred on the village of Olika, east of Łuck. The bombardment began on June 4 and the assault was made by the 40th and 8th Corps early on June 5. The 40th Corps carried three lines of enemy trenches and penetrated over two miles, and the 8th Corps, though less successful, made considerable progress. The advance continued on June 6 and on June 7 reached Łuck. By this time a wide gap had been made between the Austrian 4th Army and the 2nd Army farther south, and a great opportunity for the numerous Russian cavalry seemed to have come. But of the four cavalry divisions allotted to Kaledin's army, two had been used to hold trenches so as to enable infantry to be concentrated for the assault and one was despatched by Brusilov in a fruitless raid along the railway towards Kowel through marshes entirely unsuited for cavalry action. The one remaining division could accomplish little. Meanwhile the left wing of the 8th Army occupied Dubno on June 9; on June 10 the front of the army lay along the line of the rivers Styr and Ikwa, from Rozyszcze through Łuck to Dubno.

Attacks of the 11th, 7th and 9th Armies.—The attack of the 11th Army north-west of Tarnupol was a failure. Shcherbachev's 7th Army attacked in a sector on its extreme left near the village of Jaziowec. After two days' bombardment the infantry assaulted early on June 6 and carried the enemy positions; next day the Austrians were driven behind the Strypa. The Russians crossed the river on the 8th and gained further ground during the next two days. Counter-attacks then arrested their advance for the time being. Lechitski's 9th Army attacked some 20m. north of Czernowitz, near the village of Okna, with complete success. By June 10 the front was broken and the Austrians retreated in disorder behind the Prut. Czernowitz was captured on June 17.

Consequences of Brusilov's Success.—Thus by the middle of June the Austro-German front south of the Pinsk marshes was completely broken on both flanks, and two armies, the 4th and 7th, were in full retreat. In the centre Böhm-Ermolli's and von Bothmer's armies still held, though their outer flanks had been driven in. On three-quarters of the whole Russian south-western front their armies were moving forward. These entirely unexpected results of an offensive undertaken purely as a demonstration reacted instantly on the whole strategy both of the Russians and of the Central Powers. On the Russian side the new situation demanded the immediate transfer of the principal reserves from the north, where they had been grouped for the Molodeczno offensive, if Brusilov's success in the south were to be exploited. The decision was taken promptly enough: the Molodeczno offensive was abandoned. Lesh's 3rd Army astride the Pripet was added to Brusilov's command and troops were hurried south as rapidly as the capacity of the railways would permit. Unfortunately for the Russians the poverty and the low efficiency of their communications gave the enemy time to concentrate sufficient reinforcements to restore their front before the full weight of the Russian reserves could give a fresh impetus to the advance.

For the Germans the sudden reverse came at a difficult time, for they were fully engaged at Verdun and were expecting a Franco-British offensive at an early date; obviously, too, events might have a decisive influence on the attitude of Rumania. Reinforcements were at once collected to restore the situation; to close the principal gap it was decided to stage a counter-attack on a large scale on both sides of the Kowel-Rowne railway. This attack was entrusted to von Linsingen, the German commander of the Austro-German army holding the area of the Pinsk marshes opposite the Russian 3rd Army. He was reinforced by three German divisions from the northern part of the Eastern front, four from France and two Austrian divisions from the Trentino. During the whole of the latter half of June, as these reinforcements arrived, he counter-attacked persistently towards Łuck and to the north and south of it. These attacks, though they brought the Austro-German forces little gain of ground, had at least the effect of limiting Kaledin's break-through. On July 4 the left of Lesh's 3rd Army, in conjunction with Kaledin's right, launched an attack in the bend of the Styr east of Kowel and drove von Linsingen's army back to the Stochód river. This put an end to the Austro-German counter-attacks, and there were no further important operations on this part of the front till the end of July.

Meantime, Lechitski in the south with the Russian 9th Army was completing the conquest of the Bukovina. After the capture of Czernowitz, part of the Austrian 7th Army retreated precipitately south to the Carpathians, pursued by the left wing of Lechitski's army, which occupied Kimpolung on June 24. His right wing, advancing between the Dniester and the Prut, won a victory on June 28 and occupied Kolomyja on the following day. At the beginning of July the Austrians in the south received reinforcements and made a series of counter-attacks opposite Kimpolung and Delatyn. These were defeated, and Lechitski's right wing occupied Delatyn on July 10. His army was now, however, enormously extended and had to halt to await reinforcements.

Reorganization of Command by the Central Powers.—The German command, which had since the beginning of June sent 16 divisions to the front south of the Pinsk marshes, naturally claimed an increased influence on the direction of operations on this front. Very shortly after the first break-through at Łuck they had insisted on the removal of the Archduke Joseph Ferdinand from his command of the 4th Army and on the extension of von Linsingen's sphere of command southwards to the northern frontier of Galicia. The greater portion of Pflanzer-Baltin's 7th Army had also been transferred to von Bothmer commanding the German Southern Army. It was now proposed to appoint Hindenburg to the supreme command of the Eastern front as far south as Lemberg; the remainder of the front, on both sides of the Dniester and in the Carpathians, was to be under the Austrian heir apparent, the Archduke Charles, with the German Gen. von Seeckt as his chief of staff.

This arrangement was eventually brought into force early in August. The Archduke Charles had originally come from the Italian front at the beginning of July to command a 12th Army, which was to be formed from troops on the spot and fresh reinforcements, and was to deliver a counter-attack on a large scale on both sides of the Dniester in a south-easterly direction. But as the incoming reinforcements had always to be thrown into the battle as soon as they arrived, the formation of the 12th Army and the proposed counter-offensive never took place. Instead, the 3rd Army command from Tirol took over the troops between the Carpathians and the Dniester. The Archduke's command thus comprised the 7th, 3rd and Southern armies.

Concurrently during the latter half of July, while the Russian 8th and 9th Armies on the flanks paused to await reinforcements, Brusilov ordered Sakharov's 11th Army, which had extended its front northwards to beyond Dubno, to take the offensive. It attacked near Boromel, south-west of Łuck, on July 16, and drove the enemy back across the Lipa. Sakharov then moved south on Brody, which he captured with 40,000 prisoners on July 28—a fine victory. Meanwhile Shcherbachev's 7th Army, in spite of repeated attacks north-west of Buczacz towards Monasterzyska, had failed to make much impression on von Bothmer's Southern Army. Lechitski, however, at the end of July gained some ground towards Stanislau.

Attack on Kowel.—Towards the end of July the Russian Guard Army (1st and 2nd Guard Corps, 1st Corps, 30th Corps, Guard Cav. Corps) detrained from the north and took up a front between the 3rd and 8th Armies. The Guard had not been in action since the previous September and had been carefully trained and kept in hand for a great occasion. It was now decided to use it to force the line of the Stochód river and capture Kowel. It is difficult to understand why this line of advance was chosen for a supreme effort. The terrain is mainly marsh and advance is usually possible only on narrow causeways. The attacks, which commenced on July 28 and were continued up to Aug. 10, resulted in a complete and costly failure. The Guard Army lost 55,000 men for a trifling gain of unimportant ground. Brusilov thereafter abandoned the direct advance on Kowel, but continued up till the middle of October attempts to enlarge the Łuck salient in the direction of Włodzimierz Wolynski. All these attempts ended in failure.

In the south the Russian Army commander, Lechitski, attacked again south of the Dniester on Aug. 7 and drove back Kövess' 3rd Army. He occupied Stanislau on Aug. 10 and Nadwórna on Aug. 12. On this latter date the 7th Army occupied Monasterzyska. Under the threat from this flank and pressure from Sakharov's army south of Brody, von Bothmer now at last gave up the original line which he had held throughout all the turmoil and withdrew towards Brzezany.

Austro-German counter-attacks in the Carpathians in the first half of August had little success. On Aug. 20 the Russians reorganized their front so as to allow Lechitski's 9th Army to have as its only task the forcing of the Carpathian passes between Delatyn and Kimpolung in order to protect the right flank of the Rumanians, who joined the Allies on Aug. 27. In spite of severe fighting throughout September little progress was made on this front. Nor was any appreciable advance made elsewhere on the south-western front in spite of repeated assaults. In October the defeat of the Rumanians necessitated the transfer of troops to that theatre and the abandonment of further offensive operations. The summer which had opened so brilliantly ended in disappointment and failure.

Results of the Offensive.—Although Brusilov had recaptured practically the whole of the Bukovina and large portions of Eastern Galicia and Volhynia and had taken some 350,000 prisoners and over 400 guns, the cost had been exceedingly heavy. The casualties on the south-western front were over 1,000,000. These losses and those suffered in the abortive attacks on the Northern and Western fronts in 1916, at Lake Naroch, Baranowicze and Riga, were in the end the principal cause of the rapid infection of the army with anti-war propaganda when the Revolution came. Hailed by her Allies as proof of the complete regeneration of the Russian army, Brusilov's offensive was really its death-knell.

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LUCKA, EMIL (1877–), Austrian author and philosopher, born in Vienna on May 11, 1877, and came to the forefront of Austrian literature in 1912. His novels and shorter tales are as rich in thought as in invention, their plots being laid either in the Middle Ages as, in *Isolde Weisshand* (1912), *Heiligenrast* (1917), *Der Weltkreis* (1919), *Fredegund* (1921); or in Vienna society, as in *Das Brausen der Berge* (1918), or in the Austrian Alps, as in *Am Sternbrunnen* (1926). In the *Drei Stufen der Erotik* (1913) Lucka gives a magnificent representation of the development of love throughout the ages; in *Grenzen der Seele* a psychology of Genius; and in *Urgut der Menschheit* (1924), he discusses the problem of how the primeval myths may be revived to meet the needs of modern civilization.

LÜCKE, FRIEDRICH (1791–1855), German theologian, was born on the 24th of August 1791, near Magdeburg, where his father was a merchant. He studied theology at Halle and Göttingen. After holding various academic posts he became in 1827 professor of theology at Göttingen, where he remained until his death on Feb. 4, 1855.

Lücke, who was one of the most learned, many-sided and influential of the so-called "mediation" school of evangelical theologians (*Vermittelungstheologie*) is chiefly remembered by his *Kommentar über die Schriften d. Evangelisten Johannes* (4 vols., 1820–1832, 3rd ed. 1856).

See Sander, *Friedrich Lücke* (1890).

LUCKENWALDE, a town in the Prussian province of Brandenburg, Germany, on the Nuthe, 30 mi. S. of Berlin, on the line to Dresden and Leipzig. Pop. (1939) 28,801. The site of Luckenwalde was occupied in the 12th century by a Cistercian monastery, but the place did not become important till the reign of Frederick the Great though it became a town in 1430. Its cloth and hat manufactories are among the most extensive in Prussia. Among its other industries are brewing, and the making of metal and bronze goods, paper and pianos.

LUCKNOW (lŭk′now), a city, district and division of British India. The city was the capital of Oudh from 1775 until merged in the United Provinces in 1901. Pop. (1941) 387,177. It lies mainly on the right bank of the winding river Gumti. East of the city the Civil Lines stretch for a distance of over 2 mi.; and then comes a fine, well laid-out cantonment with a substantial civil population and accommodation for troops of all arms. It is the headquarters of the 8th division of the Indian Army.

Lucknow is a place of parks, gardens and imposing monuments, though most of the latter are of inferior architecture and material. It shares with Allahabad the position of the headquarters of the government of the United Provinces, and has a residence for the Governor; it is also the seat of the Chief Court of Oudh, and of the provincial legislature. It has a university of its own, with the Canning College, and a number of others. The Medical College is the finest in north India, and the adjoining hospital was erected on the most modern design at a cost of over £250,000. The Colvin School is intended for the education, on British public-school lines, of the sons of the taluqdars or large landlords of Oudh; and a picturesque building, known as La Martinière, takes Anglo-Indian boys and is partly supported by an endowment left by General Claude Martin in 1800. There are several important industrial establishments, chiefly paper mills, printing presses and metal works; but the city as a whole swarms with the decayed families of the hangers-on of the overgrown court of the old Oudh kingdom. The chief indigenous industries are gold and silver brocades, muslins, embroidery, brass and copper ware, pottery and moulding in clay, and vessels and ornaments in beaten silver. Lucknow being an important railway centre, there are large workshops; and it was one of the first of the towns in Upper India to be supplied with electricity.

The Residency.—Among the events of the Mutiny of 1857 the defence of the Lucknow Residency comes, in historic interest, only second to the tragedy of Cawnpore. The name "residency" is now applied not only to the residency itself, but to the whole of the outbuildings and entrenchments in which Sir Henry Lawrence concentrated his small force. These entrenchments covered almost 60 acres of ground, and consisted of a number of detached houses, public edifices, outhouses and casual buildings, netted together, and welded by ditches, parapets, stockades and batteries into one connected whole. On the summit of the plateau stands the shell of the residency proper, the official residence of the chief commissioner, a lofty building three storeys high, with a fine portico. Near the residency comes the banqueting hall, and beyond the Baillie Guardgate lie the ruins of the surgeon's house, where Sir Henry Lawrence died of a shell-wound, and where the ladies of the garrison were sheltered in underground rooms. Round the line of the entrenchments are pillars marked with the name of the various "posts" into which the garrison was distributed. The most dangerous of these was the Cawnpore battery post, where the stockade was directly exposed to the enemy's fire. The mutineers had rifles fixed in rests in the house opposite, and swept the road that led through the residency enclosure at this point. Close to the residency is the Lawrence Memorial, an artificial mound 30 ft. high crowned by a marble cross.

Other Monuments.—Among the other buildings of interest in Lucknow is the Imambara, which is one of the largest rooms in the world (162 by 54 ft.), having an arched roof without supports. This room was built by the Nawab Asaf-ud-dowlah in 1784, to afford relief to the famine-stricken people. The many monuments of his reign include his country palace of Bibiapur, outside the city. Among later buildings are the two palaces of Chhattar Manzil, erected for the wives of Ghazi-ud-din Haidar (1814) and now used as a club; the remains of the Farhat Baksh, dating from the previous reign, and adjoining the greater Chhattar Manzil; the observatory (now a bank) of Nasir-ud-din Haidar (1827); the imambara or mausoleum and the unfinished great mosque (Jama Masjid) of Mohammed Ali Shah (1837), and the huge debased Kaisar Bagh, the palace of Wajid Ali Shah (1847–1856), now divided up into residences for the chief taluqdars.

The DISTRICT OF LUCKNOW lies on both sides of the river Gumti, and has an area of 976 sq.mi. Its general aspect is that of an open champaign, well studded with villages, finely wooded and in parts most fertile and highly cultivated. In the vicinity of rivers, however, stretch extensive barren sandy tracts (*bhúr*), and there are many wastes of saline efflorescence (*usár*). The country is an almost dead level, the average slope, which is from northwest to southeast, being less than a foot per mile. The principal rivers are the Gumti and the Sai with their tributaries. The population in 1941 was 949,728.

The DIVISION OF LUCKNOW contains the western half of the old province of Oudh. It comprises the six districts of Lucknow, Unao, Sitapur, Rae Bareli, Hardoi and Kheri. Its area is 12,002 sq.mi. and its population in 1941 was 6,530,932.

LUÇON, a town of western France, in the department of Vendée, 23 mi. S.E. of La Roche-sur-Yon, on the railway from Nantes to Bordeaux, and on the canal of Luçon (9 mi. long), which affords communication with the sea in the Bay of Aiguillon. Pop. (1936) 6,802. Between Luçon and the sea stretch marshy plains, the bed of the former gulf, partly drained by numerous canals, and in the reclaimed parts yielding excellent pasturage, while in other parts are productive salt-marshes, and ponds for the rearing of mussels and other shell-fish. Luçon is the seat of a bishopric, established in 1317, and held by Richelieu from 1607 to 1624. The cathedral, 12th-century and later, was originally an abbey church. The cloisters are of the late 15th century. Near by is the bishop's palace, possessing a large theological library. There is an ecclesiastical seminary here.

LUCRE, money which is the object of greed (Lat. *lucrum,* gain). In the adjective "lucrative," profitable, there is, however, no sense of disparagement. In Scots law the term "lucrative succession" (*lucrativa acquisitio*) denotes the taking by an heir, during the lifetime of his ancestor, of a free grant of any part of the heritable property.

LUCRETIA, a Roman lady, wife of Lucius Tarquinius Collatinus, distinguished for her beauty and domestic virtues. Having been outraged by Sextus Tarquinius, one of the sons of Tarquinius Superbus, she informed her father and her husband, and, having exacted an oath of vengeance from them, stabbed herself to death. Lucius Junius Brutus, her husband's cousin, put himself at the head of the people, drove out the Tarquins, and established a republic (traditional date, 509 B.C.). The accounts of this tradition present many points of divergence.

LUCRETILIS MONS, a mountain in Sabine territory, mentioned by Horace as visible from his farm, generally (and rightly) identified with Monte Gennaro, a limestone peak 4,160 ft. high. Excavations on the site of Horace's farm have led to the discovery of the building itself, with baths added at a later date.

LUCRETIUS [TITUS LUCRETIUS CARUS] (*c.* 98–55 B.C.), one of the greatest of Roman poets, is biographically one of the most obscure. All that we know of his life is contained in the following notices: 1. Jerome's *Chronica Eusebii* has under the year 94 B.C. the entry: "Titus Lucretius the poet is born. Afterwards he was rendered insane by a love potion and, after writing, in the intervals of insanity, some books, which Cicero afterwards emended, he killed himself by his own hand in the 43rd year of his age." 2. Donatus, *Vita Vergilii,* 6, says that Lucretius died on the day that Virgil assumed the *toga virilis,* and that the consuls for the year were the same as in the year of Virgil's birth, *i.e.,* M. Licinius Crassus and Cn. Pompeius Magnus, consuls in 70 and in 55 B.C. 3. Cicero *Ad Quintum fratrem* II. IX. [XI.], a letter written in Feb. 54 B.C., says "The poems of Lucretius are as you say in your letter—they show many gleams of genius, yet also much art. But more of this when you come."

The statement of Donatus coupled with Cicero's letter seems to make it pretty certain that Lucretius died in 55 B.C. To bring Jerome's statement into harmony with Donatus we must alter either "94" or, what is far more probable, "43rd." The statement that Cicero "emended" the poems need mean no more than that he, as we should say, "saw them through the press," and in view of the interest which Cicero had in the poems, as shown by the letter to his brother, that seems natural enough. The statements of Jerome have been questioned or disbelieved on the grounds of their intrinsic improbability. They have been regarded as a fiction invented later by the enemies of Epicureanism with the view of discrediting the most powerful work ever produced by any disciple of that sect.

The story of insanity which might easily arise from such a chance phrase as *docti furor arduus Lucreti* (Statius, *Silv.* ii. 7, 76), is incapable either of proof or disproof, and is irrelevant.

His great didactic epic *De Rerum Natura* (On the Nature of Things) takes its title from the Greek Περὶ Φύσεως (*De Natura*) which was the title of didactic epics by Xenophanes of Colophon, Parmenides of Elea, Empedocles of Agrigentum, as also of the chief prose work of Epicurus, whose teaching it is the purpose of the poem of Lucretius to expound. In briefest outline the doctrine of Epicurus, based on the atomic theory of Democritus of Abdera, is as follows. 1. Nothing is created out of nothing (Epicur. *Ad Herod.* 38, Lucr. i. 159–214). The universe does not change (Epicur. *Ad Herod.* 39, Lucr. i. 670, ii. 297 *sqq.* 304 *sqq.*). The universe is infinite (Epicur. *Ad Herod.* 41, Lucr. i. 958 *sqq.*). The universe is made up of bodies (σώματα, *corpora*) and space or void (τόπος, κενόν, χώρα, ἀναφὴς φύσις: *locus, inane, spatium, intactile: cf.* Lucr. i. 454, *Tactus corporibus cunctis, intactus inani:* Epicur. *Ad Herod.* 39–40, Lucr. i. 419 *sqq.*). The existence of bodies is witnessed by the senses, the existence of space is a necessary postulate to explain the possibility of motion and to account for the difference in the specific gravity of different solid bodies: Lucr. i. 422, *Corpus enim per se communis dedicat esse Sensus; . . . Tum porro locus et spatium, quod inane vocamus, Si nullum foret, haud usquam sita corpora possent Esse neque omnino quoquam diversa meare.* The bodies (ἄτομα, *primordia*), which are of different shapes (Lucr. ii. 478 *seq.*), are and always have been unceasingly in motion (Epicur. *Ad Herod.* 42–43, Lucr. ii. 80–332), all moving with equal velocity, and it is by their collisions, due to an inherent swerve (παρέγκλισις, *clinamen,* Lucr. ii. 216–293) that so-called solid bodies are formed.

2. The soul also is made up of material atoms which are inconceivably fine (Epicur. *Ad Herod.* 63, Lucr. iii. 177), and is diffused over all the body from which it cannot exist apart (Epicur. *Ad Herod.* 64–65, Lucr. iii. 119–358). Lucretius, iii. 94–135, distinguished between the *anima* or vital principle, which is distributed over all the body and is the origin of sensation, and the *animus,* or mind, which is situated in the breast. The same distinction had been made by Democritus and appears also in Plutarch *Adv. Colot.* 20. In any case at death the soul is resolved into its primitive atoms and, therefore, death does not concern us (Epicur. *Ad Menoec,* 124–127, Lucr. iii. 830, *Nil igitur mors est ad nos neque pertinet hilum Quandoquidem natura animi mortalis habetur*).

3. Knowledge comes to us through the senses, whose evidence we must accept as unimpeachable (Epicur. *Ad Herod.* 62, Κύριαι Δόξαι 25–26. Lucr. i. 423, *Sensus cui nisi prima fides fundata valebit, Haud erit occultis de rebus quo referentes Confirmare animi quicquam ratione queamus*). All solid bodies are continually giving off fine films (εἴδωλα, τύποι ὁμοιοσχήμονες, *simulacra*), which are the exact likeness of the bodies themselves (Epicur. *Ad Herod.* 46–48, Lucr. iv. 51 *sqq.* 110 *sqq.* 196 *sqq.*). These fine films, moving with infinite speed, are conveyed to the soul by the various organs of sense. Hence arise the perceptions of sight (*Ad Herod.* 46–47, Lucr. iv. 46 *sqq.*), hearing (*Ad Herod.* 52, Lucr. iv. 563 *sqq.*), smell (*Ad Herod.* 53, Lucr. ii. 414 *sqq.* iv. 673 *sqq.*), taste (Lucr. iv. 615 *sqq.*).

4. The gods exist and they too are material, but compounded of inconceivably fine atoms. They live apart, immortal, and of perfect felicity, and take no concern in the affairs of men. Our knowledge of the gods is not derived from the senses in the same way as our other knowledge, but comes by immediate intuition. (*Ad Herod.* 49, Lucr. iv. 724 *sqq.* v. 1167 *sqq.*) This doctrine raises considerable difficulties. (*Cf.* R. Philippson, *Zur Epikureischen Götterlehre, Hermes* 51 [1916], pp. 568 *sqq.*)

The sequence of topics in Lucretius is as follows. Books i.–ii. expound the doctrine of the atoms and the void. Book iii. is concerned with showing that the soul is material and does not survive the body. Book iv. sets forth the theory of sensuous perception. Book v. gives an account of the origin of the world, of life, and of human society. Book vi. discusses various meteorological phenomena and thus corresponds largely to the Letter of Epicurus *To Pythocles.* It concludes with an account of the plague at Athens. From certain indications in the poem which point to two redactions of different dates it has been suggested that in the original scheme of the work the order of the present books was i., ii., v., vi., iv., iii. That the division into books goes back to Lucretius himself is indicated by the fact that each book begins with a highly polished exordium, which is independent of the general argument.

Apart from its philosophic and poetical interest, the poem presents several striking features, one of the most notable being the generally archaic character of the language, *e.g.,* the use of the genitive of the 1st Declension in *ai* (disyllable) for *ae* (diphthong). Doubtless one motive for this was the metrical convenience of *-ai* for forming the final spondee of the hexameter: thus of 166 cases of the genitive in *-ai,* no fewer than 107 occur at the end of the hexameter. Metrical convenience too determines the use of the infinitive passive in *-ier* or *-i;* of the ablative singular of the 3rd Declension in *-e* or *-i;* and the same motive leads to the use of such forms as *indugredi* for *ingredi, induperator* for *imperator, alid* for *aliud, sis* for *suis,* and for treating final *-s* as metrically negligible when metrically inconvenient, e.g., *fontibu' magnis,* i. 412, *Ancu' reliquit,* iii. 1025. Other archaisms are *Mavors* for *Mars, sanguen* (i. 837) for *sanguis, aevus* (ii. 561) for *aevum; cornum* (ii. 388) for *cornu, caelus* (ii. 1097) for *caelum.* In the great majority of cases the archaic form is probably chosen for metrical convenience, but in some cases—*ollis* for *illis, moenera* for *munera, reddundus* for *reddendus,* etc.—we seem to have deliberate archaism.

It is to be remembered that Lucretius had a very difficult task to perform—to expound a philosophical argument in a language which had not yet developed a philosophic vocabulary and, moreover, to expound it in hexameter verse. He was himself acutely aware of the difficulty: i. 136 *sqq., cf.* i. 830. The consequence is that he is compelled either to transliterate a Greek word, e.g., *homoeomeria* or to invent new words, e.g., *adactus, variantia, differitas, formatura, tactilis, intactilis* (= ἀναφής), *mactabilis, conciliatus.* It is probably due to the same cause that he uses compound adjectives with a facility and freedom which reminds us of Greek poetry—*falcifer, florifer, squamiger, spumiger, fluctivagus, velivolus, horrisonus.* Doubtless based on Greek models is his extensive use of periphrastic expressions such as *fida canum vis* (vi. 1222 *cf.* Virg. A. iv. 132, *odora canum vis*), *concharum genus* (ii. 374), *equorum duellica proles* (ii. 661), *silvestria saecla ferarum* (v. 967), and many others. Memmiades (i. 26) = Memmius seems in the same way to be copied from the Greek use of Οἰδιπόδης (Hom. *Od.* xi. 271, *Il.* xxiii. 679) = Οἰδίπους.

Another characteristic which gives an archaic aspect to his poetry is the frequent use of alliterations, often with very happy effect, *e.g.,* i. 72, *Ergo vivida vis animi pervicit et extra Processit longe flammantia moenia mundi,* v. 1004. A peculiar form of alliteration is the combination of words derived from the same root, e.g., *anxius angor* (iii. 993), *vel violenta viri vis* (v. 961). Less notable is the repetition of the same word in a different case, e.g., *Viva videns vivo sepeliri viscera busto.*

His management of the hexameter metre is still somewhat tentative and unequal. As compared with the Virgilian hexameter, we note in particular the frequency of monosyllabic endings, e.g., *solis uti lux* (iv. 198), *per Veneris res* (v. 848), and the use in any place in the line of words forming two feet, e.g., *religionibus* (i. 109), *principiorum* (i. 244), *praecipitavit* (i. 251). In the matter of prosody he allows himself the utmost freedom. The same word is scanned now with one quantity, now with another, *e.g., Crassaque conveniant līquidis et lĭquida crassis* (iv. 1251); *līquoris* in v. 14, but *lĭquor* in i. 453; in i. 142 *suādet* is a disyllable, but in iv. 1157 *sŭādent* is a trisyllable; in vi. 963 *dissoluit* is a trisyllable, in vi. 446 a quadrisyllable. Similarly the scansion varies in words like *diei, fidei, rei, illius, totius.* Thus *totīus* vi. 679, *totĭus* vi. 682; *rei* is a monosyllable in iii. 916, but a disyllable in ii. 112, ii. 548, vi. 919. Again *suo* is a monosyllable in i. 1022, v. 420, but elsewhere a disyllable. Such examples might be multiplied indefinitely. More remarkable perhaps are such unusual scansions as *glŏmere* (i. 360), *văcillans* (iii. 504), *Brittannis* (vi. 1106), *coruptum* (vi. 1135).

Unusual vocabulary, unusual prosody, awkward elision or hiatus, unnatural order of words (*e.g.,* ii. 791 *Nec quae nigra cluent de nigris sed variis ex*) combine to give an uncouth aspect to the more argumentative portions of the poem. And it is to be remembered that the *De Rerum Natura* is a didactic poem in the strict sense, a poem, that is to say, in which the teaching, the argument, is the chief thing, and the poetical form is rather introduced to commend the argument than the argument used as subsidiary to the poetical effect as, *e.g.,* in the *Georgics* of Virgil. Lucretius several times uses language which implies that he uses the poetical form to veil the asperity of his subject matter, *e.g.,* i. 933.

The truest analogue to Lucretius's poem would probably be *Paradise Lost.* Milton is in general more akin perhaps in genius to Lucretius than any other poet that could be named. If the sheer poetic gift of Milton is the higher, as doubtless it is, yet he has a singular affinity with Lucretius in his combination of moral earnestness with a lively sense of the beauty of external nature, animate and inanimate. And in Lucretius, as in *Paradise Lost,* the sublimest passages of pure poetry are strictly germane to the argument of which they are the crown and complement.

In his greatest passages, such as the invocation to Venus which forms the prelude to the whole poem (i. 1–40), the preludes to Books ii., iii., iv. and v., the remonstrance with the man who is afraid of death (iii. 892 *sqq.*), the progress of the seasons (v. 735 *sqq.*), the eulogy of Epicurus (i. 62 *sqq.*), the sacrifice of Iphigeneia (i. 80 *sqq.*), the cow sorrowing for her butchered calf (ii. 352 *sqq.*), and the like, he reaches heights hardly attained by any other Roman poet. Even the archaic tinge of style and diction seems but to lend such passages an austere dignity. If we seek further to inquire what is the secret of his power, we would find it not in any gift of memorable phrase—though he has memorable phrases enough—*Medio de fonte leporum surgit amari aliquid* (iv. 1125), *Suave mari magno* (ii. 1), *Tantum religio potuit suadere malorum* (i. 101)—but in his vivid imagination and consequent power of sympathy. It is this warm sympathy which gives strength and meaning and persuasiveness to his message—that the natural needs of man in this life are few (ii. 20–33) and that death is not to be feared since it is for man the last end of all (iii. 910 *sqq.*). Did he preach this doctrine of the nothingness of death from a detached point of view, as of one who could himself and would have others "leave the warm precincts of the cheerful day Nor cast one longing lingering look behind," then his message would fall on deaf or unwilling ears among men of common human sympathies and emotions. It is precisely here that we find the secret of his power. Better aware than other men of the beauty of this earth—bird, beast and flower, river and sea, mountain and sky; more than ordinarily alive to the joys of this life; feeling in all their fulness the nearness and dearness of family ties (iii. 892, *Iam iam non domus accipiet te laeta, nec uxor Optima nec dulces occurrent oscula nati Praeripere et tacita pectus dulcedine tangent*), he would, not in contempt but in a large pity, persuade men that the cloud of mortality which overhangs them, darkening them even now with the anticipation of its terrors, holds at least no other evil than that it terminates this present life, and that there is only a dreamless sleep beyond the grave. Hence it is that he preaches the negation of immortality with all the fervour with which the Christian teacher preaches the immortal hope.

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LUCRINUS LACUS [LUCRINE LAKE], in Campania, Italy, about ½ m. N. of Lake Avernus, and only separated from the sea (Gulf of Pozzuoli) by a narrow strip of land, traversed by the coast road, Via Herculanea, which runs on an embankment traditionally attributed to Heracles in Strabo's time, and the modern railway. Its size was reduced by the rise of the Montenuovo crater in 1538. Its greatest depth is about 15 ft. In Roman days its fisheries were important and were let out by the state to contractors. Its oyster-beds were, as at the present day, renowned; their foundation is attributed to Sergius Orata, about 100 B.C. It was also in favour as a resort for pleasure excursions from Baiae, and its banks were covered with villas, of which the best known was Cicero's Cuman villa (also called the Academia), on the east bank. The remnants of this villa, with the village of Tripergola, disappeared in 1538. In 1922 almost all the fish in the lake were killed by exhalations of steam and sulphuretted hydrogen from vents on the east bank.

See O. E. Schmidt, *Ciceros Villen* (Leipzig, 1899), 42–50.

LUCULLUS, LUCIUS LICINIUS, surnamed Ponticus, (*c.* 110–56 B.C.), Roman general, was the son of Lucius Licinius Lucullus and a sister of Metellus Numidicus. He joined the party of Sulla early in life, and after service in the Social war (90) went with Sulla as quaestor to Greece and Asia in 88. While Sulla besieged Athens Lucullus raised a fleet and drove Mithradates out of the Mediterranean, winning a great victory off Tenedos. Lucullus was praetor in 77, with the province of Africa to follow, and consul in 74. In the allotment of provinces he drew Cisalpine Gaul, but contrived to exchange it for Cilicia, while his colleague Cotta took Bithynia, the two provinces between them involving the joint command against Mithradates (*q.v.* for further information about this campaign). Lucullus' first season was mainly occupied in relieving Cyzicus, besieged by Mithradates, who had heavily beaten Cotta. Most of 73 and 72 were taken up in clearing the sea and the coast of Pontus, but an expedition up country to Cabeirus led to a major success, and Mithradates fled to Tigranes in Armenia. Lucullus left the final reduction of the Pontic kingdom to his lieutenants while he attended to the administration of Asia, which the combined exactions of Sulla and the *publicani* had left in a desperate condition. By drastically limiting interest rates he cleared the province of debt; but his reforms left a legacy of unpopularity for him at Rome, where the capitalist interests set themselves to destroy his reputation. Similarly his strict discipline and his moderation after victory made for trouble with the army.

In 70 B.C. Lucullus sent to Tigranes to demand the surrender of Mithradates. Tigranes refused, and Lucullus, with a small force, crossed the Euphrates and struck direct for Tigranocerta, the new capital (69). Tigranes fled, and returned with a vast army to raise the siege, but was defeated. Lucullus captured the city and dispersed its inhabitants, and wintered on the Tigris. The rest of his campaign is anti-climax. Mithradates and Lucullus were both negotiating with Parthia; Lucullus attempted to force Parthia's hand, but his troops refused to go on, so he turned north for Artaxata, won another victory, and again his troops mutinied. So he returned, took Nisibis and wintered there. The next year (67) things were worse; it was now known that he was to be superseded; he could exert no authority; he could only watch Mithradates regaining Pontus and Tigranes overrunning Cappadocia. It was left for Pompey to reap where Lucullus had sown.

On his return to Rome he was attacked by the popular party, who succeeded in delaying, though they could not prevent his triumph. He was very rich, and politics were not attractive. He retired into that elegant leisure, that luxury refined by good taste and tempered by philosophy, for which he has become proverbial. He is one of the interlocutors in Cicero's *Academica,* he had a great library, and wrote a history in Greek. His occasional interventions in public affairs were not very successful.

See Plutarch, *Lucullus;* Appian, *Mithridatic War; C.I.L.* i, 292; many allusions in Cicero; G. Boissier, *Cicero and his friends* (Eng. trans., 1897); W. Drumann, *Geschichte Roms* (1899); and authorities under MITHRADATES VI, of Pontus.

LUCUS FERONIAE, an ancient shrine in Etruria. It was visited both by Latins and Sabines even in the time of Tullus Hostilius and was plundered by Hannibal in 211 B.C. It was in the territory of Capena (*q.v.*); but in imperial times became an independent community receiving a colony of Octavian's veterans (*Colonia Iulia felix Lucoferensis*) and possessing an amphitheatre. It is probably to be placed at Nazzano, which was reached by the Via Tiberina.

LUCY, SIR HENRY (1845–1924), British journalist, was born at Crosby, near Liverpool, on Dec. 5, 1845. Educated in Liverpool, he began life in a Liverpool merchant's office, but soon became a reporter for a Shrewsbury periodical. In 1870 he joined the staff of *The Pall Mall Gazette,* London, and in 1873 became parliamentary reporter to *The Daily News,* with which paper he had a long connection in various capacities. In 1881 he also joined the staff of *Punch* and won a great reputation as the contributor of its parliamentary sketch signed "Toby M. P." He was knighted in 1909 and retired from parliamentary work in 1916. He published his autobiography, *Sixty Years in the Wilderness,* in 1909, and *The Diary of a Journalist* in 1920. He died on Feb. 20, 1924.

LUCY, RICHARD DE (d. 1179), called the "loyal," chief justiciar of England, appears in the latter part of Stephen's reign as sheriff and justiciar of the county of Essex. He became, on the accession of Henry II., chief justiciar conjointly with Robert de Beaumont, earl of Leicester; and after the death of the latter (1168) held the office alone for 12 years. The chief servant and intimate of the king, he was among the first of the royal party to incur excommunication in the Becket controversy. In 1173 he played an important part in suppressing the rebellion of the English barons, and commanded the royalists at the battle of Fornham. He resigned the justiciarship in 1179, though pressed by the king to continue in office, and retired to Lesnes abbey in Kent, which he had founded and where he died. Lucy's son, Godfrey de Lucy (d. 1204), was bishop of Winchester from 1189 to his death in Sept. 1204; he took a prominent part in public affairs during the reigns of Henry II., Richard I. and John.

See J. H. Round, *Geoffrey de Mandeville* (1892); Sir J. H. Ramsay, *Angevin Empire* (1903); and W. Stubbs, *Constitutional History,* vol. i.

LUCY, SIR THOMAS (1532–1600), the English Warwickshire squire who is traditionally associated with the youth of William Shakespeare, was born on April 24, 1532, the son of William Lucy, and was descended, according to Dugdale, from Thurstane de Charlecote, whose son Walter received the village of Charlecote from Henry de Montfort about 1190. Walter is said to have married into the Anglo-Norman family of Lucy, and his son adopted the mother's surname. Three of Sir Thomas Lucy's ancestors had been sheriffs of Warwickshire and Leicestershire, and on his father's death in 1552 he inherited Sherborne and Hampton Lucy in addition to Charlecote, which was rebuilt for him by John of Padua, known as John Thorpe, about 1558. By his marriage with Joyce Acton he inherited Sutton Park in Worcestershire, and became in 1586 high sheriff of the county. He was knighted in 1565. He is said to have been under the tutorship of John Foxe, who is supposed to have imbued his pupil with the Puritan principles which he displayed as knight of the shire for Warwick in the parliament of 1571 and as sheriff of the county, but, as Mrs. Carmichael Stopes points out, Foxe only left Oxford in 1545, and in 1547 went up to London, so that the connection must have been short.

Lucy often appeared at Stratford-on-Avon as justice of the peace and as commissioner of musters for the county. As justice of the peace he showed great zeal against the Catholics, and took his share in the arrest of Edward Arden in 1583. In 1585 he introduced into parliament a bill for the better preservation of game and grain, and his reputation as a preserver of game gives some colour to the Shakespearian tradition connected with his name. Nicholas Rowe, writing in 1710, told a story that Lucy prosecuted Shakespeare for deer-stealing from Charlecote Park in 1585, and that Shakespeare aggravated the offence by writing a ballad on his prosecutor. The trouble arising from this incident is said to have driven Shakespeare from Stratford to London. The tale was corroborated by Archdeacon Davies of Sapperton, Gloucestershire, who died in 1708. The story is not necessarily falsified by the fact that there was no deer park at Charlecote at the time, since there was a warren, and the term warren legally covers a preserve for other animals than hares or rabbits, roe-deer among others.

Shakespeare is generally supposed to have caricatured the local magnate of Stratford in his portrait of Justice Shallow, who made his first appearance in the second part of *Henry IV.,* and a second in the *Merry Wives of Windsor.* There are many considerations which make it unlikely that Shallow represents Lucy, the chief being the noteworthy difference in their circumstances. Lucy died at Charlecote on July 7, 1600.

For a detailed account of Sir Thomas Lucy, with his son and grandson of the same name, *see* Mrs. C. Carmichael Stopes, *Shakespeare's Warwickshire Contemporaries* (2nd ed., 1907). *Cf.* also an article by Mrs. Stopes in the *Fortnightly Review* (Feb. 1903), entitled "Sir Thomas Lucy not the Original of Justice Shallow," and J. O. Halliwell-Phillipps, *Observations on the Charlecote Traditions* (Brighton, 1887).

LUDDITES, the name given to organized bands of English rioters for the destruction of machinery, who made their first appearance in Nottingham and the neighbouring districts towards the end of 1811. The "Ludds" or Luddites were generally masked, and operated at night. Their leader, real or imaginary, was known as "General Ludd" from a probably mythical "Ned Ludd" of whom various stories were current. Great distress had been caused by the dismissal of handicraftsmen in the areas in which textile machinery was introduced; and even those handicraftsmen who did not lose their employment suffered considerable worsening of conditions owing to competition. The riots began with the destruction of stocking and lace frames, and, continuing through the winter and the following spring, spread into Yorkshire, Lancashire, Derbyshire and Leicestershire. The riots were directed not merely against reductions of wages but also against the poor quality goods (especially stockings) produced by the new machines. The rioters were supported by local public opinion, and they abstained from bloodshed or violence against living beings, until in 1812 a band of them was shot down by soldiers on the request of a threatened employer, Horsfall, who was afterwards murdered. They were met by severe repressive legislation, introduced by Lord Liverpool's government, a notable feature in the opposition to which was Lord Byron's speech in the House of Lords. The organization was temporarily broken up by a mass-trial at York in 1813, which resulted in many hangings and transportations: somewhere among the victims was probably the real "King Ludd," for the elaborate organization suddenly collapsed. In 1816 similar rioting was resumed, caused by the depression which followed the peace of 1815 and aggravated by one of the worst of recorded harvests. In that year, although the centre of the rioting was again in Nottingham, it extended over almost the whole kingdom. The rioters were also thoroughly organized. While part of the band destroyed the machinery, sentinels were posted to give warning of the approach of the military. Vigorous repressive measures, and, especially, reviving prosperity, brought the movement to an end.

Bibliography.—*See* G. Pellew, *Life and Correspondence of H. Addington, 1st Viscount Sidmouth* (1847); the *Annual Register* for 1811, 1812 and 1816; J. L. and B. Hammond *The Skilled Labourer* (1919). E. Toller, *The Machine Wreckers* (1923) is a dramatic presentation of the story. *Ben o' Bills* by D. E. E. Sykes (Huddersfield, n.d.) is a "novel" in which is concealed much genuine history written from the Luddite point of view. *See* also the Home office papers in the Record Office.

LUDENDORFF, ERICH (1865–1937), German soldier, was born at Kruszevnia, in the province of Posen, April 9, 1865. When 18 years old, he entered the Prussian army. In 1894 he joined the general staff, and, except for an interval of two years as company commander, remained on it from 1894 to 1913, under Count Schlieffen and the younger General von Moltke. As chief of the *Aufmarschabteilung* since 1908 he played a prominent part in the mobilization preparations. The last great increase in the strength of the army in 1913 was largely due to his initiative and energy. During the year preceding the outbreak of the World War he commanded first the 39th Fusilier Regiment at Düsseldorf, and afterwards an infantry brigade at Strasbourg.

At the outbreak of the World War Ludendorff was quartermaster general of the II. Army. His voluntary assumption in the beginning of August of a decisive *rôle* at the capture of the fortress of Liége gave him his first great opportunity. He took over the command of the 14th brigade of infantry, in the place of General von Wussow who was killed, and, breaking through the ring of fortifications at its head, seized the interior of the town. He was rewarded on Aug. 22 by being made chief of staff to Hindenburg in the VIII. Army which was fighting in East Prussia.

Campaigns in East Prussia.—The battle of Tannenberg revealed his powers of generalship, for he there demonstrated the justice of the theory of annihilation. The victory of Tannenberg over the Russian army of the Narew was more than another Cannae. For in this case there was not, as in former days, merely one enemy to be dealt with. On the contrary, the attempt was made to envelop the greatly superior main body of Russians in the presence of a second enemy force threatening the rear. And the attempt proved successful. In the subsequent operations which led to the first battle on the Masurian lakes and to the heavy defeat of the Russian army of the Niemen, the enemy's right wing was supported on the lake, and so only an envelopment of the southern wing was possible. The operations, therefore, took the form of an attack on the enemy's front and on his exposed flank.

The strategic success lay in the liberation of East Prussia from the enemy. The German Army of the East became available for the immediate support of the Austro-Hungarian ally, by this time in dire straits. This support was rendered in the brilliant October campaign of the newly-formed IX. German army directed through Southern Poland upon the Vistula. Its purpose—to facilitate the Austrian efforts in Galicia by drawing off upon the IX. Army the strongest possible body of Russian troops—was attained in a degree entailing grave danger to the outnumbered Germans themselves. The menace of envelopment by a vastly superior enemy, pouring up from the direction of Warsaw, was parried and beaten off by Ludendorff by means of an exceedingly gallant defensive action, carried out during withdrawal. In November after a rapid regrouping of the main German forces, an advance was made from the Wreschen-Thorn line against the right flank of the main body of the Russians, lying in West Poland. In the absence of sufficient strength a simultaneous frontal attack was impossible. But even so, the success achieved in the battle of Lódź was great. The Russians were definitely relegated to the defensive—and, in the pursuit which followed, were flung back behind the Bzura and the Rawka.

During the fighting in Masuria in Feb. 1915 Ludendorff achieved the destruction of another Russian army in the region of the Upper Bobr. This was followed by a period of relative inactivity on the German eastern front lasting for several months. Not before the middle of July 1915 did the army group of Hindenburg resume the war of movement. By an attack directed upon and beyond the Lower Narew it relieved, by means of a converging offensive, the army group of Mackensen which had advanced from Galicia into Southern Poland between the Vistula and the Bug. In the ensuing operations the Russian army was driven out of the Vistula positions and out of the whole of Poland towards the East. After a brief resistance the fortresses of Warsaw, Nowogeorgiewsk (Modlin) and Kovno fell. But no decisive issue was reached, because General von Falkenhayn, chief of the German general staff, rejected the proposal of Hindenburg and Ludendorff, which was to advance with the German left wing in a northerly direction through Kovno and Vilna upon Minsk, thereby cutting the Russian railway communications, to the north of Polesia. Had the operations been conducted in accordance with the views of Hindenburg and Ludendorff, the Russian army might have been dealt a mortal blow in the summer of 1915. Later, in September, the attempt was made on the German left wing, but with inadequate forces, to embarrass the retreat of the section of the Russian army withdrawing northwards from Polesia past Vilna; but the moment for success on a grand scale had gone.

After the victorious conclusion of the Balkan campaign in the winter of 1915–16 Ludendorff contemplated a great offensive into the heart of the Ukraine, with the object of breaking the back of the economic resistance of Greater Russia, which was already cut off from the sea. The offensive necessitated the occupation of Rumania; but General von Falkenhayn rejected this scheme, and chose Verdun instead of Kiev as the objective for operations. Accordingly in the year 1916 the eastern front of the allied Central Powers was assigned the duty of protecting the rear of the offensive movement in France. This task was amply fulfilled on the northern wing but on the southern wing, held by the Austrians, the front completely collapsed in June and July at Luck and in Galicia. The balance in the East was restored with difficulty by the intervention of the German command.

On Aug. 29 Field-Marshal von Hindenburg assumed the office of chief of the general staff of the armies in the field, in the place of Falkenhayn, and Ludendorff became first quartermaster general. In contrast with their predecessor's point of view, the two men still promised themselves triumph, but a triumph which could only result from a more vigorous conduct of the war by drawing upon the whole available strength of the country in wealth and population. The methods adopted for the utilization of these resources were expressed in the so-called "Hindenburg programme" of war industries and in the so-called law of auxiliary services; and here Ludendorff could only co-operate by means of suggestions and demands. In his own sphere too, he found that, owing to the almost desperate military situation inherited from his predecessor, he was not at first able to put into practice Schlieffen's doctrine of annihilation. The result of the offensive against Rumania was that this new enemy was overthrown in the winter of 1916. This victory was of inestimable value to the Central Powers, for new sources of economic power were thereby opened up.

Submarine Warfare.—After the defeat of the Rumanian army there remained but one further task. This was the frustration of the attacks of the enemy in the west, greatly superior in numbers and material. The restoration of the balance of strength thus aimed at was to enable the Central Powers later to deliver an offensive with decisive effect. A favourable diversion of this kind, however, could only be counted upon, if, during the strategical defence on land, England could be reduced to desperate straits. An intensified U-boat warfare in the blockade area round England was therefore adopted, a weapon, recourse to which had hitherto always been postponed on the score of political considerations. The disadvantage of this course was that it would give the United States a pretext for war on the side of the Entente; but regarding this as inevitable, Ludendorff hoped to render England disposed for peace before the Americans should be in a position to throw considerable forces into Europe.

Unrestricted U-boat warfare did not altogether fulfil expectations. The technical perfection of the enemy's defensive weapons and the ample scale upon which they had been completed contributed to this in a very material degree. On the other hand, without the adoption of unrestricted U-boat warfare the strategy of the Central Powers would have been altogether unable to hold the balance on land in suspense until, after Russia's collapse in the spring of 1918, there dawned a well-founded prospect of forcing a decision in France before the American forces on land became effective.

In the spring of 1917 in the western theatre of war Ludendorff was enabled, by a timely withdrawal to the Siegfried position and by the elasticity of his defensive tactics, to impose a check upon the Allied attack carried out with a gigantic expenditure of men and material. Subsequently he had another opportunity of vindicating his theory of annihilation in the warfare on land. Under the blows dealt by the German hammer at Tarnopol, Riga, Dagö and Ösel, Russia fell. The reckoning with Italy followed in the autumn of 1917, but the situation in the west, particularly in Flanders where the fighting raged with undiminished fury, rendered it impossible for Ludendorff to secure a decisive victory.

The Offensive of 1918.—The German resolution to take the offensive in the spring of 1918 was rendered imperative by the general position. The psychological condition of the army peremptorily demanded that the *rôle* of anvil should be exchanged for that of hammer. Conditions at home called for a potent remedy against the threefold poison instilled by the hunger blockade, enemy propaganda and revolutionary agitation. Germany's hard pressed allies had for long rested their sole hopes of delivery on the efforts of Germany. Ludendorff saw only one road by which a tolerable peace, in harmony with the honour of the German people, could be reached, the road of military victory. This again could be attained solely by means of an offensive which should be decisive, and in taking this course he hazarded everything. A series of small attacks with limited objectives or a powerfully conducted defence would in favourable circumstances only have secured a temporary advantage, but could not prevent the enemy from finally giving full effect to his superior strength in a battle of annihilation. It is questionable whether the choice of direction for the offensive on French territory can be defended. Many critics would have preferred an offensive in Italy, but apart from the natural difficulties, even the destruction of the Italian army could at best only have preceded the main decisive operations on French soil.

It has been questioned whether Ludendorff assembled adequate forces for the spring offensive of 1918. In March, at the beginning of this offensive, the Germans disposed of 193 divisions and three brigades in the Franco-Belgian theatre of war. The estimates of the forces commanded by the Entente in France and Belgium at the beginning of the spring offensive vary between 167 and 180 divisions. The Germans, therefore, enjoyed a slight superiority in the number of divisions. The original intention that a section of the Austro-Hungarian forces should take part in the decisive encounter in France was finally thwarted by the opposition of the Habsburg emperor. Ludendorff accordingly chose the expedient of indirect assistance to be rendered by a relieving offensive carried out by the Austro-Hungarian army in Upper Italy. This offensive, however, was undertaken much too late for the objective in view, in the middle of June, and, moreover, ended with a severe reverse. The occupation of Rumania called imperatively for four divisions and a greater number of Landsturm formations. The invasion of the Ukraine, carried out in February and March, demanded about 20 weak divisions, including eight divisions of Landwehr and three of cavalry. It is disputable whether it would have been wiser to abandon the enterprise in the Ukraine. The secretary of State of the *Kriegsernährungsamt* urged with the utmost emphasis that the economic resources of the Ukraine should be thrown open to Germany. Failing this, the Austrians' system of food supplies would collapse. The delivery of meat was important for Germany, too, and the delivery of horses was, above all, a matter of the greatest urgency.

On political and military grounds Ludendorff had resolved to deal the first decisive blow in the west against the English. For this purpose he chose the southern flank, on both sides of St. Quentin, as tactically the least defensible, with the intention of forcing his way through at this point and by advancing north of the Somme towards the northwest, to roll up the whole front gradually and press the English towards the sea. The southern wing of the German offensive was to guard his flank against a relieving attack on the part of the French. This strategy became subject to certain changes in consequence of the unexpected magnitude of the initial success of the German southern wing, which continued the offensive across the Somme and the Crozat canal against the French, in order to effect a cleavage between the English and French at and beyond Amiens. This end was not completely attained, and the result of the first offensive, though great from the tactical standpoint was strategically nugatory. A second attack on the Lys front, against the English and Portuguese, was made in the middle of April and was designed to gain possession of the commanding heights north of Bailleul and to cut off the Ypres salient; its result, however, was indecisive.

During the following months, in spite of successive brilliant diversive attacks carried out against the French front, no further headway was made in forcing a decisive engagement in Flanders; and the heavy toll of the spring offensives could not be made good rapidly enough. And yet, prior to the last great attempt to break through on both sides of Reims in July 1918, there still remained a prospect of final victory for the German arms. The goal had nearly been reached—which was a proof that the strategy adopted might have succeeded and was, therefore, the right strategy. But the fortune of war was against Ludendorff. His plans were revealed by treachery to the enemy, at a time when everything depended on secrecy and surprise. The great successes hitherto achieved had led to a wide extension of the German front, calling for the employment of disproportionately large forces and offering in its many angles and salients dangerous surfaces to the enemy's attacks. These factors now made their disastrous influence felt.

But the final cause of Ludendorff's inability to resume the initiative lay in the absence of a free command of reserves, due to the drying up of the sources of supply at home. When the German command fell back on the defensive before hostile attacks, Ludendorff realised that there was nothing to be done except to hold out until diplomacy succeeded in securing a tolerable peace, or to perish with honour. On Oct. 26, however, he was overthrown by the cabinet of Prince Max of Baden. The collapse of Germany's allies, combined with difficulties at home, rendered hopeless any further resistance by the army in the field now thrown upon its own resources.

General Ludendorff was above all a man of action, and one who rated formation of character and the attributes of leadership more highly than the acquisition of comprehensive learning. His resolution, his almost super-human and invincible powers of work and action, his understanding of the moral factors in warfare, inspired the German army with boundless confidence in his leadership and qualified it for mighty exploits. If like Hannibal and Lee he failed in the final issue, it was through no fault in generalship, but was partly due to slowness in realising that his weapon had grown blunt and that the population at home was no longer capable of the effort of endurance and the indispensable will to victory. His powers of leadership reflected his character; brain, heart and will were all unsparingly enlisted in the service of one aim, the honour of his country. Along this path he was impelled to travel, whether it led to victory or defeat. (W. Fo.)

Ludendorff's complete collapse at the end of the war was one of the tragic sensations of the time. After demanding an unconditional armistice, when the armistice was actually concluded, he abandoned his country and fled to Sweden. In the spring of 1919 he returned, to become, with his former chief of staff, Colonel Bauer, the focus of all extreme reactionary conspiracies. With Bauer he was the initiator and organizer of the "Kapp Putsch" of March 1920, although he remained in the background and avoided responsibility, nevertheless, his *rôle* was known, and he retired to the more conservative atmosphere of Munich to engage in fresh intrigues which showed a complete lack of any sense of political reality. In 1923 he emerged into the open in connection with the attempted coup of Adolf Hitler, the National Socialist leader. After wavering between the rival conspiracies of Hitler and von Kahr, Ludendorff joined the former in an attempt to establish an anti-Marxist dictatorship in Germany. The coup (Nov. 8, 1923) proved an ignominious fiasco, but Ludendorff's past reputation saved him from its consequences. In May 1924 he entered the Reichstag as a National Socialist, and in 1925 stood for president of the Reich, securing slightly over 1% of the votes cast. In the same year he retired from the presidency of his small party and began to take a less prominent part in politics. He died in Munich, Dec. 20, 1937. Ludendorff published several books on the World War, the most important of which are: *Meine Kriegserinnerungen 1914–18* (Eng. trans. *My War Memories*) (1919); *Urkunden der obersten Heeresleitung uber ihre Tätigkeit 1916–18* (1920); *Kriegführung und Politik* (1922); *Das Friedens und Waffenstillstandsangebd.* (1919). Among his polemical writings may be mentioned *Vernichtung der Freimaurerei durch Enthüllung ihrer Geheimnisse* (1927).

See H. Delbreck, *Ludendorffs Selbstporträt* (10th ed., 1922). (C. A. M.)

LÜDENSCHEID, a town in the Prussian province of Westphalia, Germany, 19 mi. by rail S.S.E. of Hagen. Pop. (1939) 43,185. From the counts of Altena it passed to the counts of the Mark, with which district it was ceded to Brandenburg early in the 17th century. It is the seat of various hardware manufactures, among them metal-plated and tin-plated goods, buckles, fancy nails and brooches, and has iron-foundries and machine shops.

LUDERITZ, a town in South-West Africa on bay of same name (26° 40′ S., 15° 5′ E.). Pop. (1936) 2,560, of which 846 are whites, 881 natives and 830 coloured. Luderitz grew out of a trading station, which was established in 1883. It is the chief centre of the diamond diggings. The hinterland is desert; the mean annual rainfall is 0.64 in. A railway leads inland, and links up with the South African system at De Aar. The town has to bring its water from Garub, 65 mi. away by train. The local fishing grounds are extraordinarily rich, and, since the British occupation, fish canning factories have been opened. Calling ships have to anchor in the bay, and cargo must be transhipped to or from lighters. Neighbouring islands yield about 8,000 tons a year of guano.

LUDHIANA, a town and district of British India, in the Punjab. The town is 8 mi. from the present left bank of the Sutlej, 228 mi. by rail N.W. of Delhi. Pop. (1941) 111,639. It is an important centre of trade in grain, and has manufactures of shawls, etc., by Kashmiri weavers, and of scarves, turbans, furniture and carriages. There is an American Presbyterian mission and a medical school for women, founded in 1894.

The District of Ludhiana lies south of the river Sutlej, and north of the native states of Patiala, Jind, Nabha and Maler Kotla. Area 1,399 sq.mi. The district consists for the most part of a broad plain, without hills or rivers, stretching northward from the state borders to the ancient bed of the Sutlej. A branch of the Sirhind canal irrigates a large part of the southwestern area. The population in 1941 was 818,615. The principal crops are wheat, millets, pulse, maize and sugar cane. The district is crossed by the main line of the North-Western railway from Delhi to Lahore, with two branches.

During the Mussulman epoch, the history of the district is bound up with that of the Rais of Rajkot, a family of converted Rajputs, who received the country as a fief under the Sayyid dynasty about 1445. The town of Ludhiana was founded in 1480 by two of the Lodi race (then ruling at Delhi), from whom it derives its name. The Lodis continued in possession until 1620, when it again fell into the hands of the Rais of Rajkot. Throughout the palmy days of the Mogul empire the Rajkot family held sway, but the Sikhs took advantage of the troubled period which accompanied the Mogul decadence to establish their supremacy south of the Sutlej. In 1806 Ranjit Singh crossed the Sutlej and reduced the obstinate Mohammedan family, and distributed their territory amongst his co-religionists. Since the British occupation of the Punjab, Ludhiana has grown in wealth and population.

LUDINGTON, city, western Michigan, U.S.A., on Lake Michigan, at the mouth of the Pere Marquette river; the county seat of Mason county. It is on Federal highways 10 and 31, and is served by the Pere Marquette railroad, lake steamers and car ferries, and motor coach lines running north, south and east. The population was 8,898 in 1930 and 8,701 in 1940 by the federal census. The harbour is open throughout the year, and its total traffic in 1940 amounted to 1,827,830 tons, most of which was carried by the Pere Marquette railroad company's car ferries, operating to Wisconsin points on Lake Michigan. The city is headquarters for the CCC in Michigan, and has factories making watchcases, game boards, furniture, men's sports clothes, highway and railway maintenance and construction equipment and various other articles. Within a few miles are many popular summer resorts. Ludington was settled about 1859 and was chartered as a city in 1873. It was first called Père Marquette, in memory of the Jesuit missionary, whose death occurred here in 1675, but in 1871 it was renamed after James Ludington, a local lumberman.

LUDLOW, EDMUND (*c.* 1617–1692), English parliamentarian, son of Sir Henry Ludlow of Maiden Bradley, Wiltshire. He went to Trinity college, Oxford, and was admitted to the Inner Temple in 1638. When the Great Rebellion broke out, he engaged as a volunteer in the life guard of Lord Essex and served through successive campaigns until 1646, when he was elected M.P. for Wilts in the room of his father and attached himself to the republican party. He was one of the chief promoters of Pride's Purge in 1648, was one of the king's judges, and signed the warrant for his execution. In February he joined the council of state. In January 1651 Ludlow was sent into Ireland as lieutenant-general of horse, holding also a civil commission. Ireton, the deputy of Ireland, died on Nov. 26, 1651; Ludlow then held the chief command, and had practically completed the conquest of the island when he resigned his authority to Fleetwood in October 1652. On returning to England in October 1655 he was arrested, as he refused to acknowledge Cromwell's authority as Protector, but he was allowed to retire to Essex. Ludlow sat in Richard's parliament of 1659, but opposed the continuance of the Protectorate. He was a member of the restored Rump, and of its council of state and of the committee of safety after its second expulsion, and a commissioner for the nomination of officers in the army. In July he was sent to Ireland as a commander-in-chief. He came back to England in January 1660, and was met by an impeachment presented against him to the restored parliament. Ludlow surrendered to the speaker on June 20, but, finding that his life was not assured, although he was not named for capital punishment, he escaped to Switzerland, where he lived at Vevey. After 30 years he came to England but was forced to return to Vevey, where he died in 1692.

His *Memoirs*, extending to the year 1672, were published in 1698–99 at Vevey and have been often reprinted; a new edition, with notes and illustrative material and introductory memoir, was issued by C. H. Firth in 1894. *See* C. H. Firth's article in *Dict. Nat. Biog.*; Guizot's *Monk's Contemporaries*; A. Stein's *Briefe Englischer Flüchtlinge in der Schweiz*; E. Ludlow, *The Adventures of Edmund Ludlow* (2 vols., Edinburgh, 1917).

LUDLOW, municipal borough in the Ludlow parliamentary division of Shropshire, England, on the river Teme below its confluence with the Corve, near the Hereford border. Pop. (1938)

5,677. Area, 1.5 sq.mi. On the peninsula the castle, founded about 1085 by Roger de Lacy, occupies a commanding position. Interesting features are the late Norman circular chapel, the Decorated Gothic state rooms and Perpendicular and Tudor details.

Ludlow is supposed to have existed under the name of Dinan in pre-Saxon days. Eyton identifies it with one of the "Ludes" mentioned in the Domesday survey. Its position on the Welsh border, particularly in relation to routes north and south and into Wales past Bishop's Castle (*q.v.*) ensured it an important place in the military and commercial life of the middle ages. Ludlow was a borough by prescription in the 13th century, but the burgesses owe most of their privileges to their allegiance to the house of York. Of the confirmation of early charters the last, dated 1665, continued in force until the Municipal Corporations act of 1835. The market rights are claimed by the corporation under the charters of Edward IV (1461) and Edward VI (1552). The Council of the Marches, established by the first of these monarchs, held its court at Ludlow from the reign of Henry VII onwards until 1689.

Of the town walls one gateway and a part abutting on the castle remain. Thanks to its strong position, Ludlow was the last Shropshire fortress to yield to the parliamentary forces in 1646. The town has many beautiful half-timbered buildings. The parish church of St. Lawrence is of great size with a lofty central tower and a fine east window with 15th century glass. Ludlow once rivalled Shrewsbury in the dressing and sale of cloth, and as a market for Welsh woollen fabrics. It was also famous for its smiths' work. It is a market for Hereford cattle but there are few industries except those connected with agriculture and the sale of "dhu (black) stone" from the Clee hills.

See *Victoria County History, Shropshire;* Thomas Wright, *The History of Ludlow and its Neighbourhood* (1826).

LUDLOW, a city of Kenton county, Ky., U.S.A., on the Ohio river, opposite Cincinnati; served by the Southern railway. It is a residential suburb, with a population of 6,185 in 1940.

LUDOLF or **LEUTHOLF, HIOB** (1624–1704), German orientalist, was born at Erfurt on June 15, 1624. After studying philology at the Erfurt academy and at Leyden, he travelled. In Italy he is said to have become acquainted with one Gregorius, an Abyssinian scholar, who taught him the Ethiopian language. In 1652 he entered the service of the duke of Saxe-Gotha, retiring in 1678 to Frankfurt-on-Main. In 1683 he visited England to promote a scheme for trading with Abyssinia, but failed. In 1690 he was appointed president of the *Collegium imperiale historicum.* He died at Frankfurt on April 8, 1704.

The works of Ludolf, who is said to have been acquainted with 25 languages, include *Sciagraphia historiae aethiopicae* (Jena, 1676); and the *Historia aethiopica* (Frankfurt, 1681), which has been translated into English, French and Dutch, and which was supplemented by a *Commentarius* (1691) and by *Appendices* (1693–94).

See C. Juncker, *Commentarius de vita et scriptis Jobi Ludolfi* (Frankfurt, 1710); L. Diestel, *Geschichte des alten Testaments in der christlichen Kirche* (Jena, 1868); and J. Flemming, "Hiob Ludolf," *Beiträge zur Assyriologie* (Leipzig, 1890–91).

LUDWIG, EMIL (1881–), German author and playwright, was born in Breslau on Jan. 25, 1881, of a Jewish family named Cohn. As a young man he practised law, and also had some practical commercial experience; but from a very early age was engaged in literary productions, mainly dramatic, in prose and verse. A number of these works were staged; they include *Ein Friedloser, Ein Untergang, Napoleon, Die Borgia, Tristan und Isolde, Atalanta* and *Ariadne* (ballet). Ludwig spent some time in England shortly before World War I studying modern tendencies, and during the war was employed as the foreign correspondent of a Berlin paper in the chief political centres of German-speaking Europe. During this period he wrote novels (*Manfred und Helena; Diana*) and sketches (*An die Laterne*), besides more dramatic pieces (*e.g., Friedrich Kronprinz von Preussen*). He now began to indulge his real bent for "humanizing" historical biography in a series of biographies, in which the main emphasis was laid on the psychological motive, represented in a vivid and flamboyant style. His subjects were Goethe (1920 and 1923), Wagner, Bismarck (a trilogy: *Volk und Krone* and *Die Entlassung,* 1922, *Genie und Charakter,* 1923); *Napoleon* (1924); *Wilhelm II* (1925), and Christ (*Menschensohn*) (1928). Of these the works on the emperor William and Bismarck were written with considerable inside political knowledge and in a stimulating and controversial fashion, and aroused great interest, especially in England, where a series of his works were translated (*Wilhelm II* and *Bismarck,* 1926; *Napoleon* and *Goethe* [the latter containing only half of the original German edition], 1927; *The Son of Man,* 1928). The works on Napoleon, and still more that on Christ, revealed, on the other hand, an unhistorical manner, not redeemed by their psychological insight. From 1906–40 Ludwig lived almost continuously in Switzerland, becoming a citizen of that country. In 1940 he went to the United States. His later works include *The Nile* (1936), *Roosevelt: A Study in Fortune and Power* (1938), *Bolivar* (1942) and *The Mediterranean* (1942).

LUDWIG, KARL FRIEDRICH WILHELM (1816–1895), German physiologist, was born at Witzenhausen, near Cassel, on Dec. 29, 1816. He studied medicine at Erlangen and at Marburg, where he taught anatomy and physiology until 1849. He then became professor at Zurich. In 1855 he went to Vienna in the same capacity and ten years later was appointed to the newly created chair of physiology at Leipzig. By the new apparatus and methods that he introduced into the service of physiology, Ludwig exercised a great influence on the progress of that science. He adapted the kymograph invented by Thomas Young for the obtaining of a written record of the variations in arterial pressure and of the movements of respiration. For his researches on the gases in the blood he designed the mercurial blood-pump, which also aided him in his work on the gases of the lymph, the gaseous interchanges in living muscle, the significance of oxidized material in the blood, etc. In regard to secretion, he showed that the secretory glands, such as the submaxillary, are more than mere filters, and that their secretory action is attended by chemical and thermal changes both in themselves and in the blood passing through them. He demonstrated the existence of a new class of secretory nerves that control this action, and showed that if the nerves are appropriately stimulated the salivary glands continue to secrete, even though the animal be decapitated. This was but one phase of his rejection of the assumption of the vitalist that the phenomena of life depend on laws and forces different from those operating in inorganic nature, a rejection which was expressed in his *Text-book of Human Physiology* (1852–56).

LUDWIG, OTTO (1813–1865), German dramatist, novelist and critic, was born at Eisfeld, Thuringia, on Feb. 11, 1813. He attracted the attention of the duke of Meiningen by an opera, *Die Köhlerin,* and Ludwig was sent to Leipzig in 1839 to continue his musical studies under Mendelssohn; but he turned exclusively to literary studies, and wrote several stories and dramas, *Der Erbförster* (1850) attracting immediate attention as a masterly study of bourgeois life and conditions. This was followed by *Die Makkabäer* (1852), in which the realistic method of *Der Erbförster* was transferred to a biblical *milieu,* which allowed more brilliant colouring and a freer play of the imagination. With these tragedies, to which may be added *Die Rechte des Herzens* and *Das Fräulein von Scuderi,* the comedy *Hans Frey,* and an unfinished tragedy on the subject of Agnes Bernauer, Ludwig ranks immediately after Hebbel as Germany's most notable dramatic poet at the middle of the 19th century. His *Shakespeare-Studien* was published in 1891. He died at Dresden on Feb. 25, 1865.

Ludwig wrote some excellent short stories and a powerful novel, *Zwischen Himmel und Erde* (1855); his *Gesammelte Schriften* were published by A. Stern and E. Schmidt in 6 vols. (1891–92); critical ed. by P. Merker (6 vols. 1912–27).

See A. Stern, *Otto Ludwig, ein Dichterleben* (1891; 2nd ed., 1906); A. Sauer, *Otto Ludwig* (1893); F. Lueder, *Die Epischen Werke Otto Ludwigs und ihr Verhältnis zu Charles Dickens* (Leipzig, 1910); Bruns, *Hebbel und Otto Ludwig* (1913); G. Raphael, *Otto Ludwig, Ses Théories et ses oeuvres romanesques* (1920).

LUDWIGSBURG, a town in the *Land* of Württemberg, Germany, 9 mi. N. of Stuttgart and $1\frac{1}{2}$ mi. from the river Neckar. Pop. (1939) 43,540. It was founded at the beginning of the 18th century by the duke of Württemberg, and was enlarged and improved by Duke Charles Eugene. Constructed as the adjunct of a palace, the town has straight streets and spacious squares. The former royal palace which stands in a park and contains a portrait gallery and the burial vault of the rulers of Württemberg is now a museum. The industries include the manufacture of organs and pianos, of celluloid, watch cases, cotton, woollen and linen goods, chemicals, iron and wire goods, and brewing and brick-making. From 1758 to 1824 the town was famous for the production of a special kind of porcelain.

LUDWIGSHAFEN, a town of Germany, in the Bavarian Palatinate, on the Rhine, immediately opposite Mannheim. Pop. (1885) 21,042, (1939) 143,417. Founded in 1843 by Louis I., king of Bavaria, Ludwigshafen was not made a town until 1859. It has trade in iron, timber, coal and agricultural products, fostered by a harbour opened in 1897 which is also a free port; and also large factories for making aniline dyes, soda, cellulose, tobacco, carriages, artificial manure, flour and malt; there are saw-mills, iron foundries and breweries. During World War II it was severely bombed by the British R.A.F.

LUDWIGSLUST, a town of Germany, situated in the *Land* of Mecklenburg, 22 mi. by rail S. by E. of Schwerin. Pop. (1939) 10,733. The castle was built by the duke of Mecklenburg-Schwerin, Frederick II, in 1772–76. Chemicals are manufactured.

LUEGER, KARL (1844–1910), Austrian administrator, burgomaster of Vienna, was born on Oct. 24, 1844, the son of an usher, and, studying under the greatest material difficulties, succeeded in qualifying as an advocate (1874). He was at first a partisan of the Democratic party, then a leader of the Christian Socialists, an anti-Semite and advocate in the courts for artisans and "small men." He was a deputy to the Austrian parliament in 1885 and 1891. He overthrew the German-Liberal municipal government of Vienna, and was elected burgomaster in 1895, but the emperor did not confirm the appointment, and Vienna was placed under the governorship of a state commission. In the new elections Lueger allowed another member of his party to be set up as dummy burgomaster, while he himself in form became vice-burgomaster. In 1897, however, when the "people's candidate," Lueger, was again elected burgomaster, the emperor confirmed his election and repeatedly honoured him. He held the post for ten years. He was a zealous Catholic, and wished to "capture the university" for the Church; he would have neither Social Democrats nor Pan-Germans nor Jews in the municipal administration. He secured good treatment for Czech immigrants, and established Viennese municipal electrical stations, gasworks and tramways, independent of the English gas and tramway companies. He planned to make Vienna one of the most beautiful of garden cities. He died on March 10, 1910 in Vienna.

See Tomola, *Unser Bürgermeister, Dr. Karl Lueger* (Vienna, 1904); and Stauracz, *Dr. Karl Lueger, zehn Jahre Bürgermeister* (1907).

LUFFA or LOOFAH, the name given to the fruit of *Luffa cylindrica,* an herbaceous plant of the family Cucurbitaceae (*q.v.*). The vascular tissues of the pericarp form a kind of loose felt which supplies the well-known bath loofah.

LUFKIN, a city of eastern Texas, U.S.A., 118 mi. N.E. of Houston, near the Angelina river; the county seat of Angelina county. It is served by the St. Louis Southwestern, the Southern Pacific and several short railways. The population in 1940 was 9,567 by the federal census. Lufkin is in an agricultural and lumbering region. The city is surrounded by 2,656 sq.mi. of virgin pine forests which make it a centre for many lumber industries. Some of the largest saw mills in the south are located in this area and numbered about 275 in 1940. A large paper mill was completed to convert the forest trees into pulp for the manufacture of newsprint. Aside from the manufacture of wood products, there are factories engaged in making oil well equipment and cotton gins. The large forest area is under governmental protection and is policed by members of the fire-fighting field station which is maintained in Lufkin. The forest is a favourite recreation centre. An experimental station in the vicinity is engaged in forestry research and conservation. The town was settled about 1875 and was incorporated as a city in 1890. It has a commission and city-manager form of government.

LUGANO, the most populous and thriving town in the Swiss canton of Ticino on the lake of Lugano at an altitude of 906 ft. Pop. (1941) 17,025, almost all Italian-speaking. To the south is Monte Salvatore (3,004 ft.), on the southeast (across the lake) Monte Generoso (5,591 ft.) and to the east Monte Bré (3,061 ft.). All three are accessible by railways. By rail Lugano is 124 mi. from Lucerne and 51½ mi. from Milan. Situated on the main St. Gotthard railway line, Lugano is much frequented by visitors (largely German) in spring and in autumn. Though politically Swiss since 1512, Lugano is Italian in appearance and character. The railway station is connected with the quays by a funicular railway. The principal church, San Lorenzo, in part dates back earlier than the 15th century. This church is now the cathedral church of the bishop of Lugano, a see with jurisdiction over the Italian parts of Switzerland. The church of Santa Maria degli Angioli, built about 1499, and till 1848 occupied by Franciscans, contains several frescoes painted 1529–30 by Bernardino Luini. During the struggle of 1848–66 to expel the Austrians from Lombardy, Lugano served as headquarters for Mazzini. Books and tracts intended for distribution in Italy were produced there and at Capolago and the Austrian police were powerless to prevent their circulation.

LUGANO, LAKE OF, lying between Lago Maggiore and the Lake of Como, N. Italy (anc. *Lacus Ceresius*). The great promontory of Monte Salvatore (3,004 ft.) nearly cuts off the western arm from the main lake. The area is 19½ sq.mi., greatest length about 22 mi., greatest width 2 mi. and greatest depth 945 ft., surface 885 ft. above sea-level. Between Melide (south of the town of Lugano) and Bissone (on the east shore) the lake is so shallow that a great stone dam has been built across for the St. Gotthard railway line and the carriage road. The chief town is Lugano (at its north end), which by the St. Gotthard line is 19 mi. from Bellinzona and 9 mi. from Capolago, the station at the southeastern extremity of the lake, which is but 8 mi. by rail from Como. At the southwestern extremity a railway leads southwest from Porto Ceresio to Varese (9 mi.). Porlezza, at the east end of the lake, is 8 mi. by rail from Menaggio on the Lake of Como, while Ponte Tresa, at the west end of the lake, is about the same distance by electric railway from Luino on Lago Maggiore. Of the total area of the lake, about 7½ sq.mi. are in the Swiss canton of Ticino (Tessin), formed in 1803 out of the conquests made by the Swiss from the Milanese in 1512. The remainder of the area is in Italy to which also belongs the small enclave of Campione, almost opposite the town of Lugano. The lake lies among the outer spurs of the Alps that divide the Ticino (Tessin) basin from that of the Adda, where the calcareous strata have been disturbed by the intrusion of porphyry and other igneous rocks. It is fed by numerous torrents issuing from short glens in the surrounding mountains, while it is drained by the Tresa, an unimportant stream flowing into Lago Maggiore.

The first steamer was placed on the lake in 1856.

(W. A. B. C.)

LUGANSK: *see* VOROSHILOVGRAD.

LUGARD, FREDERICK JOHN DEALTRY LUGARD (1ST BARON) cr. 1928 (1858–1945), British administrator, son of the Rev. F. G. Lugard, was born on Jan. 22, 1858. He entered the army in 1878 and served in the Afghan War (1879–80), in the Sudan campaign (1884–85) and in Burma (1886–87). In May 1888 he took command of an expedition organized by the British settlers in Nyasaland against the Arab slave traders on Lake Nyasa, and was severely wounded. In April 1889 he was engaged by the Imperial British East Africa company. In their service he explored the Sabaki river region, and elaborated a scheme for the emancipation of the slaves in the Zanzibar mainland. In 1890 he was sent by the company to Uganda, where he secured British predominance and put an end to the civil disturbances, though not without severe fighting, chiefly notable for an unprovoked attack by the "French" on the "British" faction. While administering Uganda he journeyed round Ruwenzori to Albert Edward Nyanza, mapping a large area of the country. He also visited Albert Nyanza, and brought away some thousands of Sudanese who had been left there by Emin Pasha and H. M. Stanley.

In 1892 Lugard returned to England, where he opposed the abandonment of Uganda by Great Britain, contemplated by the fourth Gladstone administration. In 1894 Lugard was despatched by the Royal Niger Company to Bornu, where, distancing his French and German rivals, he secured treaties with the kings and chiefs acknowledging the sovereignty of the British company. In 1896–97 he took charge of an expedition to Lake Ngami on behalf of the British West Charterland Company. He was recalled by the British government and sent to West Africa, to raise a native force to protect British interests in the hinterland of Lagos and Nigeria against French aggression. In Aug. 1897 he raised the West African Frontier Force, and commanded it until the end of December 1899. The differences with France were then composed, and, the Royal Niger Company having surrendered its charter, Lugard was chosen as high commissioner of Northern Nigeria. The part of Northern Nigeria under effective control was small, and Lugard's task in organizing this territory was impeded by the refusal of the sultan of Sokoto and many other Fula princes to fulfil their treaty obligations. In 1903 a successful campaign against the emir of Kano and the sultan of Sokoto facilitated the extension of British control over the whole protectorate, and when in Sept. 1906 he resigned his commissionership, the whole country was being peacefully administered under the supervision of British residents. (*See* NIGERIA.) In April 1907 he was appointed governor of Hong-Kong. He was appointed in March 1912 Governor of both Northern and Southern Nigeria, with instructions to amalgamate the two administrations. The amalgamation became effective on Jan. 1, 1914, Sir Frederick being given the personal title of governor-general. He guided the affairs of Nigeria throughout World War I, retiring in 1919, and was made a privy councillor in 1920. In 1922 he published *The Dual Mandate,* a book dealing with the duties of European Powers in tropical Africa. From November of that year until 1936 he was a member of the permanent mandates commission of the League of Nations. (*See* MANDATE; NIGERIA.)

Lugard was created K.C.M.G. in 1901 and G.C.M.G. in 1911. He became a colonel in 1905, and held the local rank of brigadier-general. He married in 1902 Flora Louise Shaw (daughter of Major-General George Shaw, C.B., R.A.), who for some years had been a distinguished writer on colonial subjects for *The Times.* Lord Lugard, then Captain Lugard, published in 1893 *The Rise of our East African Empire* (partly auto-biographical), and was the author of various valuable reports on Northern Nigeria issued by the Colonial Office. Throughout his African administrations Lugard sought to ameliorate the condition of the native races, especially by the exclusion of alcoholic liquors, and by the suppression of slave raiding and slavery. He was created a baron in 1928. He died April 11, 1945, at Surrey.

LUGGER, a small vessel with light rigging carrying two or three masts and a lug-sail, and with or without topsails. It is used chiefly as a fishing vessel.

LUGO, a maritime province of northwestern Spain, formed in 1833 of districts taken from the old province of Galicia, and bounded north by the Atlantic, east by Oviedo and León, south by Orense, and west by Pontevedra and Corunna. Pop. (1940) 512,735; area, 3,815 sq.mi. The coast, which extends for about 40 mi. from the estuary of Rivadeo to Cape de Vares, is extremely rugged and inaccessible, and few of the inlets, except those of Rivadeo and Vivero, admit large vessels. The province, especially in the north and east, is mountainous, being traversed by the Cantabrian chain and its offshoots; the sierra which separates it from Leon attains in places a height of 6,000 ft. A large part of the area is drained by the Miño. This river, formed by the meeting of many smaller streams in the northern half of the province, follows a southerly direction until joined by the Sil, which for a considerable distance forms the southern boundary. Of the rivers flowing north into the Atlantic, the most important are the Navia, which has its lower course through Oviedo; the Eo, for some distance the boundary between the two provinces; the Masma, the Oro and the Landrove.

The principal agricultural wealth is on the Miño and Sil, where rye, maize, wheat, flax, hemp and a little silk are produced. Agriculture is in a very backward condition, mainly owing to the extreme division of land that prevails throughout Galicia. Iron is found at Caurel and Incio, arsenic at Castroverde and Cervantes, argentiferous lead at Riotorto. There are also quarries of granite, marble and various kinds of slate and building stone. There are manufactures of leather, preserves, coarse woollen and linen stuffs, timber and osier work.

Lugo, the capital (pop., 1940, 21,115) and the towns (1940 pop.) of Chantada (1,552), Fonsagrada (887), Mondoñedo (2,901), Monforte (11,168), Villalba (2,546) and Vivero (3,529) are described in separate articles. The province was taken by Nationalists in the civil war of 1936–39.

LUGO, capital of the above Spanish province, on the river Miño and on the railway from Corunna to Madrid. Pop. (1940) 21,115 (mun., 42,805). Lugo (*Lucus Augusti*) was a flourishing city under Roman rule (*c.* 19 B.C.–A.D. 409) and was made by Augustus the seat of a *conventus iuridicus* (assize). Its sulphur baths were then well known. It was sacked by barbarians in the 5th century, and suffered greatly in the Moorish wars of the 8th century. Franco's forces captured it in the civil war of 1936–39.

Lugo is an episcopal see, and was formerly the capital of Galicia. Suburbs have grown up round the original town, the form of which, nearly quadrangular, is defined by a massive Roman wall 30 to 40 ft. high and 20 ft. thick, with projecting semicircular towers which numbered 85 as late as 1809, when parts of the fortifications were destroyed by the French. The wall now serves as a promenade. The Gothic cathedral, on the south side of the town, dates from the 12th century, but was modernized in the 18th. The principal industries are tanning and the manufacture of linen and woollen cloth. About 1 m. S., on the left bank of the Miño, are the famous hot sulphur baths of Lugo.

LUG-SAIL: *see* RIGGING.

LUGUDUNUM, an old Celtic place-name (fort or hill of the god Lugos or Lug) used by the Romans for several towns in ancient Gaul. The most important was the town at the confluence of the Saône and Rhone, now called Lyons (*q.v.*). This place had in Roman times two elements. One was a Roman *colonia* (municipality of Roman citizens, self-governing) on the hill near the present Fourviéres (*Forum vetus*). The other was the Temple of Roma and Augustus, to which the inhabitants of the 64 Gallic cantons in the three Roman provinces of Aquitania, Lugudunensis and Belgica—the so-called Tres Galliae—sent delegates every summer to hold games and otherwise celebrate the worship of the emperor which was supposed to knit the provincials to Rome. The two elements composed the most important town of western Europe in Roman times. Lugudunum controlled the trade of its two rivers, and that which passed from northern Gaul to the Mediterranean or vice versa; it had a mint; it was the capital of all northern Gaul, despite its position in the south, and its wealth was such that, when Rome was burnt in Nero's reign, its inhabitants subscribed largely to the relief of the Eternal City.

LUINI, BERNARDINO (*c.* 1475–*c.* 1532), Italian painter of the Lombard school, the son of Giovanni Lutero of Luino, a village on the Lago Maggiore. Very little is known of Luini's early life and none of his early pictures is dated. They are painted in the style of the Lombard school as represented by Borgognone and Bramantino. To this period belong the "Pietà" in the church of Santa Maria della Passione, Milan; the frescoes painted for the Convent S. Maria d. Vetere now in the Brera, Milan; and the "Virgin with Child and St. John" of the Mond collection, National Gallery, London. In the works of his second period extending from about 1510–20 the influence of Leonardo is apparent. To this period may be assigned the "Virgin and Child" in the Brera, Milan; "Modesty and Vanity" in the collection of Edmond de Rothschild; the large Holy family in the Ambrosiana at Milan; the "Virgin and Child" with two saints in the museum at Budapest; the "Madonna" at the Louvre; and the "St. Catherine" in the Mond collection, National Gallery, London (replica at Leningrad). Leonardo's influence only modified to some extent Luini's own strongly individual style, of which the finest productions are those painted after 1520 in the so-called *maniera bionda.*

During the last decade of his life Luini carried out commissions outside Milan. In 1523 he painted the fine polyptych for the parish church of Legnano; in 1525 he executed the frescoes in the church of S. Maria Miracoli at Saronno, representing the "Marriage of the Virgin," "Christ among the Doctors," the "Presentation in the Temple," and the "Adoration of the Magi." The story goes on that Luini sought asylum in the sanctuary of Saronno after killing a man in self-defence and executed this work at the bidding of the monks. In 1526 he erected three altarpieces for the Cathedral of Como; in 1529 he was at Lugano painting the large fresco of the "Crucifixion" in S. Maria degli Angeli. His last important work was the cycle of frescoes in the Monastero Maggiore, Milan, executed shortly before his death in Milan in 1531 or 1532.

Vasari calls Luini "an exceedingly delicate and very pleasing master." A dignified serenity is the most marked characteristic of his works. Their beauty depends as much upon the loving and dreamy expression in the faces as upon the refinement of form. This quality of expression imbues his sacred pictures with a peculiarly religious grace. Besides the works mentioned above the following are notable. "Christ Teaching" (in the National Gallery, London) a fine work of the late period, for which a drawing is in the Albertina at Vienna. Of "Salome with the Head of John the Baptist" various versions exist—in the Louvre, the Prado, the Uffizi, the Museo Borromeo in Milan, the Vienna museum, and with Prince Ascoli at Naples. In the Castello at Milan are a series of medallion portraits of members of the Sporza family; in the Ambrosiana, a fresco representing the "Crowning with Thorns"; in the Poldi Pezzoli collection, the "Marriage of St. Catherine" and three other pictures. The Brera in Milan has the "Virgin Enthroned with Saints" (dated 1521) from the church of S. Maria in Brera; and the "Virgin and Child and the Rose-Hedge"; also the frescoes from the old church of La Pace with scenes of the life of the Virgin; and the fresco decoration of the Casa Pelucca near Monza. This series is classic in conception. The "Girls playing at Forfeits" and the "Three Angels depositing St. Catherine in her Sepulchre" are gracefully composed. Portions of this same series are in the Louvre. Here too are frescoes taken from the Oratorio di Greco Milanese. In the Certosa di Paria is a fresco of "Madonna and Child," and one of "St. Sebastian and St. Christopher."

See Dr. G. C. Williamson, *B. Luini* (1900); Luca Beltrami, *B. Luini e l'Opera sua a Lugano* (Lugano, 1910); *Luini 1512–1532. Materiale di stüdio raccolto a cura di Luca Beltrami* (Milan, 1911).

(I. A. R.)

LUKE, the traditional author of the third Gospel and the Book of Acts, and the most literary among the writers of the New Testament. He was of non-Jewish origin (Col. iv. 11, 14), a fact of great interest in relation to his writings. His name, a pet form of Lucanus (*cf.* Silas for Silvanus, Acts xv. 40, 1 Thess. i. 1)—or, as some think, of Lucius—taken together with his profession of physician (Col. iv. 14), suggests that he was the son of a Greek freedman of some Roman family; and as Julius Caesar gave Roman citizenship to all physicians in Rome (Sueton. *Jul.* 42), Luke may have inherited this status. Such a man would have the attitude to things Roman which appears in the works attributed to Luke. He seems to have remained in constant attendance on Paul, as physician as well as friend (Col. iv. 14; 2 Tim. iv. 11). That Luke was once an adherent of the synagogue—one of those "worshippers" of God to whom Acts often alludes—is probable also from its warm reference to Barnabas (xi. 23 *seq.*) and its feeling for the Jewish Christian or Hellenistic type of piety, as distinct from specific Paulinism.

The statement of the Muratorian Canon (*c.* 190) that Paul took Luke for his companion *quasi ut juris studiosum*—whether we take *ut juris* as = *itineris* and render "as devoted to travel" or not—is inference from biblical data. Origen expresses the belief that Luke was the "brother" of 2 Cor. viii. 18, "whose praise in the Gospel" (= his Gospel) was "throughout all the churches." Though the basis of this identification be a mistake, yet it is quite likely in fact: Luke seems almost the only non-Macedonian (as demanded by 2 Cor. ix. 2–4) of Paul's circle available at the time (*see* Acts xx. 4). If an ancient prologue to the Lucan writings (extant only in Latin) really goes back in part to Marcion or his circle, it may preserve a genuine tradition in stating that Luke died in Bithynia at the age of seventy-four. Fiction usually took the form of martyrdom, as in a later tradition touching his end. The same prologue, and indeed all early tradition, connects him originally with Antioch (*see* Euseb. *Hist. Eccl.* iii. 4, 6, possibly after Julius Africanus in the first half of the 3rd century).

That he was actually a native of Antioch is doubtful: but internal evidence suits the view that he practised his profession in Antioch, where (or in Tarsus) he probably first met Paul. The detailed information in Acts as to the Gospel in Antioch (xi. 19 ff., xiii. 1 ff., xiv. 26–xv. 35) suggests Luke's connection with that church. The Bezan reading in Acts xi. 27, "when *we* were assembled," may imply local memory of this.

But while Luke probably met Paul in Antioch, and thence started with him on his wider missionary enterprise, partly as his medical attendant (*cf.* Gal. iv. 13), Acts shows also some special feeling for the north-eastern part of the Aegean. Ramsay and others fancy that Luke's home was Philippi, and that in fact he may have been the "certain Macedonian" seen in vision by Paul at Troas, inviting help for his countrymen (xvi. 9 f.). But this is as precarious as the view that, because "we" ceases at Philippi in xvi. 17, and then re-emerges in xx. 6, Luke must have resided there during all the interval. The use and disuse of the first person plural, identifying Paul and his party, has probably a more psychological meaning (*see* Acts of the Apostles). The local connection in question may have been subsequent to that with Antioch, dating from Luke's work with Paul in the eastern provinces of Asia Minor, and being resumed after Paul's martyrdom. This accords at once with Harnack's argument that Luke wrote Acts in Asia, and with the early tradition, above cited, that he died in Bithynia.

The later traditions about Luke's life are based on fanciful inference or misunderstanding, *e.g.*, that he was one of the Seventy (4th century).

A good deal can still be gathered by study of his writings as to the manner of man he was. He was the one man of letters among the N.T. writers (*see* Cadbury, *The Making of Luke—Acts*). But further, it was a beautiful soul from which came "the most beautiful book" ever written, as Renan styled his Gospel. The selection of stories which he gives us—especially in the section peculiar to himself (ix. 51–xviii. 14)—reflects his own character as well as that of the source he mainly follows. His was indeed a *religio medici* in its pity for frail and suffering humanity, and in its sympathy with the triumph of the Divine "healing art" upon the bodies and souls of men (*cf.* Harnack, *The Acts*, Excursus, iii.). His was also a humane spirit, so tender that it saw further than almost any save the Master himself into the soul of womanhood. In this, as in his joyousness, united with a feeling for the poor and suffering, he was an early St. Francis of Assisi.

Characteristic of his soul, as of his Gospel, was its universalism—its sensitiveness to the fact, so emphasized by St. Paul, that in Christ a common call was issued to Jew and Gentile alike.

Bibliography.—Introductions to commentaries like A. Plummer's on Luke's Gospel in the "Intern. Crit." series; R. B. Rackham's *Acts of the Apostles;* the article "Luke" in Bible Dictionaries; Ramsay's *Paul the Traveller* and *Pauline and other Studies;* A. Harnack, *Luke the Physician;* and H. J. Cadbury, *The Making of Luke—Acts* (1927); Introduction to *Acts* in the *Westminster Version of the Sacred Scriptures* (London, 1933); M.-J. Lagrange, *Evangile selon S. Luc* (Paris, 1927), pp. vii–cli; E. Jacquier, *Les Actes des Apôtres,* 2nd ed. (Paris, 1926), pp. xciii–ci; A. T. Robertson, *Luke the Historian in the Light of Research* (Edinburgh, 1920); F. J. Foakes Jackson and Kirsopp Lake, *The Beginnings of Christianity,* Part I, The Acts of the Apostles, Vol. II, ch. 2.

(J. V. B.; X.)

LUKE, GOSPEL OF, a narrative dealing with the life of Jesus of Nazareth, included in the list of books used by the Christian church as a New Testament. In this canon it came to occupy the third place among the Gospels. It is, however, only the first volume of a longer work written by the same author and addressed to the same patron, Theophilus (Luke i. 3, Acts i. 1). Another New Testament book, the Acts of the Apostles, is the succeeding volume. Since much of the contents of this gospel (as well as nearly all of Acts) is not preserved in other writings, this writer is for us the most important historian of the beginnings of the Christian movement. His distinctive qualities of mind and style give his work additional interest and attractiveness. Because other gospels are extant, dealing with the same figure of history and with many of the same events and teachings, any consideration of the Gospel according to Luke inevitably suggests comparison with them.

Contents.—The first long sentence is a preface, introductory, probably, to the whole book, setting forth the reasons for writing. The first book which follows consists of narrative episodes loosely strung together, and of utterances of Jesus (and some others) sometimes more and sometimes less associated with the narrative context. Few main divisions are suggested by the author, but on the basis of the geography and contents of the other gospels, subdivision of the text is often attempted by modern scholars. The author himself used for purposes of division (or connection) at most such summary statements as appear at i. 80; ii. 40, 52; iii. 18; iv. 14–15, 37, 44; xiii. 22; xxi. 37, 38 and the like in Acts. At i. 5; iii. 1–2; viii. 1–3 and perhaps elsewhere it is natural to suspect that the words are introductory, not merely to a single incident, but to a larger series.

Some of the more significant sections are:

(i.) Prediction and birth of John the Baptist and of Jesus (i. 5–ii. 40). These are parallel narratives alternating between the experiences in the two families with special emphasis on the predictions of future greatness. There is a poetic character in the words of rejoicing of Zacharias (the *Benedictus*), of Mary (the *Magnificat*), of the angels (the *Gloria in Excelsis*) and of Simeon (the *Nunc Dimittis*). These songs and also the narrative are Semitic in style and reminiscent in wording of the Old Testament. The account is completely independent of our other ancient account of Jesus' birth in Matthew i.–ii.

(ii.) Jesus' precocity as shown in the Temple when twelve years old (ii. 41–51). This is closely bound with the preceding and is not recorded elsewhere.

(iii.) Genealogy from "Jesus the son of Joseph as was supposed" to "Adam the son of God" (iii. 23–38), independent of and apparently at variance with the genealogy from Abraham to Joseph in Matt. i. 2–15.

(iv.) Address in the synagogue at Nazareth (iv. 16–30), comparable to a scene in Mark vi. 1–6—Matt. xiii. 54–58, but notable in giving the text and contents of Jesus' address and the murderous effect on the hearers.

(v.) Call of four fishermen as disciples (v. 1–11), comparable to a scene in Mark i. 16–20—Matt. iv. 18–22, but relating a remarkable catch of fishes as in John xxi.

(vi.) An address (vi. 20–vii. 1) briefer than Matthew's Sermon on the Mount (Matt. v., vi., vii.) but with beginning, middle and end of identical contents. In both gospels there follows the like concluding sentence and the same miracle, viz., the cure made, *in absentia,* on the request of a centurion in Capernaum (vii. 2–10).

(vii.) Raising from the bier the deceased only son of a widow at Nain (vii. 11–17).

(viii.) Discussion by Jesus about John the Baptist (vii. 18–35), also found in Matthew.

(ix.) Anointing of Jesus by a sinful woman in the house of Simon, a Pharisee; and discussion including the parable of two debtors, vii. 36–50. The incident is independent of the anointing (by Mary according to John) as told in the three other gospels, though in both cases there was an alabaster cruse and the house owner had the same name ("Simon the leper," Mark xiv. 3).

(x.) Incidents connected with the welcome of Jesus on his journey, (ix. 51–x. 42), including the mission and return of seventy messengers sent ahead in pairs (comparable to the mission of the twelve related by Mark, Matthew and even Luke). The rejection in one village by the Samaritans and the reception in another by Martha.

(xi.) Talk with a lawyer about the duty of love to God and neighbour (compare a like incident in Mark xii. 28–31 and Matt. xxii. 34–40) and illustration of neighbourliness in parable of the good Samaritan.

Out of the long and interesting section that follows, full of various teachings of Jesus recorded not at all in Mark and only about half of them in Matthew, may be mentioned as peculiar to Luke:

(i.) Cures and consequent conversations: on the sabbath a bent woman (xiii. 10–17) and a dropsical man (xiv. 1–6); near Samaria ten lepers of whom one, a Samaritan, gave thanks (xvii. 19).

(ii.) Parables, dealing (*a*) with wealth: the Rich Fool (xii. 13–21); the unjust steward (xvi. 1–8); the rich man and Lazarus (xvi. 19–31); parable of the pounds (xix. 11–27), cf. Matthew's parable of the talents; (*b*) with humility and prayer: the obedient servant (xvii. 7–10); the widow and the unjust judge (xviii. 1–5); the Pharisee and the publican (xviii. 9–14); (*c*) with the recovery of the lost: the sheep (also in Matt.), the coin, the prodigal son (xv.); the fruitless fig tree (xiii. 6–9).

(iii.) Incidents associated with local rulers or current history: the Galileans slain by Pilate; those injured by fall of tower of Siloam (xiii. 1–5); reply to warning about Herod (xiii. 31–33).

From the later part of the gospel may be mentioned as peculiar to Luke the story of Zacchaeus at Jericho (xix. 1–10) and the disclosure of the risen Jesus to two disciples walking to Emmaus (xxiv. 13–35). Many details in the familiar and continuous series of events from Jesus' entry into Jerusalem until after his death are peculiar to Luke.

The remaining contents of Luke show considerable overlapping with Matthew and Mark. The passages most closely parallel with Mark occur in Luke in the same order as in Mark, and are usually continuous, as iv. 31–43; v. 12–vi. 19; viii. 4–ix. 50; xviii. 15–43; xix. 29–xxiv. 11, the last section with some notable additions and variations. Most of this material occurs also in Matthew in nearly the same order. There are besides a considerable number of passages which Luke shares with Matthew alone, but in these agreement of order is less frequent.

In nearly every case of agreement of subject matter mentioned there is a considerable though varying agreement in wording. These likenesses are generally believed to be due to some literary relationship between the three gospels, and the question to be solved is called the Synoptic problem. The solution that has come into most general favour is (1) that Mark was written first and was employed as a source by both Matthew and Luke, and (2) that further material appearing alike in Matthew and Luke was derived by them ultimately from a common written source. (*See* GOSPEL.)

The Sources of Luke.—The sources are thus disclosed in part by comparison with the other gospels. One of them was our Gospel of Mark. Possibly the form of Mark used by Luke differed in more than slight detail from our Mark. For example, since Luke followed and used nearly everything in our Mark except Mark vi. 47 to viii. 26, it may be conjectured that the copy of Mark which he used did not contain those seventy-three verses. But it is also possible that he omitted them. He habitually copies out Mark in blocks. In this instance he may have omitted, consciously or by accident, a solid block of Mark's material.

Some other omissions by Luke of Mark's material are best explained by supposing that of certain episodes in Mark he had an alternative version which he preferred and substituted, not always inserting it in exactly the same place. In the early part of his gospel he uses just such alternative accounts of the temptation of Jesus, of the call of four fishermen, of the visit to Nazareth, and of the anointing by a woman. His whole account of Jesus' trial and death is sufficiently independent of Mark to permit of the suggestion that Luke is here following an independent source for the whole series of events.

In any case the material which he shares with Matthew alone of the evangelists is derived from a written source other than Mark. This is generally agreed, and the common material is referred to by scholars as Q, a symbol derived from the German *Quelle* (source). But in what form or scope this material came to Luke is unknown. It has been usual to regard this source as a collection mainly of the sayings of Jesus as found in both Luke and Matthew, and to attribute to a third source most of the matter peculiar to Luke. The second source is often conjectured to be the *Logia* of Jesus, a work which Papias (*c.* A.D. 140) says Matthew wrote in Hebrew. The third or special Lucan source is believed by some to have been a written source with a certain homogeneity of language and interests. Another hypothesis is that practically all the material in Luke not found in Mark was already collected into a kind of gospel or Proto-Luke when at last it was combined with Mark by the simple method of inserting blocks of Mark into it.

No variations of style, nor any explanation from the author, helps to establish the relative probability of these theories. Except where close verbal parallels exist it is even possible that the evangelist is quoting oral traditions from memory. In his preface he refers to earlier information, both oral and written, but does not indicate which he uses. When he copies the gospel of Mark he paraphrases it so freely that his own style rather than Mark's remains the more conspicuous. It has been claimed that the Semitic style of the birth stories implies a written source—some would say a source written in a Semitic language like Hebrew or Aramaic, or even in poetry. The phenomena could be explained, however, if a written source in Greek or unwritten traditions were used by Luke and cast or kept by him in an appropriate Greek Biblical style.

Characteristics.—The Greek style of the work shares with other New Testament writings the flavour of the vernacular speech of the time, but is more literary than that of Mark which Luke repeatedly improves in passages where Mark is being employed as a source. The use of the formal preface, of the elaborate dating in iii. 1–2, and other facts, suggest that the author is more akin to the *litterateur*. He sometimes avoids foreign words, whether Latin or Aramaic, found in his sources, conforming thereby to the better approved habits of style. There is a secular character to his work, and there are references in the gospel to the wider Roman world and its officials, as is the case more abundantly in Acts.

Certain artistic qualities in the work are felt by the observant reader. Renan calls this gospel the most beautiful book in the world. Scenes are portrayed with imagination and with feeling, and are joined together with some effort at connection. The parables told in Luke are among the most effective stories recorded in the Bible. Several passages in the gospel are marked by real pathos, *e.g.*, the "only" children at vii. 12; viii. 42; ix. 38; while elsewhere the spirit of joy is prominent. The qualities of tenderness and sympathy are emphasized. There is also frequent reference to suspense and to final enthusiasm.

How far the traits of the gospel are due to the author and how far to the lost sources cannot now be known. Only in changes in sections derived from Mark is the author's own responsibility provable. It may be, however, partly his own choice of materials and editorial treatment that explain the following apparent emphases in his subject matter: Prayer; repentance and forgiveness; the Holy Spirit (and more conspicuously in Acts); the prominence of women in the narrative and in the parables; praise of poverty and of almsgiving, and warning against wealth; illustration from figures of money or property; comparisons of foreigners, Samaritans, publicans, and the like with self-righteous Jews to the disadvantage of the latter. Equally distinctive emphases in matters of theology can hardly be discovered. The author is a Christian and shares the general early Christian standpoint.

Origin of the Gospel.—That the gospel and Acts are from the same author has been mentioned. This is generally agreed and is confirmed by such marks of stylistic identity in the two volumes as one would expect in works from the same author. The origin of each book is therefore a question that can scarcely be discussed in full separately (*see* ACTS OF THE APOSTLES).

That the author was Luke, the associate named by Paul (Col. iv. 12 "the beloved physician," Philemon 24, a "fellow worker"), is a tradition that can be traced back for each volume before 200 A.D. In favour of this tradition is not so much the antiquity or continuity of the tradition, as the fact that a person so obscure in the records of the church would be less likely to have attributed to him the authorship of such important and well regarded writings than would one of the twelve apostles. The contents of the volumes may be said neither to confirm nor to weaken this tradition, though a series of interesting arguments pro and con have been put forward.

In favour of the tradition are urged the passages in Acts (xvi. 10–17, xx. 5–16, xxi. 1–18, xxvii. 1–xxviii. 16) in which the first person plural is used. That the author of the work was himself a companion of Paul is a natural conclusion from this use of "we." Of course, the companion's name is not thereby revealed, but Luke is not excluded, as he is nowhere mentioned in Acts in the third person. Other critics hold that these "we" sections come not from the author of Luke and Acts, but from a written source that he incorporated. In that case Luke might be the author of the source, but probably not of the whole work.

Against this alternative is urged the consideration that (except for the "we") the style of the autobiographical sections in Acts is identical with that of the rest of the work. This is felt to indicate identity of authorship. If, however, we may judge from his use of Mark, this evangelist regularly recast his sources in his own style and may possibly have done so with a "we" source, though why, when otherwise rewording it, he should retain the first person, is not evident.

A favourite argument in defence of Lucan authorship, for some years, was derived from the alleged medical expressions and interests displayed in the two writings. Few of the expressions cited, if any, are really technical, and the actual amount of matter connected with the medical profession is not so extensive as to exclude lay authorship.

Whether the author's narrative and his religious viewpoint are such as to imply first-hand contact with Paul or not, has been hotly debated. There are apparent contradictions between his earlier narratives about Paul and the biographical allusions in Paul's own letters. On the other hand, there are lifelike touches in his accounts of Paul, whether written in the first person or the third, and some striking agreements with details in the Pauline epistles. It would be rash to say of the discrepancies that no one who subsequently knew Paul could have written them, and equally rash to say of the agreements that no one except an actual associate of Paul could have written them.

So, although no conclusive internal evidence condemns the tradition of Lucan origin as erroneous, the possibility may be left open that the attribution of these writings to Luke was an early conjecture made when the real origin of the work was unknown. Luke i. 1 may have seemed to early readers to exclude all the apostles from the writing of the gospel, while 2 Tim. iv. 11 may have seemed to exclude all the other companions of Paul from the writing of the conclusion of Acts. Since, however, the "we" appeared to indicate that the work as a whole came from some such companion, the total inference from the scriptures would fix on Luke. Elaborate conjectures on such matters were not uncommon in the second century, and when once made often became unchallenged tradition.

Of the place and date at which the author wrote, little can be said with certainty. The gospel was written before Acts, though perhaps not much before. The Acts was written after the "two years" of Paul in Rome with which it closes, *i.e.*, about A.D. 60–62. Some have supposed that it was written immediately after and for that reason stops abruptly with a statement of the *status quo*. But nothing prevents a later date for both volumes. If the prophecy of Luke xxi. was affected by the actual fulfilment in the year A.D. 70, both volumes are at least as late as that. Neither volume shows any certain knowledge of the works of Josephus, though this has been asserted, or of Paul's letters. The gospel, as has been said, is dependent on and therefore subsequent to both Mark and other material shared by Matthew, but the exact date of neither of these predecessors is known.

Nothing certainly is known of Theophilus, to whom both gospel and Acts are addressed, but the author's purpose in writing is stated in the preface and can be read between the lines of the whole book. In like manner the contents of the books disclose more of the author's character and personality than would his name, date, or place of residence, if we knew them.

BIBLIOGRAPHY.—*See* the books mentioned under ACTS OF THE APOSTLES, and GOSPEL. For commentaries on Luke *see* those by A. Plummer (1896, in *International Critical Commentary*); W. F. Adeney (1901 in *Century Bible,* popular); J. Wellhausen (1904); M. J. Lagrange (1921, in French, Roman Catholic); T. Zahn (1913, in German, conservative); E. Klostermann (*Handbuch z. N.T.* 1919); B. S. Easton (1926, exegetical and critical); A. Loisy, *Les Évangiles Synoptiques* (1907). On the author and his work in general *see* the technical "introductions" to the New Testament by B. W. Bacon, J. Moffatt, M. Goguel (in French), T. Zahn (in German), and others, and the following more popular books: A. Harnack, *Luke the Physician* (1907); H. McLachlan, *St. Luke: the Man and his Work* (1920); H. J. Cadbury, *The Making of Luke—Acts* (1927). On special questions,

W. K. Hobart, *The Medical Language of St. Luke* (1881); A. M. Perry, *The Sources of Luke's Passion-Narrative* (1920); H. J. Cadbury, *The Style and Literary Method of Luke* (1920); V. Taylor, *Behind the Third Gospel* (1926, on the Proto-Luke hypothesis).

(H. J. C.)

LUKEMAN, HENRY AUGUSTUS (1871–1935), American sculptor, was born at Richmond, Va., on Jan. 28, 1871. He studied at the National Academy of Design, New York city, and was a pupil of Launt Thompson and Daniel Chester French, perfecting his knowledge of anatomy by a year's study at Bellevue hospital. In 1894 he spent a year in Paris studying under Falquière at the École des Beaux-Arts, and on his return to the United States settled in New York city. His work includes portraits, busts, statues, memorials and bas-reliefs, among the best known being "Mann, the Law Giver of India" for the Appellate Court building, New York city; the statue of President McKinley at Adams, Mass.; "Genoa," the figure of Columbus on the United States customs house, New York city (1905); the Soldiers' Monument at Somerville, Mass. (1908); the group "Women of the Confederacy," at Raleigh, N.C. (1912); the Soldiers' Memorial, Red Hook park, Brooklyn, N.Y. (1920); the equestrian statue of Francis Asbury, Washington, D.C. (1921). He was appointed in 1925 to succeed Gutzon Borglum as sculptor in charge of the Stone mountain memorial near Atlanta. (*See* ATLANTA, GEORGIA.)

LULEÅ, a seaport of Sweden, capital of the district (*län*) of Norrbotten, on the Sandö peninsula at the mouth of the Lule river. Pop. (1943) 15,139. Luleå as founded by Gustavus Adolphus was 7 mi. higher up the river, but was moved to the present site in 1649. It is connected at Boden (22 mi. N.) by rail from Stockholm to Gellivara and Narvik on Ofoten Fjord in Norway. It ships iron ore mined at Gellivara, 127 mi. N. by W., and there are smelting works at Karlsvik. Timber is exported, being floated down the River Lule. As a rule the port is closed by ice from November to the end of May. The town was almost entirely burned in 1887.

LULEAN, an independent linguistic stock of South American Indians, so called from the Lules, the most important tribe. They lived on the western border of the Argentine Chaco, on the Salado river in the provinces of Santiago del Estero and Tucuman. They were a semi-agricultural folk of simple culture, and known only from brief references by the 18th-century writers. There is considerable uncertainty as to just what tribes are to be included in the stock, the data available being very meagre and conflicting. The Vilela, on the Vermejo, who were near neighbours of the Lule, are, however, certainly members of the stock.

See D. G. Brinton, "The Linguistic Cartography of the Chaco Region" (*Proc. Amer. Philos. Soc.*, vol. xxxvii.); L. Kersten, "Die Indianerstämme des Gran Chaco, etc." (*Internat. Archiv. für Ethnographie,* vol. xvii., pp. 1–75).

LULE BURGAS, BATTLE OF. This was the principal battle of the BALKAN WARS OF 1912–1913, under which heading it is described. Arising out of the advance of the Bulgarian armies into Thrace it lasted from Oct. 28–30, 1912, and ended with the defeat of the Turkish field forces and their retirement to the Chatalja Lines, covering the approaches to Constantinople.

LULL (or LULLY), **RAIMON** (or RAYMOND) (*c.* 1235–1315), Catalan author, mystic and missionary, was born in Palma (Majorca). Married at an early age to Blanca Picany, he led a dissipated life till his conversion (1266), when he resolved to devote himself to evangelical work among the heathen, to write an exposure of infidel errors, and to promote the teaching of foreign tongues in seminaries. He dedicated nine years to the study of Arabic, and in 1275 showed such signs of mental exaltation that, at the request of his wife and family, an official was appointed to administer his estate. He withdrew to Randa, there wrote his *Ars major* and *Ars generalis,* visited Montpellier, and persuaded the king of Majorca to build a Franciscan monastery at Miramar. There for ten years he acted as professor of Arabic and philosophy, and composed many controversial treatises. After a fruitless visit to Rome in 1285–86, he journeyed to Paris, residing in that city from 1287 to 1289, and expounding his bewildering theories to auditors who regarded him as half insane. In 1289 he went to Montpellier, wrote his *Ars veritatis inventiva,* and removed to Genoa where he translated this treatise into Arabic. In 1291, after many timorous doubts and hesitations for which he bitterly blamed himself, Lull sailed for Tunis, where he publicly preached Christianity for a year; he was finally imprisoned and expelled. In Jan. 1293 he reached Naples, where his efforts to interest Clement V. and Boniface VIII. in his favourite project of establishing missionary colleges were unavailing. In 1300 he sailed to Cyprus to seek support for his plan of teaching oriental languages in universities and monasteries. He was rebuffed once more, but continued his campaign with undiminished energy. Between 1302 and 1305 he wrote treatises at Genoa, lectured at Paris, visited Lyons in the vain hope of enlisting the sympathies of Pope Clement V., crossed over to Bougie in Africa, preached the gospel, and was imprisoned there for six months. On being released he lectured with increasing effect at Paris, attended the General Council at Vienne in 1311, and there witnessed the nominal adoption of his cherished proposals. Though close on 80 years of age, Lull's ardour was unabated. He carried on his propaganda at Majorca, Paris, Montpellier and Messina, and in 1314 he crossed over once more to Bougie. Here he again resumed his crusade against Mohammedanism and raised the fanatical spirit of the inhabitants, was stoned outside the city walls and died of his wounds.

The circumstances of Lull's death caused him to be regarded as a martyr, local patriotism helped to magnify his merits, and his fantastic doctrines found many enthusiastic partisans. The *doctor illuminatus* was venerated throughout Catalonia and afterwards throughout Spain as a saint, a thinker and a poet; but his doctrines were disapproved by the powerful Dominican order, and in 1376 they were formally condemned in a papal bull issued at the instance of the inquisitor, Nicolas Emeric. The authenticity of this document was warmly disputed by Lull's followers, and the bull was annulled by Martin V. in 1417. The controversy was renewed in 1503 and again in 1578; but the general support of the Jesuits and the staunch fidelity of the Majorcans saved Lull from condemnation.

The speculations of Lull are now obsolete outside Majorca where his philosophy still flourishes, but his more purely literary writings are extremely curious and interesting. In *Blanquerna* (1283), a novel which describes a new Utopia, Lull renews the Platonic tradition and anticipates the methods of Sir Thomas More, Campanella and Harrington, and in the *Libre de Maravelles* (1286) he adopts the oriental apologue from *Kalilah and Dimnah.* And as a poet Lull takes a prominent position in the history of Catalan literature; such pieces as *El Desconort* (1295) and *Lo Cant de Ramon* (1299) combine in a rare degree simple beauty of expression with sublimity of thought and impassioned sincerity.

See José R. de Luanco, *Ramon Lull, considerado como alquimista* (Barcelona, 1870), and *La Alquimia en España* (Barcelona, 1889–97).

(J. F.-K.)

LULLY or **LULLI, JEAN-BAPTISTE** (1639–1687), French composer, of Italian birth, was born in Florence on Nov. 29, 1639. Through the duc de Guise he entered the service of Madame de Montpensier as scullery-boy. He then studied the theory of music under Métra and entered the court orchestra, being appointed director in 1652, and court composer in 1653. The influence of his music produced a radical revolution in the style of the dances of the court itself. Instead of the slow and stately movements which had prevailed until then, he introduced lively ballets of rapid rhythm. The music for his ballets was arranged as orchestral suites, a new form which was cultivated in Germany as well as in France. In December 1661 he was naturalized as a Frenchman, his original name being Giovanni Battista Lulli. For fifteen years (1672–87) Lully was the director of the Paris opera. While directing a *Te Deum* on the 8th of January 1687 with a rather long baton he injured his foot so seriously that a cancerous growth resulted which caused his death on the 22nd of March. Lully was the founder of French opera, forsaking the Italian method of separate recitative and aria for a dramatic consolidation of the two and a quickened action of the story. Moreover, he laid more stress on rhythm and less on melody. He improved the composition of the orchestra, into which he introduced several new instruments. Lully was a friend of Molière, for some of whose best plays he composed illustrative music. Of his church music his *Miserere,* written for the funeral of the minister Séguier, is a work of genius; and on his death-bed he wrote *Bisogna morire, peccatore.*

A modern edition of the most important of his operas *Alceste* (1674), *Armide* (1686) will be found in the *Chefs d'oeuvre classiques de l'opéra français.*

See E. Radet, *Lully, homme d'affaires, propriétaire et musicien* (1891); Romain Rolland, *Musiciens d'autrefois* (1908); L. de la Laurencie, *Lulli* (1911); J. B. de Lully, *Lully et l'opera français* (1925).

LUMBAGO, a term in medicine applied to a painful ailment affecting the muscles of the lower part of the back, generally regarded as of rheumatic origin. An attack of lumbago may occur alone or be associated with rheumatism in other parts of the body. It usually comes on suddenly as severe pain in the small of the back, greatly aggravated on movement, especially in attempting to rise from the recumbent posture and in drawing a deep breath, coughing or sneezing. The absence of any great constitutional disturbance beyond the pain renders the diagnosis a matter of no great difficulty. Lumbago seems to be brought on by exposure to cold and damp. Sometimes it follows a strain of the muscles of the loins. The attack is in general of short duration, but occasionally it continues for a long time as a feeling of soreness and stiffness on movement. The treatment includes that for rheumatic affections in general (*see* RHEUMATISM) and the application of local remedies to allay the pain.

LUMBERING, a term applied to the harvesting of the products of the forest, and their conversion into various shapes and sizes for further commercial use. Lumbering deals with the growing, manufacture and distribution of lumber and lumber products. One of the first great obstacles encountered by the early American settlers was the forest, and other than supplying logs for the shelter then needed, the forests were deemed useless. Trees were felled primarily to clear the ground, and the logs were referred to as "lumber," according to the original meaning of the word. Later, when small amounts of "lumber" were shipped to England —sometimes as mere ballast—the British sailors are said to have referred to the bothersome material as "just so much lumber." For clarity, the definition of lumber is restricted to include only those products of the saw and planing-mills not further manufactured than by sawing, re-sawing and passing lengthwise through a standard planing machine, cross-cut to length, and matched. These are classified as follows: (1) Yard lumber—intended for general building and construction purposes; (2) shop or factory lumber—intended for further manufacture; (3) structural lumber—2in. or more in thickness and width, intended for use where working stresses are required. (*See* American Lumber Standards, Dept. of Commerce, Simplified Practice Recommendation R 16-39.)

Lumbering, one of the leading American industries, involves much more than the mere manufacture of lumber. Millwork products, such as sash, doors, frames, blinds, etc.; veneers, shingles, lath, poles, posts, piling, cross ties, flooring, box shooks, etc., all are produced by the lumber industry. Pulp wood, consumed by the paper industry; bark for tanning, medicines, mattings, etc.; resinous products such as turpentine, rosin, tar, pitch, etc.; chemical products such as wood alcohol, pyroligneous acid, charcoal, creosote, etc., are directly dependent upon the lumber industry, and in many cases these various secondary industries incorporate lumbering into their operations as an integral part.

Development of Lumbering.—The forests, the principal source of materials for shelter, in early American times provided lumber for the houses, stockades for refuge against the savages and fuel, all in bountiful measure. For safety from hostile Indians, great tracts had to be cleared and in those clearings communities developed. Before the people could move inland from the Atlantic coast, the forests had to be penetrated and trails blazed and roads made. Thus lumbering was the first industry in the United States. Spars and ship timbers were shipped even before tobacco and other agricultural products were exported. The first sawmills were located at Jamestown, Va., in 1625, and Berwick, Me., in 1631. These early mills were operated by water-power and produced only a few hundred board feet of lumber a day. They were an unimportant factor until the advent of steam about 200 years later. Timbers were hewn, shingles were split and boards were sawed by hand. The development of the American lumber industry can be traced concurrently with the expansion of agriculture. Likewise, the shifting of lumber centres from New England to the north, south and west closely parallels the industrial development of America. For years Maine led in lumber production and supplied home and foreign markets with white pine spars, staves, shipbuilding lumber. Virginia and the Carolinas produced large quantities of oak and other Southern States yellow pine and rosin. By 1840 the lumber production of the United States approximated 8,000,000,000 board feet. The centre of the industry had shifted to the State of New York, which was then producing 20% of the lumber manufactured. In 1859 Pennsylvania took the lead, but ten years later gave way to Michigan, which led in lumber production until about 1899, when, according to U.S. Government statistics, Wisconsin ranked first. Minnesota also came into prominence about the same time; but the peak of lumber production in the Lake States was reached in 1892. Since 1895, southern yellow pine has supplied from 20 to 40% of the total lumber production of the country and more lumber has been produced in the South and Southeast than in any other one section of the country. The Pacific coast States, and principally Washington and Oregon, came into prominence as a lumber-producing region about 1900. From 1905 to 1922 (except 1920) Washington and Louisiana were the leading lumber-producing States. In 1920 and from 1923 to 1937, Washington and Oregon led in the order named. In 1938 lumber production in Oregon was largest for the first time on record.

BY COURTESY OF THE LONG-BELL LUMBER COMPANY

TOPPING A TWO-HUNDRED FOOT TREE

The topper cuts the top from the tree and then clings to the swinging trunk as the top crashes to the ground

Production and Consumption.—The average annual production of lumber in the United States for the five-year period, 1923–28, was approximately 37,000,000,000 bd.ft., of which 31,000,000,000 was softwood, and 6,000,000,000 was hardwood. In the five-year period, 1933–38, it averaged 21,200,000,000 bd.ft. of which 17,700,000,000 bd.ft. was softwood, and 3,500,000,000 hardwood. In 1937 it reached a total of 26,000,000,000ft., about 40% of which was produced in the South, including the Carolinas, and approximately 42% in the Pacific North-west and California. About 83% of the total production consists of softwoods, the leading species being southern pine and Douglas fir. Oak, gum, and maple are the principal hardwoods (*see* U.S. Bureau of Census). The United States is the world's largest lumber-producing country. It is also the largest consumer of lumber, using between 65% and 70% of its annual production for building and all other construction. About 8% of the total supply is consumed by the railroads for ties, timber, and planking, and 24% by manufacturers other than those remanufacturing lumber into building materials. In addition to the lumber and lumber products previously mentioned, approximately 3,620,000,000 cu.ft. of wood are removed annually for fuel from the commercial forests of the United States. The paper industry consumed approximately 10,400,000 cords of pulpwood in 1937. About 1,500,000 cords of pulpwood and 2,394,600 tons of wood pulp were imported in 1937 (U.S. Department of Commerce).

In 1937 there were 7,647 establishments which reported production of lumber and timber products only, valued at $5,000 or more. These establishments employed 323,928 wage-earners; paid wages amounting to $275,033,684; used materials, supplies, and fuel costing $345,800,156; produced products valued at $848,481,316. In the lumber and allied products industries (forest products industries) in 1937, there were 18,012 establishments, employing approximately 754,000 persons, earning wages and salaries totalling about $764,000,000, and producing products valued at $2,440,000,000.

TABLE I.—*Value of Exports and Imports of Wood and Paper*

	1929		1937	
	Exports ($)	Imports ($)	Exports ($)	Imports ($)
Total lumber and logs*	125,924,782	71,866,896	61,369,397	35,163,269
Wood manufactures	40,938,366	10,837,568	20,255,266	7,258,000
Total wood and manufactures	166,863,148	82,704,464	81,624,663	42,421,269
Paper base stock	5,078,346	118,132,740	23,642,334	117,852,433**
Paper and manufactures	37,189,486	163,365,011	31,065,538	137,070,553
Total wood and paper	209,130,980	364,202,215	136,332,535	297,344,255

*Includes railroad ties, lath, shingles, also poles, piling, firewood, etc.
**Includes pulpwood $12,393,457; wood and other pulp, $98,297,822; rags and other paper stock, $7,161,154.

Value of products included cost of materials, fuel, supplies, etc., of $1,174,000,000 and value added by manufacture of $1,266,000,000 (Bureau of Census). In 1929, 3,250,000 railway cars were loaded with lumber and lumber products. In 1937 these carloadings were 1,828,000. Water shipments through the Panama canal in the fiscal year 1937 were 2,750,000 long tons. Exports of lumber and sawn timber in 1937 were 1,413,850,000 feet. Lumber imports in 1937 totalled 687,000,000 bd.ft., of which softwoods amounted to 572,500,000ft. and hardwoods (including sawed cabinet woods) to 114,100,000 feet. Spruce is the leading species imported. About 90% of all softwood imports are from Canada.

Biennial census figures for 1937 show forest products (including remanufactures) as fifth on a list of 15 general industrial groups in number of wage-earners and tenth in value of products. In the States of Washington, Oregon, Mississippi, Louisiana, Arkansas, Florida, Kentucky, Montana, Idaho, and New Mexico, lumber production (logging and sawmill operations) was the leading industry in 1937, based on average number of wage-earners. Lumber products in 1937 was the second most important industry, based on number of wage-earners, in Alabama, Arizona, California, South Carolina, Texas, and Wyoming (U.S. Bureau of Census).

TABLE II. *Distribution of Saw-Timber Stands*

Region	Softwoods	Hardwoods	Total saw-timber
	(Million board feet)		
North-eastern	41,056	42,969	84,025
Central	369	13,932	14,301
Lake	20,881	36,735	57,616
South:			
Coastal plain	82,105	35,669	117,774
Piedmont	70,197	38,790	108,987
Mountain	7,940	37,450	45,390
Delta	2,849	30,155	33,004
Pine-hdwd.—West	51,541	29,874	81,415
Total South	214,632	171,938	386,570
Pacific North-west:			
West coast	597,594	4,655	602,249
Interior	280,082	301	280,383
Total	877,676	4,956	882,632
California	213,480	....	213,480
South Rocky Mt.	124,991	1	124,992
Plains	35	....	35
Total United States	1,493,120	270,531	1,763,651

Lumber is also an important industry in many other States, giving rise to valuable local manufactures.

Timber Available for Lumbering Operation.—In considering the quantity of timber available in the United States for lumbering operations, we are confronted with several considerations of varying character such as changes in the standards of lumber mill utilization, growth of small trees to saw log size, conditions of markets for other wood products which may at any time divert saw timber into other uses such as pulp, poles, piling, shakes, and ties, because of the higher prices offered for such uses. The tendency in many parts of the country is to increase the minimum size of trees cut in lumber manufacture by the practice of selective logging. We cannot forecast the portion of available timber to be used for lumbering; we can only indicate the quantities that probably will be so used if conditions continue to follow the present trends.

In Tables II. and III., classification has been made into regions by character of forest growth. The South extends from Maryland and the Ohio river to mid-Texas. The Mountain region is Kentucky, Tennessee, West Virginia and parts of Virginia, and North Carolina. Piedmont and Coastal Plain include all other South to Louisiana and Arkansas. The West coast is western Washington and Oregon. Interior is eastern portion of these States with Idaho and Montana.

These tables are from a comprehensive survey on the timber situation recently completed by the U.S. Forest Service.

Recent developments in technique have made it possible to produce satisfactory pulp from species not previously useful for this purpose. A large newsprint industry is being established in the South, utilizing southern yellow pine. It is estimated that

TABLE III.—*Estimated Gross Annual Growth of Hardwood and Softwood Saw-Timber in the United States*

Region	Saw-timber growth		
	Softwood	Hardwood	Total
	(Million board feet)		
North-eastern	1,142	1,483	2,625
Central	21	957	978
Lake	613	1,237	1,850
South:			
Coastal plain	4,397	1,248	5,645
Piedmont	4,903	1,938	6,841
Mountain	272	1,538	1,810
Delta	148	1,130	1,278
Pine-hdwd.-West	3,590	1,239	4,829
Total	13,310	7,093	20,403
Pacific North-west:			
West coast	2,657	82	2,739
Interior	2,495	13	2,508
Total	5,152	95	5,247
California	414	....	414
South Rocky Mt.	516	....	516
Plains	....	....	....
Total United States	21,168	10,865	32,033

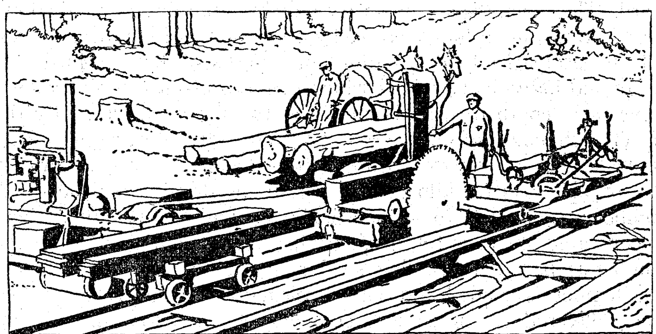
75% of the rayon is manufactured from wood pulp. Increasing demand has made it practicable to utilize trees of saw-timber size for pulpwood. It is difficult to estimate the quantity of timber which actually will be made into lumber products and the quantity that will be devoted to other uses.

The estimated depletion of timber is estimated by the U.S. Forest Service as 13,463,000,000 cu.ft., the year 1936 being quoted as a typical year. Of this total, the timber cut for commodities was 11,400,000,000 cu.ft., of which 6,610,000,000 cu.ft. were softwoods and 4,790,000,000 cu.ft., hardwoods. Of the total, 5,367,500,000 cu.ft. is lumber; 3,620,000,000 fuelwood; 705,924,000 pulpwood; 681,250,000 hewed ties and fence posts. Fire and other destructive agencies, as insects and disease, account for loss of about 2,000,000,000 cu.ft. a year, about 70% of which is softwood. The present stand, plus growth, less depletion and losses may be said to give an indication of the life of the lumber industry. But a rapidly increasing interest in reforestation and practice in timber management have been developing and the growth factor has been changed by increased productivity of forest crops and the growth and drain equation has been approximating a balance. With vigilance in preventing forest fires and depreciation and losses from insects and other natural causes, the lumber industry has a long life in prospect.

METHODS OF MANUFACTURE

In the early days of American history and also the history of the American lumber industry, the manufacture of lumber was a comparatively simple and inexpensive and likewise crude process. The trees were felled as needed, hand sawed and shaped into rough planks and timbers by manual labour for nearby immediate use. Later on, as the country developed, a greater demand for lumber resulted and more efficient lumbering methods were needed and were created. Furthermore, as population and industry expanded westward, the forests moved farther and farther away from the centres of consumption, and each new lumber district presented somewhat different problems in logging, manufacture and distribution due to topography and species of wood found—all of which had a marked influence upon the development of modern lumbering methods.

Logging.—The work in the forest preparatory to that of the sawmill, logging, has been one of the most interesting features

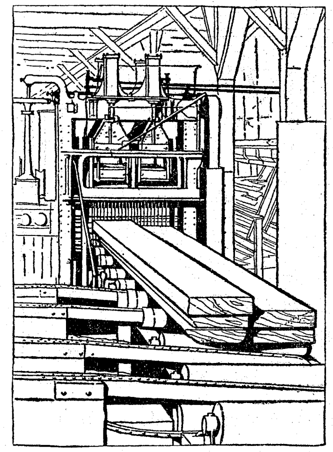


BY COURTESY OF THE SIMONDS SAW AND STEEL COMPANY

SLICING LOGS INTO BOARDS WITH A MACHINE-OPERATED CIRCULAR SAW

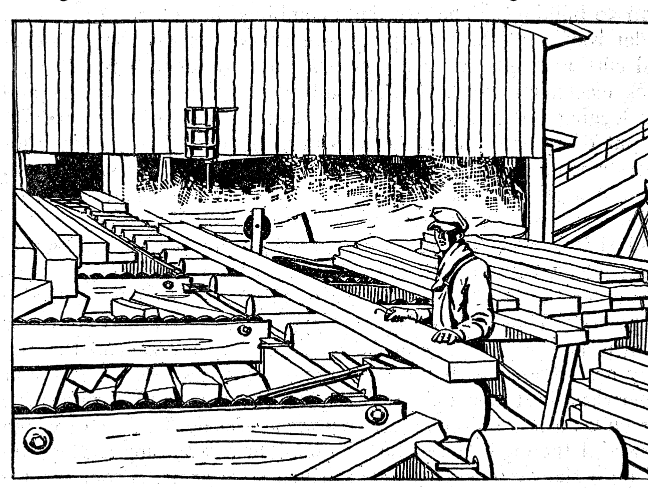
of the American lumber industry. In the early days and until recent years in many localities, the lumbermen depended almost wholly upon natural forces in the logging operations. In the North-eastern and Northern States the fall and winter seasons were devoted to the felling of the trees. The logs were hauled out on snow sleds, either to sawmills close by or to concentration points on the banks of streams, where, in the latter case, the logs were rolled into the water as soon as the ice was gone, and floated down stream to mills or market centres. In the South the lumbermen had to resort to other means of transporting the logs from the forests to the mills, due to a lack of swift-flowing streams and snow for sledding. Oxen and high-wheel carts were the principal means of log transportation for years and in some districts in the South-east they still are used. In the mountainous country, both in the East and West, chutes and flumes were used. Later came the use of wire cables stretched across valleys and canyons. The logs were hung from a pulley; then, by gravity, travelled to the lower end of the cable. Although these relatively primitive methods of transportation are still used in hauling logs from places where they are cut to the "log landing," in some areas they have been supplanted by tractors. At the "landing," they are loaded on trucks or railroad cars for transportation to the mill. Many of the larger companies have built their own railroads or truck roads long distances from the woods to the sawmill. There are approximately 30,000 mi. of logging railroads in the United States and probably an even greater mileage of truck roads. The development of truck hauling of logs has made accessible large areas of timber which had not previously been practicable to reach and has extended the life of many mills for years after the expiration of the expected cutting period. The early logging camps were very crudely built. They consisted of as few buildings as possible. The logging men or "lumberjacks" lived in rough shacks or bunk houses. Conditions were unsanitary and even as late as the 20th century many logging camps were more primitive than the first communities in Massachusetts and Virginia. Recreation consisted of "swapping" stories, fighting and drinking. Only at the end of the season did the lumberjack have an opportunity to mingle with civilization in some town a hundred or more miles away. But conditions changed. There are fewer lumber camps and more lumber towns. The average lumberjack can raise a family as well in the forest as he can in the city because he has, right at hand, schools, churches, stores, modern sanitary conditions and amusements.

The methods of felling trees and converting them into logs are generally the same. First, the standing tree is undercut with an axe on the side of fall. A cross-cut saw, handled by two men—one at each end—is employed opposite the undercut. Where the ground is flat, the men cut from the ground; but where the ground is rough or sloping and irregular, and particularly on the west coast, the undercutting and sawing is done from a platform or spring-board. After felling, branches are trimmed off and the tree is sawed or "bucked" into log lengths, usually 16 ft. except in the North-west, where much longer lengths are handled (24 to 40 ft. are common and in the most modern operations 49 to 65 ft. are the most favoured units of length). Certain other districts also cut logs to lengths greater than 16 ft. After bucking, the logs are dragged or "skidded" to concentration points by horses, oxen or power, but as previously explained, steam or electric power has supplanted, in many instances, the horses and oxen. Where steel cables are employed over valleys and canyons, the method is called "high-lead" skidding. Other methods are known as overhead skidding—where the logs are hoisted up over the brush and ground for some distance, and ground-line skidding which is the dragging of the log over the ground by means of a cable. In the North-west a "spar" tree frequently is employed in the skidding operations. This tree is selected for its height and favourable location with regard to the surrounding trees to be felled. A man known as a "high-climber," ascends the tree, aided by climbing spurs affixed to his shoes and a rope around the tree. He is equipped with a saw and axe and as he ascends he cuts off interfering branches until he reaches the desired height which usually is about 175 to 200 ft., and some 30 to 50 ft. from the tree top. Then he saws off the top, waits until the swaying caused by the top's rebound has stopped, and descends. Another man, known as a "rigger," next ascends, carrying equipment for rigging. Finally the spar is rigged at the top with cable and pulleys and a loading boom is affixed some 20 ft. above the ground. A cable with grab hooks on the end is carried to the log to be skidded



BY COURTESY OF THE DOUGLAS FIR EXPLOITATION AND EXPORT COMPANY

A MILL GANG-SAW IN OPERATION



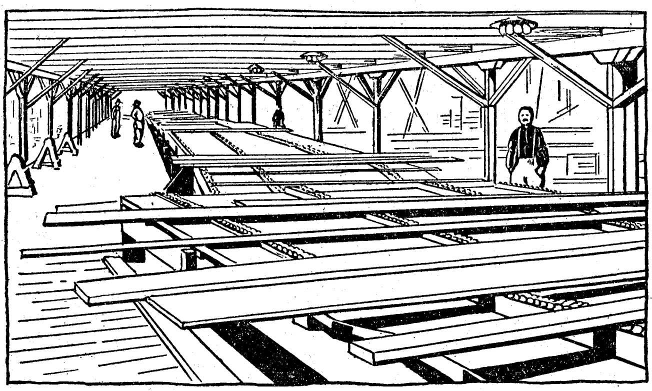
BY COURTESY OF THE SOUTHERN PINE ASSOCIATION

CUTTING PINE BOARDS INTO THE PROPER LENGTH FOR SHIPPING

and then, by means of a steam or electric skidder the log is dragged within distance of the loading boom which raises the log off the ground and loads it direct onto a nearby car or stacks it for future loading. When the logs reach the mill centres, they are stored in log ponds which usually cover a number of acres. Here they are kept until ready for manufacture. The ponds facilitate assorting and cleaning, and also prevent deterioration which would occur if the logs were left dry for any appreciable length of time.

Sawmill Practice.—The first sawmills in the United States, as noted, were built at Jamestown, Va., and Berwick, Me., and were modelled after the European type of mill, employing water-power and a single sash-saw.

Production was small until steam power supplanted water-power about the year 1850. About the same time the single sash-saw gave way to the circular saw and the latter was widely used until about 1890, at which time the band saw became popular in the larger mills. For the next 20 years lumber production increased rapidly. Many new inventions and more efficient methods of operation brought the lumber industry to the front with almost astonishing rapidity. Most modern sawmills employ the same general type of machinery and follow somewhat similar plant layouts. Band-saws of varying types such as single-cutting, double-cutting, vertical and horizontal band-resaws and gang-saws are common in the larger mills. Many labour-saving devices are employed. Various types of conveyors and other machinery permit the log to enter the mill and pass out as manufactured lumber with very little handling or moving by hand.



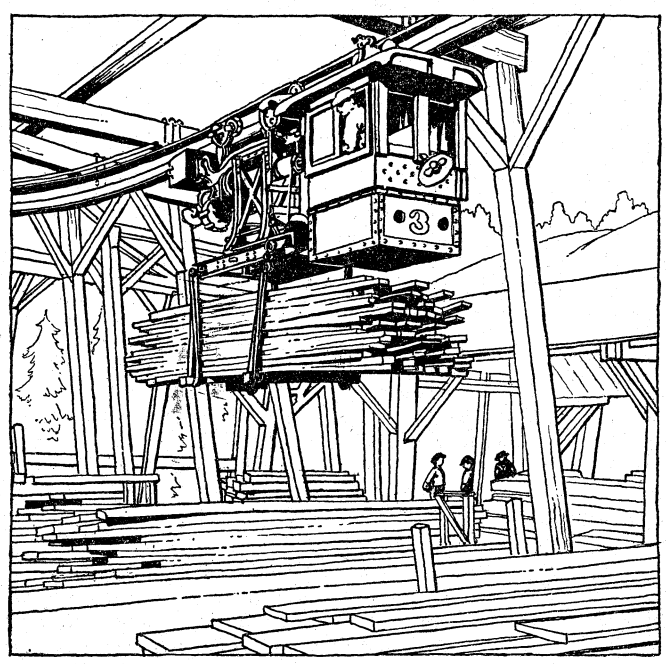
BY COURTESY OF THE PACIFIC LUMBER COMPANY
THE SORTING TABLE, WHERE LUMBER IS GRADED ACCORDING TO DURABILITY AND PERFECTION OF GRAIN

The modern methods of lumber manufacture are so intricate and so efficient as a rule, that the term "sawmill" has given way to that of "lumber manufacturing plant." The largest lumber manufacturing plant in the world in 1928 at Longview, Wash., consisted of two groups, each a complete unit consisting of more than 30 buildings. The two units combined have a total of 78 ac. under roof, and the total plant site covers 1,737 acres. Storage and cutting ponds cover 125 acres. The power-plant, which supplies electricity for both the lumber manufacturing plants and the logging operations some 30 m. away has a present capacity output of 24,000 kilowatts, and can be increased to 36,000 kilowatts whenever necessary. The power-plant derives its fuel from sawmill waste. The daily output of the two lumber manufacturing units is approximately 2,000,000 bd. ft. of Douglas fir.

Mill Process.—The following method of lumber manufacturing is prevalent, with variations to fit certain local requirements. The logs enter the head mill from the pond over an inclined chute or "log slip." They are transported by an endless spiked conveyor known as a jack ladder or jack chain. As they ascend the slip they are sprayed with water to remove grit and dirt that might otherwise dull the saws. From the slip the jack ladder carries the log under a large circular saw known as the deck saw and which is used if the log is to be shortened; otherwise the log is "kicked" off onto the log deck by steam-driven steel arms. From the log deck the log rolls onto the log carriage. A steam or air "nigger" (mechanically operated steel arms) helps to place the log in the proper position. The carriage is a long, flat platform which is made to travel back and forth rapidly on a track, keeping the log against a band or "head" saw which squares it and reduces it into flitches or cants. The log is turned from time to time on the carriage by means of the steam or air operated "nigger." If the log is to be used as a timber, it is squared and edged and then passed immediately to the rear of the mill where the timber dock usually is located. If to be converted into lumber, the flitches or cants enter the remanufacturing plant directly behind the head mill, where they pass to the gang-saws and edgers and then to the trimmers.

From the remanufacturing plant the lumber passes through sorters and to explain this step the following description is given of a large modern lumber manufacturing plant in the North-west. Joining immediately on the end of the remanufacturing mill are three sorters. The first is a 2 in. yard sorter where nothing is handled except 2 in. common lumber, all lengths and widths, which will be segregated into various packages as to grades, widths and lengths. These packages are then delivered by a monorail hoist to cars which are drawn by storage battery locomotives to the green yard. The second is a 1 in. sorter on which nothing is handled except 1 in. common lumber to the yard. The third is a drop sorter, which automatically drops different lengths of lumber into separate and individual pockets which deliver onto a chain that conveys each length to what is known as the Whaley sorter. By the latter each length of lumber is segregated to five different stacking units. Thus, all lengths, widths and thicknesses are separately put on kiln cars for kiln drying. From the drop sorter the rough lumber is delivered to automatically controlled dry kilns where superheated steam is the usual drying agent. From the kilns the lumber is passed to cooling sheds; thence to dry sorters where the lumber is graded and sorted, picked up by overhead cranes and delivered to an endless conveyor which runs through unstacker sheds into rough lumber storage sheds and on to the planing-mill.

Not all lumber passes from the kilns to the planing-mill, a very important and necessary part of a lumber manufacturing plant. Some of it is placed in stock. Other packages pass on to the planing-mill where the lumber is surfaced as plain boards and "dimension" or worked into "ceiling," "flooring," "siding," "moulding," "partition," "casing," etc. From the planing-mill the lumber is conveyed to the "dressed lumber" sheds to be stored or to the loading sheds, ready for shipment. Waste resulting from the various steps of manufacture is converted into "short length" lumber wherever possible; some of it goes into the manufacture of paper and pulp board, and some is ground up for fuel. Wood is the principal source of fuel for power in lumber operations. The larger slabs and edgings may be converted into lath and small wooden items.



BY COURTESY OF THE PACIFIC LUMBER COMPANY
ELECTRIC MONORAIL CARRYING A UNIT OF LUMBER TO THE DRYING SHED

FUTURE OF THE INDUSTRY

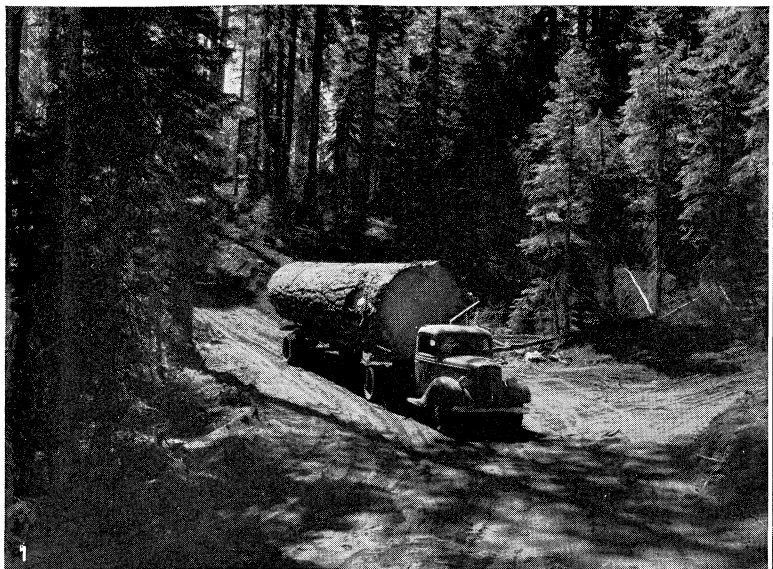
The migration of the lumber-producing centres from the Atlantic to the Pacific coast has been of great economic importance in the opening up of new territories for agricultural and various

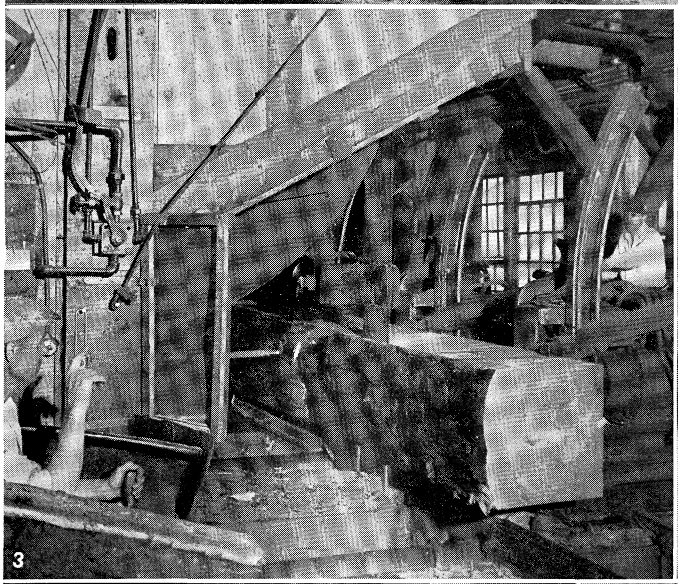
BY COURTESY OF (1, 3, 5, 6) AMERICAN FOREST PRODUCTS INDUSTRIES INC. AND (1, 6) WEYERHAEUSER TIMBER CO., (3, 5) RED RIVER LUMBER CO., PHOTOGRAPHS BY JACK ROGNON, WESTWOOD, CALIF.; PHOTOGRAPHS, (2, 4) PUBLIX

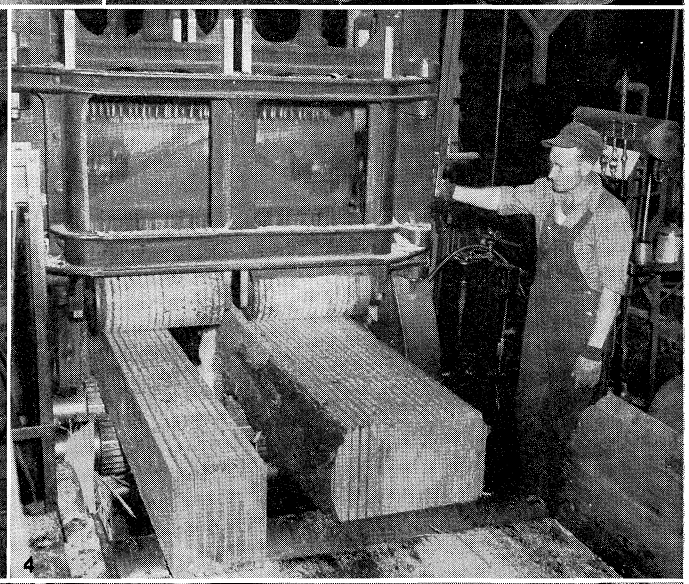
LOGGING OPERATIONS

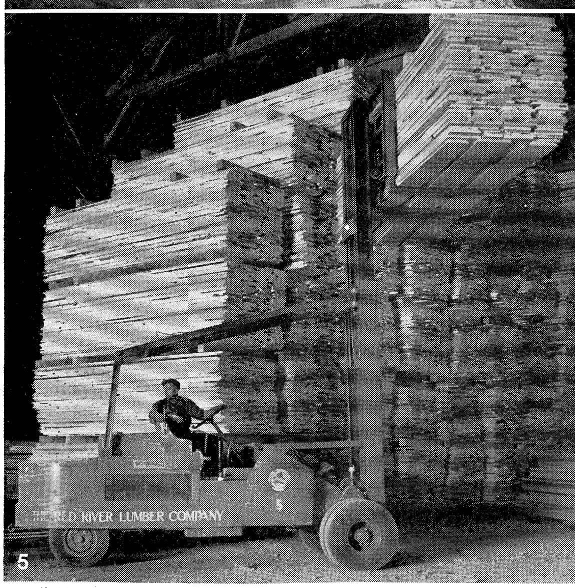
1. "Topping" a giant spar tree, to be equipped with a cable for skidding logs over the ground
2. Notching a tree with axes. The tree falls in the direction of the notch
3. Sawyers using an electric drag saw. They begin sawing on the opposite side from the notch
4. Large tree falling after being sawed through to the notch
5. Revolving crane loading logs on a truck
6. Logs being hauled from the forest by Diesel tractor

LUMBERING









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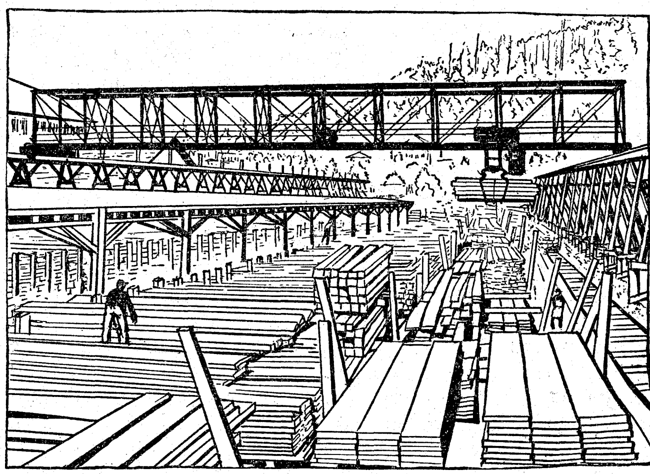
LOGGING AND THE MANUFACTURE OF LUMBER

1. Transporting a sugar-pine log by truck
2. Train of logs on the way to the mill
3. Band mill or "head rig" cutting a big log. The head sawyer at the left gives signals to the setter (right) for the cut
4. A gang saw in operation
5. Nose-lift lumber carrier which stacks and unstacks units of lumber
6. Lumber piles and overhead crane

other industrial purposes. In all probability, the future will see lumbering having just as much effect, if not more, upon the economic development of America as it has had in the past. The consumption may not increase with such rapidity, nor are there new virgin forests to be worked, but neither does any other present major industry promise to develop as rapidly in the future as in the past, for the industrial zones of the United States are more



BY COURTESY OF THE PACIFIC LUMBER COMPANY
AN ELECTRIC CRANE TRANSPORTING LUMBER TO THE SHIPPING YARD

or less permanently fixed and established. A steady increase in the demand for lumber will keep pace with the increase of population and development of industry. In the past lumber has been "mined." In the future timber crops will be harvested.

By proper reforestation methods and programs, America should always be able to grow sufficient lumber to meet her needs. Since the beginning of time, new forests have arisen on the old, and wherever a forest area consists of old-growth, matured-timber growth is approximately balanced by decay. Like all other crops, trees must be harvested to permit proper regrowth. In the future, lumber will come from forests regrown under scientific management—sometimes from seedlings and sometimes from hand planting. This means that not only will present-producing forests continue to be productive, but also part, if not all, of the 76,738,000ac. of forest land, non-productive in 1936, will be brought back in time to a state of production. The future will see a more efficient use of lumber. Much good lumber goes to waste because of the public's expensive habits. Nearly one-third of the lumber used by the building industry is finally consumed in lengths under 8 ft.; 10% more is under 9 ft.; or a total of 43·6% of all lumber consumed in building is in lengths under 9 ft. Yet, it has been customary to buy lumber in lengths of 14, 16, 18 and 20 ft.

Trees cannot be changed; but we will change our lumber-buying habits. We are already using more and more of the "short lengths" cut at the mills because it is less expensive and, in many cases, better suited for general building requirements. The Government, industry and the public are co-operating to bring about these things. Since 1918 the lumber industry, in co-operation with consuming industries and the U.S. Government, has done much to standardize its product through the creation of the American lumber standards and has been engaged in a program for developing the marketing of American standard, trade-marked, grade-marked lumber.

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LUMBERJACK, one engaged in felling and preparing timber for the mill; usually applied to the woodsmen or lumbermen working in lumber camps in the northern United States and Canada. The lumberjack's work may be any one of the processes involved, from the chopping of the tree in the forest to the delivery of the logs at the mill. The lumberjack may also have to cut roads through the forest or even build railways where there is no way of floating the logs. He must be a good judge of the quality of timber, and be able to estimate closely the number of board feet in a log. Most important of all, he must have physical strength in order to stand the heavy work, long hours and extreme cold, the thermometer often falling as low as 40 or 50° below zero in the more northern districts.

LUMBINĪ, the grove in which, according to Buddhist legend, the Buddha was born. There are two references to the name in the Pāli scriptures, the first in the narrative poem prefixed to the Nalaka-sutta in the Sutta-nipāta, where it is related how the gods rejoicing in the sky inform the sage Asita that "the Bodhisatta, the incomparable jewel, has been born for weal and happiness in the world of men, in a village of the Sakyas, in the Lumbinī country" (*janapade Lumbineyye*). The other reference is in the Kathāvatthu, one of the latest works in the Canon. The detailed story of the birth as known to Pāli Buddhism first occurs in the introduction to the commentary on the *Jātaka.* This account says that Queen Mahāmāyā, when her time was come, desired to go to her parents' home at Devadaha. On the way she alighted to sport in the Lumbinī grove, her pains came upon her, and there the future Buddha was born. The earliest canonical accounts of the birth are not in the Pāli Canon, but in the Sanskrit scriptures of two other schools, the Mahāvastu (ii., 18), and the Lalitavistara (ch. 7). Neither of these works can be put earlier than the 3rd or 4th century A.D., but the discovery of an inscription of Asoka makes it probable that the whole legend was established at least as early as the 3rd century B.C. The inscription was found in 1896, a few miles within the border of Nepal and some miles east of the site which had already been identified as Kapilavatthu, the city of Buddha's family. It contains one doubtful word, but the inscription has always been accepted as genuine, and it is clear that it records that "Piyadasi [*i.e.,* Asoka], after he had been consecrated 20 years, came in person and worshipped, because here was born Buddha Śākyamuni. He both caused a stone [horse?] to be made, and caused a pillar to be set up, because here the Lord was born. He made the village of Lummini free of taxes and paying (only) one-eighth part [of the crop]." This makes the dates 245 B.C., according to the accepted chronology of Asoka's reign. There is a shrine at the place, now known to the Nepalese officials and hillmen as Rupadei. Führer's statement that it is locally called Rummindei has never been verified. The shrine contains a bas-relief representing the birth of the Buddha. The legends with their fantastic details are not historical documents, but the archaeological evidence which has accumulated increases the probability that they have originated in a historical event.

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(E. J. T.)

LUMHOLTZ, CARL (1851–1922), Norwegian explorer and naturalist, was born in 1851 at Faaberg in Gudbrandsalen. After graduating in theology at the university of Oslo (then Christiania) in 1876, he was sent by the university to Australia, where he spent four years (1880–84) in collecting zoological materials and anthropological data of various kinds. In 1890 he went on behalf of the American Museum of Natural History to Mexico, accompanied by the Swede Hartmann, and there he succeeded in tracing and communicating with the Tarahumare Indians of Sierra Madre —descendants of the Aztecs. A unique collection, containing over 1,700 photos, was the result of this expedition, which, with two later visits to Mexico, was described in his *Blandt Mexicos Indianere* (Christiania 1902–03), later translated into English and Spanish; *New Trails in Mexico* (1912) deals more especially with the second of these expeditions. During the World War Lumholtz went to India, and in 1915–17 to Borneo. From Borneo he brought home a large zoological collection and valuable anthropometrical measurements, with new information on the language and customs of the Dyaks, recorded in *Through Central Borneo, Two Years' Travel in the Land of the Head Hunters* (2 vols., New

York, 1920). He died in the Saranac Lake Sanatorium, New York, on May 5, 1922.

LUMINOUS PAINT. The commercial sulphides of calcium, barium and strontium, after exposure to light, possess the property of appearing luminous ("phosphoresce") in the dark, and are used in the manufacture of luminous paints. The feeble light emitted by these substances gradually diminishes in intensity, but on re-exposing these compounds to light their luminosity is again restored. This singular property has been long known, and calcium sulphide was formerly termed Canton's phosphorus, and barium sulphide Bononian (or Bolognian) phosphorus. The introduction of minute traces of other elements such as bismuth, lead, cadmium, manganese, etc., modify the colour of the phosphorescent glow so that by this means sulphides emitting various phosphorescent colours, such as violet, orange, green, blue, etc., may be obtained. These various phosphorescent sulphides are converted into paint form by mixing with suitable mediums, such as solutions of gum arabic or gum dammar varnishes.

Radio-active luminous paints, which are largely used for painting watches, compasses, etc., differ from the formerly known phosphorescent substances in the fact that they do not require any prior exposure to light. The action is in this case produced permanently by the rays emitted by the radio-active substances such as mesothorium and radiothorium, used in their preparation.

(J. G. Be.)

LUMMIS, CHARLES FLETCHER (1859–1928), American author, was born at Lynn, Mass., on March 1, 1859, and educated at Harvard. After several years as newspaper editor in Ohio he tramped by a roundabout route to Los Angeles, Calif., where he became city editor of the *Los Angeles Daily Times.* A stroke of paralysis in 1886 forced him to suspend his editorial work and for a number of years he spent much of his time travelling over the South-west on horseback. For five years he lived in the Indian pueblo of Isleta, N.M., learning the Indian languages and customs. In 1892 he accompanied the historian, Adolph F. Bandelier, on a scientific expedition to Peru and Bolivia. He was the founder and editor of *Out West Magazine,* 1894–1909, and librarian of the Los Angeles public library, 1905–10. He was founder and president of the Landmarks club of California and was active in securing the preservation of a number of South-western missions. He was one of the incorporators of the Archaeological Institute of America and founder of the Southwest museum. He made phonograph records of 550 old Spanish songs of the South-west and 425 Indian songs. His writings did much to make the many interesting phenomena of the South-west more widely known. He died at Los Angeles, Calif., on Nov. 25, 1928.

Besides many articles, stories and poems in various magazines he published *A Tramp Across the Continent* (1892); *Some Strange Corners of Our Country* (1892); *The Spanish Pioneers* (1893); *The Land of Poco Tiempo* (1893); *The Man who Married the Moon, and Other Pueblo Indian Folk-stories* (1894); *The Awakening of a Nation* (1898); *Mesa, Cañon and Pueblo* (1925); *Spanish Songs of Old California* (1925–28).

LUMP-SUCKER or **LUMP-FISH** (*Cyclopterus lumpus*), a marine fish, of the small family Cyclopteridae. The lump-suckers have the ventral fins united into a circular concave sucker which enables them to attach themselves firmly to rocks or stones. The body is short and thick, with a thick, scaleless skin, covered with rough tubercles. The first dorsal fin is a mere lump on the back. The lump-sucker inhabits the coasts of both sides of the north Atlantic; it is not rare on the British coasts, but becomes more common farther north. In the spring the fish approaches the shores to spawn, clearing out a hollow on a stony bottom in which it deposits an immense quantity of pink-coloured ova. The male guards the spawn very assiduously until the young are hatched. A lump-sucker may weigh as much as 20 lb. The male is only one-half or one-third the size of the female, and during the breeding season becomes bright blue, with red below. The bones are soft, and contain little inorganic matter.

LUMSDEN, SIR HARRY BURNETT (1821–1896), Anglo-Indian soldier, son of Colonel Thomas Lumsden, C.B., was born on Nov. 12, 1821. He joined the 59th Bengal Native Infantry in 1838, was present at the forcing of the Khyber Pass in 1842, and went through the first and second Sikh wars, being wounded at Sobraon. Having become assistant to Sir Henry Lawrence at Lahore in 1846, he was appointed in 1847 to raise the Corps of Guides. The regiment was located at Mardan on the Peshawar border, and became one of the most famous in the Indian army. For the equipment of this corps, Lumsden originated the *khaki* uniform. In 1857 he was sent on a mission to Kandahar and was in Afghanistan throughout the Mutiny. He took part in the Waziri Expedition of 1860, was in command of the Hyderabad Contingent from 1862, and left India in 1869. He became lieutenant-general in 1875, and died on Aug. 12, 1896.

See Sir Peter Lumsden and George Elsmie, *Lumsden of the Guides* (1899).

LUNA, ALVARO DE (d. 1453), constable of Castile, grand master of Santiago, and favourite of King John II. of Castile, was the natural son of Alvaro de Luna, a Castilian noble. Sent to court as a page by his uncle, Pedro de Luna, archbishop of Toledo, in 1410, he early acquired an ascendancy over the young prince. When Ferdinand, John's uncle, was elected king of Aragon, and the regency remained in the hands of the king's mother, Constance, daughter of John of Gaunt, Alvaro became a very important person. He was a master of all the accomplishments the king admired—a fine horseman, a skilful lance and a writer of court verse. Until he lost the king's protection he was the central figure of the Castilian history of the time. His story is in the main one of expulsion from the court by victorious factions, and of his return when his conquerors fell out among themselves. Expelled in 1427, he was recalled to court in 1428; in 1431 he sought to employ the turbulent nobles in a war for the conquest of Granada. Some successes were gained, but a consistent policy was impossible with a rebellious aristocracy and a king of indolent character. In 1445 the Infantes de Aragon, Alvaro's main enemies, were beaten at Olmedo, and the favourite, who had been constable of Castile and count of Santesteban since 1423, became grand master of Santiago by election of the knights. His fall was due to Isabella of Portugal, the king's second wife, who urged her husband to free himself from slavery to his favourite. In 1453 Alvaro was arrested, and, after a mere parody of justice, executed at Valladolid on June 2, 1453.

See *Cronica de don Alvaro de Luna* (1784), mainly panegyrical; *Cronica del . . . Rey Don Juan el segundo* (Valencia, 1779); Quintana, *Vidas de Españoles célebres* (1807, etc.).

LUNA (mod. *Luni*), ancient city, Etruria, Italy, 4½ m. south-east of Sarzana. It was the frontier town of Etruria, on the left bank of the river Macra, the imperial boundary between Etruria and Liguria. When the Romans first appeared, however, the Ligurians were in possession of the territory as far as Pisa. It derived its importance mainly from its harbour, the Gulf of Spezia, and not merely the estuary of the Macra as some have supposed. The town was apparently not established until 177 B.C., though the harbour is mentioned by Ennius, who sailed hence for Sardinia in 205 B.C. under Manlius Torquatus. It was traversed by the coast road (Via Aurelia), and was renowned for marble from Carrara, which bore the name of Luna marble. Pliny speaks of the quarries as only recently discovered in his day. Good wine was also produced. There are some remains of a theatre and an amphitheatre. The town was destroyed by the Arabs in 1016, and the episcopal see transferred to Sarzana in 1204.

LUNACHARSKY, ANATOLY VASILIEVICH (1875–1933), Russian politician, author and dramatist, was born in Poltava of well-to-do parents. He joined the revolutionary movement when at college in Kiev, and afterwards studied natural science and economics at Zurich. He began his revolutionary activities in Russia in 1892 and was deported to Vologda in 1898, where he remained for three years, achieving a reputation as a brilliant writer and lecturer on Socialism. In 1903 Lunacharsky joined the Bolshevik wing of the social democratic party. He met Lenin in the following year, and joined the editorial staff of the Bolshevik *Vpered* (Forward). He was chiefly concerned with social democratic propaganda and with lectures and political meetings for Russian students and political refugees abroad.

During the revolution of 1905 Lunacharsky was imprisoned, and when the reaction set in he left Russia for Italy. Together with Gorky and Bogdanov, a well-known social democrat, he formed the so-called "left-wing" of Bolshevism (opposed to Lenin on theoretical points), and was one of the promoters of the social democratic party schools at Capri and Bologna.

During the World War Lunacharsky maintained a determined internationalist attitude, and disseminated violent anti-war propaganda in Paris and Switzerland, renewing closer contact with the Lenin group after a temporary estrangement. In March 1917 he joined Lenin and Trotsky in Russia in their revolutionary opposition to the provisional government. He was arrested after the Bolshevik rising in July; but was subsequently liberated and elected vice-president of the Petrograd municipal board. In the initial stages of the November revolution and during the civil war, Lunacharsky was one of the ablest speakers of the party, and acted as emissary of the military revolutionary council to the various war fronts. As people's commissar for public instruction, 1917–29, in the new Government, Lunacharsky ensured the preservation of works of culture and art during the civil war. He promoted mass instruction, while his especial concern for the welfare of the theatre furthered the development of the Russian stage.

Lunacharsky wrote 14 plays (published in 2 vol.), of which several were produced with conspicuous success in Russia and in Berlin. "Vasilisa the Wise," "Faust and the City" and "The Magi" were translated into English by Leonard Magnus and published under the title of *Three Plays* (1923). He was appointed ambassador to Spain in 1933. He died Dec. 26, 1933.

LUNACY: *see* INSANITY.

LUNATION, the period of return of the moon (*luna*) to the same position relative to the sun; for example, from full moon to full moon. Its duration is 29·5305884 days.

LUNAWADA, a native state in India, in the Rewa Kantha agency, Bombay. Area, 419 sq.mi.; pop. (1941) 105,318. The chief, whose title is maharana, is a Rajput of high lineage. The capital is Lunawada town, said to have been founded in 1434; pop. (1941) 12,811.

LUND, TROELS FREDERIK (1840–1921), Danish historian, was born in Copenhagen on Sept. 5, 1840. He studied at Copenhagen, and was employed in the state archives department from 1870–75. His first important work, *Historiske Skitser* (1876), was followed by *Danmarks og Norges Historie i Slutningen af det xvi. Aarhundreds,* 14 vols., 1879–1901, a history of daily life in Denmark and Norway at the close of the 16th century. Troels Lund was the pioneer of the remarkable generation of young historians in northern Europe about 1880. He concentrates his attention on the life, death, employments, pleasures and prejudices of the ordinary men and women of the age with which he deals, using to illustrate his theme a vast body of documents. Lund was appointed historiographer-royal to the king of Denmark and comptroller of the Order of the Dannebrog. He published in 1909 *Lye Tanker i det xvi. Aarhundreds.* In 1911–12 appeared his historical tales, *Tider og Tanker*. He died on Feb. 12, 1921.

See Knud Fabricius, *Troels Lund* (1921).

LUND, a city of Sweden, the seat of a bishop, in the district (*län*) of Malmöhus, 10 mi. N.E. of Malmö by rail. Pop. (1943) 28,480. Lund (*Londinum Gothorum*), the "Lunda at Eyrarsund" of Egil's Saga, was of importance in Egil's time (*c.* 920). It appears that, if not actually a seaport, it was at least nearer the Sound than now. In the middle of the 11th century it was made a bishopric, and in 1103 the seat of an archbishop who received primatial rank over all Scandinavia in 1163, but in 1536 Lund was reduced to a bishopric. Close to the town, at the hill of Sliparabacke, the Danish kings used to receive the homage of the princes of Skåne. A university was founded here in 1668 by Charles XI., with faculties of law, medicine, theology and philosophy. Its library of books and mss. is entitled to receive a copy of every work printed in Sweden. The folk-museum near the university with its reconstructed old houses is important. The Romanesque cathedral was founded about the middle of the 10th century. The crypt under the raised transept and choir is one of the largest in the world. The chief industries are sugar-refining, iron and brick works, and the manufacture of furniture and gloves.

LUNDY, BENJAMIN (1789–1839), American philanthropist, prominent in the anti-slavery conflict, was born at Hardwick, N.J., on Jan. 4, 1789. From 1808–12 he lived at Wheeling, Va., (now W.Va.), an important headquarters of the inter-state slave trade. Here he first became deeply impressed with the iniquity of the institution of slavery. In 1815 he organized an anti-slavery association, known as the "Union Humane Society," with a membership of more than 500 men. In 1821 he founded at Mount Pleasant, O., an anti-slavery paper, the *Genius of Universal Emancipation.* From Sept. 1829 until March 1830 Lundy was assisted in the editorship of the paper by William Lloyd Garrison (*q.v.*). Lundy travelled extensively on behalf of the cause, visiting Haiti twice, in 1825 and 1829, the Wilberforce colony of freedmen and refugee slaves in Canada in 1830–31; and Texas in 1832, and again in 1833. These visits were made, in part, to find a suitable place outside of the United States to which emancipated slaves might be sent. Between 1820 and 1830, Lundy says he travelled "more than 5,000m. on foot and 20,000m. in other ways, visited 19 States of the Union, and held more than 200 public meetings." He was bitterly denounced for his anti-slavery agitation, and in Jan. 1827 was assaulted and seriously injured by a slave-trader, Austin Woolfolk. In 1836–38 Lundy edited in Philadelphia a new anti-slavery weekly, *The National Enquirer.* This paper under the editorship of Lundy's successor, John G. Whittier, became *The Pennsylvania Freeman.* Lundy died Aug. 22, 1839.

See *The Life, Travels and Opinions of Benjamin Lundy* (Philadelphia, 1847), compiled (by Thomas Earle) "under the direction and on behalf of his children."

LUNDY, ROBERT (*fl.* 1689), governor of Londonderry. He had seen service in the foreign wars before 1688, when he was at Dublin with the rank of lieutenant-colonel in the regiment of Lord Mountjoy. Mountjoy and his regiment were well received in the north, and the citizens of Derry permitted him to leave within their walls a small Protestant garrison under the command of Lundy, who assumed the title of governor. Lundy declared himself an adherent of William; and he obtained from him a commission confirming his appointment as governor. But from the moment Londonderry was menaced by the troops of King James, Lundy paralysed the defence of the city. On April 14, English ships appeared in the Foyle with reinforcements for Lundy under Colonel Cunningham. Lundy dissuaded Cunningham from landing his regiments, representing that a defence of Londonderry was hopeless; and that he himself intended to withdraw secretly from the city. At the same time he sent to the enemy's headquarters a promise to surrender the city at the first summons. When the enemy appeared before the walls Lundy gave orders that there should be no firing. But the people flew to arms under the direction of Major Henry Baker and Captain Adam Murray, who organized the famous defence in conjunction with the Rev. George Walker (*q.v.*). Lundy made his escape by the connivance of Walker and Murray. He was apprehended in Scotland and sent to the Tower of London. He was excluded from the Act of Indemnity in 1690, but his subsequent fate is unknown.

See Rev. George Walker, *A True Account of the Siege of Londonderry* (1689); J. Mackenzie, *Narrative of the Siege of Londonderry* (1690); Rev. John Graham, *A History of the Siege of Derry and Defence of Enniskillen, 1688–89* (Dublin, 1829); John Hempton, *The Siege and History of Londonderry* (Londonderry, 1861); Lord Macaulay, *History of England,* vol. iii. (Albany edition of complete works, 1898).

LUNDY, an island, at the entrance to the Bristol channel, 12 m. N.W. of Hartland point on the north coast of Devonshire, England. The nearest ports are Clovelly and Bideford. The island is 3 m. from north to south, a mean breadth of ½ m. but nearly 1 m. wide in the south. Area 1,150 acres. The component rock is a hard granite, except at the south, where slate occurs. An extreme elevation of about 450 ft. is found in the southern half, and the greater part of the coast is cliff-bound and very beautiful. The landing, at the south-east, is sheltered by the small Rat island, where the once common black rat survives. There are prehistoric remains on Lundy, and the foundations of an ancient chapel of St. Helen. There are also ruins, and the still inhabited keep of

Marisco castle occupying a strong precipitous site on the south-east. In the 17th century the island became a hiding place for French privateers. It has some cultivable land and heath pasture, and had a population in 1931 of 21. A daily air service from Barnstaple was inaugurated in 1934.

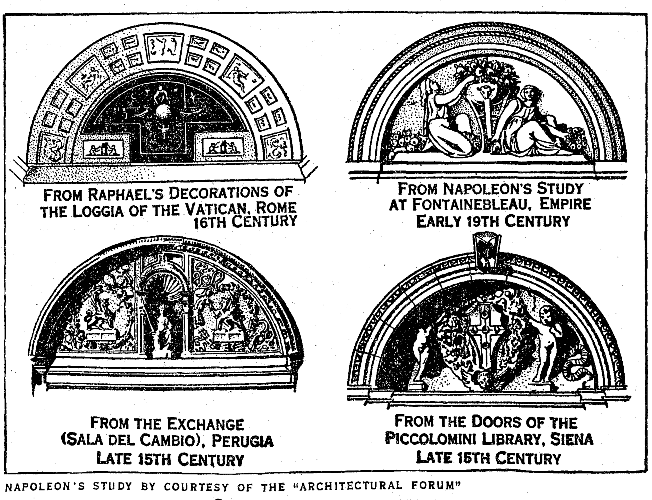
LÜNEBURG, a town in the Prussian province of Hanover, Germany, near a small hill named the Kalkberg, on the navigable Ilmenau, 14 mi. above its confluence with the Elbe and 30 mi. by rail S.E. of Hamburg. Pop. (1939) 38,578.

Lüneburg existed in the days of Charlemagne, and gained importance after the erection of a convent and a castle on the Kalkberg in the 10th century. After the destruction of Bardowiek, then the chief commercial centre of North Germany, in 1189, Lüneburg inherited much of its trade and subsequently became one of the principal towns of the Hanseatic League. Having belonged to the duchy of Saxony it was the capital of the duchy of Brunswick-Lüneburg from 1235 to 1369; later it belonged to one or other of the branches of the family of Brunswick. The reformed doctrines were introduced into the town in 1530 and it suffered heavily during the Thirty Years' War. It reached the height of its prosperity in the 15th century, and in the 17th century it was the depot for much of the merchandise exported from Saxony and Bavaria to the mouth of the Elbe; after a period of decay the 19th century witnessed a revival of its prosperity. In 1813 the German war of liberation was begun by an engagement with the French near Lüneburg.

The finest of its squares are the market-place and the so-called Sand. The churches of St. John, with five aisles; of St. Michael, containing the tombs of the former princes of Lüneburg, and of St. Nicolas, are Gothic edifices of the 14th and 15th centuries. The town-hall dates from the 13th century. It contains a magnificent hall—the Fürstensaal—decorated with wood-carving and stained-glass windows.

The gypsum and lime quarries of the Kalkberg afford the materials for cement works. Other industries are the making of beer, spirits, chemicals, ironware, carpets and haircloth.

LUNEBURGER HEIDE, a district of Germany, in the province of Hanover, lying between the Aller and the Elbe and intersected by the railways Harburg-Hanover and Bremen-Stendal. Its main character is that of a broad saddle-back, running for 55 m. from south-east to north-west (mean elevation about 250 ft. and greatest height, Wilseder Berg, 561 ft.). The soil is quartz sand and is chiefly covered with heather and brushwood. In the north, and in the deep valleys there are extensive forests of oak, birch and beech, and in the south, of fir and larch. Though the climate is raw and good soil rare, the heath is not unfertile. Its main products are sheep—the celebrated Heidschnucken breed—potatoes, bilberries, cranberries and honey. The district is also remarkable for numerous megaliths, popularly called Hun graves.



FROM RAPHAEL'S DECORATIONS OF THE LOGGIA OF THE VATICAN, ROME 16TH CENTURY

FROM NAPOLEON'S STUDY AT FONTAINEBLEAU, EMPIRE EARLY 19TH CENTURY

FROM THE EXCHANGE (SALA DEL CAMBIO), PERUGIA LATE 15TH CENTURY

FROM THE DOORS OF THE PICCOLOMINI LIBRARY, SIENA LATE 15TH CENTURY

NAPOLEON'S STUDY BY COURTESY OF THE "ARCHITECTURAL FORUM"

SPECIMENS OF LUNETTES

LUNETTE, a crescent-shaped or semi-circular object. In architecture, the term is applied to any semi-circular shape or panel which is decorated, and especially to those which occur under semi-circular arches or vaults. By extension, the term is used of small vaults intersecting a larger vault at right angles, especially if used for lighting the larger vault, as in the clerestories of St. Paul's cathedral in London and St. Peter's in Rome. Oval or circular openings through any vault are also sometimes known as lunettes.

LUNÉVILLE, an industrial and garrison town of north-eastern France, capital of an arrondissement in the department of Meurthe-et-Moselle, 21 m. E.S.E. of Nancy on the railway to Strasbourg. Pop. (1936) 23,125. The name of Lunéville (*Lunae villa*) is perhaps derived from an ancient cult of Diana, the moon goddess, a sacred fountain and medals with the effigy of this goddess having been found at Léormont, some 2 m. E. of the town. Lunéville belonged to Austrasia, and after various changes, fell in 1344 to the house of Lorraine. A walled town in the middle ages, it suffered in the Thirty Years' War and in the campaigns of Louis XIV. from war, plague and famine. The town flourished again under Dukes Leopold and Stanislas, on the death of the latter of whom at Lunéville, Lorraine was united to France (1766). The treaty of Lunéville between France and Austria (1801) gave the left bank of the Rhine to France. The town stands on the right bank of the Meurthe between it and the Vezouze, a little above their confluence. Its 18th century château, the favourite residence of Duke Leopold of Lorraine, is now a cavalry barracks, and the gardens form a public promenade. Lunéville is an important cavalry station with a large riding school. The 18th-century church of St. Jacques has two domed towers. The town is the seat of a sub-prefect. The principal industries of Lunéville include cotton-spinning and the manufacture of railway material, motor vehicles, porcelain, toys, hosiery, embroidery, straw-hats and gloves. Trade is in grain, wine, tobacco, hops, cotton goods, etc.

LUNG, in anatomy, the name of each of the pair of organs of respiration in man and other air-breathing animals, the organs in fishes with the corresponding function being the *branchiae* or gills. (*See* RESPIRATORY SYSTEM, ANATOMY OF; HEART AND LUNG, SURGERY OF.)

LUNG, one of the four symbolical creatures of Chinese legend. It is a dragon with a scaly snake-like body, long claws, horns, a bristly face, and its back-bone armed with spikes.

LUNGCHOW, a town of 13,600 inhabitants in the province of Kwangsi, South China (22° 22′ N. and 106° 45′ E.), near the frontier of Tonkin. It is important as a military frontier station. It was opened to foreign trade in 1889 in the hope of building a railway from Tonkin to Kwangsi, but the Tonkin railway terminated at the frontier, so that the trade remained insignificant. After the fall of Canton in 1938 and the strengthening of the Japanese sea blockade efforts were made to complete the railway to Hengyang and a brief tremendous trade increase resulted over railway and motor roads. Comparative figures for imports are $49,295 (U.S.) (1936) and $18,932,188 (U.S.) (1939); for exports $172,493 (U.S.) (1936) and $29,801,109 (U.S.) (1939). With the surrender of French Indo-China this connection ceased. In 1940 the Japanese attacked Lungchow from the south China coast and occupied it temporarily. But the Chinese recaptured the city in the same year and the retreating Japanese fought their way into French Indo-China in contravention of the terms of the newly concluded Franco-Japanese agreement.

LUNGE, GEORG (1839–1923), German chemist, was born at Breslau on Sept. 15, 1839. He studied at Heidelberg (under R. W. Bunsen [*q.v.*]) and Breslau, graduating at the latter university in 1859. Turning his attention to technical chemistry, he became chemist at several works both in Germany and England, and in 1876 he was appointed professor of technical chemistry at Zurich polytechnic, a post which he resigned in 1907. Lunge's original contributions cover a very wide field, dealing both with technical processes and analysis. His treatises *Coal Tar and Ammonia* (5th ed. 1909; 1st ed. 1867), *Destillation des Steinkohlentheers* and *Sulphuric Acid and Alkali* (1st. ed. 1878, 4th ed. 1909) are standard works; a completely re-written English edition of the latter work was published between 1923 and 1925. He was also part author of the well-known Lunge-Berl *Chemische Unter-*

suchungs-Methoden (7th ed: 1921–1924). He died on Jan. 3, 1923.

LUNG-FISH, a name given to the fishes of the order Dipneusti (double-breathers), with gills and with the air-bladder closely resembling the lung of higher vertebrates, and used for breathing air. *Neoceratodus* of Queensland only occasionally comes to the surface to breathe air. The Lepidosirenidae, including *Protopterus* of Africa and *Lepidosiren* of South America, inhabit swamps and marshes, and rise to breathe air at frequent intervals; in the dry season, when the swamps dry up, the fishes curl up and sleep at the bottom of a burrow, the entrance to which is closed with a plug of mud, with one or more openings for the admission of air. It may be noted that fishes of other groups have the air-bladder primitive and lung-like in structure, and use it for breathing air, particularly the African *Polypterus*. (*See* FISHES.)

LUPERCALIA, a very ancient Roman festival. Its rites were under the superintendence of a corporation of priests called *Luperci* (possibly "wolf-averters," *lupus*+*arceo*: so Vaniček), whose institution is attributed either to Evander or to Romulus and Remus. But the festival itself, which was held on Feb. 15 contains no reference to these late fictions. It began with the sacrifice by the Luperci (or the flamen Dialis) of goats and a dog; after which two of the Luperci were led to the altar, their foreheads were touched with a bloody knife, and the blood wiped off with wool dipped in milk; then the ritual required that the two young men should laugh.

The sacrificial feast followed, after which the Luperci cut thongs from the skins of the victims and ran in two bands round the walls of the old Palatine city. A blow from the thong cured sterility in women. The celebration of the festival went on until A.D. 494, when it was changed by Gelasius into the feast of the Purification. The Luperci were divided into two colleges, called *Quinctiliani* (or *Quinctiales*) and *Fabiani,* from the gens Quinctilia (or Quinctia) and Fabia; at the head of each of these colleges was a magister. In 44 B.C. a third college, Luperci Iulii, was instituted in honour of Julius Caesar, the first magister of which was Mark Antony. In imperial times the members were usually of equestrian standing.

So far, no really convincing explanation of the ceremonies has been put forward. The ritual is apparently in honour of no god; Lupercus, whom our authorities sometimes name, seems a mere invention, Faunus is a guess of the moderns. Two elements may be distinguished: (1) The Luperci trace a magic circle around the old settlement to keep off harm (from wolves); (2) They are called *creppi,* he-goats, and "doctored" to fill them with good magic. They thus are charged with and can convey fertility. But much remains obscure.

See W. Warde Fowler, *Roman Festivals* (1899), p. 390 *et seq.*

LUPIN or **LUPINE,** any plant of the genus *Lupinus,* which comprises about 200 species of annual and perennial herbaceous plants of the family Leguminosae. Species with digitate leaves range in America from British Columbia to northern Chile, while a few occur in the Mediterranean regions. A few others with single leaflets are found in Brazil and eastern North America. The leaves are remarkable for "sleeping" in three different ways. From being in the form of a horizontal star by day, the leaflets either fall and form a hollow cone with their bases upwards (*L. pilosus*), or rise and the cone is inverted (*L. luteus*), or else the shorter leaflets fall and the longer rise, and so together form a vertical star as in many species; the advantage in every case being apparently a protection of the surfaces of the leaflets from radiation. The flowers are of the usual "papilionaceous" or pea-like form, blue, white, purple or yellow, in long terminal spikes. The stamens are monadelphous and bear dimorphic anthers. The species of which earliest mention is made is probably *L. Termis,* which was cultivated by the ancient Egyptians. It is wild in some parts of the Mediterranean area and is extensively cultivated in Egypt. Its seeds are eaten by the poor after being steeped in water to remove their bitterness. The lupine of the ancient Greeks and Romans was probably *L. albus,* which is still extensively cultivated in Mediterranean countries for forage, for soil enrichment, and for its round flat seeds, which form an article of food. Yellow lupine (*L. luteus*) and blue lupine (*L. angustifolius*) are also cultivated in Europe as farm crops for green manuring. *L. texensis,* the state flower of Texas, is the bluebonnet.

LUPU, NICHOLAS (1876–), Rumanian politician, was born at Arsura (Rumania) on Nov. 8, 1876. He started his career as a country doctor and entered politics in 1905. He played an important part during the peasant revolt in 1907 when, as prefect of the Falciu district, he succeeded in pacifying the peasants without having recourse to violent measures. In 1913 he was elected deputy and in 1919 he entered the Vaida-Voevod Coalition cabinet as minister of the interior, representing, together with Mihalache, the Peasant (Tsaranist) party, of which Dr. Lupu became one of the principal leaders. During World War I, Dr. Lupu visited Russia, France, England, Italy and the United States and carried on an active propaganda campaign on behalf of Rumania. During the succeeding period of Liberal Government, Lupu necessarily remained in the background.

LUPUS, PUBLIUS RUTILIUS, Roman rhetorician, flourished during the reign of Tiberius. He was the author of a treatise on the figures of speech (Σχήματα λέξεως), abridged from a similar work by the rhetorician Gorgias of Athens. In its present form it is incomplete. The work is valuable chiefly as containing a number of examples from the lost works of Greek rhetoricians. The author has been identified with the Lupus mentioned in the Ovidian catalogue of poets (*Ex Ponto,* iv. 16), and was perhaps the son of Publius Rutilius Lupus, a supporter of Pompey.

See editions by D. Ruhnken (1768), F. Jacob (1837), C. Halm in *Rhetores latini minores* (1863); *see* also monographs by G. Dzialas (1860 and 1869), C. Schmidt (1865), J. Draheim (1874), Thilo Krieg (1896).

LUPUS, a disease of the skin occurring in two varieties. *Lupus vulgaris,* tuberculosis of the skin, is caused by *B. tuberculosis* and is characterized by the formation in the skin or mucous membrane of small nodules consisting of inflammatory cells liable to coalescence, retrograde change, ulceration and destruction of the tissues, and, if it heals, to the subsequent formation of permanent white scars. It is most commonly seen in early life, and in women, and occurs chiefly on the face, about the nose, cheeks or ears. But it may also affect the body or limbs. It first shows itself as small, slightly prominent, nodules covered with thin crusts or scabs. The disease may be superficial, in which case both the ulceration and the resulting scar are slight (*lupus non exedens*); or the ulcerative process may be deep and extensive, destroying a large portion of the palate, nose or cheek, and leaving much disfigurement (*lupus exedens*). Formerly scraping with a sharp spoon, application of caustics or carbonic acid snow were employed but now treatment by ultra-violet light, Finsen rays, or X-rays is used with better results. Prolonged X-ray treatment, however, has in several instances been followed some years later by cancer in the irradiated area. The other and less serious variety, *lupus erythematosus,* occurs on the nose and adjacent portions of the cheeks in the form of red patches covered with thin scales, underneath which are seen the widened openings of the sebaceous ducts. With a longitudinal patch on the nose and spreading symmetrical patches on each cheek the appearance is usually that of a large butterfly. It is slow in disappearing, but does not leave a scar. As medicines, cod-liver oil, iron and arsenic are useful in both varieties.

LUQMĀN or **LOKMAN,** the name of two, if not of three, persons famous in Arabian tradition. The first was of the family of ʽAd, and is said to have built the great dike of Mārib and to have received the gift of life as long as that of seven vultures, each of which lived 80 years. The name of the second Luqmān, called "Luqmān the Sage," occurs in the Koran (31, 11). Two accounts of him are found. According to Masʽūdī (i. 110) he was a Nubian freedman who lived in the time of David. According to some commentators on the Koran he was the son of Bāʽūrā, one of the sons of Job's sister or maternal aunt. Derenbourg in his *Fables de Loqmân le sage* (1850) identifies Bāʽūrā with Beoi, and believes the name *Luqmān* to be a translation of *Balaam.* The grave of

Luqmān was shown on the east coast of the lake of Tiberias, also in Yemen.

The so-called *Fables of Luqmān* are known to have existed in the 13th century, but are not mentioned by any Arabian writer. They were edited by Erpenius (Leyden, 1615) and have been reprinted many times. For the relation of these to similar literature in other lands, *see* J. Jacobs's edition of Caxton's *Fables of Aesop*, vol. i. (1889).

LURAY CAVERN, a large cave in Page county, Va., U.S.A., 39° 35′ N. and 78° 17′ W., near the village of Luray, on the Norfolk and Western railway. The valley, here 10m. wide, extends from the Blue Ridge to the Massanutton mountain. The ridges lie in vast folds and wrinkles; and elevations in the valley are often found to be pierced by erosion. Cave Hill, 300ft. above the water-level, had long been an object of local interest on account of its pits and oval hollows or sink-holes, through one of which, on Aug. 13, 1878, Andrew J. Campbell and others entered, thus discovering the cavern now described.

The Luray cavern does not date beyond the Tertiary period, though carved from the Silurian limestone. At some period, long subsequent to its original excavation, and after many large stalactites had grown, it was completely filled with glacial mud charged with acid, whereby the dripstone was eroded into singularly grotesque shapes. After the mud had been mostly removed by flowing water, these eroded forms remained amid the new growths. To this contrast may be ascribed some of the most striking scenes in the cave. The many and extraordinary monuments of aqueous energy include massive columns wrenched from their places in the ceiling and prostrate on the floor; the Hollow Column, 40ft. high and 30ft. in diameter, standing erect, but pierced by a tubular passage from top to bottom; the Leaning Column nearly as large, undermined and tilting like the campanile of Pisa; the Organ, a cluster of stalactites in the chamber known as the Cathedral; besides a vast bed of disintegrated carbonates left by the whirling flood in its retreat through the great space called the Elfin Ramble.

The stalactitic display is one of the most remarkable in the world. The old material is yellow, brown or red; and its wavy surface often shows layers like the gnarled grain of costly woods. The new stalactites growing from the old, and made of hard carbonates that had already once been used, are usually white as snow, though often pink, blue or amber-coloured. The Empress Column is a stalagmite 35ft. high, rose-coloured, and elaborately draped. The double column, named from Professors Henry and Baird, is made of two fluted pillars side by side, the one 25 and the other 60ft. high, a mass of snowy alabaster. Several stalactites in the Giant Hall exceed 50ft. in length. The smaller pendants are innumerable; in the canopy above the Imperial Spring it is estimated that 40,000 are visible at once.

The "cascades" are wonderful formations like foaming cataracts caught in mid-air and transformed into milk-white or amber alabaster. The Chalcedony cascade displays a variety of colours. Brand's cascade, the finest of all, is 40ft. high and 30ft. wide, and is unsullied and wax-like white, each ripple and braided rill seeming to have been polished. The Swords of the Titans are monstrous blades, eight in number, 50ft. long, 3 to 8ft. wide, hollow, 1 to 2ft. thick, but drawn down to an extremely thin edge, and filling the cavern with tones like tolling bells when struck heavily by the hand. Their origin and also that of certain so-called scarfs and blankets is from carbonates deposited by water trickling down a sloping and corrugated surface. Sixteen of these alabaster scarfs hang side by side in Hovey's Balcony, three white and fine, 13 striated like agate with every shade of brown, and all perfectly translucent. Down the edge of each a tiny rill glistens like silver, and this is the ever-plying shuttle that weaves the fairy fabric.

Streams and true springs are absent, but there are hundreds of basins, varying from 1 to 50ft. in diameter, and from 6in. to 15ft. in depth. The water in them is exquisitely pure, except as it is impregnated by the carbonate of lime, which often forms concretions, called according to their size, pearls, eggs and snowballs. A large one is known as the cannon ball. On fracture these spherical growths are found to be radiated in structure.

The waters of this cavern appear to be entirely destitute of life; and the existing fauna comprises only a few bats, rats, mice, spiders, flies and small centipedes. When the cave was first entered, the floor was covered with thousands of tracks of raccoons, wolves and bears—most of them probably made long ago, as impressions made in the tenacious clay that composes most of the cavern floor would remain unchanged for centuries. Layers of excrementitious matter appear, also many small bones, and a few large ones, all of existing species. The traces of human occupation are pieces of charcoal, flints, moccasin tracks and a skeleton embedded in stalagmite in a chasm, estimated, from the present rate of stalagmitic growth, to have lain there for not more than 500 years. Temperature is uniformly 54° F, coinciding with that of Mammoth Cave, Ky. The air is very pure, and the avenues are not uncomfortably damp. The parts open to the public are lighted by electricity. (H. C. Hy.)

LURGAN, a market-town and urban district of Co. Armagh, Northern Ireland, 20 mi. S.W. of Belfast by rail. Pop. (1937) 13,766. Area, 1.3 sq.mi. Lurgan is famed for its diapers, and the linen trade is of the first importance. A grant of the town was made to William Brownlow by James I. In 1619 it consisted of 42 houses, all inhabited by English settlers. It was burned by the insurgents in 1641, and again by the troops of James II. After its restoration in 1690 a patent for a market and fair was obtained. Shankill church is the largest parish church in Ireland. Brownlow house, a former seat of the Lords Lurgan, is a modern Elizabethan structure now owned by the Orange Lodge.

LURIA, ISAAC BEN SOLOMON (1534–1572), Jewish mystic, was born in Jerusalem. From his German descent he was surnamed *Ashkenazi* (the German). In 1559 Luria was living in Cairo and trading as a spice merchant with his headquarters in Alexandria. He had come to Egypt as a boy after his father's death, and was brought up by his wealthy maternal uncle Mordecai Francis. At seventeen a copy of the Kabbalistic "Bible"—the *Zohar* of Moses de Leon (*q.v.*) came into his hands. In order to meditate on the mystic lore he withdrew to a hut by the Nile, returning home for the Sabbath. Elijah, who had been his godfather in his babyhood, now paid him frequent visits, initiating him into sublime truths. By night Luria's soul ascended to heaven and conversed with celestial teachers who had once been men of renown on earth. In 1566 at earliest Luria removed to Safed, where there was a large circle of Talmudists. He died at Safed in 1572. But these years were momentous for Judaism. He founded a school of mystics who powerfully affected Judaism after the master's death. The Holy Spirit, we are told, rested on him, drawn to him by the usual means of the mystics—self-flogging, ablutions and penance. He had wonderful gifts of insight, and spoke to the birds. Miracles abounded. More soberly true is the statement that he went on long walks with enthusiastic disciples, whom he taught without books. Luria himself wrote no mystical works; what we know of his doctrines and habits comes chiefly from his Boswell, Hayim Vital.

There was little of originality in Luria's doctrines; the theory of emanations, the double belief in the process of the Divine Essence as it were self-concentrating (*Zimzum*) and on the other hand as expanding throughout creation; the philosophical "scepticism" which regards God as unknowable but capable of direct intuition by feeling—these were all common elements of mystical thought. Luria was an inspirer of saintly conduct rather than an innovator in theories. Not beliefs, he said, but believers need rebirth. He or his school introduced innumerable ritual customs, some of them beautiful enough.

See S. Schecher, *Studies in Judaism,* second series, pp. 251 *seq.*; *Jewish Encyclopedia,* viii. 210; E. Worman in *Revue des Études Juives,* lvii. 281.

LURISTAN, in the more restricted sense, is a province of Iran, in the wider sense, the "Land of the Lurs," namely that part of western Iran which is bounded by 'Iraq on the west and extends for about 400 mi. northwest-southeast from Kirmanshah to Fars with a breadth of 100 to 140 mi. It is chiefly mountainous, being intersected by numerous ranges running northwest-southeast. The central range has many summits, rising to 13,000 ft. and more, and in it are the sources of Iran's most important rivers. Between the higher ranges are many fertile plains and low hilly districts, well watered. The Lurs are thought to be aboriginal Persians with a mixture of Arab blood. Their language is a dialect of Persian. Outwardly they are Mussulmans of the Shiah sect, but most of them show little veneration for either Prophet or Koran. The northern part of Luristan is inhabited by the Feili Lurs, and these are divided into the Pishkuh (cis-montane) Lurs in the east and Pushtkuh (ultra-montane) Lurs in the west adjoining 'Iraq. They number about 350,000. Little Luristan was governed by a race of independent princes of the Khurshidi dynasty, called atabegs, from 1155 to the beginning of the 17th century when the last atabeg, Shah Verdi Khan, was removed by Shah Abbas I, and the government of the province given to Husain Khan, the chief of a rival tribe, with the title of vali. The descendants of Husain Khan have retained the title but now govern only the Pusht-i-kuh Lurs. The southern part of Luristan was formerly known as Lur-i-Buzurg (great Luristan) and is composed of the Bakhtiari district of the province and the districts of the Manasani and Kuhgalu which belong to Fars. The Bakhtiaris number about 200,000, the others 40,000. Great Luristan was an independent state under the Fazlevieh atabegs from 1160 until 1424, and its capital was Idaj, now only mounds and ruins at Malamir 60 mi. S.E. of Shushtar.

Luristan acquired widespread fame in 1929–32, when then and in immediate subsequent years local diggers discovered powerfully designed, technically competent bronzes: vessels, implements, personal adornments and particularly, horse trappings; covering a period from 2600 B.C. to A.D. 800, the majority of the finest pieces datable by cuneiform inscriptions between the 12th and the 19th century B.C. Two archaeological expeditions by the Iranian institute under the direction of Erich Schmidt and a survey by Sir Aurel Stein provide authentic information about the finds.

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LUSATIA (LAUSITZ), a name applied to two neighbouring districts in Germany, between the Elbe and the Oder, viz., "Upper" and "Lower" Lusatia. Lusatia in the middle ages comprised what is now known as "Lower" Lusatia; it is only in the 15th century that the "district of the six towns" (*"Sechsstädteland"*)—now "Upper" Lusatia—came to be included, that is to say, the towns: Bautzen, Görlitz, Zittau, Löbau, Lauban and Kamenz. The territory, named after a Slav tribe, the Lusitzi, was incorporated into the Holy Roman empire of the German nation by the margrave Gero in 938, sold in 1303 to the margraves of Brandenburg of the Askanian line, the oldest dynasty in Europe.

In 1368 the territory fell to the crown of Bohemia on the ground that it had been granted by the emperor Frederick I. to Ladislav in 1160. Thenceforth it was administered by governors appointed by the kings of Bohemia. During the Hussite wars, at the beginning of the 15th century, the people remained loyal to the Roman Catholic Church. After many changes, due to the fact that the territory was "mortgaged" by its penurious rulers, the people recognized the sovereignty of Matthias Corvinus, king of Hungary, for 23 years (1467–90), but returned to the allegiance to the crown of Bohemia in 1490. By the treaty of Prague (1635) both Upper and Lower Lusatia became part of the dominions of the elector of Saxony and (apart from temporary subdivisions among dynasts of this princely house) remained in their possession until the congress of Vienna (1815) when the territory, in bulk, became incorporated within the kingdom of Prussia.

In the reconstituted Germany after 1918, Lusatia remained a part of Prussia, save for the communes of Zittau, Bautzen, Löbau, and Kamenz, which, as before, are incorporated in Saxony.

(W. L. B.)

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LUSCHAN, FELIX VON (1854–1924), Austrian anthropologist and ethnographer, was born on Aug. 11, 1854, in Vienna. He studied medicine in Vienna, anthropology in Paris, became demonstrator in physiology at the university at Vienna, and in 1878 organised the Austro-Hungarian section for anthropology and ethnology at the World Exhibition in Paris. As a military doctor in Bosnia, he studied anthropology and archaeology, and in 1880 travelled in Dalmatia, Montenegro and Albania. During the following 10 years he was often in Asia Minor and Egypt, and in 1883 excavated the ruins of Sendschirli in Northern Syria on behalf of the Berlin Oriental Committee. After a brief period as lecturer in anthropology in Vienna, he became directorial assistant at the Ethnological Museum in Berlin, of which he was director from 1904 until his death, on Feb. 7, 1924.

His works include: *Beiträge zur Völkerkunde der deutschen Schutzgebiete* (1897); *Die Ausgrabungen von Sendschirli*, 2 pts. (1893, 1898); *Beiträge zur Ethnographie von Neu-Guinea* (1899); *Beiträge zur Anthropologie von Kreta; Rassen und Völker* (1908); *Völker, Rassen und Sprachen* (1922).

LUSHAI HILLS, a mountainous district of Assam, south of Cachar, on the border between Assam and Burma. Area, 8,142 sq.mi.; pop. (1941), 152,786. The hills are for the most part covered with dense forest or bamboo jungle, in which there are clearings for cultivation. They are sparsely inhabited by the Lushais and cognate tribes. The earliest known inhabitants were Kukis, and the Lushais were not heard of until 1840 when they invaded the district from the north. Their first attack upon British territory took place in 1849, and after that date their warlike spirit and predatory habits made them one of the most troublesome tribes on the north-east frontier of India; but military operations in 1890 resulted in the pacification of the northern Lushais, and in 1892 of the eastern Lushais. The final submission of the chiefs of the southern Lushai hills, who were under the control of the Government of Bengal, was not secured till 1895. The latter hills were in 1898 transferred to Assam and amalgamated with the northern hills in one district. The limits of the district have more recently been extended by the inclusion of 900 sq.m. between the south of the Lushai hills and the Chin hills in Burma. The headquarters are at Aijal, 3,500 ft. above sea-level, where a battalion of the Assam Rifles is stationed.

The villages are, as a rule, perched on the tops of ridges or spurs. Each is ruled by a chief or headman, in whose house live the orphans and poor of the village. In another house all the young unmarried men and strangers sleep. Dogs, said to be similar to those eaten by the Chinese, are used both for sacrifices and for food. Between 1911 and 1931 mass conversions to Christianity took place among the Lushais, due to the efforts of the Welsh Presbyterian Mission at Aijal, and of the London Baptist Mission at Lungleh. The number of Christians consequently rose from 2,000 to 59,000 or nearly one-half of the total population.

LUSIGNAN, the name of a family which sprang from Poitou and long held the kingdom of Cyprus (1192–1475). A Hugh de Lusignan appears in the ill-fated crusade of 1100–1101; another Hugh, the Brown, came as a pilgrim to the Holy Land in 1164, and was taken prisoner by Nureddin. In the last quarter of the 12th century the two brothers Amalric and Guy, sons of Hugh the Brown, played a part in the history of the Latin East. About 1180 Amalric was constable of the kingdom of Jerusalem. His brother Guy married in 1180 Sibylla, the widowed heiress of the kingdom. Guy acted as regent in 1183, but he had little success, and was deprived of all right of succession. In 1186, however, on the death of Baldwin V., he became King of Jerusalem in spite of the opposition of Raymund of Tripoli. Next year he suffered a crushing defeat at the battle of Hittin, and was taken prisoner by Saladin. Released on parole in 1188, he at once broke his parole, and began the siege of Acre Difficulties, however, had arisen with Conrad of Montferrat; and after Sibylla's death, Conrad won fresh support and was generally recognized as king in 1192. Though Conrad was almost immediately assassinated, the crown did not return to Guy, but went to Henry of Champagne, who married the widowed Isabella. Guy bought from the Templars the island of Cyprus, and there he reigned for the last two years of his life (1192–1194). He is judged harshly by contemporary writers, as *simplex* and *insufficiens,* but Dodu (in his *Histoire des institutions du royaume de Jérusalem*) suggests that Guy was depreciated because the kingdom had been lost in his reign, in much the same way as Godfrey of Bouillon was exalted because Jerusalem had just been won at his accession.

Guy was succeeded in Cyprus by his brother Amalric, who acquired the title of king of Cyprus from the emperor Henry VI., and became king of Jerusalem in 1197 by his marriage to Isabella, after the death of Henry of Champagne. (*See* AMALRIC II.) Amalric was the founder of a dynasty of kings of Cyprus, which lasted till 1475, while after 1269 his descendants regularly enjoyed the title of kings of Jerusalem For the history of the Lusignan kings *see* CYPRUS. The most famous were Hugh III. (the Great) (1267–85) to whom, apparently St. Thomas dedicated his *De Regimine Principum;* Hugh IV. (1324–59), to whom Boccaccio dedicated one of his works, and who set on foot an alliance with the pope, Venice and the Hospitallers, which resulted in the capture of Smyrna (1344); and Peter I. (1359–69). Peter and his chancellor de Mezières represent the last flicker of the crusading spirit. (*See* CRUSADES.)

Before the extinction of the line in 1475, it had placed a branch on the throne of Armenia. Five short-lived kings of the house ruled in Armenia after 1342, "Latin exiles," as Stubbs says, "in the midst of several strange populations all alike hostile." The kingdom of Armenia fell before the sultan of Egypt, who took prisoner its last king Leo V. in 1375, though the kings of Cyprus afterwards continued to bear the title; the kingdom of Cyprus itself continued to exist under the house of Lusignan for 100 years longer. The mother of the last king, James III. (who died when he was two years old) was a Venetian lady, Catarina Cornaro. She had been made a daughter of the republic at the time of her marriage to the king of Cyprus; and on the death of her child the republic first acted as guardian for its daughter, and then, in 1489, obtained from her the cession of the island.

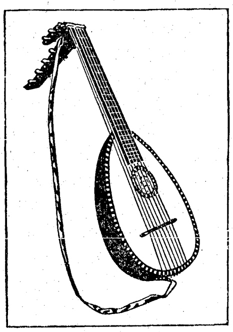
See J. M. J. L. de Mas-Latrie, *Histoire de l'île de Chypre sous les princes de la maison de Lusignan* (1852–53); W. Stubbs, *Lectures on Mediaeval and Modern History* (3rd ed., Oxford, 1900).

LUSSIN, an island of the Quarnero group, transferred at the post-war settlement in 1918, with the closely adjacent island of Cherso, to Italy. *See* CHERSO.

LUSTRATION, a term that includes all the methods of purification and expiation among the Greeks and Romans. Among the Greeks two ideas prevailed; that human nature must purify itself (*κάθαρσις*) from guilt before it is fit to enter into communion with God or even to associate with men, and that guilt must be expiated voluntarily (*ἱλασμός*) by certain processes which God has revealed. The methods of purification consist in ceremonies performed with water, fire, air or earth, or with a branch of a sacred tree, especially of the laurel, and also in sacrifice and other ceremonial. The torch and sulphur (*τὸ θεῖον*) were also powerful purifying agents. Purification by air was most frequent in the Dionysiac mysteries; puppets suspended and swinging in the air (*oscilla*) formed one way of using the lustrative power of the air. Rubbing with sand and salt was another method. The sacrifice chiefly used for purification by the Greeks was a pig; among the Romans it was always, except in the Lupercalia, a pig, a sheep and a bull (*suovetaurilia*). On extraordinary occasions lustrations were performed for a whole city. So Athens was purified by Epimenides after the Cylonian massacre, and Delos in the Peloponnesian War (426 B.C.) to stop the plague and appease the wrath of Apollo. In Rome, besides such annual ceremonies as the *Ambarvalia, Lupercalia, Cerealia, Paganalia,* etc., there was a lustration of the fleet before it sailed, and of the army before it marched.

See C. F. Hermann, *Griechische Altertümer,* ii.; G. F. Schömann, *ib.* ii.; J. Donaldson, "On the Expiatory and Substitutionary Sacrifices of the Greeks," in *Transactions of the Royal Society of Edinburgh,* xxvii. (1876); Marquardt, *Römische Staatsverwaltung,* iii. p. 200 (1885); P. Stengel, *Die griechischen Kultusaltertümer* (1898); J. E. Sandys, *Companion to Latin Studies,* with bibliography (1925) and the articles by A. Bouché-Leclercq in Daremberg and Saglio, *Dictionnaire des Antiquités,* and by W. Warde Fowler in Smith's *Dictionary of Greek and Roman Antiquities* (3rd ed., 1891).

LUTE, an ancient, stringed musical instrument, derived in form as well as name from the Arabs. The complete family consisted of the pandura, tanbur or mandoline as treble, the lute as alto or tenor, the barbiton or theorbo as bass, and the chitarrone as double bass. The Arab instrument, with convex sound-body, pointing to the resonance board or membrane having been originally placed upon a gourd, was strung with silk and played with a plectrum of shell or quill. It was adopted by the Arabs from Persia. Instruments with vaulted backs are all undoubtedly of Eastern origin; the distinct type, resembling the longitudinal section of a pear, is more specially traced in ancient India, Persia and the countries influenced by their civilization.



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THE LUTE

As long as the strings were plucked by fingers or plectrum the large pear-shaped instrument may be identified as a forbear of the lute. When the bow, obtained from Persia, was applied to the instrument by the Arabs, a fresh family was formed which was afterwards known in Europe as rebab and later rebec. The lute family is separated from the guitars, also of Eastern origin, by the formation of the sound-body which is in all lutes pear-shaped and joined directly to the sound-board without the sides or ribs necessary to the structure of the flat-backed guitar and cither. Observing this distinction, the little Neapolitan mandoline of 2ft. long is included in the lute family no less than the large double-necked Roman chitarrone, which was not infrequently 6ft. long. Mandolines are partly strung with wire, and are played with a plectrum, indispensable for metal or short stiff strings. Perhaps the earliest lyres were so played, but the large lutes and theorbos strung with catgut have been invariably touched by the fingers only.

The lute was in general use during the 16th and 17th centuries. In the 18th it declined though J. S. Bach wrote a partita for it. Peri, Caccini and Monteverde used theorbos to accompany their newly devised recitative, the invention of which in Florence, from the impulse of the Renaissance, is well known. Handel wrote a part for a theorbo in *Esther* (1720); but after that date it appears no more in orchestral scores, though it remained in private use until nearly the end of the century.

LUTECIUM, a rare metallic element of the rare-earth group, was discovered by Urbain and independently by Von Welsbach; the latter named the element cassiopeium. (Symbol Lu, atomic number 71, atomic weight 175·0.) Lutecium occurs along with ytterbium, erbium, etc., in the minerals gadolinite, euxenite, xenotime, etc. It is separated from the other members of the group by the fractional crystallization of the bromates; lutecium bromate being the most soluble passes into the mother-liquor. Like ytterbium it forms a white oxide and colourless salts giving no absorption spectrum. In general its salts are more soluble than those of ytterbium; the magnetic susceptibility is less than that of the latter, and in addition it possesses a characteristic spark spectrum. (*See* RARE EARTHS.) (C. J.)

LUTHER, HANS (1879–), German statesman, was born in Berlin, on March 10, 1879, and studied law in Berlin, Kiel and Geneva. He then entered the local administration service. At first he was stationed in Charlottenburg, and from 1907–13, in the Magistrat in Magdeburg under the former minister of finance, Lenze. In 1913 he was elected secretary to the German and Prussian "Städtetag." On July 5, 1918, he was elected burgomaster of Essen in the Ruhr district. There he gained the reputation of being one of the best local administrative officials in the west of Germany. On Dec. 2, 1922, he entered the Cuno cabinet, and became minister of food and agriculture. He retained his post in Essen and, when the French marched into the Ruhr in Jan. 1923, he returned to Essen immediately. There he was the hero of a famous episode. The general commanding the troops marching into Essen wished to speak with the burgomaster at the door of the Rathaus (town hall). Dr. Luther sent a message that he was only to be seen in his office. The order was repeated twice, but at last the general was obliged to give way.

After Cuno ceased to be chancellor, Luther retained his office in the Stresemann cabinet. In Stresemann's second cabinet, he became minister of finance. As minister of finance, he performed signal services in stabilising the German currency, and in balancing the budget of the Reich. Dr. Luther kept his office in the Marx ministry which followed, and had a share in the preparations for the Conference of London and the conclusion of the Dawes agreement. In the autumn of 1924 he concluded the Dawes loan for Germany. He has himself given an account of his work in restoring the finances of Germany (*Feste Mark—solide Wirtschaft,* 1924). After the elections in Dec. 1924, Marx, in spite of many endeavours, was not able to form a new cabinet and Luther took over the task in the middle of Jan. 1925. A cabinet was formed under him, which was the first since the revolution of 1918 to include members of the German National party. Luther carried through a great taxation reform, completed the revaluation legislation, and made a provisional customs tariff which made it possible to commence negotiations for commercial agreements with some prospect of success for German economic life. This economic legislation was accompanied by the Locarno policy initiated by Stresemann with the essential agreement of Luther, who, as chancellor, was responsible for the conduct of policy as a whole.

At the Conference of Locarno, the German delegation which initialled the clauses of the treaty was led by Luther as chancellor. After his return from Locarno, the German National party left the Government. In spite of this, the cabinet found a majority for the policy of Locarno, and on Dec. 1, 1925, signed the Rhine Pact and the Arbitration Treaties in London, after which it resigned. After tedious Government crises, Luther again received the mandate to form a cabinet. As the Social Democrats forsook the chancellor, there was nothing left but to form a cabinet out of the moderate bourgeois parties. Dr. Luther was not a party politician, and often proclaimed his independence. While in charge of the affairs of the Reich he distinguished himself by extraordinary energy and sober clarity of political judgment, and the German people indubitably made important progress towards reconstruction under his leadership. On May 13, 1926, he resigned his office as chancellor. (*See* GERMANY.) (F. KLE.)

LUTHER, MARTIN (1483–1546), the great German religious reformer, was born on Nov. 10, 1483, at Eisleben, in the county of Mansfeld, whither his parents, Hans Luther and Margaret Ziegler, who belonged to the free peasant class, had migrated from Möhra in Thuringia. Six months later they removed to the town of Mansfeld, the centre of the iron ore mining and smelting industry, in which his father found employment as a miner. Within the next decade Hans Luther became the lessee of several smelting furnaces and one of the four elected members of the town council. For some years he had a hard struggle to maintain his growing family, and Luther in later years speaks of the poverty of his childhood. The atmosphere of the home was a pious one, and there is no ground for the tale that his father was a Hussite and was disaffected to the traditional Church. Luther was reared in the current religious beliefs and popular superstitions, which the parents taught their children. Both were strict disciplinarians, and Luther later complained of the harshness of his upbringing, whilst recognizing that his parents meant well by it and cherishing a deep affection and gratitude towards them. The harsh discipline prevailed in the local Latin school, to which he was sent in his seventh year and in which he passed through a graduated course in Latin grammar and syntax, as set forth in the text-books of Donatus and Alexander de Ville Dieu, in select passages from some of the classical authors, and in religious instruction and singing. According to Mathesius he was a diligent and apt pupil, and he evidently profited from this early training, in spite of his later drastic criticism of the schools and schoolmasters of the pre-Reformation period. In his 14th year (1497), he was sent to Magdeburg to continue his education, and in accordance with the practice of the time earned his bread by singing in the streets. His teachers at Magdeburg were members of the Brotherhood of the Common Life, which devoted itself specially to education and was distinguished by its practical reforming spirit. On the conclusion of the school year he removed to Eisenach, where he attracted the interest of an opulent burgher, Kuntz Cotta, and his wife, who received him into their home and relieved him from the necessity of singing for his bread in the streets. He was fortunate, too, in finding in the Rector Trebonius and his assistant Wigand efficient teachers of the higher courses in Latin grammar, composition, rhetoric, and poetry, in which he easily out-distanced his fellow pupils. At the close of this training, which extended over three years, he entered the University of Erfurt in the spring of 1501. At this period the fame of Erfurt exceeded that of all the German universities. The curriculum for the bachelor of arts degree, which he took in the autumn of 1502, included grammar, logic, rhetoric, physics, and philosophy. Two years further study were required for the master's degree, the course including, besides higher instruction in the subjects already studied, mathematics, metaphysics, and ethics. At the age of 22 his ability and proficiency secured him the second place in a list of 17 candidates who passed the master's examination in the winter of 1505.

As the result of these four years of intensive study he had acquired a firm grasp of the current scholastic philosophy, and had developed a marked dialectic skill. He was the ornament of a circle of fellow-students, who met to discuss philosophy, and to whose intercourse his musical gifts contributed an additional charm. Among his teachers were Trutvetter and Ulsingen who professed the Nominalist philosophy as expounded by William of Occam, the great English Franciscan of the 14th century. Under their influence Luther became an enthusiastic adherent of the Occamist or "modern" school of thought as against the various forms of Realism represented by Thomas Aquinas and Duns Scotus. He speaks of Occam as "my master," and refers to his school as "my sect," and he retained his predilection for the philosophic teaching of the great schoolman even after he came to differ from his distinctive theology. He owed allegiance, too, to the authority of Aristotle, whose logic and philosophy dominated all the schools, including that of Occam. Whilst thus absorbed in the conventional scholastic study, he does not seem to have been influenced at this period to any appreciable extent by the humanist movement, which only later took a firm hold of the university, though he found both pleasure and benefit in reading some of the Latin authors, including Cicero, Virgil, and Livy.

The Augustinian Friar.—At the desire of his father, rather than from personal inclination, he entered on the study of law in May 1505. Two months later (July 17) he suddenly renounced the world and entered the monastery of the Augustinian Eremites at Erfurt. There is a difference of opinion among his biographers whether his resolution to become a monk was the result of a sudden impulse, or the climax of a gradually maturing predilection for the monastic life, due in part to certain influences, religious and psychic, working on his high-strung temperament. On the whole the evidence tends to show that his decision was unpremeditated. He himself ascribes it to the fear of sudden death during a thunderstorm, which overtook him, on the road near Erfurt, whilst returning from his home at Mansfeld, when he was prostrated by a flash of lightning and vowed to become a monk. It was in pursuance of this vow that, to the distress and bitter chagrin of his father and the astonishment and regret of his friends, he immured himself in the Erfurt monastery. In any case he regarded his involuntary vow as a call from Heaven, and its fulfilment as an imperative act of obedience to God. It had thus a religious significance which he could not ignore, and he devoted himself to his new vocation with consuming thoroughness.

The Erfurt Augustinians belonged to the strict section of the order, in contrast to the Conventuals or laxer section. After a year's novitiate Luther took the vows of obedience, poverty and chastity, and submitted to the drudgery which was an essential part of his training. Under his preceptor, Nathin, he then went through a course of theological instruction in preparation for his ordination as priest, which took place in 1507. Thereafter he continued his theological studies for the degrees of biblical bachelor and master of the sentences (*Sententiarius*), or dogmatic theology, as expounded in the Sentences of Lombardus, attending the lectures of the theological faculty of the university as well as the theological school of the monastery. In accordance with the prescribed course, he studied the Bible, the Sentences, and the works of Occam, and his disciples D'Ailly and Biel, and dipped into those of St. Bernard, Duns Scotus, and Augustine. He continued these studies at Wittenberg, where he spent a year from the autumn of 1508 to that of 1509 as lecturer on Aristotle's *Ethics*, and where he enjoyed the personal intercourse of John Staupitz, professor of theology and vicar-general of his order. On his return to Erfurt he obtained the degree of *sententiarius,* and began to lecture on the Sentences. The books which he read in his preparation of these lectures were discovered in the library at Zwickau in 1889, and contain on the margins a large number of notes (given in vol. ix. of the Weimar edition of his works) in his own handwriting, which throw light on his theological and philosophical thought and standpoint at this stage of his development. Whilst displaying a critical, enquiring mind, they show no material departure from the scholastic method and the scholastic theology in its Occamist form, though some modern theologians like Seeberg find evidence in them of a distinctive divergence from his theology. At most they reveal a growing predilection for the teaching of Augustine.

This lectureship he filled till the late autumn of 1511, when, at the instance of Staupitz, he was transferred to the monastery at Wittenberg, of which he was ere long appointed sub-prior at a meeting of his order at Cologne in the following year. In Oct. 1512 he took the degree of doctor of theology of the university and became the successor of Staupitz as professor of biblical literature. Towards the end of 1510 he had paid a short visit to Rome on business connected with his order, and though his visit was that of the devout pilgrim, he appears to have been painfully impressed by the secularized ecclesiasticism and the low moral standard of the Holy City. There is, however, no evidence for the oft-repeated statement that the discovery of his distinctive doctrine of justification by faith came to him as he climbed on his knees the steps of the Scala Sancta at the Lateran church.

Conversion.—It was only during the winter of 1512–13 that this decisive illumination dawned on his mind as he meditated in the Black Monastery at Wittenberg on Romans i. 16–17, and suddenly attained a new apprehension of this doctrine. Despite the most punctilious performance of the minutiae of the rule of his order, the most rigorous asceticism, he had hitherto failed to find peace of conscience, the assurance of acceptance in the sight of God, and he had been periodically harassed by doubts on the score of his personal salvation. Hence the long spiritual struggle in the quest for a gracious God, which had clouded his early years as a monk and which Denifle unwarrantably contests as a later fabrication invented by him to justify his apostasy from the Church. Luther's testimony as to the reality of this spiritual ordeal cannot be thus invalidated, even if we make due allowance for the later tendency to exaggerate it under the influence of his changed religious standpoint.

The root of this struggle to find a gracious God lay in his personal temperament, his lofty religious and moral ideal and in the religious, the practical, and the theological teaching of the mediaeval Church. In temperament he was high-strung, emotional, impressionable, and liable to fits of depression which took at times an acute form. He had a sensitive conscience and a keen sense of sin, which the meticulous observance of the rule of his order only tended to intensify. To him sin and the sinful tendency (concupiscence) were terrible realities in keeping with his exalted conception of God as perfect righteousness and the retributive character of this righteousness (*justitia Dei*), which impels Him to judge and condemn the sinner, and which was emphasized in the teaching and practice of the mediaeval Church. How to attain to the ideal divine righteousness and thus enter into a proper relation of acceptance and fellowship with God, and thereby also ensure salvation from the Divine retribution for sin, was the problem that obsessed him and led to this recurring spiritual conflict (*Anfechtungen*). In the sacrament of penance the Church sought to ensure the penitent sinner against this retribution by imposing penitential works in satisfaction for sins. Luther, however, could not be sure of the sufficiency either of his contrition or of his penitential satisfaction in spite of official absolution. The Church further sought to ensure the sinner against the Divine judgment by its doctrine of merits, based on the relative freedom of the will to do the good whereby, with the aid of God's grace, he could conciliate the Divine favour on the day of judgment. Here again Luther, conscious of the weakness of the will to attain the absolute good which alone could avail in the sight of a perfectly righteous God, failed to find the assurance of salvation in this teaching. In addition he was distressed over the doctrine of predestination, which had for him not only a speculative, but a religious significance. How could he be sure that he was among the number of the elect whom God had predestined and chosen, according to the Occamist teaching, by an act of his absolute, arbitrary will.

The vicar-general, Staupitz, during his sojourn at Wittenberg in 1508–09, as well as his preceptor and his confessor in the Erfurt monastery, did their best to help him, and to them he owed at least a relative appeasement of his spiritual distress. He owed something, too, to the sermons of St. Bernard, to which an old monk directed him, and to the writings of Gerson. But his full deliverance came to him only in the winter of 1512–13, when, as the result of long and intense meditation on Romans i. 16–17 he grasped the truth that the righteousness of God in this passage is not to be understood of his retributive justice (*justitia activa*), by which he judges the sinner according to his merits, but in the sense of the righteousness which he mercifully gives or imputes to the sinner (*justitia passiva*), and which the sinner receives by faith, and is thereby justified in His sight and made capable of entering into a filial relation to Him, living the divine life in active obedience to the will of a merciful God. Justification is thus due solely to the mercy or grace of God and the merit of Christ appropriated by faith, not to human works or merits which, being vitiated by sin, can in no way avail to avert the retributive justice of God, or bring the soul into a feasible and assured relation to Him.

This conception is already reflected in his lectures on the Psalms (1513–15), and is elaborated in those on the Epistle to the Romans (1515–16) in which the influence of Augustine and also the mystic teaching of Tauler and the "German Theology" (*Theologia Deutsch*) on the one hand, and the reaction from the scholastic theology are alike apparent, though he still makes use of the scholastic method and terminology. As the result of this elaboration of his new religious conception on the basis of this fundamental doctrine, he could justly claim to be the exponent of a "new theology," though he was still unconscious of any material divergence from the received teaching of the Church, whilst boldly attacking the philosophy of Aristotle and the scholastic theology which was based on it (98 Theses against the scholastic theology, Sept. 1517, which one of his students defended in a public disputation for the degree of biblical bachelor).

The 95 Theses.—In the lectures on Romans he already appears as the practical reformer, and in the year 1517 he emerged in this capacity from the academic sphere with his epoch-making challenge to the work of reformation in his 95 Theses against the abuse of indulgence, which he posted up on Oct. 31, in the door of the Castle church at Wittenberg. The practice of indulgence had grown out of the penitential system of the ancient Church, which punished grave sins by temporary exclusion from the fellowship of the Christian community. In course of time it became customary to mitigate this discipline by permitting the delinquent to make satisfaction, in part at least, in the form of a money contribution. In the later middle age it was extended by the popes as a means of inciting the faithful to participate in the crusades against the infidel (the Cross Indulgence). Those taking part in the holy war or contributing for this purpose were thereby guaranteed the relaxation of penance due for their sins, or even the plenary remission of sin. The practice brought large sums into the papal treasury. With the decline of the crusading spirit, it was extended by Pope Boniface VIII. in connection with the celebrations of the jubilee year 1300. The revenue brought in by this jubilee indulgence was increased by the subsequent expedient of reducing the jubilee years from 100 to 50, or even 25 years and thereby establishing more frequent jubilee celebrations. Indulgences were also issued in connection with other projects such as the rebuilding of St. Peter's at Rome, and by the beginning of the 16th century, the practice had become a regular financial expedient for increasing the papal revenue. In 1447 the efficacy of indulgence was extended by Pope Calixtus III. to souls in purgatory.

The practice was based on the doctrine of the "Treasure of the Church," consisting of the infinite merits of Christ and the superfluous merits of the saints, which was elaborated by Thomas Aquinas and officially sanctioned by Pope Clement VI. in 1343. According to this doctrine, the pope could draw on this inexhaustible source for the benefit of the faithful, whose own merits were insufficient. Theoretically confession and contrition were incumbent on those desiring the benefit of an indulgence. It was further assumed that it could not take away the guilt and eternal punishment of sin, which was only obtainable in the sacrament of penance through the absolution of the priest. It could only ensure the remission of the temporal punishment of actual sins to which the sinner was still liable in this life and in purgatory, and the attainment of this benefit pre-supposed contrition and confession for these sins on the part of the applicant. In the case of the buying of an indulgence in behalf of souls in purgatory, however, contrition and confession on the part of the purchaser were not deemed essential. The practice was liable to great abuse, inasmuch as the indulgence preachers, in their striving to raise as much money as possible for the specific object of any given indulgence, did not always make the conditions and limitations underlying it clear to their hearers. There was besides difference of opinion among the doctors of the Church on both the doctrine and the practice, especially on the question of the application of indulgence to souls in purgatory, as well as widespread dissatisfaction over its abuse.

On both doctrinal and practical grounds Luther felt impelled to attack the system in connection with the Indulgence of 1515–17, which was issued by Pope Leo X. professedly for the rebuilding of St. Peter's. In reality its object was to enable Albrecht of Brandenburg, Archbishop of Mainz, who also held the sees of Magdeburg and Halberstadt, to pay the large debt which he had incurred to the banking house of the Fuggers of Augsburg in payment of the papal dispensation, plus the usual fees, to enable him to acquire the additional office. John Tetzel and other preachers, to whom the archbishop entrusted the business of selling the indulgence, were doing a brisk trade in these pardons when Luther, who discovered in the confessional their misleading teaching on the subject and its nefarious moral and spiritual effects, intervened by posting up his 95 Theses and sending a copy, with a strongly worded letter of protest, to the archbishop. In these theses he distinguished between true repentance and mere penance for sin, maintained that the pope could only remit penalties imposed by his own authority or that of canon law, that God alone can remit the guilt of sin, which is obtained only in the sacrament of penance, not by papal indulgence, and that in the sacrament, pope and priest have only a declaratory power of remission, which is due to the grace of God in Christ as proclaimed in the Gospel—the true "Treasure of the Church." He further denied that the remission of canonical penalties through the papal indulgence applies to souls in purgatory, and, whilst recognizing the principle of indulgence in a strictly limited sense, vigorously denounced the false teaching and the pernicious activity of the indulgence preachers, and asserted the right of every penitent Christian to remission apart from this mercenary traffic in pardons.

The proposed disputation did not actually take place. But the theses were widely circulated, both in the original Latin and in a German translation, and before the end of the year were being eagerly read and discussed throughout the empire, and even beyond its bounds. The attack provoked a counter attack on the part of Tetzel and the Dominican Order, of which he was a member, in the form of a series of anti-theses in defence of the traditional doctrine, which, though ascribed to Tetzel, were drawn up by Wimpina, professor of theology in the University of Frankfurt-on-the-Oder. In a couple of effusions under his own name, Tetzel roundly accused Luther of heresy and schism; and a more formidable opponent, John Maier of Eck, otherwise known as Dr. Eck, professor of theology at Ingolstadt, repeated the charge in a communication to the bishop of Eichstadt, entitled "Obelisks," which, though not printed, was circulated in manuscript. Both Tetzel and Eck maintained that the 95 Theses were an attack on the papal power as well as on a received institution of the Church. Luther replied to Wimpina and Tetzel in a "Sermon on Indulgence and Grace"; to Eck in a series of "Asterisks," in which he stoutly rebutted the charge of heresy. At a congregation of his Order at Heidelberg (April 1518) he expounded and defended his distinctive theology, and amplified his theses in a work entitled *Resolutiones,* which shows a distinct advance in their standpoint, and explicitly emphasizes his fundamental doctrine of justification by faith as the criterion of faith and practice. This work he sent to the pope as a vindication of his action and a confutation of the charges of his opponents, coupled with a respectful and submissive, but outspoken letter (May 1518).

Citation to Rome.—By this time the pope, to whom the archbishop had sent the theses, and who was at first disposed to regard the controversy as a mere monks' quarrel, had decided to take action. As the result of an official examination of Luther's Theses by Prierias, the master of the palace, Leo cited him to appear at Rome within 60 days as a heretic and a rebel against ecclesiastical authority. The citation was forwarded to the learned Dominican, Thomas di Vio, otherwise known as Cardinal Cajetan, the papal legate in Germany. Through the intervention of the elector Frederick of Saxony and for political reasons connected with the prospective election of a successor to the emperor Maximilian I., the pope ultimately consented to forego the citation and to refer the case to the legate, who was empowered to receive Luther's submission. In accordance with this decision he appeared before Cajetan at Augsburg in Oct. 1518. During the interview the legate insisted on unconditional retractation, and Luther stoutly refused to retract unless he was proved from Scripture to be in error, and, appealing from the cardinal to the pope, he secretly left Augsburg. He published an account of the proceedings (*Acta Augustana*), and in November appealed from the pope to a general council.

The issue of a papal decretal on the subject of indulgences left no doubt that Luther's standpoint was irreconcilable with the official doctrine and practice. The attempt of Miltitz, whom the pope sent as his nuncio to Germany to confer the Golden Rose on the Saxon elector, to bring about an accommodation proved fruitless. At a conference at Altenburg in Jan. 1519 Luther went the length of agreeing to refrain from further discussion and to refer the case to the arbitration of a German bishop, on condition that his opponents also observed silence. Miltitz also, in his eagerness to play a rôle in the case which was not warranted by his commission, sent a misleading report to the pope, representing that Luther was not only prepared to refrain from further agitation, but to retract his errors. In reply the pope invited him in a friendly spirit to Rome for this purpose (March 29, 1519). This missive, which never came into Luther's hands, was based on a complete misunderstanding of his real position. What he had refused to Cajetan he was not prepared, at the instance of a busybody like Miltitz, to concede to the pope himself, though at the instigation of the elector he wrote an *Instruction to the People,* in which, whilst emphasizing the abuses in the institutions of the Church, he still recognized the papal supremacy and the duty of obedience to the Roman Church.

Controversy with Eck.—The death of the emperor Maximilian on Jan. 11, 1519, and the long negotiations relative to the election of his successor, brought a lengthy pause in the further consideration of his case as far as the Roman Curia was concerned. Meanwhile the condition of the truce between him and his opponents was broken by the intervention of Eck, who challenged him to a debate at Leipzig on the subject of the papal power. Luther accepted the challenge and in preparation for the disputation made an intensive study of the constitution of the ancient Church and the later claims of the bishop of Rome to its headship, as expressed in the papal decretals. Thus carefully prepared, he encountered his formidable antagonist in the famous disputation which took place in July 1519 and forms another landmark in the development of his reforming teaching. In the course of it he controverted the divine right of the papacy, asserted the supreme authority of Scripture, maintained that John Hus had been unjustly condemned by the council of Constance, and questioned the infallibility of a general council. Eck, who was a practised debater, had skilfully led him into these compromising admissions and claimed the victory. He had at all events shown that he was at variance with the received teaching of the Church, not merely in the comparatively minor subject of indulgences, but on fundamental doctrines. Though both parties had at the outset agreed to refer the contest to the judgment of the universities of Paris and Erfurt, both continued it in a number of controversial writings, to which new adversaries—Alveld, Emser, Dungersheim, Hoogstraten—contributed on the side of Eck, and Melanchthon, Occolampadius, Bucer, Hutten and others on the side of Luther. Luther himself, as well as Eck, added an important quota in the *Resolutiones Lutherianae,* a sermon on the sacrament of the altar, and a treatise on good works, which only widened the breach between him and his opponents.

Bull of Condemnation.—Ultimately Eck betook himself to Rome to prosecute the suit against Luther which the Curia had determined to resume and bring to a final issue. As the result of the re-examination of his case by a series of commissions appointed by the pope in the spring of 1520, the bull *Exsurge Domine,* condemning 41 errors in his teaching, was formulated, and after discussion in the consistory, was issued in June. It granted to the heretic an interval of 60 days after its publication in Germany for the purpose of retracting and returning to the Church. Failing compliance, he and his adherents were to be excommunicated, arrested and punished as notorious and pertinacious heretics. Excommunication was also denounced against all, of whatever rank, who should refuse to comply with the provisions of the bull, which Eck and Aleander were commissioned, as papal nuncios, to publish throughout the empire.

The Bull of Condemnation only fanned the pugnacious spirit of the reformer. At first he professed to see in it a fabrication of Eck, and denounced it in two defiant philippics, *Eck's New Bulls and Lies,* and *Against the Execrable Bull of Antichrist.* Then, recognizing its authenticity, he renewed his appeal to a general council, and finally, on Dec. 10, 1520, publicly consigned it, with a copy of the canon law and other documents, to the flames. During the previous summer and early autumn he had sent forth his three great reform treatises—the *Address to the German Nobility, The Babylonic Captivity of the Church* and *The Freedom of a Christian Man.* In the first he arraigned in passionate language the abuses rampant in the Church, and appealed to the secular power to undertake the work of reformation on the ground of its divine institution, its Christian character, and its ethical functions which entitle it to summon a general council to rectify what is amiss in the Church, and even to undertake this clamant duty in case the Church refuses to reform itself. In the second he attacked the mediaeval sacramental system, reduced the number of the sacraments from seven to three, and asserted the right of the individual Christian to emancipate himself from priestly bondage. In the third he expounded anew in simple, non-controversial terms his fundamental doctrine of justification, which involves alike the freedom of the individual from the work-righteousness of mediaeval religion and the obligation of self-discipline and service for others as the indispensable fruit of justifying faith.

The Diet of Worms.—In Jan. 1521, the pope, in consequence of Luther's refusal to retract and submit to the authority of the Church, launched a Bull of Excommunication against him (*Decet Romanum*), and called on the emperor Charles V., the successor of Maximilian, to execute it forthwith. Instead of complying, the emperor, in deference to the intervention of the Saxon elector and the will of the majority of the diet, which met at Worms at the end of January and continued its sittings till May, decided to summon him to appear for examination before the diet under the imperial safe conduct, whilst promulgating an edict against his writings at the instigation of the papal nuncio Aleander. On April 16, Luther entered Worms. On his appearance before the assembly on the following day he acknowledged the authorship of the books on the table, the titles of which were recited by a secretary. But, in answer to the question whether he was prepared to recant any part of them, he asked for time for consideration on the ground of the importance of the issue involved. He was granted an interval of 24 hours. Late on the morrow, the 18th, he was asked by the official of the archbishop of Treves, Dr. John von der Ecken, who acted as interrogator, whether he was now prepared to defend all the books which he had recognized as his. In reply he proceeded to show why he should not be asked straight away to recant, and requested to be convinced of his errors from Scripture. If thus convinced he would forthwith revoke and be the first to throw his books into the fire. In a long harangue the official rebuked his audacity in arrogating a knowledge of the Scriptures against all the doctors of the Church, and concluded by demanding a definite and straightforward answer to the question whether he would retract his errors or not. Then came the fateful words uttered in firm and clear tones: "Unless I am convinced by the testimony of Scripture or by an evident reason (*ratione evidente*)—for I confide neither in the pope nor in a council alone, since it is certain that they have often erred and contradicted themselves—I am held fast by the Scriptures adduced by me, and my conscience is taken captive by God's Word, and I neither can nor will revoke anything, seeing that it is not safe or right to act against conscience. God help me. Amen." On retiring from the excited assembly he was greeted by the emperor's Spanish guards with the cry "To the fire with him!" whilst he and his adherents passed on with uplifted hands after the old German fashion of celebrating a victory. "I am through," he cried joyfully on reaching his lodging and receiving the congratulation of his friends. He persisted in his refusal before a committee appointed by the diet to bring about a feasible accommodation, and was commanded by the emperor to leave Worms on April 26. On May 4 he was intercepted by a party of horsemen in the Thuringian forest, in accordance with a previous arrangement of the elector of Saxony and two of his trusty councillors, and was furtively lodged in the electoral castle of the Wartburg, overlooking Eisenach. On May 26, after the close of the diet on the previous day, the emperor, having received the assurance of the papal support in his war against Francis I. of France, formally signed the Edict of Worms placing him and his adherents under the ban of the empire and instituting a rigorous censorship of the press. It professed to be issued "with the unanimous consent and will" of the estates of the empire. In reality it had been submitted on the previous evening to only a fraction of the members after the formal closing of the diet, and did not represent the mind of the German people. As the result of these four years of strenuous conflict, the breach between Rome and Luther was complete and irretrievable, and the indomitable, heroic monk had won the sympathy and support of a large proportion of his countrymen on material and economic as well as religious grounds.

The Wartburg.—Luther remained at the Wartburg under the pseudonym of "Knight George" till the spring of 1522. He continued and extended the attack on Rome in a series of controversial writings, including those on auricular confession, on the abrogation of private Mass, and on monastic vows, and kept in touch with his colleagues and friends by a voluminous correspondence. He began and completed the translation of the Greek New Testament which, after revision with the co-operation of Melanchthon, was published in Sept. 1522. It is a monument of his linguistic ability in moulding the vernacular into a fitting medium of the language and thought of the Greek original. He challenged the resumption of the indulgence traffic under the auspices of the archbishop of Mainz at Halle, and so potent had his influence become that the archbishop was fain humbly to apologize and put a stop to the business. He wrote a series of sermons (Postille) for the instruction of the people in the new evangelism, which afford an insight into his distinctive power and style as a preacher. Early in Dec. 1521 he paid an incognito visit to Wittenberg and enjoyed for a few days the renewed personal intercourse with his colleagues. He expressed his satisfaction with all that he had seen and heard in spite of the popular demonstrations against the old religion which had resulted in student riots, but which he did not take very seriously. On the other hand, the spirit of religious and social unrest among the people, which he had observed by the way, impelled him to issue a *Warning Against Tumult and Revolt,* in which he inculcated his characteristic doctrine of submission to constituted secular authority in the matter of religious innovations, the necessity of leaving the Word of God to work gradually the transformation of traditional beliefs and institutions, and the inadmissibility of irresponsible violence in the work of reformation.

This passive attitude did not commend itself to the more militant reformers at Wittenberg like Carlstadt and Zwilling, who in the winter of 1521–22 introduced communion in both kinds, demanded the removal of images from the churches and championed the marriage of the clergy. In this forward policy they had the support of the university theological faculty and the town council, and the town council embodied it in an ordinance regulating on evangelical lines the religious and social life of the community. But it encountered the opposition of the elector on political grounds, and the *impasse* which supervened led Luther to leave the Wartburg at the beginning of March 1522 and resume his public activity at Wittenberg.

The Reformed Worship.—Though he approved on principle of communion in both kinds and the marriage of the clergy, he was a striking combination of the conservative and the revolutionary, and was disposed to consider the expediency of actual changes before making them, and of avoiding precipitate measures which the weaker brethren were not prepared to approve. In a series of eight consecutive sermons during the first week after his arrival, he won over his hearers to his own policy of the gradual institution of an evangelical order in place of the old usages, and modified the ordinance in this direction. It was not till the following year that he deemed the time ripe for a more incisive reform of worship and usages and the reorganization of the church at Wittenberg and elsewhere in accordance therewith, though these changes were to be made without constraint of conscience. Hence the *Formula Missae,* or reformed communion service, which he drew up for Wittenberg, and the order of worship for the church at Leisnig which served as a model for other reformed churches.

At the same time he carried on a brisk campaign against his Romanist opponents, whose antagonism these innovations tended to intensify. These controversial writings included an onslaught on the hierarchy, *Against the Falsely called Ecclesiastical Estate of the Pope and the Bishops,* and a reply to King Henry VIII., who had written an anti-Lutheran *Defence of the Seven Sacraments* (*Assertio Septem Sacramentorum adversus Martinum Lutherum*). He added a *Vindication of Married Life* as a divine and natural institution on behalf of the marriage of the clergy. In 1525 he himself followed the example of the increasing number of married ex-priests, monks, and nuns by contracting a union with Catherine von Bora, who had renounced the conventual life, and bore him a family of three sons and two daughters, and proved a worthy helpmate throughout the remaining 20 years of his wedded life.

As the result of this propagandist activity and the co-operation of a growing band of preachers, drawn largely from the ranks of the secular and regular clergy, the evangelical movement ere long attained such formidable dimensions that it was practically impossible to enforce the edict of Worms throughout a large part of the empire. The diet which met at Nuremberg during the winter of 1522–23 refused to support the demand of pope Adrian VI., the successor of Leo X., for its execution, declined to suppress the evangelical preachers, and, whilst authorizing the punishment of married priests and apostate monks, insisted on the convocation within a year in some German city of a free Christian council in which the laity should have a voice. "Luther's doctrine," reported the archduke Ferdinand to his brother, Charles V., "has taken such deep root that among a thousand persons there is not one who is not to some extent touched by it." A second diet, which assembled in the same city during the winter of 1524, proved less recalcitrant under the manipulation of Campeggio, the legate of Adrian's successor, Clement VII. But it would only undertake to enforce the edict against Luther "as far as possible," and renewed the demand for the convocation of a free council in Germany. In reply Luther launched a strongly-worded philippic (*Two Contradictory Mandates concerning Luther*) in which he unsparingly aspersed the emperor as well as the majority of the diet.

The Peasant Revolt.—Towards the close of 1524 the influence of the evangelical movement on the mass of the people received a startling exemplification in the rising of the peasants which followed the miscarried attempt of Franz von Sickingen and Ulrich von Hutten to vindicate by force the rights of the lesser nobility against the princes in the previous year. In his tract *On the Civil Power* (1523), Luther, in contrast to his attitude to the State on the *Address to the German Nobility* three years previously, sharply distinguished between the political and spiritual spheres, and, whilst denouncing the misgovernment of the princes, inculcated anew the duty of the subject to submit to the civil power and the established order in the State and to suffer, not actively repel, injustice. Some of the evangelical preachers were, however, less restrained, and actively sympathized with the demand of the peasants for social emancipation and the radical modification of the feudal system to this end. Moreover, Thomas Münzer, the leader of the extreme wing of the evangelical party, advocated a social and religious revolution by forcible methods, and Carlstadt, who had by this time been estranged from Luther, though less violent, also actively espoused the cause of the peasants. On theological grounds Luther was repelled by these extremists, who professed a more subjective type of religious thought, based not exclusively on the Word of God, but on the illumination of the individual believer in direct communion with God (the "inner light"). Their association with the social movement contributed to prejudice him against it, though he had pleaded for a more equitable treatment of the common man in the spirit of the Gospel. At the same time his own revolt against the traditional Church, his resounding appeals for its drastic reformation, and on behalf of the rights of the individual mind and conscience enlightened by the Word of God, his doctrine of justification by faith alone, and especially of the spiritual priesthood of all believers, contained democratic implications which the mass of the people were not slow to apply in the service of a social as well as a religious reformation, and of a far-reaching transformation of the prevailing order in the State and society as well as the Church. This popular movement found expression in the *Twelve Articles* of the Swabian peasants which were evidently drawn up under the influence of evangelical preachers like Schappeler and Hubmaier, if not actually composed by them, demanded the abolition of serfdom and the preaching of the pure Gospel, and were widely adopted. The leaders of the peasants submitted these articles, which were couched in a moderate spirit, for Luther's judgment, and whilst deprecating the resort to force, he expressed sympathy with the reasonable grievances of the common man, and counselled both sides to seek an accommodation (*An Exhortation to Peace in Response to the*

Twelve Articles of the Swabian Peasants, April, 1525). When, however, the peasant bands in southern, western, and central Germany discarded his advice and took arms to enforce this programme of social reforms, he took the side of the princes and lords and issued a sanguinary and ill-judged appeal to a war of extermination against the rebels (*Against the Murderous and Thieving Peasant Bands,* May, 1525). Not only was the rising ruthlessly suppressed; the princes and lords sullied their victory by a savage retribution, of which many thousands of their subjects became the victims, and which both dashed the hope of achieving the legitimate social aspirations of the masses in connection with the religious reformation, and embittered the common man against the reformer, whom they denounced as the accomplice of their oppressors.

Organization of Reform.—In this year Luther was deprived by death of his potent protector, the elector Frederick. His successor, the elector John, was, however, a confirmed adherent, and his cause had won the ardent support of the landgrave Philip of Hesse, Albert of Brandenburg, grand master of the Teutonic order, and other princes, as well as a large number of cities, and its princely supporters were beginning to league themselves in its defence. On the other hand, the archduke Ferdinand of Austria, the two dukes of Bavaria, the elector of Brandenburg, and Duke George of Saxony had combined to stem the progress of the movement, and the persecution of his adherents had already begun in Romanist territories. In the diet which met at Spires in 1526 the Lutheran princes, in conjunction with the moderate Roman Catholics, were strong enough to carry a resolution to suspend the edict of Worms pending the meeting of a general, or at least a national, council; and meanwhile so to act in the matter of the edict as its members should answer to God and the emperor.

The evangelical princes interpreted the decision as entitling them to organize the evangelical Church within their territories, and for this purpose Melanchthon, by direction of the elector John, drew up, and Luther revised, a church ordinance (*Kirchenordnung*) which formed alike a confession of faith, a directory of public worship, a scheme of educational reform, and contained the germ of the later consistorial form of Church government, which consigned the ecclesiastical administration to a body of State officials or consistory, composed of theologians and jurists, under the supremacy of the territorial prince. At the second diet of Spires in 1529 the emperor Charles, through his commissioners, succeeded in reversing the decision of the previous diet. On this occasion the extreme Catholics were in the majority and carried a resolution enforcing the diet of Worms in Catholic territories and disallowing further religious innovations in the Lutheran States, whilst prohibiting the profession of the Zwinglian and Anabaptist forms of the reformed faith. Against these decisions the Lutheran minority appealed and protested and this Appellation and Protestation was signed by 14 cities as well as by the elector of Saxony, the landgrave of Hesse and four other princes. Hence the name Protestant as a designation of the evangelical party.

The Zwinglian Controversy.—This reverse to the Lutheran reformation was aggravated by the dissension between Luther and the Swiss theologians on the doctrine of the Lord's Supper. Whilst rejecting the mediaeval doctrine of transsubstantiation, Luther firmly believed in the bodily presence of Christ in the bread and wine (consubstantiation). Zwingli, the reformer of Zurich, and the south German theologians, on the other hand, accepted only a spiritual presence in the elements, and a bitter controversy had been proceeding for some years over this question before the landgrave Philip, in the hope of uniting the warring parties, summoned the leaders to a conference at Marburg in October 1529. During the three days' debate Luther doggedly argued in support of the literal interpretation of the words, "This is my body" (*Hoc est meum Corpus*) against Zwingli and his Swiss and South German colleagues Occolampadius, Bucer and Capito, who contended in favour of the figurative sense of the words. They further adduced the impossibility of the presence in the elements of Christ's body, which had ascended into Heaven, against Luther's contention on behalf of its ubiquity in virtue of Christ's divine nature which was not subject to any human limitations. Neither party would give way on these two fundamental points, and the debate ended in a complete deadlock. Luther refused to extend the right hand of fellowship to Zwingli, who was prepared to agree to differ for the sake of unity. Despite this *impasse* the landgrave, after the formal close of the debate in the afternoon of Oct. 3, made a final effort to secure unanimity. He besought both parties to consider in private the possibility of finding a formula which they could subscribe. In response Luther drew up a formula which, while asserting that "the body of Christ is truly, *i.e.,* essentially and substantially" present in the sacrament, waived further discussion on the question as to the mode of its presence. This was undoubtedly a considerable concession on Luther's part, and Bucer was at first disposed to accept it as a satisfactory solution. Zwingli and Occolampadius, on the other hand, could not bring themselves to subscribe this Lutheran formula in the course of the private discussion of the following day, and held to their view that Christ is present only in a spiritual sense. The next best thing in the interest of the landgrave's policy of a comprehensive evangelical union was to give expression to their agreement on the other doctrines of the reformed faith, and Luther joined with his opponents in subscribing the Marburg Articles which he drew up for this purpose. The Marburg conference was thus not a total failure. The inability to see eye to eye on the sacramental question resulted, however, in an unfortunate estrangement between the Lutheran and the Swiss and south German Churches for the time being at least, and frustrated the project of a great evangelical alliance in defence of the Reformation to meet the menace of the impending imperial attempt to suppress it.

The movement had by this time lost the support of Erasmus and the older humanists, whilst retaining the adhesion of the younger votaries of the new learning like Melanchthon and Bucer. Up to the diet of Worms Erasmus had exerted his influence to shield Luther from the hostility of his scholastic opponents of Cologne, Louvain and other centres of the scholastic theology, who were also his own enemies. He used his influence with the German princes to secure him a fair hearing, and denounced the obscurantism and intolerance of the heresy hunters. Luther who had a deep sense of the value of the new learning for the evangelical movement had cultivated his friendship, whilst disapproving of his theological standpoint. After the diet of Worms and the actual initiation of the Reformed Church, Erasmus, in his fear of revolution, became more critical, and at length, yielding to the solicitations of powerful patrons, entered the lists against his theological teaching in a controversial work on Free Will (*De Libero Arbitrio,* 1524). Luther replied with a counter attack in the Unfree Will (*De Servo Arbitrio,* 1525), and though both observed a relative moderation of style in these writings, the breach between them in the theological sphere was henceforth irretrievable.

The Augsburg Confession.—As an outlaw Luther was not present at the diet of Augsburg in 1530, at which the emperor appeared in person, and to which Melanchthon presented a confession of the Lutheran faith (the Confession of Augsburg). But he energetically intervened by his letters to the elector John and to his pliant colleague who, in the course of the long negotiations, was in danger of conceding more than he was prepared to approve. He thus stiffened their opposition to the final ultimatum of the emperor to agree to a material modification of its teaching in a Romanist sense. Thus strengthened, the elector left the diet in the face of the imperial demand for surrender to his Romanist policy; and Luther at last overcame his scruples on the score of active resistance to the imperial authority in defence of the evangelical cause. He not only consented to the defensive Protestant League of Schmalkald, which the elector and the landgrave cemented, but published a manifesto asserting the right of such resistance to authority oppressively exercised over conscience and the Gospel. (*Warning to the Germans,* October 1530, and *Declaration* of November 1530.) In consequence of this combination and the menace of a Turkish invasion by the sultan Solyman, Charles was fain to agree to an accommodation in the religious peace of Nuremberg (1532).

In further negotiations with Bucer and the South German theologians on the sacramental question, Luther relaxed somewhat in his exclusive dogmatism on the subject, and agreed to the Wittenberg Concord (1536). Though the agreement did not include the Zwinglians, he meantime maintained friendly relations with Bullinger, Zwingli's successor at Zürich, and was impressed by the mediating view of Calvin, though he never came into direct contact with the Genevan reformer. Towards the anabaptist movement, on the other hand, he adopted an attitude of uncompromising antagonism. These sectaries, who took their rise at Zurich in 1525, and rapidly spread their views from Switzerland over the Empire, continued the more radical tendency of Münzer, whose revolutionary teaching was adopted by the more extreme section and eventuated in the fantastic and fanatic attempt to establish the reign of the saints at Münster in Westphalia. The more moderate section led by Hubmaier, Hetzer, and Denck, all of them men of scholarly attainments, eschewed revolutionary violence, and advocated adult baptism as the exclusive scriptural practice, and a more literal revival of primitive Christianity as they understood it. To Luther both sections were alike obnoxious as subverters of religious and social order, and he ultimately belied his own principle of freedom of conscience by supporting the persecution to which both sections were alike subjected in Protestant as well as Roman Catholic territories, and in joining Melanchthon in pronouncing for the infliction of the death penalty for persistent profession of Anabaptist error (1536).

Last Years.—In spite of the increasing ill-health from which he suffered during the last ten years of his life, he continued to toil at the task of maintaining and vindicating the Reformation. Whilst compromising it by his secret, though reluctant sanction of the bigamous marriage of the landgrave, Philip (1540), which ere long leaked out and was not rendered less scandalous by his honest, but warped attempt to justify it, Luther continued the warfare against the papacy as anti-Christian in a closing series of controversial works. He staunchly opposed the policy of Paul III. to effect a reunion with Rome through a general council, which the pope at last agreed to convene. Such a reunion could only be achieved at the price of sacrificing the essential principles of the Reformation as a revival of the teaching and the institutions of the New Testament and the early Church, which he claimed to have vindicated against the corrupt and secularized Roman distortion of them. He maintained a sceptical, though less uncompromising attitude towards the attempt of the emperor, for political reasons, to bring about a feasible accommodation (*The Wittenberg Reformation,* Jan. 1545). His more constructive contribution to the movement during these declining years is the revision, with the assistance of his colleagues, of his translation of the Old Testament, which he had completed between 1523 and 1532, as well as that of the New Testament. By the year of his death the number of editions of this Luther Bible, or parts of it, had risen to 377, exclusive of the Low German versions of it. Had he contributed nothing else besides this literary and religious treasure to the Reformation, he would amply deserve the title of the greatest religious benefactor of his people in modern times. He added to the value of this service by his commentaries on the books of the Bible, which entitle him to a high place among biblical exegetes, and which were the fruit of his expositions of Holy Writ in the classroom. Next to the influence of his translation of the Bible, may be placed that of the hymns with which he enriched the reformed worship, and the two catechisms which he composed in 1529 for instruction in the distinctive doctrines of the Christian faith.

He did not live to experience the force of the blow to his cause which the emperor was at last preparing to deliver. He died on Feb. 18, 1546, at Eisleben, where he had been born 63 years before. He had paid a visit to his birthplace to arbitrate in a dispute between Counts Albrecht and Gebhard of Mansfeld. He successfully accomplished his mission, and preached several times to crowded congregations. But the exposure to the inclement weather during the journey thither, and the protracted negotiations, proved too great a strain for his infirm body, and in the early morning of the 18th he passed quietly away. His last word was an emphatic "yes" to the question of Jonas whether he remained steadfast in the doctrine which he had taught. Count Albrecht would fain have laid him to rest in his native Eisleben. But the elector, John Frederick, insisted on the transference of his body to Wittenberg, where his life work had been done, and there, on Feb. 22, it was interred in the Castle church, in the presence of his stricken widow and children and a great concourse of notables, disciples and burghers.

The impression produced by his personality and his work on his closest associates is reflected at first hand in the funeral sermon preached by Bugenhagen and the funeral oration delivered by Melanchthon to this great assembly. A man, said Bugenhagen, who never feared anyone, however great and mighty, in much the same words as the regent, Morton, used at the grave of John Knox. Though to some he appeared too sharp and bitter in reproof and denunciation, this was his due prerogative as a prophet, as it was of Christ himself in his conflict with the scribes and the Pharisees. In his rôle as a prophet sent by God, he rediscovered and vindicated the Gospel and delivered the Church from the corruption and tyranny of Rome. The preacher could only liken him to the angel of the Apocalypse who flew in midheaven with the everlasting Gospel to proclaim to the dwellers on earth, and the effects of his prophetic mission could only be described in the words of the second angel, "Fallen, fallen is Babylon the great!" Dead in the body, Luther would live in his work in accordance with his own prophecy, *Pestis eram vivus, moriens tua mors ero Papa* ("In life I was thy pestilence; dying, I will be thy death, O Pope").

For Melanchthon, Luther was the unique praeceptor. He belonged to the long line of God-inspired teachers and leaders who from the days of the patriarchs onwards had successively preserved and renewed the Church. In this succession he was worthy to stand beside Isaiah, John the Baptist, Paul, Augustine. He was the great renovator, not the innovator of the Church, which he had striven to purify from error and abuse. Strife and division had ever been an inevitable concomitant of the working of the Divine Spirit at such crises in its history, and the responsibility for this division lay with those who refused to hear the truth. Melanchthon assumes that what Luther taught in his long struggle with his opponents was the true doctrine, of which he gave a rapid summary. He combined in the highest degree the gifts of the great Christian teacher and the active reformer. As in the days of Nehemiah the builders of Jerusalem rebuilt the walls with the one hand and held the sword in the other; so Luther had maintained the struggle with the enemies of the true doctrine, and had at the same time, by his writings and his translations of the Scriptures, brought enlightenment and comfort to a multitude of burdened consciences. For this double work pious Christian hearts would be eternally grateful to him and thank God for him. Melanchthon, who had sometimes to suffer under his masterfulness and his vehemence, indicated, indeed, that there might be truth in the complaint of some—and these good-hearted people—that Luther was too hard and rough in his controversial writings. In the face of such a charge he reminded his hearers of the reputed saying of Erasmus, "God in these last times, in which great and terrible diseases have prevailed, has given the world also a sharp physician." As God placed His Word in the mouth of Jeremiah to tear up and break down, to plant and to build, so in the case of Luther. Certain it was that, in defending his teaching, he was acting solely in obedience to his conscience, not merely from quarrelsome and malevolent motives. All who knew him must bear him this testimony. They would, too, readily testify to his amiability, his kindliness, his goodness in private intercourse. "His heart was true and without falseness, his utterance friendly and kindly, and his striving ever to observe the Apostles' command, 'Whatsoever things are true, etc.'" Undeniable, too, his deep piety, his striving to exercise himself in the Christian virtues and in all good and useful studies and arts, his continence and freedom from vice, his readiness to conciliate and arrange the quarrels of others, his hatred of intrigue and trimming, his singleness of purpose, his constant recourse to prayer in the midst of the trial and stress of affairs, his unfailing courage in reliance on God's help as his immovable rock, his rare intellectual acumen and quickness in dealing with difficult situations and problems, his power of observation and ability to read character, his devotion to study, his wide knowledge, his aptness to apply it in his writings and lectures, and his wonderful gift of language.

The picture is, in the circumstances, naturally drawn from the angle of a poignant sense of loss. Nevertheless, the words addressed by one who had been Luther's close associate as disciple, co-worker and friend for nearly 30 years to an audience which had known him in daily intercourse for a longer period, leave on the reader the impression of having been uttered in complete sincerity and truth.

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See also REFORMATION. (J. M.)

LUTHERANS, the general title given to those Christians who have adopted the principles of Martin Luther in his opposition to the Roman Church, to the followers of Calvin, and to the sectaries of the times of the Reformation. Their distinctive name is the *Evangelical*, as opposed to the *Reformed* church. Their dogmatic symbols are usually said to include nine separate creeds which together form the *Book of Concord* (*q.v.*). Three belong to the Early Christian church—the *Apostles' Creed*, the *Nicene Creed* (in its Western form, *i.e.*, with the *filioque*), and the so-called *Athanasian Creed;* six come from the 16th century—the *Augsburg Confession*, the *Apology for the Augsburg Confession*, the *Schmalkald Articles*, Luther's two *Catechisms* and the *Formula of Concord*. But only the three early creeds and the Augsburg Confession are recognized by all Lutherans. Luther's Catechisms, especially the shorter of the two, have been almost universally accepted, but the Formula of Concord was and is expressly rejected by many Lutheran churches. The Augsburg Confession and Luther's Short Catechism may therefore be said to contain the distinctive principles which all Lutherans are bound to maintain, but, as the principal controversies of the Lutheran church all arose after the publication of the Augsburg Confession and among those who had accepted it, it does not contain all that is distinctively Lutheran. Its universal acceptance is perhaps due to the fact that it exists in two forms (the *variata* and the *invariata*) which vary slightly in the way in which they state the doctrine of the sacrament of the Supper. The *variata* edition was signed by Calvin, in the meaning, he said, of its author Melanchthon.

After Luther's death the more rigid Lutherans declared it to be their duty to preserve the *status religionis in Germania per Lutherum instauratus*, and to watch over the *depositum Jesu Christi* which he had committed to their charge. As Luther was a much greater preacher than a systematic thinker, it was not easy to say exactly what this deposit was, and controversies resulted among the Lutheran theologians of the 16th century. (*a*) The Antinomian controversy was the earliest (1537–1560). It arose from differences about the precise meaning of the word "law" in Luther's distinction between law and gospel. Luther limited the meaning of the word to mean a definite command accompanied by threats, which counts on terror to produce obedience. He declared that Christ was not under the dominion of the law in this sense of the word, and that believers enter the Christian life only when they transcend a rule of life which counts on selfish motives for obedience. But law may mean ethical rule, and the Antinomians so understood it, and interpreted Luther's declaration to mean that believers are not under the dominion of the moral law. (*b*) The Arminian controversy in the Reformed church, the Jansenist controversy in the Roman Catholic church, had their parallel in disputes among the Lutherans lasting from 1550 to 1580. In the end it was generally agreed that sin had not totally destroyed man's ethical nature, and that grace changed what was morally insensitive into what was morally sensitive, so that there could be a co-operation between God's grace and man's will ("synergism"). (*c*) The controversy raised by Andreas Osiander was more important. He felt that Luther had omitted to make adequate answer to an important practical question, how Christ's death on the cross could be brought into such actual connection with every individual believer as to be the ground of his actual justification. It was answered that the principal effect of Christ's work on the cross was to change the attitude of God towards the whole human race, and that, in consequence, when men come into being and have faith, they can take advantage of the change of attitude effected by the past historical work of Christ. The Reformed church, on the other hand, constructed their special doctrine of the limited reference in the atonement. (*d*) The other controversies concerned mainly the doctrine of the sacrament of the Supper, and Luther's theory of Consubstantiation. This required a doctrine of *Ubiquity*, or the omnipresence of the body of Christ extended in space, and therefore of its presence in the communion elements. Calvin had taught that the true way to regard substance was to think of its power (*vis*), and that the presence of a substance was the immediate application of its power. The presence of the body of Christ in the sacramental elements did not need a presence extended in space. Melanchthon and many Lutherans accepted the theory of Calvin, and alleged that Luther before his death had approved of it. Whereupon the more rigid Lutherans accused their brethren of Crypto-Calvinism, and began controversies which dealt with that charge and with a defence of the idea of ubiquity. The University of Jena, led by Matthias Flacius, was the headquarters of the stricter Lutherans, while Wittenberg and Leipzig were the centres of the Philippists or followers of Melanchthon.

Conferences only increased the differences. The Lutheran church seemed in danger of falling to pieces. In the end, the greater proportion adopted the *Book of Concord* (1577). Its recognition was mainly due to the efforts of Augustus, elector of Saxony. The churches within Germany which refused the *Book of Concord* became for the most part Calvinistic or Reformed. They published as was the fashion among the Reformed churches, separate creeds for themselves, but almost all accepted the *Heidelberg Catechism.* These differences in the German Protestant churches of the second half of the 16th century are reflected in the great American Lutheran church. The church exists in three separate organizations. The General Synod of the Evangelical Church of the United States, organized in 1820, has no other creed than the *Augsburg Confession,* so liberally interpreted as not to exclude Calvinists. The Synodical Conference of North America, organized in 1872, compels its pastors to subscribe to the whole of the nine creeds contained in the Book of Concord. The General Council, a secession from the General Synod, was organized in 1867, and accepts the "unaltered" (*invariata*) *Augsburg Confession* in its original sense, and the other Lutheran symbols as explanatory of the Augsburg Confession.

The divided state of German Protestantism, resulting from these theological differences, contributed in no small degree to the disasters of the Thirty Years' War, and various attempts were made to unite the two confessions. Conferences were held at Leipzig (1631), Thorn (1645), Cassel (1661); but without success. At length the union of the two churches was effected by the force of the civil authorities in Prussia (1817), in Nassau (1817), in Hesse (1823), in Anhalt-Dessau (1827) and elsewhere. These unions for the most part aimed, not at incorporating the two churches in doctrine and in worship, but at bringing churches or congregations professing different confessions under one government and discipline. They permitted each congregation to use at pleasure the *Augsburg Confession* or the *Heidelberg Catechism.* The enforced union in Prussia was combined with the publication of a new liturgy intended for common use. This led to secessions from the state church. These seceders were at first treated with great harshness, but have won their way to toleration, and form the Lutheran Free churches of Germany.

The liturgies of the Lutheran churches exhibit the same diversities in details as appear in their constitutions. It may be said in general that while Luther insisted that public worship ought to be conducted in a language understood by the people, and that all ideas and actions which were superstitious and obscured the primary truth of the priesthood of all believers should be expurged, he wished to retain as much as possible of the public service of the mediaeval church. The external features of the mediaeval churches were retained; but the minor altars, the *tabernacula* to contain the Host, and the light permanently burning before the altar, were done away with. The ecclesiastical year with its fasts and festivals was retained in large measure. In 1526 Luther published the *German Mass and order of Divine Service,* which, without being slavishly copied, served as a model for Lutheran communities. It retained the altar, vestments and lights, but explained that they were not essential and might be dispensed with. The peril attending the misuse of pictures in churches was recognized, but it was believed to be more than counterbalanced by the instruction given through them when their presence was not abused. In short Luther contented himself with setting forth general principles of divine service, leaving them to be applied as his followers thought best. The consequence was that there is no uniform Lutheran liturgy.

The divergences in ritual and organization, the principle underlying all the various ecclesiastical unions, viz., to combine two different confessions under one common government, and, resulting from it, the possibility of changing from one confession to another, have all combined to free the state churches from any rigid interpretation of their theological formulas. A liberal and a conservative theology (rationalist and orthodox) exist side by side within the churches, and while the latter clings to the theology of the 16th century, the former ventures to raise doubts about the truth of such a common and simple standard as the Apostles' Creed. The extreme divergence in doctrinal position is fostered by the fact that the theology taught in the universities is in a great measure divorced from the practical religious life of the people, and the theological opinions uttered in the theological literature of the country cannot be held to express the thoughts of the members of the churches. Up to the beginning of the Great War, the relation of the Lutheran Church to the state was essentially as follows. In each state the sovereign was held to be the *summus episcopus.* He appointed a minister of public worship, and through him nominated the members of the governing body, the *Oberkirchenrath* or *Consistorium* or *Directorium.* This council dealt with the property, patronage and all other ecclesiastical matters. But each parish elected its own council for parochial affairs, which had a legal status and dealt with such matters as the ecclesiastical assessments. Delegates from these parish councils formed the *Landessynode.* In cases that call for consultation together, the *Consistorium* and the Synod appoint committees to confer. The income of the state churches was derived from four sources. The state made an annual provision for the stipends of the clergy, for the maintenance of fabrics and for other ecclesiastical needs. The endowments for church purposes, of which there were many, and which were destined to the support of foreign missions, clerical pensions, supply of books to the clergy, etc., were administered by the supreme council. The voluntary contributions of the people were all absorbed in the common income of the national churches and were administered by the supreme council. Each parish was legally entitled to levy ecclesiastical assessments for defined purposes.

German Lutherans.—The reorganization of the German Empire aimed at the separation of Church and state. Since an immediate complete separation would be disastrous to the churches and not to the best interest of the state, the churches were guaranteed diminishing state support, with the ultimate purpose of divorcing them entirely from the state governments. By this arrangement the churches have, in part, the character of voluntary associations and, in part, that of state controlled institutions. Two problems have presented especial difficulties. The one is the problem of aim and purpose. Is the Church to continue, under new forms of administration, to be the one recognized institution of religion for that state (*Volkskirche*), or is it to be an institution for the promulgation of a single doctrinal type of Christianity (*Bekenntniskirche*)? The second problem concerns the relation of the Church to the state schools. No fully satisfactory solution of either problem has been reached as yet, though the idea of the *Volkskirche* seems, for the present, to have the stronger following, and the general trend is toward a separation of the Church from the schools. The acute economic depression of 1922–4 affected most disastrously those elements of the laity from which the greatest measure of church support was to be expected, and it subjected the clergy to severe privations. All the activities of the churches were impaired, and the great voluntary associations for Christian work—the societies for foreign and inner missions—were practically paralyzed. Substantial financial support was furnished during this crisis by Lutherans of foreign countries, especially of America, and with the beginning of economic recovery the normal church activities were, by 1926, gradually being resumed.

The endeavour of the more extreme Nazis to control and "Paganize" religion has led to a sharp conflict between the totalitarian state and the Confessional Churches in Germany. On August 24, 1936, an outspoken manifesto against official "insults" was read from pulpits with the question "whether the Christian faith is to retain its right to exist or not." The pastors demanded an end to parades that interfere with public worship and to the ban on religious meetings in buildings other than churches.

Central European Countries.—The formation of the new national states of Poland, Latvia, Estonia, Czechoslovakia, Yugoslavia and Hungary has been followed by a new organization of the Lutheran churches in those countries. The same tendencies that were operative in Germany have shown themselves in these lands. The churches have tended to organize with a large measure of self-support and self-government. Where entire independence of the state has not been feasible it has been apparent as the ultimate aim. An episcopal form of spiritual oversight has also been introduced into most of these churches.

Russia and Rumania.—In 1924 the Lutherans of Russia were permitted for the first time in their history, to organize as a Russian Church with a synod and two bishops. In Rumania, on the other hand, the disestablishment of the Transylvanian Lutheran Church has caused severe, if temporary, hardships.

On questions of doctrine the same divergences continue to exist. The more conservative element has been organized since 1868 in the General Lutheran Conference (*Allgemeine evangelisch-lutherische Konferenz*), an international society for the maintenance of confessional Lutheran teaching. In 1922 the conference united with the American National Lutheran Council in the calling of the First Lutheran World Convention, held at Eisenach, Germany, in Aug. 1923. The members of the convention came from 20 different countries, including the United States and Canada, and effected a new international organization, with an executive committee of six members, charged especially to secure co-operation among the Lutherans of the world in works of mercy, foreign missions and care for migratory Lutherans, and "in cases of emergency to speak for the whole Lutheran Church." The Lutheran Alliance is a society of ultra-conservative Lutherans, the members of which are drawn chiefly from the free churches of Germany.

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(T. M. LI.; C. M. J., X.)

UNITED STATES AND CANADA

In 1927, the Lutheran Church in the United States and Canada had 2,707,183 communicant members divided among 21 ecclesiastical bodies. The largest of these were the United Lutheran Church (908,190), the Missouri Synod (675,956), the Norwegian Lutheran Church (303,368), the Augustana Synod (225,346), the Iowa Synod (141,889), the Joint Synod of Ohio (169,155), the Joint Wisconsin Synod (145,115), the Lutheran Free Church (22,737), the United Danish Church in America (19,013) and the Suomi Synod (20,659). The Synodical Conference, a consultative federation, comprising the Missouri Synod, the Joint Wisconsin Synod and two smaller bodies, formed a single well-defined group with a membership of 839,843. The names of many of these bodies point to one of the reasons for their separate existence. At their organization nearly all of them were expressions of the church consciousness of groups of immigrants from the Lutheran countries of Europe, and they continue to perpetuate, to a greater or smaller degree, the religious tradition of the countries of their origin. With the slackening of north European immigration toward the end of the 19th century the nationalistic traits tended to become less marked, and the process of Americanization was greatly hastened by the World War. Since 1914 the foreign languages have been rapidly replaced in the services by English and the separated bodies have been drawing closer together.

Organization.—In 1918 the United Lutheran Church was formed by the union of the General Synod, the General Council and the United Synod in the South. These three bodies represented a single line of American tradition reaching back to colonial days. Most of their synods owed their foundation, directly or indirectly, to the work of Henry Melchior Mühlenberg, the great colonial missionary (d. 1787). They had had doctrinal differences, but these were regarded as too small to keep them longer apart. The Augustana Synod, a body of Lutherans of Swedish origin, did not enter the union, though it had been a part of the General Council. In 1917 three bodies of Norwegian Lutherans united to form the Norwegian Lutheran Church in America. Since 1921 discussions have been in progress looking towards the union of other separated bodies. The National Lutheran Commission for Soldiers' and Sailors' Welfare was organized in 1917 to minister to the spiritual welfare of the 400,000 Lutheran men in the army and navy of the United States. Its membership included all the larger bodies except the Missouri and Wisconsin Synods. It was dissolved in 1921. The National Lutheran Council was organized in 1918 by the same bodies that had previously organized the commission. Its purpose was to provide an agency for certain kinds of co-operative work. Its most important task has been to extend aid to the Lutheran churches of Europe during their period of reconstruction. Between 1918 and 1925 it distributed among the Lutherans of 20 different countries more than $6,500,000 in money and goods. For about two decades the Luther League of America, founded in 1888, existed as a general organization of young peoples' societies, crossing synodical lines. In later years, however, it ceased to be inter-synodical.

Doctrines.—Doctrinally, the Lutherans of America are pronounced conservatives. All of them subscribe to the Augsburg Confession and the Small Catechism, and most of them accept the whole body of the 16th century Lutheran confessions. Their doctrinal differences have been, at times, acute, but have usually concerned the theological interpretation of the confessions. Their form of government is theoretically congregational, but the whole tendency in the larger bodies is towards a rather highly centralized synodical administration. The most conservative type of American Lutheranism is represented by the Synodical Conference. Its theological standards are those of 17th century orthodoxy; it strongly opposes any recognition of or co-operation with other churches, and it is vigorously hostile to the membership of its pastors and people in secret societies. The United Lutheran Church, though insistent upon the enforcement of confessional standards, is less rigid both in theology and practice.

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(C. M. J.)

LUTON, market town, municipal borough, in the Luton parliamentary division, Bedfordshire, England, 30 mi. N. of London on the L.M.S. and L.N.E. railways. Pop. (est. 1938) 90,840. Area 13.6 sq.mi. It lies on the Chiltern hills. St. Mary's church is mainly Decorated, but some portions and the font are Early English. Luton is the principal seat in England of the manufacture of hats and other straw goods from straw-plait. The industry originated with the colony of straw-plaiters transplanted by James I from Scotland. The town was extended in 1933 and 1939. It has foundries, motor car works, dyeing and chemical works and manufactures vacuum cleaners, etc. Town planning schemes are in operation and there is a municipal aerodrome.

LUTSK: *see* LUCK.

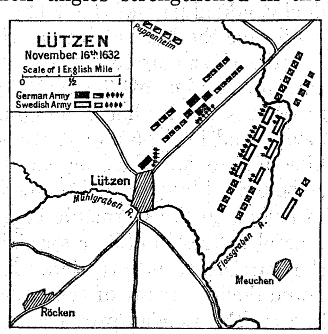
LUTTERWORTH, a town of Leicestershire, England; 90 mi. N.N.W. from London by rail. Pop. (1931) 2,395. The church of St. Mary is mainly Decorated and Perpendicular; here are preserved relics of John Wycliffe, who was rector 1374–84.

LUTTRELL, HENRY (*c.* 1765–1851), English wit and writer of society verse, was the illegitimate son of Henry Lawes Luttrell, 2nd earl of Carhampton. In 1820 he published his *Advice to Julia,* of which a second edition, altered and amplified, appeared in 1823 as *Letters to Julia in Rhyme.* This poem, suggested by the ode to Lydia in the first book of Horace's *Odes,* was his most important work. His more serious literary contemporaries nicknamed it "Letters of a Dandy to a Dolly." In 1827 in *Crockford House* he wrote a satire on the high play then in vogue. Byron characterized him as "the best sayer of good things, and the most epigrammatic conversationist I ever met"; Sir Walter Scott wrote of him as "the great London wit," and Lady Blessington described him as the one talker "who always makes me think." Luttrell died in London on Dec. 19, 1851.

LÜTTRINGHAUSEN, a town in the Prussian Rhine province, Germany, 6 mi. S.E. of Elberfeld by rail. Pop. was 13,673. It has various iron and other metal industries, and cloth and calico mills. It was incorporated with Remscheid (*q.v.*) in 1929.

LUTYENS, SIR EDWIN LANDSEER (1869–1944), British architect, was born in London on March 29, 1869. After a brief training in the South Kensington schools and in architects' offices, he received his first commission at the age of 19. He afterwards designed a number of country houses, in which he gradually developed an individuality of design which was, however, tempered by a reticence which dissociated his work from any attempts at "originality." Much of his domestic work was done in connection with the restoration of old houses, notably Lindisfarne castle, Holy Island (1903–12). He also executed much civic work, being responsible for the *Country Life* offices in London and for the British sections at the exhibitions in Paris (1900) and Rome (1911). The garden suburb at Hampstead, London, has many good examples of his treatment of small houses. It was as the architect of the New Delhi (*see* DELHI) that the culmination of his professional career was reached. He also designed the Cenotaph in Whitehall, London, and the British embassy in Washington, D.C. He was head of the committee of the Royal academy in charge of the reconstruction of London after World War II. Sir Edwin, who was knighted in 1918, became A.R.A. in 1913, R.A. in 1920 and P.R.A. in 1938. He was created K.C.I.E. in 1930. He died Jan. 1, 1944, in London.

LÜTZEN, a town in Prussian Saxony, in the circle of Merseburg (pop. in 1933, 4,977), chiefly famous as the scene of a great battle fought on Nov. 6–16, 1632, between the Swedes, under King Gustavus Adolphus, and the Imperialists, under Wallenstein. After being foiled in his prolonged effort to bring Wallenstein to battle at Nuremburg (*see* THIRTY YEARS' WAR), Gustavus moved south to the Danube. But instead of being drawn by this threat to Bavaria, Wallenstein advanced into Saxony in pursuance of his aim of detaching the Elector from the Swedish Alliance. The menace led Gustavus to march rapidly north, pausing at Nuremburg, 60m. south of his rival at Leipzig, to await reinforcements. As Gustavus had thrown up entrenchments Wallenstein, assuming that no immediate attack was likely, allowed Pappenheim to take a large detachment in order to lay siege to a small castle near Halle. When Gustavus heard of Pappenheim's departure he determined to strike while his enemy was thus weakened. His approach was, however, signalled to Wallenstein, who sent Pappenheim an urgent summons. Fortunately also for him, his posts at Weissenfels and Rippach prevented Gustavus from fighting his main battle the same evening, and the Swedes went into camp near Rippach, a little more than an hour's march from Lützen. In the mist of the early morning Wallenstein's army was formed in line of battle along the Leipzig road with its right on Lützen. Its left was not carried out as far as Flossgraben in order to leave room on that flank for Pappenheim. His infantry was arranged in five huge oblongs, four of which (in lozenge formation) formed the centre and one the right wing at Lützen. These "battalias" had their angles strengthened in the old-fashioned way that had prevailed since Marignano (*q.v.*), with small outstanding bodies of musketeers, so that they resembled rectangular forts with bastions. On either side of this centre was the cavalry in two long lines, while in front of the centre and close to the right at Lützen were the two batteries of heavy artillery. Lützen was set on fire as a precaution. Skirmishers lined the bank and the ditch of the Leipzig road. The total strength of the Imperial army was about 12,000 foot and 8,000 horse.



Gustavus's hopes of an early decision were frustrated by the fog, which delayed the approach and deployment of the Swedes, and it was 8 A.M. before all was ready. The royal army was in two lines and a small reserve in rear. The infantry in the centre was arrayed in the small and handy battalions then peculiar to Gustavus's army, the horse on either wing extended from opposite Lützen to some distance beyond Wallenstein's left, which Pappenheim was to extend on his arrival. By the accident of the terrain, or perhaps, following the experience of Breitenfeld (*q.v.*), by design, the right of the Swedes was somewhat nearer to the enemy than the left. In front, near the centre, were the heavy guns and each infantry battalion had its own light artillery. The force of infantry and cavalry on either side was about equal, the Swedes had perhaps rather less cavalry and rather more infantry, but their artillery was superior to Wallenstein's. Not till 11 A.M. was it possible to open fire, for want of a visible target, but about noon, after a preliminary cannonade, Gustavus gave the signal to advance.

The king himself commanded the right wing, which had to wait till small bodies of infantry detached for the purpose had driven in the Imperialist skirmish line, and had then to cross a ditch leading the horses. They were not charged by the Imperialists at this moment, for Pappenheim had not yet arrived, and the usual cavalry tactics of the day were founded on the pistol and not on the sword and the charging horse. Gaining at last room to form, the Swedes charged and routed the first line of the Imperial cavalry but were stopped by the heavy squadrons of cuirassiers in second line, and at that moment Gustavus galloped away to the centre where events had taken a serious turn. The Swedish centre (infantry) had forced their way across the Leipzig road and engaged Wallenstein's living forts at close quarters. The "Blue" brigade—Gustavus's infantry wore distinctive colours—overran the battery of heavy guns, and the "Swedish" (so called as being the only brigade containing no foreign elements in the army) and "Yellow" brigades engaged the left face of the Imperialist "lozenge" with success. But a gap opened between the right of the infantry and the left of the cavalry and Wallenstein's second-line squadrons pressed into it. It was this which brought Gustavus from the extreme right, and he was killed here in leading a counter-charge.

On the extreme left, meanwhile, the "Green" brigade had come to close-quarters with Wallenstein's infantry and guns about Lützen, and the heavy artillery had gone forward to close range between the "Green" and the "Yellow" infantry. But the news of Gustavus's death spread and the fire of the assault died out. Wallenstein recaptured his guns and drove the Swedes back.

But the fiery Duke Bernhard of Saxe-Weimar took up the command and ordered a fresh advance. He was too good a soldier to waste his reserves and only brought up a few units of the second line to help the disordered brigades of the first. Again the Imperialists were driven in and their guns recaptured, this time all along the line. About three in the afternoon the Swedes were slowly bearing back Wallenstein's stubborn infantry when Pappenheim appeared. The famous cavalry leader had brought on his mounted men ahead of the infantry and asking, "Where is the king of Sweden?" charged at once in direction of the enemy's right. Wallenstein thus gained time to re-establish his order, and once more the now exhausted brigades of the Swedish first line were driven over the road. But Pappenheim fell in the moment of victory, and his death disheartened the Imperialists, whereas the fall of Gustavus had filled the Swedes with furious energy. For the last time, Bernhard, wounded as he was, forced the Swedish army to the attack. The three infantry brigades of his second line had only been engaged in part, and, as usual, the last closed reserve, resolutely handled, carried the day. Wallenstein's army made good its retreat under cover of darkness, and the Swedes slept on the battlefield. Robbed of their leader they failed to gain the strategic profit of their victory. Of the losses on either side no accurate statement can be given, but the Swedish "Green" and "Yellow" brigades are said to have lost five-sixths of their numbers. Near the spot where Gustavus fell a granite boulder was placed in position on the day after the battle. A canopy of cast-iron was erected over this *Schwedenstein* in 1832, and close by, a chapel, built by Oskar Ekman, a citizen of Gothenburg (d. 1907), was dedicated on Nov. 6, 1907.

Lützen is famous also as the scene of a victory of Napoleon over the Russians and Prussians on May 2, 1813. (*See* NAPOLEONIC CAMPAIGNS.) This battle is often called *Gross Görschen.*

LÜTZOW, ADOLF, FREIHERR VON (1782–1834), Prussian lieutenant-general, was born in Berlin on May 18, 1782, and entered the army in 1795. At the outbreak of the "war of liberation," he received permission from Scharnhorst to organize a "free corps" consisting of infantry, cavalry and Tirolese marksmen, for operating in the French rear and rallying the smaller governments into the ranks of the allies. At Kitzen (near Leipzig) the whole corps, warned too late of the armistice of Poischwitz, was caught on the French side of the line of demarcation and, as a fighting force, annihilated. Lützow cut his way out with the survivors, and recruited and reorganized the corps, which fought at Gadebusch (where Körner fell), Göhrde (where Lützow was wounded), and at the siege of Jülich. At Ligny Lützow led the 6th Uhlans to the charge, but they were broken by the French cavalry, and he was captured, escaping, however, on the day of Waterloo. He died at Berlin on Dec. 6, 1834. One of the last acts of his life for which Lützow is remembered is his challenge (which was ignored) to Blücher, who had been ridden down in the rout of the 6th Uhlans at Ligny, and had made, in his official report, comments thereon, which their colonel considered disparaging.

See K. von Lützow, *Adolf Lützows Freikorps* (1884); Fr. von Jagwitz, *Geschichte des Lützow'schen Freikorps* (1892).

LUXEMBOURG, FRANÇOIS HENRI DE MONTMORENCY-BOUTEVILLE, Duke of (1628–1695), marshal of France, the comrade and successor of the great Condé, was born at Paris on Jan. 8, 1628. He was the son of the comte de Montmorency-Bouteville, and was brought up by his aunt, Charlotte de Montmorency, princess of Condé, with her son, the duc d'Enghien. The young Montmorency (or Bouteville as he was then called) shared his cousin's successes and reverses throughout the troubles of the Fronde. He returned to France in 1659 and was pardoned, and Condé arranged his marriage to the greatest heiress in France, Madeleine de Luxembourg-Piney, princesse de Tingry and heiress of the Luxembourg dukedom (1661), after which he was created duc de Luxembourg and peer of France. At the opening of the War of Devolution (1667–68), Condé, and consequently Luxembourg, had no command, but during the second campaign he served as Condé's lieutenant-general in the conquest of Franche Comté. In 1672 he held a high command against the Dutch. He defeated the prince of Orange at Woerden and ravaged Holland, and in 1673 made his famous retreat from Utrecht to Maestricht with only 20,000 men in face of 70,000, an exploit which placed him in the first rank of generals. In 1674 he was made captain of the *gardes du corps,* and in 1675 marshal of France. In 1676 he commanded the army of the Rhine, but failed to keep the duke of Lorraine out of Philipsburg; in 1677 he stormed Valenciennes; and in 1678 he defeated the prince of Orange, who attacked him at St. Denis after the signature of the peace of Nijmwegen. Luxembourg spent some months of 1680 in the Bastille, but on his release took up his post at court as *capitaine des gardes.*

When the war of 1690 broke out, the king and Louvois gave Luxembourg command of the army of Flanders. On July 1, 1690, he won a victory over the prince of Waldeck at Fleurus. In 1691 he commanded the army which covered the king's siege of Mons and defeated William III. of England at Leuze on Sept. 18, 1691. Again in the next campaign he covered the king's siege of Namur, and defeated William at Steenkirk (*q.v.*) on June 5, 1692; and on July 29, 1693, he won his greatest victory over his old adversary at Neerwinden, after which he was called *le tapissier de Nôtre Dame* from the number of captured colours that he sent to the cathedral. He was received with enthusiasm at Paris by all but the king, who looked coldly on a relative and adherent of the Condés. In the campaign of 1694, Luxembourg did little in Flanders, except that he conducted a famous march from Vignamont to Tournay in face of the enemy. He died on January 4, 1695. As a general he was Condé's grandest pupil. Though slothful like Condé in the management of a campaign, at the moment of battle he seemed seized with happy inspirations, against which no ardour of William's and no steadiness of Dutch or English soldiers could stand. He left four sons, the youngest of whom was a marshal of France as Maréchal de Montmorency.

See, besides the various memoirs and histories of the time, Beaurain's *Histoire militaire du duc de Luxembourg* (Hague and Paris, 1756); *Mémoires pour servir à l'histoire du maréchal duc de Luxembourg* (Hague and Paris, 1758); Courcelles, *Dictionnaire des généraux français,* vol. viii. (Paris, 1823). *See* Ségur *La jeunesse du maréchal de Luxembourg, 1628–68* (1900); *Le maréchal de Luxembourg et le prince d'Orange, 1668–98* (1902) and *Les dernières années du maréchal de Luxembourg* (1904), also Canonge, *Le maréchal duc de Luxembourg* (1924).

LUXEMBOURG, grand-duchy of Europe, which consists mainly of the upper basins of the Sauer and its feeder the Alzette, draining and dissecting the south-east flank of the Ardennes. A province of the same name forms the Ardennes highland in the kingdom of Belgium, and the two together, with certain other small areas, form the historic Luxembourg.

History.—Under the Romans the district was included in the province of *Belgica prima,* afterwards forming part of the Frankish kingdom of Austrasia and of the empire of Charlemagne. Luxembourg's recorded history dates back to 963, when Sigefroi, count of Ardennes, an offspring of Charlemagne, founded the actual capital. Sigefroi, the first sovereign ruler of the little country, was a contemporary of Otto the Great, who founded, in 962, the first German empire, and of Hughes Capet, creator of modern France. About 1060 it came under the rule of Conrad (d. 1086), who took the title of count of Luxembourg. His descendants ruled the county, first in the male and then in the female line, until the death of Sigismund (1437), the fourth and last emperor of the house of Luxembourg. Among the early rulers of Luxembourg, the outstanding figure is that of Countess Ermesinde, who reigned in the first half of the 13th century. She granted charters of franchise to the most important towns of the country—the charter of the city of Luxembourg dates from 1244. In 1354 Charles IV, the second emperor of this house, made the county into a duchy. Through the marriage of Sigismund's daughter, Elizabeth, with the German king, Albert II, Luxembourg passed for the first time to the house of Habsburg, but was seized in 1443 by Philip III the Good, duke of Burgundy, who based his claim upon a bargain concluded with Sigismund's niece Elizabeth (d. 1451). Regained by the Habsburgs in 1477 when Mary, daughter and heiress of duke Charles the Bold, married the German king Maximilian I, the duchy passed to Philip II of Spain in 1555. At the peace of the Pyrenees (1659), a section on the southwestern border, with the towns of Thionville and Montmédy, was ceded to France.

In 1684 the French conquered the fortress of Luxembourg, but 13 years later, by the peace of Ryswick, Louis XIV was compelled to return it with Belgium to Spain. By the treaty of Utrecht (1713) Luxembourg and Belgium passed from Spanish sovereignty to Austrian. In 1795 the troops of the French republic occupied Luxembourg, which was retained by France, as the Departement des Forêts, until the end of the Napoleonic wars.

The Congress of Vienna (1814–15) erected it into a grand duchy, added part of the duchy of Bouillon to it, but on the other hand gave the Luxembourg territories situated east of the Moselle and the river Our to Prussia. This grand duchy was assigned to William I, king of the Netherlands, in return for the German territories of the house of Orange-Nassau, which Napoleon had confiscated in 1806 and which were given by the congress to the king of Prussia. Thus the Netherlands and Luxembourg were only to be united by personal union. Furthermore the grand duchy was to belong to the Germanic confederation, its capital was to be a federal fortress and by a special arrangement with king William I the garrison was Prussian. Nevertheless William I ruled the grand duchy as part of the kingdom of the Netherlands. So, when in 1830 the Belgian provinces separated from Holland, the grand duchy revolted also and put itself under Belgian authority, with the exception of the town of Luxembourg, which, owing to the presence of the Prussian garrison, remained under the rule of William I. In Nov. 1831, the powers divided the grand duchy in two parts, of which the larger western part, with a Walloon and French-speaking population, was to be included as a province in the new kingdom of Belgium, and the smaller eastern part should be retained by William I as grand duke of Luxembourg. The grand duchy, thus reduced to less than half of its former area, remained in the Germanic confederation with the Prussian garrison in her capital. But William I refused to accept this arrangement. Consequently the whole of Luxembourg remained in the possession of the Belgians until 1839, when the treaty of April 19, concluded at the conference of London, enforced the partition of 1831, and recognized Luxembourg as a sovereign and independent state under the guarantee of the European powers. The king of the Netherlands retained the grand-ducal crown.

In 1842 the grand duchy, which had no common frontier with Holland and was therefore economically wholly isolated, entered the German Zollverein under the special control of Prussia. As the Germanic confederation had dissolved (1866), the town of Luxembourg had ceased to be a federal fortress, but Prussia maintained her garrison in spite of French protests. When King William III of the Netherlands offered to sell his rights over the grand duchy to Napoleon III war between France and Germany was in sight. The question was referred to a conference of the powers in London. The treaty of London (May 11, 1867) decided that the Prussian garrison must be withdrawn and the fortress dismantled. At the same time the great powers guaranteed collectively the neutrality of the grand duchy which, while remaining a member of the Zollverein, formed now an independent state.

Personal union with Holland ceased at the death of William III in 1890. The king having no male descendant, while his daughter Wilhelmina could succeed to the throne of Holland, the grand duchy, according to the family pact of the house of Nassau, passed to the last agnate of that house, Adolphus, whose duchy of Nassau had been annexed by Prussia in the German war of 1866. Adolphus died in 1905 and was succeeded by his son William, whose eldest daughter, Marie-Adelaide, ascended the throne in 1912. On Aug. 2, 1914, the German armies invaded the grand duchy, on the pretext that it was necessary to protect the German control and working of the Luxembourg railways against a French invasion. On Aug. 4 Herr von Bethmann-Hollweg admitted to the reichstag that the violation of Luxembourg neutrality was wrong, and promised reparation. The Luxembourg government and the sovereign protested against this violation, but the grand duchy remained in German occupation for the duration of the war.

The grand duchess, Marie-Adelaide, abdicated (Jan. 10, 1919) in order to save the independence of the grand duchy, and was succeeded by her sister, Princess Charlotte. Marie-Adelaide died in 1924. By the referendum of Sept. 28, 1919, the Luxembourg people pronounced for the maintenance of the monarchy with Charlotte as grand duchess. On May 10, 1940, German troops again overran the duchy. The Allied offensives in 1944 and 1945 liberated Luxembourg from German rule and the duchy's independence was restored. (*See* World War II.)

Population.—The population is 296,913 (Dec. 31, 1935), the great majority being Roman Catholics. The chief towns are: the capital, Luxembourg, with 57,740 inhabitants, the three towns in the mining district, Esch-Alzette (27,517), Differdange (15,945) and Dudelange (13,572), and the old town of Echternach (3,280) famous for its "dancing procession."

The common language is called *letzeburgesch*. Based upon old Teutonic origins, it has extensively borrowed from the Celtic, Roman and French tongues. German and French roots have been phonetically altered throughout the centuries. This was declared the official language in 1939.

Constitution.—Luxembourg is a constitutional monarchy with the crown hereditary in the house of Nassau. The actual sovereign is the grand duchess Charlotte (born Jan. 23, 1896), who married on Nov. 6, 1919, Prince Felix of Bourbon-Parma. The heir to the throne is Prince Jean (born Jan. 5, 1921).

By a law of May 15, 1919, the constitution of the grand duchy was revised in a more democratic direction. The powers of the sovereign were limited, universal suffrage, with proportional representation, was instituted, and the franchise was conferred on women. But the most interesting innovation was the creation by the law of April 4, 1924, of five chambers for traders and industrialists, agriculturists, artisans, private employees and workmen, election to the chambers being by electors in these occupations above the age of 21. These chambers have the power to create and maintain institutions, the right to propose bills which must be submitted to the chamber of deputies, and they have a right to be consulted before laws affecting their professional interests are passed by the chamber of deputies.

Customs Union with Belgium.—After the evacuation of the country by the German troops in Nov. 1918, Luxembourg denounced its membership of the German Zollverein, and from Jan. 1, 1919, it constituted an autonomous customs territory, while, by virtue of articles 41 and 268 of the treaty of Versailles, it enjoyed the right of exporting to Germany for five years, duty free, goods equivalent in quantity to its average prewar export to Germany.

By the referendum of Sept. 28, 1919, the Luxembourg people pronounced by 60,133 votes for an economic union with France against 22,242 votes for an economic union with Belgium. Association with France would have helped the agrarian interest, while the vinegrowers stood to gain from association with Belgium. After the occupation of Frankfurt, carried out jointly by French and Belgian troops (April 8, 1920), the French government made a declaration renouncing the negotiation of a customs union with Luxembourg in favour of Belgium. Relations with Belgium had been strained as a result of the plebiscite, but the new negotiations between Belgium and Luxembourg culminated in a convention (July 25, 1921) establishing an economic union between the two countries which came into force on May 1, 1922, to last for 50 years. By this treaty customs frontiers between the two countries were destroyed, and Luxembourg customs assimilated to those of Belgium, though the Luxembourg customs administration is retained. The total customs, plus the product of certain internal excise duties, are divided after a small deduction used to encourage Luxembourg cereal growing, in the proportion of 28 to 1. The state paper currency was reduced to 25,000,000 francs.

Railways.—Luxembourg has two systems of railways: the Guillaume-Luxembourg and the Prince-Henri railways. While the latter company works its lines itself, the lines of the Guillaume-Luxembourg company, which form the main part of the railways and are also of strategical importance, were, after the armistice of Nov. 1918, provisionally run by the Alsace-Lorraine railways, which belong to the French state. According to the customs convention between Luxembourg and Belgium, the Belgian state should share in working both Luxembourg railways, the two systems of normal gauge being united. After long negotiations a convention between the Luxembourg and the Belgian governments was signed at Brussels on May 13, 1924. Under its terms the entire railway system of Luxembourg was to have been administered by the Prince-Henri railway under the control of the Grand Ducal government, conjointly in so far as questions of interest to Belgium are concerned, particularly as regards transit, with the Belgian government. But this convention was rejected by the Luxembourg chamber of deputies on Jan. 20, 1925. In 1939 there were approximately 350 mi. of standard and secondary gauge railways.

Agriculture, Industry and Trade.—Although the soil of the grand duchy is not very fertile, agriculture is prosperous. The distribution of land is: 305,712 ac. arable land, 202,268 ac. forests, 67,555 ac. meadows and 3,829 ac. vineyards.

The main industry of the country is the iron industry, based on the iron ores, called minette, found in the south. In 1938 Luxembourg produced 5,666,900 short tons of iron ore—an average annual output. There were, in 1938, 35 blast furnaces with more than 20,000 workers, which produced 1,709,700 tons of pig-iron with a value of $23,800,000 (U.S.). The seven steel foundries of the grand duchy produced, in 1938, 1,584,100 short tons of steel valued at $27,294,000 (U.S.). German capital, which before World War I dominated the iron works of the grand duchy, was replaced later by Luxembourg, Belgian and French capital. Besides the factories which they own in Luxembourg, the Luxembourg metallurgical companies own or control mines, collieries, blast furnaces, steel works and factories for iron and steel manufacture in France, Belgium, Germany and in Brazil. Besides the ancient industries of sole leather, slates, metal constructions, china, explosives, gloves, drapery, woven wear, brewing and tobacco, long established in Luxembourg, new industries have grown up, and have made considerable way. These are the cement industry, the manufacture of sparkling wines, fancy leather and brushes.

Finance.—The monetary unit is the franc, whose parity was fixed in 1935 at 1.25 Belgian francs. In 1913 the public consolidated debt of the grand duchy was about 10,000,000 gold francs. In 1925 this debt had risen, in consequence of the charges which the state had to assume during the war to assure the feeding of the population and to meet the deficits in the budget, to 196,000,000 francs, plus a loan of 175,000,000 francs issued in Belgium in 1922 and intended for the exchange of notes of the Luxembourg state for notes of the National Bank of Belgium. By 1939 the consolidated debt was 625,000,000 francs ($25,000,000 U.S.). Estimated revenue for 1939 amounted to 355,230,000 francs ($14,209,000 U.S.), and estimated expenditure 353,440,000 francs ($14,137,600 U.S.).

The House of Luxembourg was descended from Count Conrad (d. 1086), and its fortunes were advanced through the election of Count Henry IV as German king in 1308 and his coronation as emperor under the title of Henry VII. Henry's son was John, king of Bohemia, who fell on the field of Crécy (1346), and John's eldest son was the emperor Charles IV, while another famous member of the family was Baldwin, archbishop of Treves (1285–1354), who took an active part in imperial affairs. Two of the sons of Charles IV, Wenceslaus and Sigismund, succeeded in turn to the imperial throne, and one of his nephews, Jobst, margrave of Moravia, was chosen German king in opposition to Sigismund in 1410. The French branch of the family was descended from Waleran (d. 1288), lord of Ligny and Roussy, a younger son of Count Henry II. Waleran's great-grandson was Guy (d. 1371), who married Matilda, sister and heiress of Guy V, count of Saint-Pol (d. 1360), and was created count of Ligny in 1367. Guy's son, Waleran (d. 1417), who became constable of France in 1412, had been carried as a prisoner to England, and had married Matilda, daughter of Thomas Holland, earl of Kent (d. 1360) and half-sister of King Richard II. To avenge Richard's death he made a raid on the Isle of Wight, and then took part in the civil wars in France. He left no sons, and was succeeded by his nephew, Peter, count of Brienne (d. 1433), who, like his brother Louis (d. 1443), cardinal archbishop of Rouen and chancellor of France, was found on the side of the English in their struggle against France. Another of Peter's brothers, John (d. 1440), a stout supporter of England, was made governor of Paris by Henry V. He sold Joan of Arc to the English. Peter's son and successor, Louis, fought at first for England, but about 1440 he entered the service of France and obtained the office of constable. King Louis XI accused him of treachery, and he took refuge with Charles the Bold, duke of Burgundy; but the duke handed him over to the king and he was beheaded in 1475. The elder branch of his descendants became extinct in the male line in 1482, and was merged through the female line in the house of Bourbon-Vendôme. Louis' third son, Anthony (d. 1510), founded the family of Luxembourg-Brienne, the senior branch of which became extinct in 1608. A junior branch, however, was the family of the duke of Luxembourg-Piney, whose last representative, Margaret-Charlotte (d. 1680), married firstly Léon d'Albert de Luynes (d. 1630) and secondly Charles Henry de Clermont-Tonnerre (d. 1674). Her daughter by her second husband, Madeleine Charlotte, married Francis Henry de Montmorenci (d. 1695) and de Luynes, and subsequently members of the family of Montmorenci claimed the title of duke of Luxembourg. The Luxembourg palace in Paris owes its name to the fact that it was built on a site belonging to the duke of Luxembourg-Piney.

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LUXEMBOURG, province of southeast Belgium, formed of the high wooded Ardennes. Area 1,705 sq.mi.; pop. (est. 1939) 218,643. The upper Ourthe and lower Semoise valleys are much visited. The extreme south, often called Belgian Lorraine, has mines of minette (iron ore) and there, to the south of the high Ardennes, cultivation also prospers. On the higher ground are forest industries and slate quarrying at Vielsalm, Herbeumont, Bertrix, Martelange, etc. The chief towns are Arlon (the capital), Virton, Marche, and Bastogne. There are 5 administrative *arrondissements*, 20 cantons and 233 communes.

LUXEMBOURG or Lutzelburg (*i.e.*, the little fortress or town), the capital of the grand duchy of the same name (*see* above), situated on the Alzette, a tributary of the Sûre. Pop. (1935) 57,740. It is situated on cliffs which overhang the river, and the principal portion of the town with the palace and public buildings covers a central plateau. The more densely populated parishes of Clausen, Pfaffenthal and Grund lie in the valley. The fortress, considered the strongest in Europe after Gibraltar, was dismantled in 1867. Two viaducts carry the railway and the approach from the railway station to the town. The Alzette is lined with tanneries, breweries and distilleries. The Hôtel de Ville contains a collection of antiquities. The church of Notre Dame was built in 1613, and that of St. Michael dates in part from 1320. There are two annual fete days, one in honour of Our Lady of Luxembourg, patroness of the city, held on the Sunday before Ascension Day, and the other the annual fair or *Schobermesse* (tent fair), instituted in 1340 by Count John of Luxembourg, king of Bohemia, and held on Aug. 24.

LUXEMBURG, ROSA (1870–1919), German revolutionary, known as "rote Rosa," was born at Zamość, Russian Poland, on Dec. 25, 1870. An active worker among Polish socialists, she migrated about 1895 to Germany, where she married a German workman in order to acquire German nationality. In 1898 she edited the Saxon *Arbeiterzeitung*, but shortly afterwards joined the staff of the *Leipziger Volkszeitung*. She took part in the Russian revolution of 1905, and on her return to Germany founded with Karl Liebknecht the Spartacus league. In 1914 she was sentenced to a year's imprisonment for inciting to insubordination and throughout World War I remained in preventive custody. After the revolution she edited, with Liebknecht, the communist paper, *Rote Fahne*. They were arrested on Jan. 15, 1919, on the charge of instigating the street fighting in Berlin which had taken place a few days earlier. While being conveyed to the Moabit prison they were brutally attacked by army officers. Liebknecht was murdered and Rosa Luxemburg died a few hours later from injuries received. Her body was thrown into the canal, and only found some days later.

Bibliography.—Her works include *Die Akkumulation des Kapitals* (1913); *Die Krise der Sozialdemocratie* (1919) under the pseudonym "Junius"; *Briefe aus dem Gefängnis* (1920) and *Briefe an Karl und Luise Kautsky, 1896–1918*. *See* also G. Zinoviev, *Karl Liebknecht et Rosa Luxemburg* (1919); C. P. A. F. Liebknecht, *The Murder of Karl Liebknecht and Rosa Luxemburg* (1924).

LUXEUIL-LES-BAINS, a town of eastern France, in the department of Haute-Saône, 18 mi. N.E. of Vesoul. Pop. (1936) 5,590. It lies in a region of forests on the right bank of the Breuchin. Luxeuil was the Roman *Lixovium* and contained many fine buildings at the time of its destruction by Attila in 451. In 590 St. Columban there founded a monastery. In the 8th century it was destroyed by the Saracens; afterward rebuilt, monastery and town were devastated by the Normans in the 9th century and pillaged several times later. The abbey schools were celebrated in the middle ages; the abbey was suppressed at the Revolution. The 14th-century abbey-church contains a curious 17th-century organ loft in the form of an immense bracket supported by a colossal figure of Hercules. The abbot's palace (16th and 18th centuries) serves as presbytery and *hôtel de ville*. A cloister of the 15th century remains. There are several mansions and houses dating from various periods from the 14th to the 16th century. The Maison Carrée, once the town hall, is an interesting specimen of 15th-century architecture. The Maison de la Baille and the Maison François I are of the Renaissance period. Luxeuil is renowned for its mineral springs, some ferruginous, and some alkaline; their temperatures range from 70° to 158°. The water is employed for drinking and for baths. The bathing establishment contains a museum of Gallo-Roman antiquities and there are also remains of Roman baths and aqueducts to be seen in or near it. Copper founding, the spinning and weaving of cotton, lacemaking, dyeing and the distilling of kirsch are carried on.

LUXOR, more properly El-Aksur, "The Castles" (plur. of kasr), a town of Upper Egypt, on the east bank of the Nile, 450 mi. above Cairo by river and 418 mi. by rail. It is the centre for visitors to the ruins of and about Thebes, and has several fine hotels. There are Anglican and Roman Catholic churches, and a hospital opened in 1891. The district is the seat of an extensive manufacture of forged antiques.

The temple of Luxor is one of the greatest of the monuments of Thebes (*q.v.*). It stands near the river bank on the S.W. side of the town and measures nearly 300 yd. from back to front. There may have been an earlier temple here, but the present structure, dedicated to the Theban triad of Amen, Mut and Khansu, was erected by Amenhotep III. The great colonnade, which is its most striking feature, was apparently intended for the nave of a hypostyle hall like that of Karnak, but had to be hastily finished without the aisles. After the heresy of Amenhotep IV (Akhenaton), the decoration of this incomplete work was taken in hand by Tutenkhamon and Horemheb. The axis of the temple ran from southwest to northeast; a long paved road bordered by recumbent rams led from the façade to the temples of Karnak in a somewhat more easterly direction, and Rameses II adopted the line of this avenue in adding an extensive court to the work of Amenhotep, producing a curious change of axis. He embellished the walls and pylons of his court with scenes from his victories over Hittites and Syrians, and placed a number of colossal statues within it. In front of the pylon Rameses set up colossi and a pair of obelisks (one of which was taken to Paris in 1831 and re-erected in the Place de la Concorde). Alexander the Great rebuilt the sanctuary. The chief religious festival of Thebes was that of "Southern Opi," the ancient name of Luxor. The sacred barks of the divinities preserved in the sanctuary of Karnak were then conveyed in procession by water to Luxor and back again; a representation of the festal scenes is given on the walls of the great colonnade. The Christians built churches within the temple, and a mosque used to cover its western end. Clearance and restoration was begun by the Service des Antiquités in 1885, and has been vigorously pursued since. The principal street of Luxor follows the line of the ancient avenue.

LUXORIUS, Roman writer of epigrams, lived in Africa during the reigns of the Vandal kings Thrasamund, Hilderic and Gelimer (A.D. 496–534). He speaks of his poor circumstances, but, from the superscription *clarissimus* and *spectabilis* in one ms., he seems to have held a high official position. About a hundred epigrams by him in various metres (the elegiac predominating) have been preserved. They are after the manner of Martial, and deal chiefly with the games of the circus and works of art. Luxorius also wrote on grammatical subjects (*see* R. Ellis in *Journal of Philology,* viii, 1879). The epigrams are contained in the *Anthologia Latina,* edited by F. Bücheler and A. Riese (1894).

LUXURY. The word luxury is derived from the Latin *luxus,* which may be translated "superfluous abundance." As generally used, it implies the notion of a relatively large consumption of wealth for unessential pleasures. But there is no absolute definition of luxury, for the conception is essentially relative to both time and person. It is a commonplace of history that the superfluities of one generation may become the necessaries of a subsequent period; there is no hard and fast line which can be drawn between luxuries, comforts and necessaries. The private bath was one of the greatest luxuries of the Roman empire; in the 19th century its use was largely confined to the wealthy; to-day it may be ranked amongst the necessaries of life. Looked at from one important standpoint, luxury might be defined as any expenditure which is in excess of the normal and customary standard of living of the class to which the individual concerned belongs.

The problem of luxury is one which involves economic, social and ethical considerations.

The Economic Aspect.—Viewed from the economic standpoint luxury has undoubtedly played a great rôle in the history of economic development. W. Sombart in his *Luxus und Kapitalismus* has shown that the luxurious expenditure of the papacy and of the courts in the middle ages had a not unimportant share in the growth of modern capitalism. The rentals of distant estates were concentrated at some central spot; wealth was accumulated there; a relatively large market was created for the products of certain industries; and the necessary conditions for the development of capitalist enterprise were fulfilled.

In France, the classic land of luxury, the continual drain of wealth from the countryside to Paris and Versailles, combined as it was with a vicious system of taxation and the burdensome restrictions of feudal tenure, produced, on the one hand, a considerable amount of industrial activity, carefully fostered by the mercantilist policy of Jean Colbert and his successors; but, on the other hand, it led eventually to the disruption of the old social order amidst the turmoil of the French Revolution. It is one of the paradoxes of history that a precisely opposite view and method of life—that of the Puritans, with their strong moral condemnation of luxury and their emphasis on the value of hard work and abstinence from all unnecessary consumption—should have contributed even more notably to the growth of capital and to the expansion of industry and commerce.

In other directions, also, luxury has made its influence felt. Thus in Italy, the rise of the merchant princes gave a new direction to the whole course of art, for the mediaeval church ceased to be the chief patron of the artist, who now had to conform in his work to the standards and tastes of those who provided the market for his products. The simple piety of the primitives gave place to the sumptuous paganism of the Renaissance period, and that in turn to the elaborate ornamentation and decorative inventiveness which was perhaps at its best in the metal work of Benvenuto Cellini, until at length the over-refinements of a decadent social life killed all artistic inspiration.

Luxury is the inevitable concomitant of the growth of wealth, which brings with it the increase and the differentiation of wants. The fact that the fundamental needs of mankind for a minimum of food, clothing and protection from the weather are relatively soon satisfied gives rise to a demand for greater variety and finer qualities as soon as income rises above the bare subsistence level. This demand, which is especially strong among the feminine portion of the human race, has, in the past, been a great stimulus to economic progress, for it has provided an enormously strong incentive to work and effort.

The attitude of the great majority of people towards the luxurious expenditure of the rich is a mixture of envy, often devoid of any feeling of resentment, and of approval based on popular economic reasoning. It is a very widespread belief that such expenditure is good for trade because it makes money circulate and therefore increases employment. The classical economists, down to and including Alfred Marshall, had no hesitation in declaring that this reasoning was based on a fallacy. They agreed that the maintenance of racing stables or private yachts, the purchase of magnificent furs or jewellery, does give employment to those engaged in the trades concerned, and that the localities in which these trades are situated benefit from such expenditure. But they argued that the fallacy of such reasoning lay in ignoring the fact that the aggregate real resources of producing power in a country are limited at any one time. A large amount of capital and labour is required to make and equip yachts and racing stables, and this capital and labour is withdrawn from other uses to which it would be put. If the wealth consumed extravagantly was saved and invested, the volume of capital would be increased, the rate of interest would tend to fall and there would be a larger demand for labour to co-operate in the production of goods consumed by other sections of the community. If, in a capitalist society, there was a sudden change in the standards of expenditure of the wealthy classes such that all expenditure commonly recognized as luxurious was regarded with strong social disapprobation, these persons would find themselves impelled to save on a much larger scale than formerly, and a great deal more capital would be available for production. But as the ultimate aim of production is consumption the net effect of the change of policy in regard to expenditure would be to transfer additional spending power to all the less wealthy members of the community. The latter would benefit by higher money wages, owing to the greater demand for their services, and from the still higher *real* wages, owing to the fall in the rate of interest and to the larger production of the type of commodities which they consume. Some proportion of this increased wealth would be consumed by the poorer classes in the form of luxuries, as we have defined this term above, or in an increased enjoyment of the quasi commodity, leisure. The ultimate consequences of such a change would depend, firstly, upon the economic and social effects of this transfer of real income to the poorer classes and, secondly, upon the willingness of the wealthier classes to continue to work as hard and efficiently as formerly to produce incomes which they do not themselves enjoy by consumption, and the spending power of which they in fact transfer to other people. Thus far the classical view of the economic effects of luxurious expenditure. More recently, however, and particularly under the influence of the ideas put forward by Lord Keynes, a fresh turn has been given to the discussion.

When closely examined the classical view is found to depend for its validity upon the assumption of full employment of the community's available resources. If there are idle resources and if the saving portion of the community prefer to hold their savings in the form of money rather than in the form of investing them in some income-yielding use (other than the purchase of old securities), then any additional expenditure on the part of any section of the community will increase the volume of employment and make the total national income larger than it would otherwise have been. While it is true on the one hand that the country as a whole cannot save what it cannot invest, any given level of investment and saving may fall short of occupying fully all the resources of the economy. Under these conditions a decision by an individual to save rather than to spend part of his income may merely have the effect of inflicting an equivalent loss on other individuals. The saver will, it is true, hold a larger command over the community's wealth than before, whether in the form of money, or in the form of securities which have had to be sold by other members of the community in order to finance their losses, but the total savings of the community have not been increased, but rather diminished, because of the resultant fall in the national output and income. It still remains true that the community will normally benefit more by an expansion of investment rather than by an increase of luxurious expenditure; but if the savings would otherwise run to waste in an increase of "hoarding," then a rise in what is called the "propensity to consume" will increase the total volume of employment and output, and will not, as in the classical case, be at the expense of an equivalent amount of investment which would otherwise have been made. In this way the popular argument has partially come into its own again in relation to short period analysis and to certain phases of the trade cycle when there is a shortage of effective demand.

The Social Aspect.—The slow process of disruption of feudalism, which is not yet completed in England, has substituted for the old hereditary, semicaste, organically knit order of a society a new plutocratic social system, amorphous and anarchic in structure, its values based on and expressed in terms of money, its relationships governed by a financial nexus. Formerly wealth had its duties and responsibilities, which were widely, if not universally, recognized, but the industrial revolution (*q.v.*) has tended for a while to divorce wealth from responsibility, and though a new social consciousness is springing up, nowhere more clearly than in the United States of America, it has not yet penetrated very deeply. As a result there has grown up in modern times in every class an enormous amount of purely ostentatious expenditure—the outcome of the desire for distinction which is one of the most deep-rooted characteristics of human nature. Until new standards arise—and there is evidence that they are being formed—distinction in the modern world is most easily afforded by the opportunities which wealth provides for display.

As T. B. Veblen has shown in his *Theory of the Leisure Class*, the evils of bad standards of expenditure are not confined to the wealthy classes from which they spring; they propagate and perpetuate themselves by example and imitation right down the social scale from top to bottom; what is called "snobbishness" is a very potent social force, but it is one which may as easily work for the good as for the harm of humanity. It has been well said that mankind is nowhere more vulgar than in the way in which it spends its incomes. No amount of time, effort or thought is grudged to the acquiring of wealth, but when we come to consume it we dissipate the fruits of our labours often with small gain to ourselves and with unforeseen and undesired repercussions on the welfare of the community as a whole. What R. H. Tawney has termed—in a notable book bearing this title, *The Acquisitive Society*—is the outcome of false social values, inspired by the all-pervading impulse to acquire riches to the elimination, or at least repression, of other higher ideals. While the churches wrangle over doctrine, they largely ignore the great problem of the art of spending which is so large a part of the art of living.

The Moral Aspect.—Moralists of all ages have attacked luxury on ethical grounds—the Stoics, because it ran counter to their ideals of simplicity of life; the early Christian Fathers, because they exalted asceticism and poverty into an ideal; the Puritans, because they feared lest the distractions and temptations of luxury might imperil the immortal soul and endanger its chances of salvation; the Socialists, because they hold unnatural and immoral the coexistence of luxury on the one side and poverty on the other.

In recent times the tendency has been increasingly for the moral judgment of luxury to be associated with the general problem of the unequal distribution of wealth—a view which, as is pointed out above, overlooks the fact that luxury is not confined to the richer sections of the community. The rigid condemnation of all luxury on moral grounds is untenable, if only for the reasons that there is no absolute measuring rod by means of which the ultimate social ethical value of expenditure can be tested, and that economic progress and changing standards of life so quickly alter contemporary notions of the types of expenditure that may be included under the category of luxuries. But a great deal of luxury is undoubtedly a waste of life, not least because of the ill effects it may have upon the individuals themselves, but also because the resulting satisfaction is frequently out of all proportion to the expenditure. As Prof. Pigou has pointed out in his *Economics of Welfare:* "It is at least arguable, that, after a point, as growing wealth gives a man command over more and more luxuries the satisfaction that he gains from each one is, as it were, taken out of relaxed interest in the others, so that the satisfaction which he derives on the whole is not substantially increased."

Consumption has its ethical as well as its economic aspects, and there are heavy moral responsibilities involved in the exercise by the individual of his right of disposal over the wealth which economic forces and social laws have placed in his hands.

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LUXURY TAXES. The imposition of taxes on articles which are deemed to be luxuries may spring from one of two motives, or frequently, from a combination of both. In the first place, the tax may be intended to restrict the expenditure of money in certain directions. Here it forms a part of sumptuary legislation designed to repress the ostentation and extravagance of private persons. When the legislator had failed by direct prohibition to stamp out a certain type of expenditure that was deemed to be injurious, there remained the alternative of levying a heavy tax upon it. The success of the tax from this point of view could be measured by the smallness of the revenue derived from it, assuming that it was not possible to evade it. In England from the 14th to the 16th centuries there is a long history of sumptuary legislation, never properly enforced, directed chiefly against the wearing of rich clothes of foreign materials, the purchase of which tended to create an adverse balance of trade and thus ran counter to one of the cardinal principles of mercantilist policy. Most English laws of this nature were repealed in 1603. Economic writers in the 17th century considered that the consumption of luxuries was good for trade, and the growth of the finer types of manufacture of silk and woollen goods inside England removed a good deal of the force of the argument which had been based on the fact that such could only be procured from abroad. In the 18th century laws were passed against the wearing of French lawns and laces, partly to protect English manufactures and partly as a weapon of offence against the French. Adam Smith objected to sumptuary laws for a curious but characteristic reason: "It is the highest impertinence and presumption in kings and ministers, to pretend to watch over the economy of private people and to restrain their expense, either by sumptuary laws or by prohibiting the importation of foreign luxuries. They are themselves always and without any exception the greatest spendthrifts in the society. If their own extravagance does not ruin the State, that of their subjects never will."

In the second place, luxury taxes are imposed for revenue purposes as a method of taxation of the rich or as a tax on that part of the expenditure of all classes that is regarded either as socially undesirable or as a superfluity over and above all necessary expenditure and therefore a specially appropriate object of taxation.

In the late 18th and early part of the 19th centuries duties were levied in England on a number of articles. Hair-powder, silver plate, clocks, watches, horses, carriages, men-servants, dogs, armorial-bearings, playing-cards—all these have, for longer or shorter periods, contributed their quota to the revenue and, in the case of the last five objects mentioned, the taxation has continued to the present day. On the continent of Europe many of the same articles were taxed, but billiard tables also appear in many countries to have made specially strong appeal to the imagination of finance ministers. It is obvious from the above list that this form of taxation, as a source of revenue, suffers from the defect of being very unproductive. The rate of taxation is generally low, because otherwise the great elasticity of demand, which is a characteristic of most real luxuries, would result in the tax stifling consumption altogether. Relatively to its yield it is also costly to collect and irritating to the taxpayer. A form of luxury taxation that has been suggested, and which has the high authority of Marshall, is that heavy duties might be imposed on certain kinds of ostentatious expenditure, where the demand for the articles in question arises chiefly from the fact that they are rare and expensive and that their possession is a sign of great wealth. Heavy taxation of such objects as large diamonds or other precious stones or rare furs would merely serve to enhance their costliness and therefore the social distinction to be derived by their owners.

In modern times there has been a strong tendency for Governments to place taxes on certain classes of expenditure which fall rather within the category of what Marshall has termed "conventional necessaries" than of what are ordinarily regarded as luxuries. Most expenditure upon alcohol, tobacco, articles of silk, entertainments, private motor-cars, etc., is clearly superfluous in the sense that a large part of it is in excess of what is required for economic efficiency and personal well-being. No man need consume any specific quantity of these things, and any contribution that he may make to the revenue by purchasing them is the result of his own voluntary act. He can avoid taxation by refraining from consuming the taxed articles. Nevertheless, in actual fact these articles are purchased on an enormous scale and, as objects of taxation, they have the great advantage from the point of view of the chancellor of the Exchequer of having, within limits, an inelastic demand and thus of bearing heavy rates of tax without an undue contraction of demand. In appearance the familiar strictures on the taxation of necessaries are observed, but in reality many people pay an altogether undue proportion of their incomes to the Exchequer, owing to their insistence on purchasing articles, much of the price of which is composed of tax; just as before the World War it was a familiar grievance in Ireland that the Irish people as a whole paid an excessive proportion in relation to their wealth of taxes to the British Government, owing to the very high level of the whisky duty.

The problem of the relation between the revenue and the sumptuary aspects of a tax on consumption is nowhere more clearly seen than in the case of taxes on alcohol. Every chancellor of the Exchequer, as a member of the Government, will lay stress on the beneficial effects of high taxation in reducing the quantity of alcohol consumed and in lessening the evils of drunkenness. But in his capacity as finance minister he is continually looking at the quantity of revenue to be derived and carefully estimating that rate of tax which will bring in the largest total receipts. The advocates of temperance reform would probably seek his support in vain if they were to urge the raising of the duties to such a level as to diminish seriously their aggregate yield to the Exchequer. The case of alcohol illustrates some of the difficulties which may arise in a financial system which depends to any important extent upon taxes on articles of a luxury character. Luxuries are notoriously subject to changes in fashion, or taste, or public opinion. An alteration in the attitude of English people towards the consumption of alcoholic beverages, which led to a large decrease in such consumption, would create a most serious budget deficit.

In considering the proper position of luxury taxes in the general tax system of a country like England, it may be pointed out that an income tax can only make very partial allowances for variations in necessary expenditure, and there is therefore a strong case for supplementing the progressive rates of direct taxation with rather high taxes on the kind of luxuries which can only be bought by those whose incomes are much in excess of all normal and necessary requirements. (C. W. G.)

The United States.—The early colonial governments followed the examples of European states and taxed those things which from traditional or arbitrary points of view were regarded as luxurious, such as billiard tables, pleasure vehicles and even window glass. "Luxury" taxation is a dubious term, for as modern economists illustrate, luxuries and necessities tend rapidly to obliterate their lines of demarcation.

The modern type of luxury tax, in the form of sales or turnover or excise taxes, began in the U.S. in the Civil War; a heavy, comprehensive system of excise taxes on "non-essentials" being adopted in 1862, the rates being increased again in 1864. These excise taxes supplied over half the Civil War tax receipts; the income tax playing a minor role. The War Revenue Act of 1917 laid new taxes on a wide range of "non-essential" commodities, many of which were promptly dubbed "nuisance" taxes. Some, like the tax on soda fountain drinks, were not only costly to collect but were frequently evaded. When the Revenue Act of 1921 was adopted, the objectionable "nuisance taxes" (on soda fountain drinks, transportation tickets, etc.) were repealed.

The impact of the 1929–35 depression was such that new luxury taxation became inevitable, not only through Federal excise taxes but through state sales taxes. The Revenue Bill of 1932 taxed admissions and laid manufacturers' excise taxes on cosmetics, furs, jewelry, sporting goods, cameras, yachts, motor boats, firearms, radios, phonographs, automobiles, mechanical refrigerators, chewing gum and candy, beverages, malt, oil, gasoline, telephone and telegraph messages, matches, pipe lines, safety deposit boxes. Earlier luxury taxes included tobacco, liquor, club-dues, playing-cards, sale of produce, oleomargarine, stock transfers, etc. Important exemptions were made—garden and farm products, food items, newspapers, periodicals.

Resistance to adoption of a general turnover or sales tax has had the natural effect, under pressure of war or depression, of raising the taxation rates on luxuries. The usual 1 or 2% rate rises to 10% or 15%. However, the history of taxation shows that only taxes on articles of wide consumption enjoying inelastic demand may be depended upon to yield large tax revenues at low collection cost. Collection of luxury turnover taxes is notoriously difficult, and they yield low revenue; taxation tending strongly to limit consumption. Ideal items of so-called luxury taxation consequently are alcoholic beverages, tobacco, coffee, tea, sugar, gasoline; but the general public will not admit that these are in a real sense luxuries. It is also a realistic tax fact that ordinary taxable articles change hands many times from producer to consumer and the tax at a low rate may total almost as much as the tax on "luxuries" at the high rate.

The policy of selected taxes is nevertheless adapted to American ideas and experience. A major part of Federal revenues ever since the Civil War has come from selective excise taxes. The issue at stake has been, and is now, whether a general sales tax may be avoided by means of the selected taxes. The remarkable rise of state sales taxes (most of which have been selective because of exemptions) during the 1929–35 depression seemed during 1934–35 to point to replacement of state sales taxes with Federal sales taxes, but revulsion against state sales taxes set in in 1935 and averted this tendency. Manufacturers' selected excise taxes prevent pyramiding in the process of producer-consumer distribution. (J. G. F.)

LUYNES, CHARLES D'ALBERT (1578–1621), 1ST DUKE OF, was brought up at court and attended the dauphin, who later became Louis XIII. He was high in Louis's favour, and used his influence to intrigue against the queen-mother Marie de Medici and her favourite Concini. Luynes, with Vitry, captain of the guard, arranged the plot that ended in Concini's assassination (1617) and secured all the latter's possessions in Italy and France. He was appointed captain of the Bastille and lieutenant-general of Normandy, and married Marie de Rohan, daughter of the duke of Montbazon. In 1619 he negotiated the treaty of Angoulême by which Marie de Medici was accorded complete liberty. He was made governor of Picardy in 1619; suppressed an uprising of nobles in 1620; and in 1621 was appointed constable of France. Luynes undertook an expedition against the Protestants, but died at Longueville in Guienne, on Dec. 15, 1621.

See *Recueil des pièces les plus curieuses qui ont esté faites pendant le règne du connestable M. de Luynes* (2nd ed., 1624) and B. Zeller, *Études critiques sur le règne de Louis XIII.: le connétable de Luynes, Montauban et la Valteline* (Paris, 1879).

LUZAN CLARAMUNT DE SUELVES Y GURREA, IGNACIO (1702–1754), Spanish critic and poet, was educated in Italy where, as a pupil of Vico, he read assiduously. He returned to Spain and there published *La Poética, ó Reglas de la poesía en general y de sus principales especies* (1737), a recast of his thesis (1728) for the academy of Palermo.

Luzan was the most powerful exponent of Franco-Italian theories in Spain, and his *Poética* is an admirable example of destructive criticism. The defects of Lope de Vega and Calderon are indicated with vigilant severity, but on the constructive side Luzan is notably weak, for he merely proposes to substitute one exhausted convention for another. The doctrine of the dramatic unities had not the saving virtues which he ascribed to it, and, though he succeeded in banishing the older dramatists from the boards, he and his school failed to produce a single piece of more than mediocre merit.

LUZERN (Fr. LUCERNE), the capital of the Swiss canton of the same name. It is one of the principal tourist centres of Switzerland, being situated on the St. Gotthard railway line, by which it is 59 mi. from Basel and 180 mi. from Milan. The nucleus of the town was the monastery, founded about 750 on the right bank of the Reuss by the abbey of Murbach in Alsace, of which it long remained a "cell." It is first mentioned in a charter of 840 under the name of "Luciaria," and the form "Lucerrun" is first found in 1252.

The germs of a municipal constitution appear in 1252, and in 1291 the Habsburgs purchased Lucerne from Murbach, an act that led a few weeks later to the foundation of the Swiss Confederation, of which Lucerne became the fourth member (the first town to be included) in 1332. It finally got rid of Habsburg domination after the victory of Sempach (1386). That victory led also to the gradual acquisition of territory ruled by and from the town. At the time of the Reformation Lucerne clung to the old faith, of which ever since it has been the great stronghold in Switzerland, and the papal nuncio resided here from 1601 to 1873. In the 16th century, as elsewhere in Switzerland, the town government fell into the hands of an aristocratic oligarchy, whose power, though shaken by the peasant revolt (1653), lasted until 1798. Under the Helvetic republic (1798–1803) Lucerne was the seat of the central government, under the act of Mediation (1803–14) one of the six "Directorial" cantons and from 1815 to 1848 one of the three ruling cantons.

The patrician government was swept away by the cantonal constitution of 1831, but in 1841 they regained power, called in the Jesuits (1844) and so brought about the Sonderbund War (1847) in which they were defeated. The Radicals lost power in the canton in 1871, after which date the Conservatives became predominant in the canton, though in the town the Radicals were in the majority. Its prosperity has always been bound up with the St. Gotthard pass, so that the successive improvements effected on that route (mule path in the 13th century, carriage road 1820–30, and railway tunnel in 1882) have had much effect on its growth. Railways also connect Luzern with Meiringen, Bern, Zug, Geten and Lenzburg.

Luzern is situated on the banks of the river Reuss, just as it issues from the Lake of Lucerne, while to the south-west rises the range of Pilatus, balanced on the east by the ridge of the Rigi. To its north still stand nine of the towers that defended the old town wall.

The Reuss is still crossed by two old wooden bridges, the upper being the Kapellbrücke (adorned by many paintings illustrating the history of Switzerland and the town and clinging to the Wasserthurm) and the lower the Mühlenbrücke (with paintings of the Dance of Death). The old Hofbrücke (on the site of the Schweizerhof quay) was removed in 1852.

The principal building is the twin-towered Hofkirche (dedicated to St. Leger or Leodegar) which, though in its present form it dates only from 1633–35, originally formed part of a Benedictine monastery. It has a 17th century organ. The 16th century town-hall (Rathhaus) now houses the cantonal museum. Both the cantonal and the town libraries are rich in old books. The Lion monument, designed by Thorwaldsen, dedicated in 1821, and consisting of a dying lion hewn out of the living sandstone, commemorates the officers and men of the Swiss Guard, who were slain while defending the Tuileries in Paris in 1792. In the immediate neighbourhood is the Glacier garden, a series of potholes worn in the sandstone rock bed of an ancient glacier.

In 1799 the population numbered but 4,337, but had doubled by 1840. Since then the rise has been rapid and continuous: 29,255 (1900); 47,066 (1930); 54,841 (1941). The majority are German-speaking (in 1930 there were 1,041 Italian-speaking and 1,340 French-speaking persons) and Roman Catholics (in 1930 there were 10,630 Protestants and 469 Jews). (For canton of Luzern, *see* LUCERNE).

LUZERNE, an anthracite-mining borough of Luzerne county, Pennsylvania, U.S.A., on the west bank of the Susquehanna river, immediately north of Kingston; served by the Lackawanna railroad. Pop. was 6,950 in 1930 and 7,082 in 1940, federal census.

LUZON, the main and most northerly island of importance in the Philippine archipelago. It extends from 18° 39′ N. to 12° 32′ N. and from 119° 44′ E. to 124° 12′ E. Running generally north and south, it is of irregular outline, with extreme dimensions 460 mi. by 140 mi., and a coastline of 2,242 mi.

The more important mountain ranges are the Cordillera Central in the north, the Sierra Madre following most of the east coast and the Zambales range near the west coast. Mt. Pulog, 9,606 ft. is the highest peak. Isolated volcanic cones, as Mt. Mayon, 7,946 ft., occur in the south. The Cagayan valley, in the north, and the 100-mi. long central Luzon plain are the chief lowland areas. The Gulf of Lingayen and the Manila bay, both indentations of the South China sea, bound this plain on the north and south. It is the heart of Luzon and is densely populated.

The Laguna de Bay (344 sq.mi.) and Taal (94 sq.mi.) both near Manila, are the chief fresh water lakes. Both are shallow. The Cagayan, 220 mi. long and draining more than 9,000 sq.mi. is the largest river. The Pasig, at the mouth of which, on Manila bay, Manila is built, is of commercial importance.

Harbours in the north are few, mostly poor and undeveloped. The southern two-thirds of the island has many good anchorages and harbours. The artificial Manila harbour, of 1,200 acres area, has wharfage facilities for the largest commercial vessels. Other ports are Olongapo on Subic bay, Batangas and Legaspi.

Luzon has an area of 40,420 sq.mi. and a population of 7,374,798 (1939 census of the Philippines).

It is a seagirt segment of the great ring of highlands that circles the Pacific, with great depths of sea along the Pacific side of the ring. Volcanoes, active, quiescent and dead occur in the southern half of the island. Together with the other Philippines, it is an unsubmerged mountain mass on the edge of the Asiatic continental platform. Folding, faulting and volcanic action have formed it. Periods of greatest formative activity were pre-Tertiary, late Miocene, early Pleistocene, with great uplift continuing into recent periods. Plutonic and older extrusives characterize most of the main mountain masses, except in the Bicol peninsula, where there is a considerable belt of younger volcanics. Alluvial and littoral deposits comprise the Cagayan and central Luzon valleys. There is an extensive tuff area south of Manila bay. Tertiary sediments are widespread in the Cordillera Central and the Bondoc peninsula.

The western and greater part of Luzon has a pronounced wet season—dry season type of climate, with heavy rains from May to October. The Pacific coast and most of the Bicol peninsula have rains the year round with a pronounced maximum rainfall in winter. The greater part of the Cordillera Central has rains most of the year, with no excessive maximum period. The Cagayan valley and southern Tayabas have a short dry season of one to three months, with rains the rest of the year. Of some 140 typhoons causing a barometric pressure of less than 745 mm. over the period 1903–38, the tracks of at least 75 crossed Luzon. These generally occur from June to October.

Temperatures are generally high, but tempered by the effect of the surrounding sea. In the mountains of the north, as at Baguio, Europeans find the temperature very agreeable. Mean temperature runs between 25.4° C. and 28.6° C., with absolute extremes during a period of 53 years of 14.5° C. and 38.6° C. Yearly rainfall varies according to the four types of climate from 82.18 in. at Manila to 175.98 in. at Lucban.

The flora of Luzon is rich, generally Malaysian in character. Some Himalayan types are found in the high mountains of the north. Many species are endemic. The difference between the occurrence of native forms in primary forests and in settled and secondary-growth areas of the lowlands would indicate considerable introduction of growths common to the great Indo-Malaysian region. Coastal vegetation is virtually the same as that of the other Asiatic tropics.

Forests, except for the pine regions (*Pinus insularis*) of the northern mountains, are of very mixed character. The dominant species at lower altitudes are *Dipterocarps*. Higher representatives of oaks, rhododendrons and other temperate species appear. Orchids are very numerous, as are ferns and mosses. Forests of any great extent or potential commercial importance are restricted to the more or less inaccessible reaches of the Sierra Madre on the Pacific coast, some areas of the Bicol peninsula and the Zambales range. Reforestation has become of sufficient need for 21 of the 25 reforestation projects in the whole archipelago to be assigned to Luzon, as of 1939. To control further deforestation, extensive forest reserves were established in the Cordillera Central.

The vegetative cover usually seen in the settled area, apart from field crops, consists of fruit trees and other cultivated utilitarian plants, as bamboo and the "acacia" (*Enterolobium saman*), the common shade and ornamental tree lining the roads and plazas of the villages. Because of the rains and nature of the soil this cover is usually of sufficient abundance and density to create the standard impression of tropical luxuriance. Among the fine or useful woods still available are molave (*Vitex parviflora*), narra (*Pterocarpus indicus*, the *padauk* of Burma and the Andamans), tindalo (*Pahudia rhomboidea*), Yakal (*Shorea* sp.), lumbayao (*Sarrietia javanica*), apitong (*Dipterocarpus grandiflorus*) and almon (*Shorea eximia*). Rattans, tanbarks, firewood, charcoal, fibres, resins, gums, oils, herbs and orchids are other forest products. The coconut palm in southern Luzon contributes heavily to the Philippines' position as the world's leading coconut products producer. Other valuable palms are the buri (*Corypha elata*) for a delicious sugar and fibre for hat-weaving, and the nipa (*Nipa fruticans*), producing alcohol, vinegar and the standard thatch-roofing of the houses of the common people.

Luzon has a great variety of food plants, native and introduced, about 500 species altogether. Of prime importance are rice, corn, coconuts, sugar-cane, yams, bananas, vegetables. Of other than food value, are abaka or Manila hemp and tobacco. Pre-eminent among fruits is the delicious carabao mango, not exceeded in quality by any other mango; some of the banana varieties have a delicate and aromatic flavor.

While the Philippines are considered an extension of the Indo-Malaysian subregion, there is much specialization in the fauna of those of them lying east of the Palawan group, thus including Luzon. Mammals are scarce, except for shrews, rats, mice and bats.

The birds show strong relationships with those of Borneo, some with Celebes and New Guinea. Many of the species are endemic. Nearly 1,000 species of birds are found in the Philippines; the exact proportion of these occurring in Luzon, or peculiar to it, is not certain. The common fowl and domesticated ducks are abundant. Turkeys, guinea fowl, etc., have been introduced.

There are many reptiles. Pythons, cobras and other poisonous species occur, but fatalities from their bites are not common.

Mosquitoes, some conveying intensely malignant malaria, butterflies, moths, beetles and ants, are the more obvious insects. They show affinity with those of other Indo-Malaysian areas.

Fish of more than 1,000 species, fresh-water and especially marine, are plentiful, and are the chief animal, protein food of the people, rather than animal flesh. At least three-quarters of the species are edible. Of the total catch of 89,213.4 short tons of fish reported marketed in the 1939 census for the whole country, 51,214.3 tons represent the Luzon production. About $25,000,000 is invested in Luzon fishponds, chiefly along the shores of Manila bay, where milkfish, or *bangus* (*Chanos chanos*) are raised, producing for market 13,503.1 tons of fish valued at $3,000,000 annually.

Marine invertebrates occur in greater variety than in any other equal area.

Gold, silver with it, iron, copper, chromium, manganese, coal and salt are found in appreciable quantity. Most of the Philippine gold and silver production of 1940, amounting to $39,218,991, came from the Luzon centres of Baguio and Camarines Norte. Oil seeps are found in the Bondoc peninsula. Drilling has been carried on, but no production has occurred.

The people are of the general southeast Asiatic type, short-statured, straight and dark-haired, dark-eyed, light brown in colour, well-proportioned and graceful and modified by centuries of infiltration of Chinese and Spanish blood, and by contact with governing occidental cultures into the quite distinctive Filipino nationality. The ethnologist can easily trace the various stocks in their physical make-up, but except for a few isolated "tribes" in the mountains of the north the population is culturally homogeneous, and has a strong common national feeling. The influence of a common and widespread school system and the extension of uniform government was rapidly reducing what differences remained at the outbreak of the war with Japan.

Despite a generally common culture, strong linguistic divisions still survive. Of these, Tagalog is the leading native language. It is well-developed, flexible, has an extensive vocabulary and is capable of further growth to express modern ideas of science and learning. It has been adopted by the Philippine government as the base for the development of a "national" language. Upon the attainment of complete independence of the Philippines, it is to become an official language, along with English and Spanish. Other important native dialects are Ilocano, Bicol, Pampango and Pangasinan.

Manufacturing is largely confined to Manila and vicinity, but household industries are widespread, as, for example, along the Ilocos coast, where nearly every settlement has its artisan specialty. Agriculture is the occupation of most of the people, with many in mining, fishing and manufacturing. Retail trade is largely in the hands of Chinese, and wholesale import and export in the hands of Americans and Europeans. Filipino participation in trade and industry more extensively has not yet measured up to the desire for it.

Important towns, other than Manila (pop. 623,492, 1939 census) and its suburbs of Quezon City, Caloocan and Pasay, are Vigan, Dagupan, Baguio City, Cavite City, Batangas, San Pablo City and Legaspi.

General living standards are simple. Rice is the staff of life for rich and poor, with fish as the commonest animal protein; pork is also common, with beef, carabao, chicken and goat as next most common foods. Fruit and vegetables are plentiful, and imported groceries are available in most large towns. A large part of the population consists of peasant farmers, usually cultivating not more than a hectare of land. Implements are few and simple, and much dependence is placed on work animals rather than on machines. The carabao, or water-buffalo, is the favoured draft animal, although steers are much used on higher land. Land distribution is very inequitable, and has been at the bottom of armed uprisings and intense agrarian unrest in the decade just prior to the outbreak of World War II. The central Luzon plain is the scene of most of these problems which had not been solved by any means at the outbreak of the war with Japan. Many of the agrarian dissidents joined the Japanese invaders, serving as spies and fifth columnists.

In religion, 5,977,333 of the people profess Roman Catholicism; 891,000 belong to the Aglipayan church (a native sect claiming to draw most of its tenets and practices from the Roman Catholic church); 223,195 are Protestants; and 261,853 are pagans (native animists). Christian missionary activity is strong among the pagans.

Those holding citizenship of other countries number 77,996 Chinese, 8,109 Japanese, 7,165 United States, 3,349 Spanish, 981 German, 834 British, 713 British Indian and 192 Swiss, with numerous other countries represented. More than half of all aliens live in Manila.

The Manila railroad, entirely on Luzon, owned and operated by the Philippine government, is the most important in the whole country. It operates a system of 665.5 mi. between San Fernando, La Union, on the South China sea and Legaspi, on the Pacific ocean in southern Luzon. Length of the main line is 451.4 mi.

Administratively, Luzon is divided into the following provinces:

Abra	Camarines Norte	Laguna	Pangasinan
Albay	Camarines Sur	La Union	Rizal
Bataan	Cavite	Mountain	Sorsogon
Batangas	Ilocos Norte	Nueva Ecija	Tarlac
Bulacan	Ilocos Sur	Nueva Vizcaya	Tayabas
Cagayan	Isabela	Pampanga	Zambales

and the following chartered cities:

Baguio	Manila	San Pablo
Cavite	Quezon	Tagaytay

The provinces are administered by elective Provincial Boards, headed by a Provincial Governor. They are further subdivided into 577 municipalities. A municipality is usually a collection of villages or *barrios,* with their farmlands, grouped around a larger or central village, called the *poblacion,* as the seat of administration. It is controlled by an elective municipal council, headed by an elective municipal mayor. The chartered cities have special forms of government, partly elective, partly appointive.

As of March 1940, the extensive and well-supported public schools and colleges on Luzon had an enrolment of 999,308 students. Of this number 58,551 were secondary, and 9,068 collegiate. Private schools had 82,687; 37,041 and 21,175 (estimated), respectively, as of the same date. Virtually all instruction, from the kindergarten on up, was given in English. Manila was the educational metropolis of the whole country, fully 80% of all collegiate enrolment being in its institutions or in those of its immediate vicinity.

As of June 1940, the following roads (in kilometres) were in existence:

	First-class	*Second-class*	*Third-class*	*Total*
Whole country	11,881.9	7,393	3,795.1	23,070
Luzon	6,153.2	3,371.7	2,141.7	11,666.6
The heart of Luzon*	2,904.4	1,238.4	1,235.2	5,378

*The nine provinces of central and southern Luzon, centring on and including Manila, with a total area less than one-fourth that of the whole island. This is the area of greatest concentration of population. It has been twice fought over in World War II and has suffered great devastation.

As of 1940, 39,654 motor vehicles were registered in Luzon, 32,788 of them being in the "heart area." Luzon had 72.6% of all motor registrations for the whole country, illustrating graphically its prime importance.

Postal, telegraph, telephone and radio-communication systems were well-developed. Manila had trans-Pacific cable and radio connections with other countries.

Manila is by far the premier port, not only for Luzon, but for the whole archipelago. During the fiscal year ending June 30, 1940, exports to the value of $53,538,625 and imports worth $132,015,980 passed through it. Similar figures for the other Luzon ports of entry are: Legaspi, $4,453,010 and $250,039; Aparri, none and $258; Jose Panganiban (Mambulao) $2,523,618 and $790,943. Nearly 75% of all foreign trade was with the United States, nearly 6% with Japan and 2½% with Great Britain, the next two.

Chief exports were sugar, Manila hemp, coconut products, base metal ores, lumber, embroidery and tobacco. Chief imports were iron and steel and manufactures thereof, cotton goods, mineral oils, tobacco products, automobiles, paper, meat and dairy products, silk and rayon, chemicals and drugs and wheat flour.

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LUZ-SAINT-SAUVEUR, a town of south-western France in the department of Hautes-Pyrénées, 21 mi. S. of Lourdes by rail. Pop. (1936) 848.

Luz stands on the Bastan 2,240 ft. above sea-level. The church of the Templars was built in the 12th and 13th centuries and fortified later. Crenelated ramparts surround it, and the tower north of the apse resembles a keep; the north door is Romanesque.

The village of St. Sauveur a little above Luz on the left bank of the gorge of the Gavè de Pau is a pleasant summer resort, visited for warm sulphurous springs. Discovered in the 16th century, the waters came into vogue after 1820. Twelve miles to the south is the village of Gavarnie, above which is the magnificent rock amphitheatre or *cirque* or Gavarnie.

LUZZATTI, LUIGI (1841–1927), Italian economist and financier, was born of Jewish parents at Venice on March 11, 1841. He studied law at Padua, was driven into exile by the Austrian police for a short time, became professor of constitutional law at Padua (1867), at Perugia (1894), and finally at Rome (1898).

Luzzatti popularized in Italy the economic ideas of Schultze-Delitzsch, worked for the establishment of a commercial college at Venice, and contributed to the spread of people's banks on a basis of limited liability throughout the country.

An enthusiast for all forms of co-operation, Luzzatti founded the first co-operative store in Italy. In 1869 he was appointed by Minghetti under secretary of state to the ministry of agriculture and commerce, in which capacity he abolished government control over commercial companies and promoted a state inquiry into the conditions of industry.

Though theoretically a free trader, he helped to create the Italian protective system. In 1877 he participated in the commercial negotiations with France, in 1878 compiled the Italian customs tariff and subsequently took a leading part in the negotiations of all the commercial treaties between Italy and other countries.

He was minister of the treasury in four cabinets between 1891 and 1909. During his last term of service at the treasury he achieved the conversion of the Italian 5% debt (reduced to 4% by the tax) to 3¾% to be eventually lowered to 3½%; although the actual conversion was not completed until after the fall of the cabinet of which he formed part the merit is entirely his.

Luzzatti was minister of agriculture and commerce in 1909, and in 1909–11 prime minister. He received many honours, including the title of minister of state for life. He died on March 29, 1927.

LUZZATTO, MOSES ḤAYIM (1707–1747), Hebrew dramatist and mystic, was born in Padua 1707, and died at Acre 1747. He attacked Leon of Modena's anti-Kabbalistic treatises, and as a result of his conflict with the Venetian Rabbinate left Italy for Amsterdam, where, like Spinoza, he maintained himself by grinding lenses. Here, in 1740, he wrote his popular religious manual the *Path of the Upright* (*Messilath Yesharim*) and other ethical works. Luzzatto's most lasting work is in Hebrew drama. His best-known compositions are: the *Tower of Victory* (*Migdal 'Oz*) and *Glory to the Upright* (*Layesharim Tehillah*).

See Grätz, *History of the Jews,* v. ch. vii.; I. Abrahams, *Jewish Life in the Middle Ages,* pp. 190, 268; N. Slouschz, *The Renascence of Hebrew Literature,* ch. i.

LVOV, PRINCE GEORGE EUGENIEVICH (1861–1925), Russian statesman, belonged to the old Russian nobility. He spent the greater part of his life in Zemstvo, that is, local government work, being a member of the executive board of the Tula Zemstvo from 1888 and president from 1902–05. In 1905 he was elected member of the first State Duma and joined the right wing of the constitutional democratic (kadet) party. During the Russo-Japanese and World wars he took an active part in the organisation for the relief of sick and wounded soldiers and in the latter war was president of the All-Russian Union of Zemstvos. On March 14, 1917 Lvov was elected prime minister and minister of the interior of the first Russian provisional government. His Government proved a complete failure. A new coalition cabinet was formed on May 16, and Lvov again accepted the leadership of the cabinet and the portfolio of the interior, but he had no real influence in political life, and he resigned from both offices on July 7. (*See* RUSSIA.) After the Bolshevist revolution in November, Lvov was arrested and imprisoned in Ekaterinburg, but he escaped to Siberia and eventually settled down in Paris. He died on March 6, 1925.

LYALL, SIR ALFRED COMYN (1835–1911), Anglo-Indian administrator and writer, was born on Jan. 4, 1835, at Coulsdon, Surrey, and educated at Eton and Haileybury. He entered the Bengal civil service in 1855 and saw service during the Mutiny in the Bulandshakr district, at Meerut, and in Rohil-Khand. Lyall's promotion was rapid; in 1865 he was appointed commissioner of Nagpur, and in 1867 of West Berar. In 1873 he was made home secretary to the Government of India, but a year later was appointed governor-general's agent in Rajputana. He drew up a *Statistical Account or Gazetteer* both of Berar and of Rajputana, which gained some attention as the first work of this kind. In 1878 he became foreign secretary to the Government of India. He resigned in 1881, and was made K.C.B. He was then lieutenant-governor of the North-West Provinces and Oudh (now the United Provinces), where he administered Lord Ripon's local self-government scheme, and carried out many important legislative reforms. On his retirement from the service in 1887 he became a member of the India council in London, where he strongly advocated the development of local self-government. In Feb. 1887 he was made K.C.I.E., and in 1896 G.C.I.E. He became a privy councillor on his retirement from the India Office in 1902. In 1907 he became chairman of the board of Dulwich college and in 1911 was made a trustee of the British Museum. In his essay *Asiatic Studies* (1882 and 1889), dealing mainly with the comparative study of religions, he displays a deep insight into Indian life and character.

His works include: *Verses written in India* (1889); *Rise and Expansion of the British Dominion in India* (1893); *Life of Warren Hastings* (English Men of Letters series, 1889); *Life of the Marquis of Dufferin* (2 vols., 1905); and many articles on Indian questions and on general literature.

LYALL, SIR CHARLES JAMES (1845–1920), K.C.S.I. (1917), English Arabic scholar, was born in London on March 9, 1845, and educated at King's College, London, and Balliol College, Oxford. He served in the Bengal civil service from 1867 to 1889, when he became secretary to the Home Department of the Government of India. He was chief commissioner of Assam in 1894, of the Central Provinces from 1895–1898, and secretary to the judicial public department of the India Office in London (1899–1910). He died in London on Sept. 2, 1920.

He published two volumes of translations of Arabic poetry (1885 and 1894); a translation of two ancient Arabic *Diwans* (1913), articles on Hindustani and Arabic literature in the *Ency. Brit.* 9th and 11th editions.

LYALL, EDNA, the pen-name of ADA ELLEN BAYLY (1857–1903), English novelist, born at Brighton, the daughter of a barrister. At Eastbourne, where most of her life was spent, she was well known for her philanthropic activity. She died on Feb. 8, 1903. Her *Won by Waiting* (1879) had some success. *Donovan* (1882) and *We Two* (1884), in which the persecuted atheist was inevitably identified with Charles Bradlaugh, made her widely popular.

A *Life* by J. N. Escreet appeared in 1904.

LYALLPUR, a district of India, in the Punjab. It was constituted in 1904 to comprise the "Chenab Colony," being in the main the waste portion of the former Jhang district that is now irrigated by the Lower Chenab canal. Area, 3,522 sq.mi.; pop. (1941) 1,396,305. The headquarters are at Lyallpur town (pop. in 1941, 69,930), named after Sir James Lyall who was lieutenant-governor of the Punjab in 1887–92. It contains several factories for ginning and pressing cotton.

LYAUTEY, LOUIS HUBERT GONZALVE (1854–1934), French marshal, was born at Nancy (Meurthe-et-Moselle) on Nov. 17, 1854. Having passed through St. Cyr and the Staff College, he first served as a cavalry officer, and was then appointed in 1894 to the staff of the troops in Indo-China, where he took part, under General Galliéni, in the operations against the pirates of Upper Tongking. He accompanied General Galliéni to Madagascar, where he applied himself to working out and putting into practice new and eminently successful methods of colonial government. Having returned to his regiment as its colonel, he was soon after appointed to the command in the territory of Aïn Sefra, which was being disturbed by incursions from Morocco. He was then placed in command of the Oran division, and was entrusted with the carrying out of international agreements with regard to Morocco. Having restored order on the Algerian-Moroccan frontier, as far as Moulouya and Guis, he took command of the X. Corps at Rennes.

In April 1912, in view of the serious situation at Fez, the Government sent him to Morocco as high commissioner and resident-general to quell disturbances and to consolidate the recently declared protectorate. Immediately on his arrival he relieved Fez and initiated the work of pacification and colonization which was to result in a few years in the creation of a well organized Government on a solid basis. On the declaration of the World War, although formally ordered by the Government to evacuate the interior of Morocco, so as to liberate the greater part of his forces, he maintained his ground for four years against all attacks, while he actually increased the subjugated territory.

In Dec. 1917 General Lyautey was appointed war minister, but resigned after three months in order to return to Morocco. From 1920 to 1924 he continued his work by conquering the Atlas, and by establishing a defensive barrier to the north of Ouergha. As a reward for these services he was made a marshal of France in Feb. 1921. He organized a victorious resistance to the attacks of the Rifi under Abdel Krim, and did not resign the post of résident-général until order was completely restored in 1925. Marshal Lyautey pacified Morocco by the adoption of judicious methods of colonial government, and by constructive work and fine organization a province was built up with a great economic future. (*See* MOROCCO.) He was made a member of the French Academy in 1914, and wrote numerous articles on colonial administration. He died July 27, 1934.

See his *Lettres de Tonkin et de Madagascar, 1894–99* (1920); and a volume of speeches entitled *Paroles d'action, 1900–26* (1927); also Britsch, *Le Maréchal Lyautey* (1921). (M. GU.)

LYCAEUS, a mountain in Arcadia, sacred in Greek belief to Zeus Lycaeus, who was born and brought up on it, and the home of Pelasgus and his son Lycaon, who founded the ritual practised on its summit. (*See* LYCAON.)

LYCANTHROPY. This term, though by derivation strictly applicable only to the taking by men of wolf forms, is applied generally to the belief in the transformation of men into wolves or other carnivorous animals, the forms taken being ordinarily those of the most formidable wild animals of the country—bears in Scandinavia, wolves on the Continent of Europe, jaguars in South America, tigers and leopards or hyenas in Asia or Africa, the latter form being particularly associated with attacks on corpses rather than on living beings. The actual practice of lycanthropy is clearly associated with a form of hysteria and a pathological condition (frequently recorded in pregnant women) manifesting a depraved appetite and an irresistible desire for raw flesh, often that of human beings, frequently accompanied by a belief on the patient's part that he or she is transformed into an animal. In the Malay race such a state is deliberately induced by suggestion in persons subject to a form of extreme suggestibility known as *latah.* Cases of tiger spirits and the like induced to enter human bodies and resulting in similar symptoms must be classed with *latah* forms of the affliction, while the salves, skins, girdles, etc., used by wer-wolves particularly in Europe, to effect transformation are probably to be regarded as material aids to hallucination.

Ideas on lycanthropy have also become confused with beliefs as to the separable soul which often appear in cognate forms. Beliefs in witches and their familiar spirits, in the power of witches to assume other bodily shapes, to alienate their souls or their vital principles, and keep them for safety in some obscure animal or plant in distant places; belief in the general possession of a bush soul, or *nagual,* as in central America; belief in totem ancestors, and in the re-incarnation of the soul in predatory creatures, such as tigers, alligators and sharks (*see* METEMPSYCHOSIS); belief in vampires, belief in possession by evil spirits—all these ideas associated with the experienced facts of lycanthropy have engendered a large number of variable, confused and sometimes fantastic beliefs associated with lycanthropy in various parts of the world.

The lycanthropist was known to the Greeks, who spoke also of kynanthropy, and Marcellus of Sida describes men as usually attacked early in the year, frequenting cemeteries and living like dogs and wolves. The Romans used a more general term *Versipellis* (*cf.* English "turnskin") for lycanthropists; Virgil (Ecl. viii.) ascribes metamorphosis into wolf form to the action of drugs. Pliny gives a story of an hereditary transformation associated with Jupiter Lycaeus; Agriopas describes a man as turned into a wolf after assisting at a human sacrifice to the same god, and Petronius tells a typical wer-wolf story. In Scandinavia and England lycanthropy seems to have been associated with outlawry, and the term *berserker* (*q.v.*) probably implies a man who was not only subject to excesses of bestial fury but who wore garments of bear or wolfskin. In the case of *berserker* the lycanthropic tendency seems to have been involuntary, but in Europe generally it is ascribed to deliberate choice and throughout the middle ages persons were believed to use magical means to transform themselves into wolves. The tradition is not extinct on the continent of Europe, and in the British Isles still lingers (in Somersetshire and Arran, for instance) in the belief in old women who turn themselves into hares. If the hare be hurt a corresponding hurt remains in the human body, which is characteristic of the belief generally. The usual method of effecting the change in Europe was by rubbing with magic salve or by putting on a girdle of wolf—or sometimes of human skin. Involuntary transformation also occurs as the result of enchantment as in Marie de France's poem "Bisclaveret," or of miracles such as that of St. Patrick who changed Veretius, king of Wales, into a wolf. Although in the European form transformation is usual, another type of lycanthropy is described by Rhanaeus as occurring in Courland, in which there is no bodily transformation; the human body remains in a cataleptic trance but in such sympathy with a real wolf attacking cattle that the human limbs move and twitch as the wolf commits his depredations. This form of lycanthropy corresponds precisely with a form taken in Assam. The wer-wolf is called *vrkolak* by Bulgars and Slovaks, and by modern Greeks βρυκόλακας. Here again the body remains cataleptic while the soul enters a wolf. After its return the body is exhausted and aches as after violent exercise. This form is connected in popular belief with vampires, and Serbs give the same name *vlkoslak* to both, thus affording a link between the corresponding wer-tiger and vampire beliefs in Assam, where the vampire's astral body devours persons' livers and causes their death.

Wer-wolves (*loup-garou*) appear to have been particularly active in France during the 16th century, but by the middle of it the true nature of the malady was recognized. In the cases of Roulet tried at Angers in 1598 and of Jean Grenier in 1603 at Bordeaux the accused, though convicted, were treated as insane. The description given of Roulet is not unlike those given of the "wolf children" who turn up from time to time in India, and in the latter case the wer-wolf asserted that he became a lycanthropist under the bidding of a supernatural being who came to him in the forest, an account identical with that given by Sema wer-leopards in Assam. Cases of cannibalism are recorded in Scotland in the 15th century, but the cannibals do not seem to have been even accused of being wer-wolves, though the belief lingered, and Verstegan (*Restitution of Decayed Intelligence,* 1625), says of wer-wolves that they "doe not onely unto the view of others seem as wolves, but to their owne thinking have both the shape and nature of wolves . . . and dispose themselves as very wolves." In Asia Minor we find the belief in Armenia, where sinful women are punished by becoming lycanthropists at the bidding of a spirit who brings them a wolf skin. They eat their own children. Herodotus mentions the Neuri, a Scythian tribe, as lycanthropists who changed into wolf form annually, and associates them with head-hunters; and in Assam we still find head-hunting Nagas subject to lycanthropy individually and believing that there are neighbouring tribes who are wer-tigers communally. The belief in lycanthropy is current in India in connection with both the wolf and the tiger. Both sexes of the Kols of Central India are believed to turn into tigers, and Dalton reports a case of a Kol tried for murder who had followed the tiger, which had devoured his wife, to the house of another Kol named Pusa. This man's own relations said he had long been suspected of such malpractices and abetted the killing of him, and explained that they had known of his devouring an entire goat one night and that he had roared like a tiger while doing so, and that on another occasion he had expressed a longing for a particular bullock, and the same night the bullock was killed by a tiger. The "wolf children" who appear periodically, whether or not they have actually been suckled by wild animals, often display symptoms of a depraved appetite similar to those of lycanthropy. A case occurred in Bhagalpur between 1912 and 1919 in which one Rupa Sao, a shop-keeper, attacked and killed a little girl by biting her throat. He was convicted of murder, but the High Court, on a reference, ordered him to be confined as a lunatic. In Assam some tribes are lycanthropic while their neighbours are not; thus the Garos are, but not the pure Khasi; the Sema Nagas are, but not the Angami Nagas; while among many tribes such as the Kachari there are clans claiming descent from or relationship with tigers (*cf.* CYNOTHERAPY). The Angami regard lycanthropy as due to drinking from a certain well; but the Sema, who are subject to it, both men and women, regard it as involuntary and acquired normally under supernatural influence. The body is not transformed, but falls into a mild cataleptic fit during which the soul is inhabiting the body of a real leopard. Apparently some sympathetic association is set up between the human being and a wild animal, as in the Ao Naga tribe a relationship of this kind is set up without any lycanthropic symptoms on the part of the human being (*see* Mills, *The Ao Nagas,* pp. 250 *seq.*). The Lhota Naga medicine men have leopard familiars, but generally the Naga idea of lycanthropy rather suggests the central American idea of the *Nagual* or bush soul. Wer-tigers are believed in in Burma, where Tamans of the Chindwin valley are reputed to transform themselves into tiger form by rolling on earth on which they have micturated. In Malaya lycanthropy is common and is associated with *latah,* as it appears to be a regular amusement to hypnotize a boy subject to this disorder and to cause him to think he is a civet cat and behave as such, running on all fours and devouring live chickens. Skeat (*Malay Magic,* p. 160–163) mentions the case of one Haji 'Abdăllah caught naked in a tiger trap in Sumatra, but the wer-tigers of the Malay Peninsula are thought invulnerable in their transformed state—a curious exception to the almost universal belief that a wound on the animal causes a corresponding injury on the human form. In the Celebes the Toradja belief approximates to that of the Naga hills, the soul, *lamboyo,* which undergoes transformation, being apparently identical with the *anoana* of the Poso-Alfures (*see* METEMPSYCHOSIS). As in the Naga hills the lycanthropic habit may be acquired by eating food left by a lycanthropist. In Java the practice may be voluntary, acquired by spells, etc., or may be inherited, as in Assam, and this view has no doubt some pathological justification. As by the Khonds of India, the transformation is sought in Java for purposes of revenge, or to guard the crops, as in Yucatan, which possibly brings lycanthropy into connection with fertility cults, as does the use of an animal form and the association with witches in Europe.

In Africa the leopard and the hyaena are the animals usually connected with lycanthropists, who are generally women in Abyssinia, where the lycanthropist is regarded as possessed and belongs as a rule to the blacksmith class. The Bondas, however, claim actual transformation, which is reported to have been witnessed by a European who also claims to have shot hyaenas with gold ear-rings in their ears. In West Africa an intimate relation is created by a blood bond between a man and an animal, and, as in the Naga hills, if the latter die the former will also die, though in the Naga hills it is (significantly) not until he hears of the death of the leopard. The Bori dancing of Nigeria also seems to connect in some respects with the *latah* of Malaya. How strong the instinct of the beast may be can be judged from Tremearne's account of a child of one of the cannibal tribes found in the bush and brought up in an institution where, having heard of the death of another child, he managed to get at the corpse and eat its face (*Tailed Head-Hunters of Nigeria,* p. 184). The societies of "human leopards" and "human alligators" in West Africa appear to be organized manifestations of a depraved taste for human flesh like that displayed in the hyaena forms of lycanthropy combined with ideas akin to those underlying head-hunting (*q.v.*), and ghouls in Syria have also been associated with temporary wolf or hyaena forms. That this propensity is not entirely destroyed by civilization is shown by a case which occurred in 1849 in Paris, when an officer was convicted of digging up and mutilating corpses in cemeteries under pathological conditions suggesting lycanthropy. The outbreaks of cattle-maiming that occur from time to time in Great Britain are probably likewise attributable to a survival of the lycanthropic instinct.

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LYCAON, a mythical king of Arcadia. At Mount Lycaeus a very extraordinary ceremony in honour of *Zeus Lukaios* took place; it is alleged (Plato, *Rep.,* viii., 565 D) that a man was sacrificed to him, and his entrails put with those of more usual victims; that anyone who tasted them became a wolf; to which later authors (*see* especially Pausanias, viii., 2, 6, with Frazer's note) add that the man thus transformed belonged to a particular clan, and that he remained a wolf for nine years (a sacred number), after which he might become a man once more if in that time he had not tasted human flesh again. The whole story is unpleasantly suggestive of the Lion and Leopard societies of Africa. In explanation the following story was told. Lycaon, in early days, was an impious and cruel king. Having occasion to entertain Zeus, he, or his sons, set before him human flesh (in some versions, the flesh of Lycaon's own son, Nyctimus). The god was not deceived, and in wrath caused the deluge which in Deucalion's time devastated the earth. It has several times been suggested that behind the figure of Lycaon is concealed some ancient local god, afterwards identified with Zeus; a theory in no way impossible, but which leads us little further, since there is no agreement as to the nature of the supposed god.

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LYCAONIA, a region in the interior of Asia Minor, north of Mt. Taurus, bounded on the east by Cappadocia, on the north by Galatia, on the west by Phrygia and Pisidia; to the south it extended to the chain of Mt. Taurus, where it bordered on the country popularly called Cilicia Tracheia. The boundaries of Lycaonia varied greatly at different times. It is mentioned by Xenophon as traversed by Cyrus the younger on his march through Asia. That author describes Iconium as the last city of Phrygia; and in Acts xiv. 5 St. Paul, after leaving Iconium, crossed the frontier and came to Lystra in Lycaonia.

Lycaonia is described by Strabo as a cold region of elevated plains, affording pasture to wild asses and to sheep. Amyntas, king of Galatia, to whom the district was for a time subject, maintained there not less than 300 flocks. It forms part of the interior tableland of Asia Minor, and has an elevation of more than 3,000ft. It suffers from want of water, aggravated in some parts by abundance of salt in the soil, so that the northern portion, extending from near Iconium to the salt lake of Tatta and the frontiers of Galatia, is almost wholly barren. In ancient times great attention was paid to storing and distributing the water, so that much land now barren was formerly cultivated and supported a large number of cities.

The plain is interrupted by some minor groups of mountains, of volcanic character, of which the Kara Dagh in the south rises above 7,000ft.

The Lycaonians were to a great extent independent of the Persian empire, and were like their neighbours, the Isaurians, a wild and lawless race of freebooters; but their country was traversed by one of the great natural lines of high road through Asia Minor, from Sardis and Ephesus to the Cilician gates, and a few considerable towns grew up along or near this line. The most important was Iconium, in the most fertile spot in the country, of which it was always regarded by the Romans as the capital. It was the capital of the Seljuk Turkish empire for several centuries. A little farther north, stood Laodicea (Ladik); and in the south, near the foot of Mt. Taurus, was Laranda, now called Karaman, which has given name to the province of Karamania. Derbe and Lystra, which appear from the Acts of the Apostles to have been considerable towns, were between Iconium and Laranda. Lycaonia was Christianized very early; and its ecclesiastical system was more completely organized during the 4th century than that of any other region of Asia Minor.

After the defeat of Antiochus the Great (*q.v.*), Lycaonia was given by the Romans to Eumenes II., king of Pergamos. About 160 B.C. part of it was added to Galatia; and in 129 B.C. the eastern half (usually called during the following 200 years Lycaonia proper) was given to Cappadocia. Its administration and grouping changed often under the Romans. In A.D. 371 Lycaonia was first formed into a separate province.

The Lycaonians appear to have retained a distinct nationality in the time of Strabo, but their ethnical affinities are unknown. The mention of the Lycaonian language in the Acts of the Apostles (xiv. 11) shows that the native language was spoken by the common people at Lystra as late as A.D. 50.

See Sir W. M. Ramsay, *Historical Geography of Asia Minor* (1890), *Historical Commentary on Galatians* (1899), and *Cities of St. Paul* (1907); M. Delahaye, *Gaianopolis* (1910).

LYCEUM, the name of a gymnasium and garden with covered walks near the temple of Apollo Lyceus at Athens (Gr. Λύκειον). Aristotle taught here, and hence the name was applied to his school of philosophy. The name has been used in many languages for places of instruction, etc. In France the term *lycée* is given to the larger secondary schools which are administered by the State.

LYCEUMS AND CHAUTAUQUAS. Early in 1826 Josiah Holbrook, of Derby, Conn., outlined a plan for a world-wide federation for the advancement of learning, calling it a lyceum, from the place where Aristotle lectured to the youth of Greece. His plan provided for organizations graduated from the community to an international lyceum, the latter to have 52 vice-presidents chosen from distinguished scholars and men of affairs from all over the world. This international organization was never realized, but a national (U.S.) lyceum was organized in New York city in 1831, and flourished for eight years. It included delegates from at least eight State lyceums which, in turn, embraced scores of county and local lyceums.

That the lyceum answered an existing need is shown by the rapid spread of its local branches. The Millbury, Mass., branch was organized in Nov. 1826. Within two years 100 other branches, and by 1834 nearly 3,000 branches, in practically every State in the Union, had been established. These local lyceums were voluntary associations for self-culture, community instruction and discussion of public questions. Essays, debates, discussions and lectures, all home-talent productions, were presented at weekly meetings. After about a decade the custom of inviting outside lecturers, to whom fees were paid, became established. Lowell, Thoreau, Beecher, Holmes, Greeley and others were among those who frequently addressed the lyceums. Many of Emerson's essays were written for lyceum lectures.

The last convention of the national lyceum, in 1839, was the most largely attended and most enthusiastic held. It formed many ambitious plans, adjourned, and never met again. The cause of this sudden demise is not known. In its eight years of life, it accomplished definite and far-reaching results. It forwarded education in Cuba, Venezuela and Mexico; it inspired many cultural movements, some of which still exist, and all of which made important contributions to American education. The lapse of the national lyceum did not affect the local branches, which flourished until the Civil War. A demand for attractions other than lectures led the bureaux to supply musicians, readers and entertainers.

Parallel with the lyceum movement is the chautauqua, which began at Fair Point (later called Chautauqua), N.Y., where a Methodist Episcopal camp meeting was annually conducted. Rev. (later bishop) John H. Vincent and Lewis Miller successfully undertook to change that camp meeting into an assembly for the study of the Bible and Sunday school methods. The first such assembly was held in 1874. Gradually the purpose expanded until it embraced the whole field of education, with popular entertainments included. Chautauqua institution, at Chautauqua, N.Y., annually conducts a ten-week assembly. This assembly was quickly copied by many communities throughout the land, each operating independently of all others, and each engaging its talent either directly or through the lyceum bureaux, which thus became a connecting link between the two movements. Their programmes were attractive combinations of lectures, music and entertainments (with drama added in later years). Distinguished men and women have contributed through these programmes towards the creation of an American culture and an informed public opinion. The wasteful extravagance resulting from the independent operation of these rapidly multiplying assemblies led to the development, in 1904, of the circuit chautauqua plan. The lyceum bureaux led in this development, organizing chautauqua committees in a circuit of towns to which a standardized programme of lectures, music and entertainment was supplied.

Bibliography.—J. H. Vincent, *The Chautauqua Movement* (1866); J. L. Hurlbut, *The Story of Chautauqua* (1921); L. H. Vincent, *John Heyl Vincent* (1925); J. S. Noffsinger, *Correspondence Schools, Lyceums, Chautauquas* (1926); D. Canfield Fisher, *Why Stop Learning?* (1927). (P. M. P.)

LYCHNIS, a genus of plants of the pink family, Caryophyllaceae (*q.v.*), including numerous species, several of which are cultivated. *L. chalcedonica* (Maltese cross), 3 ft. high, has dense heads of bright scarlet flowers, both single and double. *L. coronata,* 1 to 2 ft. high has clusters of scarlet, crimson, pink and white flowers.

Other garden species are *L. fulgens,* and *L. Haageana. L. Flos-cuculi* is the ragged robin. Several species are native to western North America, including *L. Drummondii,* found from Manitoba to Nebraska and west to the Pacific coast. All are hardy herbaceous perennials.

LYCIA, a district in the south-west of Asia Minor, occupying the coast between Caria and Pamphylia, and extending inland as far as the ridge of Mt. Taurus. It is a rugged, mountainous country, traversed by offshoots of the Taurus range, which terminate in lofty promontories. The coast is indented by a succession of bays—the most marked of which is the Gulf of Macri (anc. *Glaucus Sinus*) in the extreme west. A number of smaller bays and broken, rocky headlands, with a few small islets, constitute the coast-line thence to the south-east promontory of Lycia, known in ancient times as the "Sacred Promontory" (*Hiera Akra*). Though the mountain ranges of Lycia are all offshoots of Mt. Taurus, in ancient times several of them were distinguished by separate names. Such were Daedala in the west, adjoining the Gulf of Macri, Cragus on the sea-coast, west of the valley of the Xanthus, Massicytus (10,000ft.) nearly in the centre of the region, and Solyma in the extreme east above Phaselis (7,800ft.). The steep and rugged pass between Solyma and the sea, called the Climax ("Ladder"), was the only direct communication between Lycia and Pamphylia.

The only considerable rivers are: (1) the Xanthus, which descends from the central mass of Mt. Taurus, and flows through a narrow valley till it reaches the city of the same name, below which it forms a plain of some extent before reaching the sea, and (2) the Limyrus, which enters the sea near Limyra. The small alluvial plains at the mouths of these rivers are the only level ground in Lycia, but the hills that rise thence towards the mountains are covered with a rich arborescent vegetation. The upper valleys and mountain sides afford good pasture for sheep, and the main Taurus range encloses several extensive upland basin-shaped valleys (*vailas*). (*See* Asia Minor.)

According to Artemidorus, the towns that formed the Lycian league were 23 in number; but Pliny states that Lycia once possessed 70 towns, of which only 26 remained in his day. Recent researches have confirmed the fact that the sea-coast and the valleys were studded with towns. On the Gulf of Glaucus stood Telmessus, while a short distance inland were the small towns of Daedala and Cadyanda. At the entrance of the valley of the Xanthus were Patara, Xanthus itself, and, a little higher up, Pinara on the west and Tlos on the east side of the valley. Myra, one of the most important cities of Lycia, occupied the entrance of the valley of the Andriacus; on the coast between this and the mouth of the Xanthus stood Antiphellus, while in the interior, at a short distance, were found Phellus, Cyaneae and Candyba. In the alluvial plain formed by the rivers Arycandus and Limyrus stood Limyra. Arycanda commanded the upper valley of the river of the same name. On the east coast stood Olympus, one of the cities of the league, while Phaselis, a little farther north, which was a much more important place, never belonged to the Lycian league and appears always to have maintained an independent position.

History.—The name of the Lycians, *Lukki,* is first met with in the Tel el-Amarna tablets (1400 B.C.), and in the list of the nations from the eastern Mediterranean who invaded Egypt in the reign of Mineptah, the successor of Rameses II. At that time they seem to have occupied the Cilician coast. Their occupation of Lycia was probably later and, since the Lycian inscriptions are not found far inland, we may conclude that they entered the country from the sea. According to Herodotus (i. 173; vii. 92), the original inhabitants of the country were the Milyans and Solymi, the Lycians being invaders from Crete. In this tradition there is a reminiscence of the fact that the Lycians had been sea-rovers before their settlement in Lycia. The Lycian Sarpedon was believed to have taken part in the Trojan war. The Lydians failed to subdue Lycia, but after the fall of the Lydian empire it was conquered by Harpagus, the general of Cyrus (i. 171). While acknowledging the suzerainty of Persia, however, the Lycians remained practically independent, and for a time joined the Delian league (*q.v.*). They were incorporated into the empire of Alexander, but, even after their conquest by the Romans, preserved their federal institutions as late as the time of Augustus. Under Claudius, Lycia was annexed to the Roman empire and united with Pamphylia; Theodosius made it a separate province.

Antiquities.—Few parts of Asia Minor were less known in modern times than Lycia up to the 19th century. Visits of Sir Charles Fellows to the country in 1838 and 1840 were followed by an expedition sent by the British Government in 1842 to transport to England the valuable monuments now in the British Museum. The monuments thus brought to light are among the most interesting of those discovered in Asia Minor, and prove the existence of a distinct native architecture, especially in the rock-cut tombs. But the theatres found in almost every town, some of them of very large size, are sufficient to attest the influence of Greek civilization; and this is confirmed by the sculptures, which are for the most part Greek.

Numerous inscriptions have been discovered in the native language of the country, written in an alphabet peculiar to Lycia. A few of these inscriptions are bilingual, in Greek and Lycian, and the clue thus afforded to their interpretation has been followed up. (*See* Asianic Languages.)

The alphabet was derived from the Doric alphabet of Rhodes, but ten other characters were added to it to express sounds not found in Greek. The attempts to connect the language with the Indo-European family have been unsuccessful. Most of the inscriptions are sepulchral; by far the longest and most important is that on an obelisk found at Xanthus.

Lycian art was modelled on that of the Greeks. The rock-cut tomb usually represented the house of the living, with an elaborate façade, but in one or two instances, notably that of the so-called Harpy-tomb, the façade is surmounted by a tall, square tower, in the upper part of which is the sepulchral chamber. Lycian sculpture followed closely the development of Greek sculpture, and many of the sculptures with which the tombs are adorned are of a high order of merit. The exquisite bas-reliefs on a Lycian sarcophagus now in the museum of Constantinople are among the finest surviving examples of classical art. The bas-reliefs were usually coloured. For the coinage, *see* Numismatics: *Asiatic Coins.*

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LYCK or **LYK,** a town in East Prussia, Germany, 112 mi. by rail S.E. of Königsberg, and close to the frontier of Poland, on a lake and river of the same name. Pop. (1939) 16,667. It is the chief town of the region known as Masuria. On an island in the lake is a castle formerly belonging to the Teutonic order, and dating from 1273, now used as a prison. There are brick works, tanneries, saw-mills, flour mills, manufactures of machinery and trade in grain and cattle.

LYCOPHRON, Greek poet and grammarian, was born at Chalcis in Euboea. He flourished at Alexandria in the time of Ptolemy Philadelphus (285–247 B.C.), for whom he arranged the comedies in the Alexandrian library. As a result he wrote a treatise *On Comedy.* His own work was mostly in tragedy; Suïdas gives 20 titles, but only a few fragments survive. One poem, the *Alexandra* or *Cassandra,* in iambics, has been preserved. The poem, in which Cassandra prophesies the future of Troy and later events, is a masterpiece of erudition, full of archaisms and obscurities, and poetically quite worthless. It was very popular in the Byzantine period, and annotated by the Tzetzes brothers. The fragments of his tragic verse are very much superior to this.

See Editio princeps (1513); J. Potter (1697, 1702); L. Sebastiani (1803); L. Bachmann (1830); G. Kinkel (1880); E. Scheer (1881–1908), vol. ii. containing the scholia. C. von Holzinger (with translation, introduction and notes, 1895). Translations by F. Dehèque (1853) and Viscount Royston (1806). *See* also Wilamowitz-Möllendorff, *De Lycophronis Alexandra* (1884); J. Konze, *De Dictione Lycophronis* (1870). The commentaries of the brothers Tzetzes have been edited by C. O. Müller (1811).

LYCOPODIUM, the principal genus of the Lycopodiaceae, a family of the Fern-allies (*see* Pteridophyta). They are flowerless herbs, with an erect, prostrate or creeping widely-branched stem, with small simple leaves which thickly cover the stem and branches. The fertile leaves are arranged in strobili, and bear spore-cases (sporangia) in their axils, containing spores of one kind only. The prothallium developed from the spore is a subterranean mass of tissue of considerable size, and bears the male and female organs (*antheridia* and *archegonia*). There are about 200 species widely distributed in temperate and tropical climates; five occur in Britain on heaths and moors, chiefly in mountainous districts, and are known as club-mosses. The commonest species, *L. clavatum,* is also known as stag-horn moss. Its spores are known as "lycopodium powder," which, owing to the resinous nature of the spores and its fine state of subdivision, is highly inflammable and has been used in fireworks and for "flash-light" purposes.

If the hand is covered with the powder, it cannot be wetted when plunged into water.

Some 20 species are found in North America, being most abundant in cool, wooded regions of the Eastern United States and Canada, though 9 species are reported from the Rocky Mountain region and 8 species from the coast district of Washington.

LYCOSURA, a city of Arcadia (mod. *Palaeokastro* or *Siderokastro*), reputed to be the most ancient in Greece, and founded by Lycaon, son of Pelasgus. Its famous temple of Despoena contained the colossal group made by Damophon of Messene, of Despoena and Demeter seated, with Artemis and the Titan Anytus standing beside them. The temple and considerable remains of the sculpture were found in 1889.

See Πρακτικὰ τῆς Ἀρχ. Ἑταιρίας (1896); G. Dickens, *Annual of British School at Athens,* xii. and xiii.

LYCURGUS (Gr. Λυκοῦργος), in Greek history, the reputed founder of the Spartan Constitution. Plutarch opens his biography of Lycurgus with these words: "About Lycurgus, the lawgiver, it is not possible to make a single statement that is not called in question. His genealogy, his travels, his death, above all, his legislative and constitutional activity have been variously recorded, and there is the greatest difference of opinion as to his date." Nor has modern historical criticism arrived at any certain results. Many scholars, indeed, suppose him to be in reality a god or hero, appealing to the existence of a temple and cult of Lycurgus at Sparta as early as the time of Herodotus (i. 66) (cf. *Camb. Ancient Hist.,* vol. iii.). If this be so, he is probably to be connected with the cult of Apollo Lycius or with that of Zeus Lycaeus. But the majority of modern historians agree in accepting Lycurgus as an historical person, however widely they may differ about his work.

According to the Spartan tradition preserved by Herodotus, Lycurgus was a member of the Agiad house, son of Agis I. and brother of Echestratus. On the death of the latter he became regent and guardian of his nephew, Labotas (Leobotes), who was still a minor. Other accounts give him a different origin, and make him regent for Charillus. According to Herodotus he introduced his reforms immediately on becoming regent, but the story which afterwards became generally accepted represented him as occupying for some time the position of regent, then spending several years in travels, and on his return to Sparta carrying through his legislation when Charillus was king. He is said to have visited Crete, Egypt and Ionia, and some versions even took him to Spain, Libya and India. In any case details of his life are almost certainly mythical. Herodotus derives his constitutional ideas from Crete, but there is a 5th century tradition ascribing them to the initiative of Delphi.

The Reforms.—Herodotus says that Lycurgus changed "all the customs," that he created the military organization and instituted the ephorate and the council of elders. To him, further, are attributed the foundation of the apolla (the citizen assembly), the prohibition of gold and silver currency, the partition of the land (γῆς ἀναδασμός) into equal lots, and, in general, the characteristic Spartan training (ἀγωγή). Some of these statements are certainly false. The council of elders and assembly are not peculiar to Sparta, the ephorate is not generally allowed to be his, and the partition of land never seems to have taken place at Sparta at all—it is probably an attempt to give traditional sanction to the ideals of Agis and Cleomenes in the 3rd century. We may conclude that Lycurgus did not create any of the main elements of the Spartan Constitution, though he may have regulated their powers and defined their position. But tradition represented him as finding Sparta the prey of disunion, weakness and lawlessness, and leaving her united, strong and subject to the most stable Government which the Greek world had ever seen. Probably Grote comes near to the truth when he says that Lycurgus "is the founder of a warlike brotherhood rather than the lawgiver of a political community." To him we may attribute the unification of the several component parts of the State, the strict military organization and training which soon made the Spartan hoplite the best soldier in Greece, and above all the elaborate and rigid system of education which rested upon, and in turn proved the strongest support of, that subordination of the individual to the State which, perhaps, has had no parallel in the history of the world.

Lycurgus's legislation is very variously dated, and it is not possible either to harmonize the traditions or to decide with confidence between them. Tradition substantially agrees in placing him in the 9th century.

Bibliography.—Our chief ancient authorities, besides Plutarch's biography, are: Herodotus i. 65; Xenophon, *Respublica Lacedaemoniorum;* Ephorus *ap.* Strabo x. 481, 482; Aristotle, *Politics,* ii.; Pausanias iii. and v. 4; and scattered passages in Plato, Isocrates, Polybius, Diodorus, Polyaenus, etc. Of modern works the most important are: E. Meyer, "Lykurgos von Sparta," in *Forschungen zur alten Geschichte* (Halle, 1892), i. 211 *sqq.;* A. Kopstadt, *De rerum Laconicarum constitutionis Lycurgeae origine et indole* (Greifswald, 1849); H. K. Stein, *Kritik der Überlieferung über den spartanischen Gesetzgeber Lykurg* (Glatz, 1882); S. Wide, "Bemerkungen zur spartanischen Lykurglegende," in *Skand. Archiv.* i. (1891), 90 *sqq.;* E. Nusselt, *Das Lykurgproblem* (Erlangen, 1898); H. Bazin, *De Lycurgo* (Paris, 1885); C. Reuss, *De Lycurgea quae fertur agrorum divisione* (Pforzheim, 1878); A. Busson, *Lykurgos und die grosse Rhetra* (Innsbruck, 1887); H. Gelzer, "Lykurg und die delphische Priesterschaft" in *Rhein. Mus.* xxviii. 1 *sqq.;* F. Winicker, *Stand der Lykurgischen Frage* (Graudenz, 1884); G. Attinger, *Essai sur Lycurgue et ses institutions* (Neuchâtel, 1892); E. Kessler, *Plutarch's Leben des Lykurgos;* the general Greek histories, and the works on the Spartan Constitution cited under Sparta.

LYCURGUS (*c.* 396–325 B.C.), son of Lycophron, one of the "ten" Attic orators. He shared with Demosthenes and Hypereides the leadership of the opposition to Philip. He left the care of external relations to his colleagues, and devoted himself to internal organization and finance. He managed the finances of Athens for twelve successive years (338–326), at first directly as treasurer of the revenues (ὁ ἐπὶ τῇ διοικήσει) for four years, and in two succeeding terms, when the actual office was forbidden him by law, through his son and a nominal official chosen from his party. Part of one of the deeds in which he rendered account of his term of office is still preserved in an inscription. During this time he raised the public income from 600 to 1,200 talents yearly. He increased the navy, repaired the dockyards, and completed an arsenal, the σκευοθήκη designed by the architect Philo. He also reconstructed the great Dionysiac theatre and the gymnasium in the Lyceum, and built the Panathenaic stadium on the Ilissus. He proposed a law that statues of the three great tragedians should be erected in the theatre, and that their works should be carefully edited and preserved among the state archives. Alexander the Great demanded his surrender, but the people refused to give him up. He died while president of the theatre of Dionysus, and was buried on the road leading to the Academy at the expense of the state. (*See* Hicks, *Greek Historical Inscriptions,* no. 145.)

Lycurgus was a man of action; his orations, of which fifteen were published, were criticized by the ancients for their awkward arrangement, harshness of style, and the tendency to digressions about mythology and history, although their noble spirit and lofty morality were highly praised. The one extant example, *Against Leocrates,* fully bears out this criticism. After the battle of Charroneia (338), in spite of the decree which forbade emigration under pain of death, Leocrates had fled from Athens and on his return was impeached by Lycurgus but acquitted.

Bibliography.—The speech has been frequently edited. Editio princeps (Aldine, 1513); F. G. Kiessling (1847) with M. H. E. Meier's commentary on pseudo-Plutarch's *Life of Lycurgus* and the fragments of his speeches; C. Rehdantz (1876); T. Thalheim (1880); C. Scheibe (1885); E. Blass (ed. major, 1889), with bibliography of editions and articles (ed. minor, 1902); E. Sofer (Leipzig, 1905), with notes and introd. There is an index to Andocides, Lycurgus and Deinarchus by L. L. Forman (Oxford, 1897). The exhaustive treatise by F. Dürrbach, *L'Orateur Lycurgue* (1890), contains a list of the most important review articles on the financial and naval administration of Lycurgus and on his public works; *see* also C. Droege, *De Lycurgo publicarum pecuniarum administratore* (Minden, 1880). Several fragments of his various laws have been preserved in inscriptions (*Corpus inscriptionum atticarum,* ii. 162, 163, 173, 176, 180). And *see* authorities under Demosthenes.

LYCURGUS, "The Logothete" (1772–1851), Greek leader in the War of Independence, was born in the island of Samos. He was educated at Constantinople and accompanied Constantine Ypsilanti when he was appointed hospodar of Wallachia and served Ypsilanti's successor, Alexander Soutzos, as treasurer and chancellor (Logothete). In 1802 he returned to Samos. When the War of Independence began he induced his countrymen to declare Samos independent, and was chosen ruler. His share in the War of Independence is chiefly memorable because he provoked the massacre of Chios in 1822. He was afterwards deposed by the Samians, but recovered some influence and had a share in the defence of Samos against the Turks in 1824. When the island was left under the authority of Turkey by the protocol of the 3rd of February 1830, he helped to obtain autonomy for the Samians. He retired to Greece and died on May 22, 1851.

See G. Finlay, *History of the Greek Revolution* (London, 1861).

LYDD, a market town and municipal borough in the Ashford parliamentary division of Kent, England, 71½ mi. E.S.E. of London by S.R. Pop. (1938) 2,947. Area, 18.6 sq.mi. Lydd (Hlide, Lide, Lyde) after the Conquest became a seaport of some consequence and although it now stands nearly 3 mi. inland, a number of its inhabitants are still fishermen. In 774 land in Lydd was granted by Offa to the monks of Christ Church, Canterbury. At some time before the reign of Edward I Lydd was made a member of the Cinque Port of Romney, and in 1290 was granted the same liberties and free customs as the Cinque Ports on condition of supplying the crown with one ship. This charter was confirmed by Edward III in 1365. Lydd is called a borough in the Hundred Rolls. Its incorporation under a bailiff, of which there is evidence in the 15th century, may have been due to the archbishop or to the court of Shepway, but it was not incorporated by the crown until 1855, when the last bailiff was elected the first mayor. In 1494 a grant was made of a yearly fair on July 12 and two days following. A fair was held under this grant until 1874. The church of All Saints has a Perpendicular tower with rich vaulting within. The neighbourhood affords pasture for large flocks of sheep. On the land known as the Rypes, in the neighbourhood, there is a military camp, with artillery and rifle ranges; hence the name given to the explosive "lyddite."

LYDEKKER, RICHARD (1849–1915), F.R.S. (1894), English naturalist and geologist, was born in London on July 25, 1849, and educated at Trinity college, Cambridge. From 1874 to 1882 he was on the staff of the geological survey of India. He died at Harpenden on April 16, 1915.

His works include *Catalogues* (10 vols. 1891) of the fossil mammals, reptiles and birds in the British Museum; *A Manual of Palaeontology* (with H. A. Nicholson, 2 vols., 1889); *Phases of Animal Life* (1892); *The Royal Natural History* (with W. H. Fowler, 8 vols., 1893–96); *The Great and Small Game of India, Burma and Tibet* (1900).

LYDENBURG, a town in the Transvaal, 25° 10′ S., 30° 40′ E., altitude 4,860 feet. Pop. (1936) 3,846 (2,051 white). The surrounding district is devoted largely to sheep farming; and cotton, tobacco and wheat are being grown. Gold is produced in the neighbourhood. The town was founded by Boers in 1846. Ten years later they separated from their brethren, and proclaimed an independent republic, which was, however, incorporated in the South

African republic of 1860. The first successful gold field in the Transvaal was opened here, but it was not until 1910, that railway communication was established.

LYDFORD or **LIDFORD,** a village of Devonshire, England, 27 mi. N. of Plymouth by rail. Pop. of parish (1931) 2,218. The village stands on the small river Lyd, which traverses a deep narrow chasm, crossed by a bridge of single span; and at a little distance a tributary stream forms a cascade with a fall of 150 feet.

Lydford was one of the four Saxon boroughs of Devon, and possessed a mint in the days of Aethelred the Unready. It first appears in recorded history in 997, when the Danes made a plundering expedition up the Tamar and Tavy as far as "Hlidaforda." In the reign of Edward the Confessor it ranked after Exeter, but the Domesday Survey relates that forty houses had been laid waste since the Conquest, and the town never recovered its former prosperity. The history from the 13th century centres round the castle, first mentioned in 1216, and shortly afterwards fixed as the prison of the stannaries and the meeting-place of the Forest Courts of Dartmoor. A guild at Lideford is mentioned in 1180, and the pipe roll of 1195 records a grant for the re-establishment of the market. In 1238 the borough was bestowed by Henry III. on Richard, earl of Cornwall, who in 1268 obtained a grant of a Wednesday market and a three days' fair at the feast of St. Petrock. The borough was never incorporated by charter, and only once, in 1300, returned members to parliament. In the 18th century the castle was restored and again used as a prison and as the meeting-place of the Manor and borough courts.

LYDGATE, JOHN (*c.* 1373–*c.* 1450), English poet, was born at the village of Lydgate near Newmarket. Probably he was educated at the school attached to the Benedictine abbey at Bury St. Edmunds, and in his *Testament* he has drawn a lively picture of himself as a typical orchard-robbing boy, who had scant relish for matins, fought, and threw creed and paternoster at the cock. He was ordained sub-deacon in 1389, deacon in 1393, and priest in 1397. Lydgate passed as a portent of learning, and, according to Bale, he pursued his studies not only at both the English universities but in France and Italy. Certainly he knew France, and he visited Paris in an official capacity in 1426. It is improbable that he lived many years after 1446, when John Baret, treasurer of Bury, signed an extant receipt for a pension which he shared with Lydgate, and which continued to be paid till 1449. If it be true, as Bishop Alcock of Ely affirms, that Lydgate wrote a poem on the loss of France and Gascony, he must have lived two years longer, which would indicate the year 1451, or thereabouts, as the date of his death.

In 1434 Lydgate retired from the priorate of Hatfield Broadoak (or Hatfield Regis), to which he had been appointed in June 1423. After 1390—but whilst he was still a young man—he made the acquaintance of Geoffrey Chaucer, with whose son Thomas he was intimate. This friendship appears to have decided Lydgate's career, and in his *Troy-book* and elsewhere are reverent and touching tributes to his "master." The themes of his more ambitious poems can be traced to Chaucerian sources.

Lydgate is a most voluminous writer. The *Falls of Princes* alone comprises 7,000 stanzas; and his authentic compositions reach the enormous total of 140,000. As the result the bulk of his composition is wholly or comparatively rough-hewn. That he was capable of finished work is shown by two allegorical poems—the *Complaint of the Black Knight* and the *Temple of Glass* (once attributed to Hawes), in which he reveals himself as a not unworthy successor of Chaucer. For a couple of centuries Lydgate's reputation equalled, if it did not surpass, that of his master. This was in a sense only natural, since he was the real founder of the school which ruled English letters during the long interval between Chaucer and Spenser. One of the most obvious defects of this school is excessive attachment to polysyllabic terms. John Metham is amply justified in his censure—

> Eke John Lydgate, sometime monk of Bury,
> His books indited with terms of rhetoric
> And half-changed Latin, with conceits of poetry.

But Lydgate is lucid in style; and his writings are read more easily than Chaucer's. In spite of that, Lydgate is characteristically mediaeval—mediaeval in his prolixity, his platitude, his want of judgment and his want of taste; mediaeval also in his pessimism, his Mariolatry and his horror of death.

Dr. Schick's preface to the *Temple of Glass* embodies practically all that is known or conjectured concerning this author, including the chronological order of his works. With the exception of the *Damage and Destruction in Realms*—an account of Julius Caesar, his wars and his death—they are all in verse and extremely multifarious—narrative, devotional hagiological, philosophical and scientific, allegorical and moral, historical, satirical and occasional. The *Troy-book,* undertaken at the command of Henry V., then prince of Wales, dates from 1412–1420; the *Story of Thebes* from 1420–1422; and the *Falls of Princes* towards 1430. His last work was *Secreta Secretorum* or *Secrets of Old Philosophers,* rhymed extracts from a pseudo-Aristotelian treatise. Lydgate certainly possessed extraordinary versatility, which enabled him to turn from elaborate epics to quite popular poems like the *Mumming at Hertford, A Ditty of Women's Horns* and *London Lickpenny.*

See publications of the Early English Text Society, especially the *Temple of Glass,* edited by Dr. Schick; Koeppel's *Lydgate's Story of Thebes, eine Quellenuntersuchung* (Munich, 1884), and the same scholar's *Laurents de Premierfait und John Lydgates Bearbeitungen von Boccaccios De Casibus Illustrium Virorum* (Munich, 1885); Warton's *History of English Poetry;* Ritson's *Bibliotheca Anglo-Poetica;* Furnivall's *Political Poems* (E.E.T.S.); and Sidney Lee's article in the *Dict. Nat. Biog.*

LYDIA, a district of Asia Minor, the boundaries of which are difficult to fix, partly because they varied at different epochs. The name is found (*c.* 660 B.C.) under the form of *Luddi* in the inscriptions of the Assyrian king Assur-banipal. In Homer we read only of Maeonians (*Il.* ii. 865, etc.), and the place of the Lydian capital Sardis is taken by Hydē (*Il.* xx. 385). According to Herodotus (i.7), the Meiones (called Maeones by other writers) were named Lydians after Lydus, the son of Attis, in the mythical epoch which preceded the rise of the Heraclid dynasty. In historical times the Maeones were a tribe inhabiting the district of the upper Hermus. The Lydians must have been an allied tribe which bordered upon them to the north-west, and occupied the plain of Sardis or Magnesia. They were cut off from the sea by the Greeks, who were in possession, not only of the Bay of Smyrna, but also of the country north of Sipylus. Northwards the Lydians extended at least as far as the Gygaean lake and the Sardenē range. The plateau of the Bin Bir Tepē, on the southern shore of the Gygaean lake, was the chief burial-place of the inhabitants of Sardis, and is thickly studded with tumuli, among which is the "tomb of Alyattes" (260ft. high). Next to Sardis the chief city was Magnesia (*q.v.*) ad Sipylum in the neighbourhood of which is the famous seated figure of "Niobe" (*Il.* xxiv. 614–7), cut out of the rock, and probably intended to represent the goddess Cybele, to which the Greeks attached their legend of Niobe. Under the Heraclid dynasty the limits of Lydia must have been already extended, since the authority of Gyges reached as far as the Troad. The successes of Alyattes and of Croesus finally changed the Lydian kingdom into a Lydian empire, and all Asia Minor westward of the Halys, except Lycia, owned the supremacy of Sardis. Lydia never again shrank to its original dimensions. After the Persian conquest the Maeander was regarded as its southern boundary, and in the Roman period it comprised the country between Mysia and Caria on the one side and Phrygia and the Aegean on the other.

Lydia proper was exceedingly fertile. The hill-sides were clothed with vine and fir, and the rich broad plain of Hermus produced large quantities of corn and saffron. The climate of the plain was soft but healthy. The Pactolus, which flowed through the centre of Sardis, into the Hermus, was believed to be full of golden sand. Maeonia on the east contained the curious barren plateau known to the Greeks as the *Katakekaumenē* ("Burnt country"), once a centre of volcanic disturbance. The Gygaean lake (where remains of pile dwellings have been found) still abounds with carp.

Race and Religion.—The Lydian race was probably a mixed one, consisting of aborigines and Aryan immigrants. It was characterized by industry and a commercial spirit. The religion of the Lydians resembled that of the other civilized nations of Asia Minor. It was a nature worship, which at times became wild and sensuous. By the side of the supreme god Medeus stood the sun-god Attis, as in Phrygia the chief object of the popular cult. He was at once the son and bridegroom of Cybele (*q.v.*), or Cybebe, the mother of the gods, whose image was adored on the cliffs of Sipylus (Paus. iii. 22). At Ephesus, where she was adored under the form of a meteoric stone, she was identified with the Greek Artemis (*see* also GREAT MOTHER OF THE GODS). The priestesses by whom she was served are depicted as armed with the double-headed axe, and the dances they performed in her honour with shield and bow gave rise to the myths which saw in them the Amazons (*q.v.*) a nation of woman-warriors. The pre-Hellenic cities of the coast—Smyrna, Samorna, (Ephesus), Myrina, Cyme, Priene and Pitane,—were all of Amazonian origin, and the first three of them have the same name as the Amazon Myrina, whose tomb was pointed out in the Troad. The prostitution whereby the Lydian girls gained their dowries (Herod. i. 93) was a religious exercise, as among the Semites, which marked their devotion to the goddess Cybele.

Lydian Dynasties.—According to the native historian Xanthus (460 B.C.) three dynasties ruled in succession over Lydia. The first, that of the Attiads, is mythical. To this mythical age belongs the colony which, according to Herodotus (i.94), Tyrsenus, the son of Attis, led to Etruria. Xanthus, however, puts Torrhebus in the place of Tyrsenus, and makes him the eponym of a district in Lydia. The second dynasty was also of divine origin, but the names which head it prove its connection with the distant East. The Hittites, an Oriental people, deeply imbued with the elements of Babylonian culture, had overrun Asia Minor and established themselves on the shores of the Aegean before the reign of the Egyptian king Rameses II. Their subject allies include the Mysians and the Dardani of the Troad, while the Hittites have left memorials in Lydia. G. Dennis discovered an inscription in Hittite hieroglyphics attached to the figure of "Niobe" on Sipylus. We learn from Eusebius that Sardis was first captured by the Cimmerii 1078 B.C.; and since it was four centuries later before the real Cimmerii (*q.v.*) appeared on the horizon of history, we may perhaps find in the statement a tradition of the Hittite conquest. As the authority of the Hittite satraps at Sardis began to decay the Heraclid dynasty arose. After lasting five hundred and five years, the dynasty came to an end in the person of Sadyattes. The name Candaules, given him by Herodotus (i.7), meant "dog strangler," and was a title of the Lydian Hermes. Gyges (*q.v.*) put him to death and established the dynasty of the Mermnads, 687 B.C. Gyges initiated a new policy, that of making Lydia a maritime power; but towards the middle of his reign the kingdom was overrun by the Cimmerii (*q.v.*). The lower town of Sardis was taken, and Gyges sent tribute to Assur-banipal, as well as two Cimmerian chieftains he had himself captured in battle. A few years later Gyges joined in the revolt against Assyria; the Cimmerian hordes returned, Gyges was slain in battle (652 B.C.), and Ardys his son and successor returned to his allegiance to Nineveh. Alyattes, the grandson of Ardys, finally succeeded in extirpating the Cimmerii, as well as in taking Smyrna, and thus providing his kingdom with a port. The trade and wealth of Lydia rapidly increased, and the Greek towns fell one after the other before the attacks of the Lydian kings. Alyattes's long reign of 57 years saw the foundation of the Lydian empire. All Asia Minor west of the Halys acknowledged his sway. The Greek cities were allowed to retain their own institutions and government on condition of paying taxes and dues to the Lydian monarch, and the proceeds of their commerce thus flowed into the imperial exchequer. The result was that the king of Lydia became the richest prince of his age. Alyattes was succeeded by Croesus (*q.v.*), who had probably already for some years shared the royal power. He reigned alone only 15 years, Cyrus (*q.v.*) the Persian after an indecisive battle on the Halys, marching upon Sardis, and capturing both acropolis and monarch (546 B.C.).

Persian Conquest.—The revolt of the Lydians under Pactyas, whom Cyrus had appointed to collect the taxes, caused the Persian king to disarm them. Sardis now became the western capital of the Persian empire, and its burning by the Athenians was one of the contributing causes of the Persian War. After Alexander the Great's death, Lydia passed to Antigonus; then Achaeus made himself king at Sardis, but was defeated and put to death by Antiochus. The country was presented by the Romans to Eumenes, and subsequently formed part of the proconsular province of Asia. By the time of Strabo (xiii. 631) its old language was entirely supplanted by Greek. (*See* ASIANIC LANGUAGES.)

The Lydian empire may be described as the industrial power of the ancient world. The Lydians were credited with introducing or inventing the game of dice and also coined money. The oldest known coins are the electrum coins of the earlier Mermnads (Madden, *Coins of the Jews,* pp. 19–21), stamped on one side with a lion's head or the figure of a king with bow and quiver; these were replaced by Croesus with a coinage of pure gold and silver. The electrum coins of Lydia were of two kinds, one weighing 168·4 grains for the inland trade, and another of 224 grains for the trade with Ionia. The standard was the silver mina of Carchemish which contained 8,656 grains. Originally derived from Babylonia, this standard was passed on to Asia Minor during the Hittite conquest, but was eventually superseded by the Phoenician mina of 11,225 grains (*see* also NUMISMATICS). The inns, which the Lydians were said to have been the first to establish, were connected with their attention to commercial pursuits (Herod. i.94). Their literature has wholly perished. They were celebrated for their music and gymnastic exercises, and their art formed a link between that of Asia Minor and that of Greece. Lydian sculpture was probably similar to that of the Phrygians. Phallic emblems, for averting evil, were plentiful; the summit of the tomb of Alyattes is crowned with an enormous one of stone, about 9 ft. in diameter.

The tumulus itself is 281 yds. in diameter and about half a mile in circumference. It has been partially excavated, and a sepulchral chamber discovered in the middle, composed of large well-cut and highly polished blocks of marble. The stone basement which, according to Herodotus, formerly surrounded the mound has disappeared.

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LYDUS ("THE LYDIAN"), **JOANNES LAURENTIUS,** Byzantine writer on antiquarian subjects, was born in A.D. 490. From an early age until his dismissal in 552 he held high court and state offices. The date of his death is not known, but he probably did not survive Justinian (d. 565). Of his literary works there survive: (1) *De Ostentis* (Περὶ διοσημειῶν), on the origin and progress of the art of divination; (2) *De Magistratibus reipublicae Romanae* (Περὶ ἀρχῶν τῆς Ῥωμαίων πολιτείας); (3) *De Mensibus* (Περὶ μηνῶν), a history of the different festivals of the year.

The chief value of these books consists in the fact that the author made use of the works (now lost) of old Roman writers on similar subjects.

Editions of (1) by C. Wachsmuth (1897), of (2) and (3) by R. Wünsch (1898–1903); *see* also Christ-Schmid, *Geschichte der Gr. Lit.;* and Klotz in Pauly-Wissowa, *Realencyclopädie.*

LYE, the name given to the solution of alkaline salts obtained by leaching or lixiviating wood ashes with water; to solutions of a caustic alkali (sodium or potassium hydroxide); or, more generally to any strong alkaline solution especially one used as a detergent.

In the United States it is the trade name for sodium hydroxide. (*See* ALKALI; ALKALI MANUFACTURE.)

LYELL, SIR CHARLES (1797–1875), British geologist, son of Charles Lyell of Kinnordy, Forfarshire, was born on Nov. 14, 1797, on the family estate in Scotland. His father (1767–1849) was known both as a botanist and as the translator of the *Vita Nuova* and the *Convito* of Dante: the plant *Lyellia* was named after him. As a boy Lyell had a strong inclination for natural history, especially entomology. In 1816 he entered Exeter college, Oxford, where the lectures of Dr. Buckland first attracted him to geology. After graduating he entered Lincoln's Inn, and in 1825 he was called to the bar, and went on the western circuit for two years. In 1819 he had been elected a fellow of the Linnean and Geological societies, communicating his first paper, "On a Recent Formation of Freshwater Limestone in Forfarshire," to the latter society in 1822, and acting as one of the honorary secretaries in 1823. In that year he went to France, and in 1824 made a geological tour in Scotland in company with Dr. Buckland. In 1826 he was elected F.R.S., and in 1827 he finally abandoned law for geology.

He had already begun to plan his chief work, *The Principles of Geology* (3 vols., 1830–33). With Murchison he wrote joint papers on the volcanic district of Auvergne and the Tertiary formations of Aix-en-Provence. He then studied the marine remains of the Italian Tertiary strata, and conceived the idea of dividing this geological system into three or four groups, characterized by the proportion of recent to extinct species of shells. To these groups, after consulting Dr. Whewell as to the best nomenclature, he gave the names now universally adopted—Eocene (*dawn of recent*), Miocene (*less of recent*), and Pliocene (*more of recent*); and with the assistance of G. P. Deshayes he drew up a table of shells in illustration of this classification. Between 1830 and 1876 12 editions of *The Principles of Geology* were published, each so much enriched as to form a complete history of the progress of geology during that interval.

In 1838 Lyell published the *Elements of Geology*, which became a standard work on stratigraphical and palaeontological geology. This book, which was based on lectures, went through six editions in Lyell's lifetime. In his third great work, *The Antiquity of Man* (1863), he gave a general survey of the arguments for man's early appearance on the earth, derived from the discoveries of flint implements in post-Pliocene strata in the Somme valley and elsewhere; he discussed also the deposits of the Glacial epoch, and in the same volume he first gave in his adhesion to Darwin's theory of the origin of species.

In 1833 Lyell married Mary (1809–1873), eldest daughter of Leonard Horner, who was thenceforward associated with him in all his work.

In 1834 Lyell went to Denmark and Sweden, the result of which was his Bakerian lecture to the Royal Society "On the Proofs of the gradual Rising of Land in certain Parts of Sweden." He also brought before the Geological Society a paper "On the Cretaceous and Tertiary Strata of Seeland and Möen." In 1835 he became president of the Geological Society. In 1837 he was again in Norway and Denmark, and in 1841 travelled through the United States, Canada and Nova Scotia. This last journey, together with a second one to America in 1845, resulted not only in papers, but also in two works not exclusively geological, *Travels in North America* (1845) and *A Second Visit to the United States* (1849). He estimated the rate of recession of the falls of Niagara, the annual average accumulation of alluvial matter in the delta of the Mississippi, and studied those vegetable accumulations in the "Great Dismal Swamp" of Virginia, which he afterwards used in illustrating the formation of beds of coal. He also studied the coal-formations in Nova Scotia, and discovered, in company with Dr. (afterwards Sir J. W.) Dawson (*q.v.*) of Montreal, the earliest known landshell, *Pupa vetusta*, in the hollow stem of a Sigillaria. On a visit to Madeira and Teneriffe he accumulated evidence on the age and deposition of lava-beds and the formation of volcanic cones. He revisited Sicily in 1858, and his observations upon the structure of Etna refuted the theory of "craters of elevation" upheld by Von Buch and Élie de Beaumont. (See *Phil. Trans.*, 1859.)

Lyell was knighted in 1848 and created a baronet in 1864, in which year he was president of the British Association at Bath.

In later life he became blind. He died on Feb. 22, 1875, and was buried in Westminster Abbey.

The Lyell Medal, established in 1875 under the will of Sir Charles Lyell, is to be awarded annually (or from time to time) by the council of the Geological society. The medallist may be of any country or either sex. Not less than one-third of the annual interest of a sum of £2,000 is to be awarded with the medal; the remaining interest, known as the Lyell Geological Fund, is to be given in one or more portions at the discretion of the council for the encouragement of geological science.

See *Life, Letters and Journals of Sir Charles Lyell, Bart.*, edited by his sister-in-law, Mrs. Lyell (2 vols., 1881); *Charles Lyell and Modern Geology*, by T. G. Bonney (1895).

LYLY, LILLY or **LYLIE, JOHN** (1553?–1606), English writer, the famous author of *Euphues*, was born in Kent in 1553 or 1554. At the age of 16, according to Wood, he became a student of Magdalen college, Oxford, where in due time he proceeded to his bachelor's and master's degrees (1573 and 1575). In 1574 he applied, in vain, to Lord Burghley "for the queen's letters to Magdalen college to admit him fellow." After he left Oxford, where he had already the reputation of "a noted wit," Lyly seems to have attached himself to the service of Lord Delawarr, and in 1580 to that of Burghley's son-in-law, Edward, earl of Oxford. Two years later we possess a letter of Lyly, dated July 1582, in which the writer protests against some accusation of dishonesty which had brought him into trouble with his patron, and demands a personal interview for the purpose of clearing his character. He obtained, probably through Oxford, a lease at Blackfriars for a theatrical undertaking, which apparently failed, for he was in prison for debt in 1583, when Oxford seems to have helped him out.

In 1578 he wrote *Euphues, or the Anatomy of Wit*, which was licensed to Gabriel Cawood on Dec. 2, 1578, and published in the spring of 1579. In the same year the author was incorporated M.A. at Cambridge, and possibly saw his hopes of court advancement dashed by the appointment in July of Edmund Tylney to the office of master of the revels, a post at which, as he reminds the queen some years later, he had all along been encouraged to "aim his courses." *Euphues and his England* appeared in 1580. For a time Lyly was the most successful and fashionable of English writers. He was hailed as the author of "a new English," as a "raffineur de l'Anglois"; and, as Edmund Blount, the editor of his plays, tells us in 1632, "that beautie in court which could not parley Euphuism was as little regarded as she which nowe there speakes not French."

After the publication of *Euphues*, however, Lyly seems to have entirely deserted the novel form, which passed into the hands of his imitators, and to have thrown himself almost exclusively into play-writing, probably with a view to the mastership of revels whenever a vacancy should occur. Their lively dialogue, classical colour and frequent allusions to persons and events of the day maintained that popularity with the court which *Euphues* had won.

In 1589 Lyly published a tract in the Martin Marprelate controversy, called *Pappe with an hatchet, alias a figge for my Godsonne; Or Crack me this nut; Or a Countrie Cuffe, etc.* About the same time we may probably date his first petition to Queen Elizabeth. The two petitions, transcripts of which are extant among the Harleian mss., are undated, but in the first of them he speaks of having been ten years hanging about the court in hope of preferment, and in the second he extends the period to 13 years. It may be conjectured that the ten years date from 1579, when Edmund Tylney was appointed master of the revels with a tacit understanding that Lyly was to have the reversion of the post. But in 1589 or 1590 the mastership of the revels was as far off as ever—Tylney in fact held the post for 31 years—and that Lyly's petition brought him no compensation in other directions may be inferred from the second petition of 1593. "Thirteen yeres your highnes servant but yet nothing. Twenty freinds that though they saye they will be sure, I finde them sure to be slowe. A thousand hopes, but all nothing; a hundred promises but yet nothing. Thus casting up the inventory of my friends, hopes, promises and tymes, the *summa totalis* amounteth to just nothing." Edmund Blount says vaguely that Elizabeth "graced and rewarded" him, but of this there is no other evidence. After 1590 his works steadily declined in influence and reputation; other stars were in possession of the horizon; he seems to have received some reward in the last years of Elizabeth's reign, possibly out of the Essex forfeitures. He was buried in London at St. Bartholomew the Less on Nov. 30, 1606. He had married, in 1583, Beatrice Browne, of Mexborough, York, and had two sons and a daughter.

Comedies.—In 1632 Edmund Blount published "Six Court Comedies," including *Endymion* (1591), *Sappho and Phao* (1584), *Alexander and Campaspe* (1584), *Midas* (1592), *Mother Bombie* (1594) and *Gallathea* (1592). To these should be added the *Woman in the Moone* (Lyly's earliest play, to judge from a passage in the prologue and therefore earlier than 1584, the date of *Alexander and Campaspe*), and *Love's Metamorphosis,* first printed in 1601. Of these, all but the last are in prose. *A Warning for Faire Women* (1599) and *The Maid's Metamorphosis* (1600) have been attributed to Lyly, but on altogether insufficient grounds. The first editions of all these plays were issued between 1584 and 1601, and the majority of them between 1584 and 1592, in what were Lyly's most successful and popular years. Lyly's dialogue shows a great advance in rapidity and resource upon anything which had gone before it; it represents a great step forward in English dramatic art. His nimbleness, and the wit which struggles with his pedantry, found their full development in the dialogue of *Twelfth Night, As You Like It* and *Much Ado about Nothing,* just as "Marlowe's mighty line" led up to and was eclipsed by the majesty and music of Shakespearian passion. One or two of the songs introduced into his plays show a real lyrical gift. These, however, only appear in a posthumous edition, and critics are not unanimous in ascribing them to Lyly. His classical and mythological plots, flavourless and dull as they would be to a modern audience, were interesting enough to the court, who saw in Midas Philip II., Elizabeth in Cynthia and perhaps Leicester's unwelcome marriage with Lady Sheffield in the love affair between Endymion and Tellus which brings the former under Cynthia's displeasure. Gabriel Harvey dreaded lest Lyly should make a play upon their quarrel; Meres, as is well known, places him among "the best for comedy"; and Ben Jonson names him among those foremost rivals who were "outshone" and outsung by Shakespeare.

Euphues.—It was not, however, as a dramatist, but as the author of *Euphues,* that Lyly made his immediate mark upon the Elizabethan world. His plays amused the court circle, but the "new English" of his novel introduced a new sense of form in English prose style, and in English speech. Its exaggerations compelled attention, and in time disappeared; but the conscious preoccupation with the order and selection of words in prose bore solid fruit. The plot of *Euphues* is extremely simple. The hero, whose name may very possibly have been suggested by a passage in Ascham's *Schoolmaster,* is introduced to us as still in bondage to the follies of youth, "preferring fancy before friends, and this present humour before honour to come." His travels bring him to Naples (London), where he falls in love with Lucilla, the governor's light-minded daughter. Lucilla is already pledged to Euphues's friend Philautus, but Euphues's passion betrays his friendship, and the old lover finds himself thrown over by both friend and mistress. Euphues himself, however, is very soon forsaken for a more attractive suitor. He and Philautus make up their quarrel, and Euphues writes his friend "a cooling card," to be "applied to all lovers," which is so severe upon women that Lyly feels it necessary to balance it by a sort of apology addressed "to the grave matrons and honest maidens of Italy" (England). Euphues then leaves Naples (London) for his native Athens (Oxford), where he gives himself up to study, of which the first fruits are two long treatises—the first, "Euphues and his Ephoebus," a disquisition on the art of education addressed to parents, and the second, "Euphues and Atheos," a discussion of the first principles of religion. The remainder of the book is filled up with correspondence between Euphues and his friends. The first *Euphues* is therefore an attack on the "Italianate" society of London, and on the fickleness of woman. The book aroused violent protests both in Oxford and London, which Lyly hastened to meet by the publication of *Euphues and his England,* in which criticism is exchanged for flattery. England is all that is good; Englishwomen are chaste and virtuous, and Englishmen mirrors of chivalry.

In *Euphues and his England* Euphues and Philautus travel from Naples to England. They arrive at Dover, halt for the night at Fidus's house at Canterbury, and then proceed to London, where they make acquaintance with Surius, a young English gentleman of great birth and noble blood; Psellus, an Italian nobleman reputed "great in magick"; Martius, an elderly Englishman; Camilla, a beautiful English girl of insignificant family; Lady Flavia and her niece Fraunces. After endless correspondence and conversation on all kinds of topics, Euphues is recalled to Athens, and from there corresponds with his friends. "Euphues' Glasse for Europe" is a flattering description of England sent to Livia at Naples. It is the most interesting portion of the book, and throws light upon one or two points of Lyly's own biography.

Such is a brief outline of the book which for a time set the fashion for English prose. Two editions of each part appeared within the first year after publication, and 13 editions of both are enumerated up to 1636, after which, with the exception of a modernized version in 1718, *Euphues* was never reprinted until 1868, when Dr. Arber took it in hand. The long disquisitions on love, religion, exile, women or education, on court life and country pleasures, handled all the most favourite topics in the secularized speculation of the time; the foreign background and travel talk pleased a society of which Lyly himself said "trafic and travel hath woven the nature of all nations into ours and made this land like arras full of device which was broadcloth full of workmanship"; and, although Lyly steered clear in it of the worst classical pedantries of the day, the book was steeped in classical learning, and based upon classical material. A large proportion of its matter indeed was drawn from classical sources, but he always gave to his borrowed material a colouring which is peculiarly his own, the note which is described as eupheuistic.

It was not the matter of *Euphues,* however, so much as the style which made it famous. (*See* EUPHUISM.) The source of Lyly's peculiar style has been traced to the influence of Don Antonio de Guevara (*q.v.*), whose *Libro Aureo de Marco Aurelio* (1529) was translated by Lord Berners (1531), and, as *The Dial for Princes,* by North (1557). The sententious and antithetical style of *The Dial for Princes* is substantially that of *Euphues,* though Guevara on the whole handles it better than his imitator.

Lyly was not the first to appropriate and develop the Guevaristic style. The earliest book in which it was fully adopted was *A petite Pallace of Pettie his Pleasure* (1576) by George Pettie. Lyly, however, carried the style to its highest point, and made it the dominant literary fashion. His principal followers in it were Greene, Lodge and Nash, his principal opponent Sir Philip Sidney; the Arcadia in fact supplanted *Euphues,* and the Euphuistic taste proper may be said to have died out about 1590 after a reign of some 12 years. According to Landmann, Shakespeare's *Love's Labour Lost* is a caricature of the Italianate and pedantic fashions of the day, not of the peculiar style of *Euphues.* The only certain allusion in Shakespeare to the characteristics of Lyly's famous book is to be found in *Henry IV.,* where Falstaff, playing the part of the king, says to Prince Hal, "Harry, I do not only marvel where thou spendest thy time, but also how thou art accompanied; for, though the camomile the more it is trodden on the faster it grows, yet youth the more it is wasted the sooner it wears." Here the pompous antithesis is evidently meant to caricature the peculiar Euphuistic sentence of court parlance.

(M. A. WA.; X.)

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LYME REGIS, a municipal borough and watering-place, Western parliamentary division, Dorsetshire, England, 151 mi. S.W. of London by the Southern railway. Pop. (1938) 2,715. Area, 2 sq.mi. It is situated at the mouth of a narrow valley opening upon a fine precipitous coast-line, and there is a sandy shore affording excellent bathing. The church of St. Michael and All Angels is mainly Perpendicular, but the tower (formerly central) and the portion west of it are Norman. A guildhall and assembly rooms are the chief public buildings. The principal industries are stone-quarrying and the manufacture of cement. A curved pier, known as the Cobb, is first mentioned in 1328. The harbour, with a small coasting trade, is under the authority of the corporation.

In 774 Cynewulf, king of the West Saxons, granted land here to the church of Sherborne. In 1086 three manors of Lyme are mentioned. The town was first known as Lyme Regis in 1316. Lyme ranked as a port in 1234, and Edward I in 1284 granted to the town a charter making it a free borough, with a merchant gild. In the following January the bailiffs were given privileges implying considerable foreign trade; the importance of the port is also evident from the demand of two ships for the king's service in 1311. It received another grant from Edward III (1332). In 1591 Elizabeth incorporated Lyme, and further charters were obtained from James I, Charles II and William III. Lyme returned two members to parliament from 1295 to 1832 when the representation was reduced to one. The borough was disfranchised in 1867. The fairs granted in 1553 for the 1st of February and the 20th of September are now held on altered dates. Trade with France began as early as 1284. In 1685 Lyme was the scene of the landing of James, duke of Monmouth, in his attempt upon the throne.

LYMINGTON, a municipal borough and seaport in Hampshire, England, 98 mi. S.W. of London by the S.R. Pop. (1938) 17,910. Area, 23.7 sq.mi. There was a Roman camp nearby, but there is no evidence that a town existed here until after the Conquest. Its importance began when it was granted to Richard de Redvers, earl of Devon, in the reign of Henry I. No charter has been found, but a judgment given under a writ of *quo warranto* in 1578 confirms to the burgesses freedom from toll, passage and pontage, the tolls and stallage of the quay and the right to hold two fairs—privileges which they claimed under charters of Baldwin de Redvers and Isabel de Fortibus, countess of Albemarle, in the 13th century, and Edward Courtenay, earl of Devon, in 1405. The town was governed by the mayor and burgesses until the corporation was reformed in 1835. A writ for the election of a member to parliament was issued in the reign of Edward III., but no return was made. From 1585 two members were regularly returned; the number was reduced to one in 1867, and in 1885 the representation was merged in that of the county. Fairs on May 13 and 14 and Oct. 2 and 3, dating from the 13th century, are still held. The Saturday market probably dates from the same century. Lymington was made a port in the reign of Henry I., and its large shipping trade led to frequent disputes with Southampton as to the levying of duties. The case was tried in 1329 and decided against Lymington, but in 1750 the judgment was reversed, and since then the petty customs have been regularly paid. From an early date and for many centuries salt was the staple manufacture of Lymington. The rise of the mineral salt-works of Cheshire led to its decline in the 18th century, and later the renewed importance of Southampton completed its decay. It lies on the estuary of the Lymington, which opens into the Solent. The church of St. Thomas the Apostle, an irregular structure, dates from the reign of Henry VI., but has been frequently restored. The harbour contains five berths, and ships drawing 11 ft. may be berthed at high tide. There is some coasting trade, and yacht-building is carried on. Regular passenger steamers serve Yarmouth in the Isle of Wight. In summer the town is frequented for sea-bathing.

LYMPH, ITS FORMATION AND MOVEMENT. In order to gain an insight into the significance of lymph it is necessary to consider the whole question of fluid circulation in the tissues. The most convenient point at which to commence such a review is the blood. The function of this medium is to transport oxygen and nutritive materials to tissues requiring them and to remove certain waste products such as carbon dioxide. Blood is conveyed in a totally closed circulatory system, the nearest point of approach to the actual tissue cells being in the capillary area. The materials conveyed by the blood have to be transferred from the interior of this capillary system through a wall of thin endothelium to fluid surrounding the cells and in intimate contact with them. This fluid, which is known as tissue fluid, acts as a middleman, conveying substances from the fluid of the blood directly to the cells of the organ.

With the important exceptions of the central nervous system the skeletal muscle bundles and spleen pulp, all tissues and organs are supplied with another set of capillary vessels in intimate contact with the tissue fluid, but, as in the case of the capillary blood vessels, separated from it by a continuous wall of thin endothelium. These vessels are the lymphatic capillaries. They begin as blind extremities and unite, usually with a very extensive anastomosis, to form plexuses of larger vessels with thicker walls. These in turn are drained by the lymphatic trunks which usually course with the main blood vessels of the part. The main trunks coming from the hind limbs and abdominal organs are united into one large vessel, the receptaculum chyli from which the thoracic duct passes up on the left side of the oesophagus to drain into the venous system on the left side of the neck. A smaller duct drains the right side of the head and neck and right upper limb, emptying into the veins in an analogous position on that side.

The lymph vessels coming from organs or limbs pass through lymphatic glands at some part of their course. This whole network of vessels and glands is known as the lymphatic system. Early work on this system gave rise to the view that the lymph capillaries were in direct communication with the tissue spaces. Lymph therefore was simply tissue fluid which had passed through openings in the walls of the smallest lymphatic vessels. Later work substituted the opinion that lymph capillaries were totally closed by endothelial plates in the same way as blood capillaries. This view, which has been restated and strengthened by the observations of Sabin, is that now generally held to be correct.

One is therefore left with the conception that the tissue of an organ consists of a collection of cells completely surrounded by a fluid medium—the tissue fluid. As a channel for the supply of nutriment there are blood capillaries. As a channel of exit only

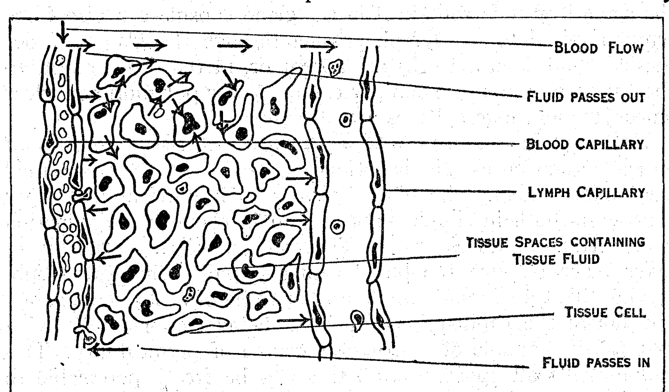

DIAGRAM SHOWING FLUID EXCHANGES TAKING PLACE IN ACTIVE TISSUE
The arrows indicate the direction of flow of the fluid, which comes from the blood vessel and passes between the tissue cells to enter the lymph capillary, to form lymph. Arrows on the tissue cells show that fluid exchange is occurring between them and the surrounding tissue fluid

there are the lymph capillaries, and, as we shall see, the blood vessels also subserve the same function. The fluid, therefore, which is derived from the tissue fluid, after passage through the endothelial wall of the lymphatic, is lymph. Obviously its composition relative to tissue fluid depends on the properties of the lymphatic endothelium.

It is with the composition, mode of production, function and propulsion of this fluid that we have to deal.

Composition.—Lymph can be collected by allowing the fluid to drop into a vessel from a canula—a small glass or metal tube

—inserted into one of the larger trunks passing from an organ or limb. Mixed lymph, *i.e.*, lymph from all parts intermingled, is collected from a canula inserted into the thoracic duct in the neck. Mixed lymph when collected from a fasting animal is colourless or yellowish. Its specific gravity varies from 1015 to 1025. The lymph so collected readily clots, but the clot is not so firm as that of blood. The total solids vary from 3·6 to 5·7%. The proteins consist of fibrinogen, paraglobulin and serum albumin. The salts are similar to those of the liquor sanguinis and are present in the same proportions. According to some, however, salts such as sodium chloride may be present in greater concentration than in blood plasma. The electrical conductivity of lymph has also been found to vary in the inverse way to that of blood in certain circumstances.

If the lymph is collected from an animal fed some time previously with a fatty meal it has a milky appearance due to the presence of innumerable fine drops of fat about ·5 to ·75μ in diameter. This fat is absorbed by the lymphatics of the small intestine, which because of their white appearance during digestion are called lacteals.

If, however, lymph is collected separately from various organs and limbs it is found to differ very considerably in its protein content. Thus lymph collected from the liver is very little inferior in protein content to that of blood, while that of leg lymph is considerably less. These two examples represent the extremes of difference, samples from other organs falling between these values.

The Amount of Lymph.—In the dog as much as 0·6 litres, in the cow about 2 litres of lymph per 10 kilos of body weight is eliminated by the thoracic duct in 24 hours. Direct measurements have not been made on man but probably 4 to 5 litres —equal to the whole blood volume—passes through the duct in a day.

Formed Elements.—The formed elements of lymph consist almost entirely of lymphocytes which are added to it in its passage through the lymphatic glands, and from the lymphatic tissue such as is present in the spleen, intestine and tonsils. The actual number present at any time is very variable, in a cat usually 10,-000–20,000 per c.mm. in the lymph from the intestine. It has been found that mechanical pressure on lymphatic glands is capable of increasing this number very considerably, so that the lymphocytosis in the blood after exercise can be explained on this basis alone. Nevertheless there is some evidence that contraction of the smooth muscle contained in the gland capsule can also force lymphocytes into the lymph passing through the gland. Under normal conditions red cells are absent or, in the dog, present to the extent of 1,000 to 2,000 per c.mm. A few polymorphonuclear leucocytes and macrophages are also found.

Mode of Production and Function.—A tissue consists of an agglomeration of cells in intimate contact with the tissue fluid surrounding them. The blood conveys to it nutrient and other substances both in simple solution and in chemical combination with certain of its elements. The transfer of these substances takes place through the blood capillary wall. The forces subserving this transference would appear to be of a physical character though the capillary endothelium, being composed of living material, is capable of altering its degree of permeability. This endothelial wall appears at all times to be freely permeable to dissolved salts, but its permeability to proteins is a variable factor. The physiological conditions under which this permeability alters are not known, but under pathological conditions, such as are produced by mechanical injury, the proteins may pass freely through the injured endothelium.

Transference of Fluid.—The forces producing a transference of fluid and dissolved substances from the interior of the capillary to the tissue spaces are blood pressure, diffusion and osmosis. The hydrostatic pressure existing in a blood capillary over that in the extravascular tissue spaces causes a filtration through the endothelial wall of fluid having the same composition in salts as blood but varying in protein content. At the same time diffusible substances at a greater concentration in the blood tend to pass to a region of less concentration in the tissues. The third force, that of osmosis, also comes into play owing to the fact that water is capable of passing through the capillary membrane more quickly than salts,—thus if a hypertonic solution of sodium chloride is injected intravenously there is a passage of water from the tissue to the blood which is greatly increased in volume, with a concomitant desiccation of the tissues. At the same time salt passes more slowly into the tissues till a new equilibrium is reached. In the reverse direction an increased molecular concentration in the tissues is capable of drawing fluid from the blood. These factors are sufficient to account for a passage of fluid and dissolved substances from the blood to the tissues. The products of tissue metabolism, however, have to be removed together with excess water and salts, the former of which has been the vehicle for the conveyance of nutriment.

Return of Fluid—Two Courses.—Two courses are open for the return of fluid. It may go back directly into the blood vessels or pass into the lymphatics. That substances can be absorbed directly into the blood vessels has been quite conclusively demonstrated. The explanation of the forces involved in their passage was supplied by Starling. He showed that the proteins of blood plasma possess an osmotic pressure of between 25 and 30 mm. Hg. It is estimated that the hydrostatic pressure of the blood at the arterial end of a capillary is above this figure, while at the venous end it is below. At the arterial end, therefore, the excess of hydrostatic pressure causes the fluid to pass from the capillary to the tissue spaces. At the venous end the excess of osmotic pressure produces the reverse phenomenon and fluid passes from the tissue spaces into the capillary.

This conception has recently been very beautifully confirmed in the frog by Landis who has directly measured the intracapillary pressure and found, when compared with the osmotic pressure of the proteins, to bear out the above relationship. One can thus understand that a constant interchange between blood and tissue fluid can take place without the production of a drop of lymph. Indeed this is the case in a limb at rest. In the muscular tissue of this part the blood capillaries are relatively impermeable so that a considerable colloid osmotic pressure is available for the work of resorption.

Function of the Lymphatics.—If, however, the limb is thrown into action the arterioles and capillaries of the part dilate and the hydrostatic pressure in them consequently increases. That is to say the length of capillary over which resorption can occur by virtue of the excess of osmotic over hydrostatic pressure is lessened so that fluid tends to accumulate in the tissue spaces. As will be shown later this is not the only cause of accumulation of fluid, but it is under these conditions that a flow of lymph occurs.

In the liver the blood capillaries are extremely permeable, so that very little osmotic pressure is available for the resorption of fluid. This excess fluid which cannot return to the blood vessels passes into the lymphatics and is continuously drained away in that fashion. It would appear then that the lymphatics are a system for draining the tissues of excess fluid and so preventing them from becoming oedematous and waterlogged.

Metabolism and Lymph Flow.—Apart from the forgoing explanation the following considerations are of great importance. An organ or tissue in activity is breaking down larger into a greater number of smaller molecules, that is, the metabolic processes result in the production of a fluid possessing greater osmotic pressure than the fluid of the resting tissue. This increase of osmotic pressure attracts water from the blood, and so increases the amount of fluid in the tissue.

The effects of metabolism on lymph flow can be very well seen in the case of the submaxillary gland. During the secretion of saliva, consequent on stimulation of the chorda tympani nerve there is a great increase of the lymph flow from the gland. If now the secretory apparatus is paralysed by atropine so that stimulation of the chorda tympani no longer evokes a secretion of saliva, there is no increase in lymph outflow, though the dilator action of the nerve on the blood vessels remains unimpaired. Obviously the activity of the salivary secretory cells is the determining factor of the increased lymph output.

It is to be emphasized that tissue metabolism is of the utmost importance in the production of lymph not only quantitatively but qualitatively. In consequence much recent work has been an attempt to gain a clearer insight into intermediate tissue metabolism from a study of lymph coming from various parts. From this work it has been found that hormones such as adrenalin and insulin have considerable influence not only on the quantity of lymph produced by a part, but also on its composition with regard to proteins and salts.

The tissue cells at all times do not hold the same amount of water—in different physiological conditions different quantities are found. For example it seems probable that a change in hydrogen ion concentration is capable of altering the water balance of a tissue, and in all probability alterations in the concentration of other ions also have a like influence. Such fluctuations alter the lymph flow.

Heidenhain's Researches and Theories.—The views presented are at the present time not universally accepted as expressing the whole truth. Heidenhain, in a long series of researches, endeavoured to establish the view that lymph production depended on a secretory activity on the part of the endothelial cells of the lymphatic capillaries. That is, lymph would be a secretion and would not reflect the composition of tissue fluid. Some of the main arguments adduced by Heidenhain depended on observations of substances which produced an increased lymph flow—lymphagogues—when injected intravenously.

He divided the lymphagogues into two groups. Those of the first are proteins or protein degradation products, for example, extract of mussels, crabs, strawberries, and peptone. Those of the second group are of a salt character, for example sodium chloride, which are possessed of considerable osmotic qualities. The injection of lymphagogues of the first order produces an increased flow of lymph, mainly from the liver. It has been pointed out that substances of this nature when pricked into the skin cause wheals. Recent work has shown conclusively that the fluid content of these wheals is derived from the blood through a capillary wall which has become more permeable.

It has therefore been argued that this type of lymphagogue injures the blood capillary endothelium and leads to an increased filtration of fluid and thence of lymph. It should be noted that such substances as peptone stimulate the liver cells so that this may be an added factor in the increased lymph production. Heidenhain, on the other hand, maintained that these substances specifically excited the lymph capillary endothelium to secrete lymph.

The action of the second type of lymphagogue has been correlated with the great osmotic activities of these substances. Injected salts at first attract considerable quantities of water into the blood stream. This increase of the circulating blood volume increases the intracapillary pressure which tends to force fluid back into the tissue spaces. The flow of lymph depends on the relative activities of these two factors. With this class of lymphagogue the flow is also in conditions of rest, mainly from the liver and intestines.

It has been shown that after injections of large quantities of saline solutions the muscles increase their water content very considerably, but there is no flow of lymph from the limb under such conditions. This has been held to refute the filtration-osmosis theory of lymph production and to make essential the conception of active secretion by the lymphatic endothelium. A point, however, which has not been considered is that skeletal muscle is not supplied with lined lymphatic vessels. These only exist in the perimysium—the tissue surrounding the muscle bundles. Thus it is clear that muscle can take up large quantities of fluid which are not in actual contact with absorbing lymphatics, whereas organs such as the liver and intestines possess an extremely rich lymphatic capillary system.

It has also been urged that as injected salt accumulates to a greater extent in lungs and skin than in muscle, therefore a purely osmotic conception of its transfer is inadmissible. While this is true, our ignorance of the phenomena and laws governing salt distribution in the body cells does not make it necessary to deny potency to forces demonstrably present. Attempts have been made to show that injections of small quantities of salt solution have a stimulant action on tissue cells, leading to increase of the water exchange and general metabolism of an organ and so to increase of the lymph outflow.

Permeability of Lymphatic Capillaries.—It appears to be established that the lymphatic capillaries are made up of a complete membrane of endothelial cells. The degree of permeability of this endothelial wall has to be considered. The data so far accumulated on this subject are inadequate to give a complete picture but it is certain that in some parts, for example the lymphatics of the peritoneal surface of the diaphragm, there are vessels remarkably permeable to solid particles of considerable dimensions. Their permeability to fluids seems to be without limit. The fluid and particles in this region pass between the junctions of the cells lining the peritoneum and lymphatics. The central lymphatics of the intestinal villus also has a very considerable permeability as is shown by the fact that particles of fat ·5 to ·75μ in diameter as well as red blood corpuscles under certain circumstances, are capable of entering them.

That at least some portion of the lymphatic tree in every tissue has a like grade of permeability is made probable by the fact that bacteria and similar sized particles are readily taken up to be arrested in the nearest lymphatic gland. Whether the whole capillary system is equally permeable has not yet been ascertained. If it is, the endothelial wall of the lymphatic has little influence, apart from any "secretory" power, in the matter of selective filtration through its walls. An interesting observation dealing with the permeability of lymphatic vessels to diffusible substances has been made by T. Lewis. If histamine or adrenalin is inserted into the skin by puncture, some of the substance is taken up by the lymphatics nearby. They both however again pass out through the lymphatic wall as is shown by the fact that the course of the latter is traced out in the one case by a reddish line of dilated capillaries and venules, and in the other by a white line due to a contraction of these vessels.

These observations suggest the following conclusions:—Substances may first be absorbed from the tissues by the lymphatics and then, during their passage down these channels, pass out again into the surrounding tissue fluid to be re-absorbed by the blood vessels. Consequently the composition of lymph collected from a lymphatic trunk does not necessarily represent that from a lymph capillary.

Absorption of Hormones.—It has been shown by Hicks that the active principle of the thyroid gland is absorbed in part at least, by the lymphatics of that organ.

It is probable that the less diffusible chemical products of other organs of internal secretion are also absorbed in the same way, but only in the case of the thyroid gland is such evidence forthcoming.

To sum up concisely the views generally held as to the mechanism of lymph formation, it may be said that the physical forces of osmosis and filtration are largely responsible for the interchange of fluid and salts between blood, tissue and lymph. The metabolic activities of the tissue cells are also an important factor in determining both the quality and quantity of lymph outflow.

The permeability of the blood capillary wall partly controls the composition of the tissue fluid and lymph resulting therefrom: the influence of lymphatic permeability is not known. The balance of evidence is against endowing the lymphatic endothelium with specific secretory properties.

The Propulsion of Lymph.—The propulsion of blood and lymph is effected by very different agencies. The blood vascular system forms a completely closed circle through which fluid is pumped by the heart continuously in one direction. The lymphatic system begins as blind ended capillaries which unite, finally to pour their contents into the venous system. Thus there is no circulation of lymph in the same sense as there is of blood, but there is movement of lymph from the periphery, represented by the lymph capillaries, to the centre represented by the venous system. The factors involved in this propulsion have to be examined. The forces concerned may be grouped into those of extrinsic and of intrinsic origin.

Extrinsic Forces.—Of the greatest importance from a mechanical point of view is the fact that all the larger and most of the smaller trunks are liberally supplied with valves. These usually consist of two folds of endothelium, though occasionally more cusps are encountered. They are set so as to prevent flow towards the periphery. They have long cusps which are particularly efficient in preventing reflux and it is by virtue of their presence that muscular contraction or massage forms one of the chief propulsive agents. When a muscle contracts it squeezes the lymphatic vessels, thus tending to empty them in the direction permitted by the valves. That this mechanism is of very great importance can be seen if the lymph flow from a canula inserted into a lymphatic of a limb be examined. In a condition of rest no lymph flows from the canula, but if the limb is massaged or the muscles stimulated to contract actively, there is a considerable flow.

Blood Pressure.—From organs such as the liver and intestine there is a continuous flow of lymph at all times. That from the liver is obviously independent of muscular contraction. It has been shown that the flow from these organs is in close relationship with the blood pressure in their capillaries, the continuous outflow of lymph being due to a transmission of this pressure by way of the tissue fluid. In the case of the intestine the pressure in the main efferent lymphatic may be as much as 7 to 10 cm. of water. It is noteworthy that liver and intestinal lymph is by far the richest of any in protein, from which it is argued that the blood capillaries of these regions are very permeable, thus offering the best conditions for a transference of the hydrostatic pressure within them via tissue fluid to the lymphatics. In the limbs where the lymph has a low protein content, due to a relative impermeability of the blood capillaries, the driving power of the blood pressure is minimal.

Pressure in Tissue Spaces.—It follows that any increase of pressure in the tissue fluid causes more of the latter to be thrust through the lymph capillary wall, thus massage, apart from its action on the main valved trunks, forces fluid from the tissue spaces into the lymph capillaries. This can be especially well seen in the case of the lymphatics of the diaphragm, where it has been shown that increased intra-abdominal pressure from massage or active movements has a very considerable effect in forcing both fluid and particles into the lymph capillaries.

An objection to these views has been raised on the ground that it is difficult to see how pressure of tissue fluid can be transferred to lymph capillaries. These vessels should collapse if the pressure of the fluid outside them were greater than that inside. An observation, however, made long ago by Gaskell enables one to see how this relationship can occur. He noticed in the epiglottis that fine fibres of an elastic nature passed from the lymph vessels into the surrounding tissue, so that if the latter became swollen with fluid, these fibres were pulled on and helped to keep open the lumen of the vessel to which they were attached.

Arterial Pulsation.—In some situations the lymph vessels form sheaths round the arteries. In these it is obvious that arterial pulsation will have a tendency to propel the lymph forwards. The beating of the aorta assists in this forward movement by rhythmical compression of the thoracic duct where it passes behind that artery. The influence of this factor can be seen especially well in the flow from a thoracic duct canula in an animal which is breathing very slowly.

Respiration.—If the lymph rising into a thoracic duct canula is observed it is seen to issue most rapidly during expiration. During inspiration the external pressure on the thoracic duct is lessened and so the pressure within it becomes less than that in the vessels of the abdomen. There is thus a tendency for the lymph to flow from the abdomen into the thoracic duct. At the same time as this suction action occurs, the diaphragm is contracting and descending to increase the intra-abdominal pressure so that lymph is also actively pushed from the abdominal vessels into the thoracic duct.

Thus, during inspiration the thoracic duct is completely filled. During expiration the reverse phenomenon occurs, the pressure on the walls of the distended thoracic duct is increased, and, owing to the presence of valves, the lymph is forced out from the duct into the canula, or, in conditions of normal life, into the venous system. According to Lee, normal respiration is capable of raising the pressure in the thoracic duct to about 11 mm.Hg. while excessive breathing will raise it to as much as 26 mm.Hg.

Intrinsic Forces.—The foregoing description of the forces involved applies to mammals such as man or dog. In some types of animal, however, such as fish, amphibia, reptiles and birds special contractile sacs have been developed which have the function of actively propelling the lymph into the venous system by means of rhythmical beats. These "lymph hearts" have disappeared from mammals, but two species, the rat and guinea pig, and according to some the mouse, possess mesenteric lymphatic vessels which are rhythmically contractile throughout their course and actively propel the lymph forward. In the guinea pig rhythmically contracting vessels have also been seen on the pleural surface of the diaphragm. Similar vessels in several species have been examined, but under the conditions of experiments have not been seen contracting rhythmically. Nevertheless, these vessels are actively contractile to certain stimuli and are supplied with nerves, the stimulation of which causes contraction and, according to some, dilatation as well. Dogiel states that the innervation extends even to the lymph capillaries.

From the foregoing observations one concludes that the contraction of the vessel walls themselves is a factor in the propulsion of lymph. That such contraction does occur at some time seems to be undeniable, but the requisite physiological conditions have so far escaped detection.

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LYMPHATIC SYSTEM. In anatomy, the lymphatic system comprises the *lymphoid* or *adenoid* tissue so plentifully distributed about the body, especially in the course of the alimentary canal (*see* Connective Tissues), *lymph spaces, lymphatic vessels* of which the lacteals are modifications, *lymphatic glands, haemolymph glands,* and the *thoracic* and *right lymphatic ducts* by which the lymph (*q.v.*) finally reaches the veins.

Lymph Spaces.—These are mere spaces lying outside the capillaries and between them and the cells of the tissues they nourish. Usually, they have no special lining, though sometimes there is a layer of endothelial cells like those of the lymphatic and blood vessels. Most of these spaces are very small, but the *sub-epicranial space* of the scalp, the *capsule of Tenon* in the orbit, and the *retropharyngeal space* in the neck, are large adaptations to allow free movement. Opening from these spaces, and also communicating with the serous membranes by small openings (stomata) are the *lymph capillaries* (*see* Vascular System), which converge to the *lymphatic vessels.* These resemble veins in having an internal layer of endothelium, a middle unstriped muscular coat, and an external coat of fibrous tissue, though in the smaller vessels the middle coat is wanting. They have numerous endothelial valves, formed of two crescentic segments allowing the lymph to pass toward the root of the neck. When the vessels are engorged these valves are marked by a constriction, and so the lymphatics have a beaded appearance. The vessels divide and anastomose freely, and do not, like the veins, increase in calibre as they approach their destination. It is usual to divide the lymphatic vessels into a superficial and a deep set; speaking generally, the superficial ones are found near the course of the superficial veins, while the deeper ones accompany the arteries. The *lacteals,* so called from the milky appearance of their contents during digestion, are lymphatic vessels which carry the chyle from the intestine; they begin in lymphatic spaces in the villi and round the solitary and agminated glands, and pass into the mesentery, where they enter into *mesenteric glands* before reaching the *receptaculum chyli.*

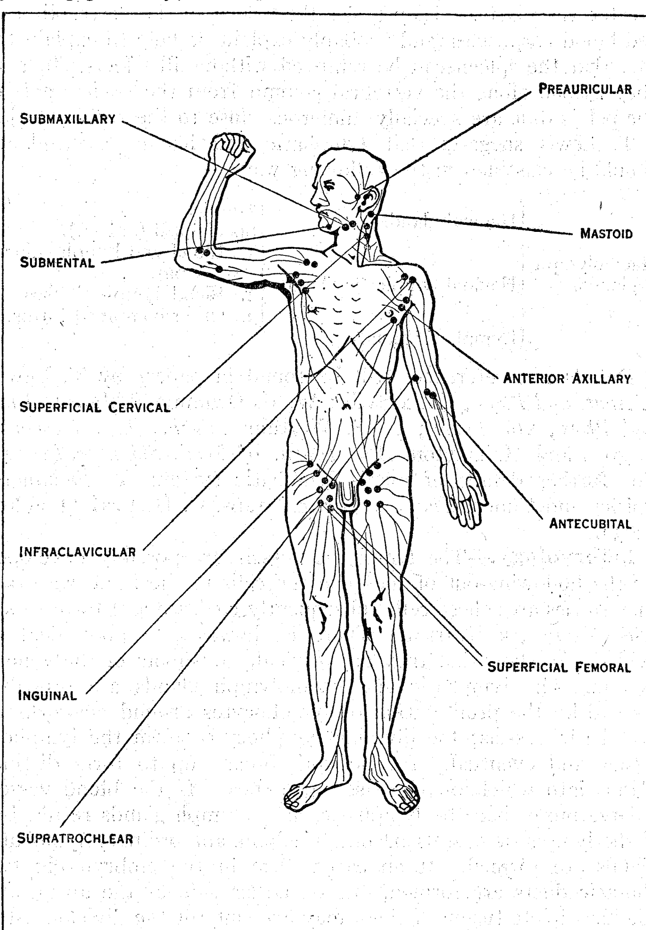


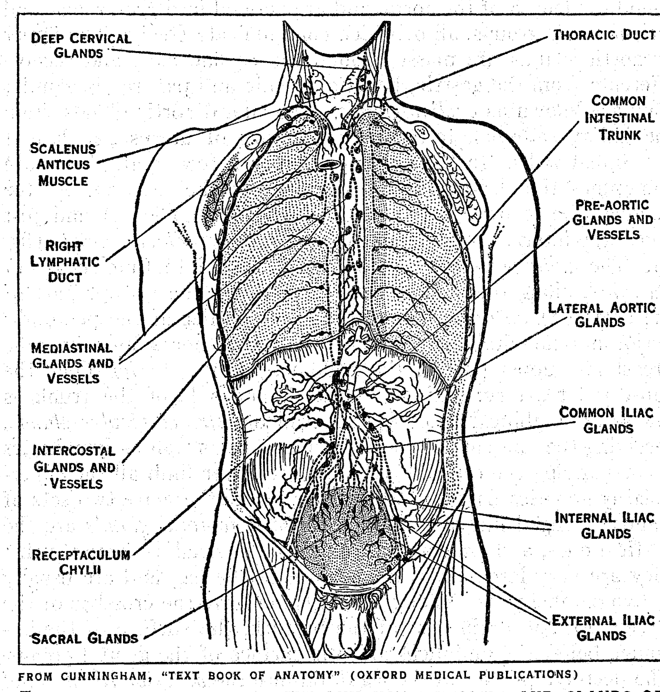
FIG. 1.—DIAGRAM SHOWING THE SUPERFICIAL LYMPHATIC VESSELS AND GLANDS
The glands are indicated by black circles with the group names alongside

Lymphatic Glands.—The lymphatic glands are pink bodies situated in the course of the lymphatic vessels, to which they act as filters. They are generally oval in shape and about the size of a bean, but sometimes, especially in the groin, they form irregular flattened masses 2in. long, while, at other times, they are so small as almost to escape notice. They are usually found in groups.

Each gland has a fibrous capsule from which trabeculae pass toward the centre, where they break up and interlace, forming a network, producing a cortical and medullary region for each gland; the intervals are nearly filled by lymphocytes, but close to the trabeculae is a lymph path or sinus, which is only lined by endothelial cells and crossed by the reticular stroma of the gland. In this region foreign particles carried in the lymph are held. Thus the bronchial glands of city dwellers where there is much soot in the air are black from carbon strained off in its passage from the lungs, while the axillary glands of a tattooed arm are blue. The blood-vessels enter at the *hilum,* and are distributed along the trabeculae. In addition the lymphatic glands are probably one of the sources from which the leucocytes are derived.

The exact position of the various groups of glands is very important from a medical point of view, but here it is only possible to give a brief sketch which will be helped by reference to the accompanying diagram. In the head and neck are found *occipital* and *mastoid glands* (fig. 1), which drain the back of the scalp; *internal maxillary glands,* in the zygomatic fossa, draining the orbit, palate, nose and membranes of the brain; *preauricular glands,* embedded in the parotid, draining the side of the scalp, pinna, tympanum and lower eyelid, and *buccal glands,* draining the cheek region. In the neck are the *superficial cervical glands* along the course of the external jugular vein, draining the surface of the neck; the *submaxillary glands,* lying just above the salivary gland of the same name and draining the front of the face and scalp; the *submental glands,* beneath the chin, draining the lower lip, as well as sometimes the upper, and the front of the tongue; the *retropharyngeal glands,* draining the naso-pharynx and tympanum; the *pretracheal glands,* draining the trachea and lower part of the thyroid body; and the *deep cervical glands,* which are by far the most important and form a great mass close to the internal jugular vein; they receive afferent vessels from most of the glands already mentioned and so are liable to be affected in any trouble of the head or neck, especially of the deeper parts. Into them the lymphatics of the brain pass directly. The lower part of this mass is sometimes distinguished as a separate group called the *supra-clavicular glands,* which drain the back of the neck and receive afferents from the occipital and axillary glands. The efferents from the deep cervical glands join to form a common vessel known as the *jugular lymphatic trunk,* and this usually opens into the thoracic duct on the left side and the right lymphatic duct on the right.

In the thorax are found *intercostal glands* (fig. 2), near the vertebral column draining the back of the thoracic walls and pleura; *internal mammary glands,* draining the front of the same parts as well as the inner part of the breast and the upper part of the abdominal wall; *diaphragmatic glands,* draining that structure and the convex surface of the liver; *anterior, middle, posterior* and *superior mediastinal glands,* draining the contents of those cavities. The *bronchial glands,* draining the lungs, have already been referred to.



FROM CUNNINGHAM, "TEXT BOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

FIG. 2.—DIAGRAM OF THE DEEP LYMPHATIC VESSELS AND GLANDS OF THE THORAX AND ABDOMEN
Afferent vessels are indicated by continuous lines, and the interglandular vessels by dotted lines. The main lymphatic trunk, the thoracic duct, is shown at its junction with the left subclavian vein

In the abdomen and pelvis the glands are usually grouped round the large arteries and are divided into visceral and parietal. Among the visceral are the *gastric glands,* draining the stomach (these are divided into *coronary, subpyloric* and *retropyloric* groups); the *splenic glands* at the hilum of the spleen, draining that organ, the tail of the pancreas and the fundus of the stomach; the *hepatic glands* in the small omentum, draining the lower surface and deep parts of the liver; the *pancreatic glands,* behind the lesser sac of the peritoneum, draining the head and body of the pancreas; the *superior mesenteric glands,* from one to two hundred in number, lying in the mesentery and receiving the lacteals; the *ileo-caecal glands,* draining the caecum, one of which is known as the *appendicular* gland and drains the vermiform appendix and right ovary; the *colic glands* along the right and middle colic arteries, draining the ascending and transverse colon; the *inferior mesenteric glands* in the course of that artery, draining the descending iliac and pelvic colons; the *rectal* glands, behind the rectum, draining its upper part.

Among the parietal glands are the *external iliac glands,* divided into a lateral and mesial set (fig. 2), and receiving the inguinal efferent vessels and lymphatics from the bladder, prostate, cervix uteri, upper part of the vagina, glans penis vel clitoridis and urethra. The *supra* and *infra-umbilical glands* receive the deep lymphatics of the abdominal wall, the former communicating with the liver, the latter with the bladder. From the latter, vessels pass to the epigastric gland lying in front of the termination of the external iliac artery. The *internal iliac glands* (fig. 2) are situated close to the branches of this artery and drain the rectum, vagina, prostate, urethra, buttock and perinaeum. *Common iliac glands* lie around that artery and receive afferents from the external and internal iliac glands as well as a few from the pelvic viscera. (For further details of the pelvic glands *see* "Seventh Report of the Committee of Collective Investigation," *Journ. Anat. and Phys.,* xxxii. 164.) The *aortic glands* are grouped all round the length of the aorta, and are divided into *pre-, retro-* and *lateral aortic* groups, all of which communicate freely. The upper preaortic glands are massed round the coeliac axis, and receive afferents from the gastric, hepatic, splenic and pancreatic glands; they are known as *coeliac glands.* The lateral aortic glands drain the kidney, adrenal, testis, ovary, fundus of uterus and lateral abdominal walls. In the upper extremity a few small glands are sometimes found near the deep arteries of the forearm. At the bend of the elbow are the *ante-cubital glands* (fig. 1) and just above the internal condyle, one or two *supra-trochlear glands* (fig. 1). The *axillary glands* (fig. 1) are divided into four sets: (1) *External,* along the axillary vessels, draining the greater part of the arm; (2) *anterior,* behind the lower border of the pectoralis major muscle, draining the surface of the thorax including the breast and upper part of the abdomen; (3) *posterior* along the subscapular artery, draining the back and side of the trunk as low as the umbilical zone; (4) superior or *infra-clavicular glands,* receiving the efferents of the former groups as well as lymphatics accompanying the cephalic vein. In the lower limb all the superficial lymphatics pass up to the groin, where there are two sets of glands arranged like a T. The *superficial femoral glands* are the vertical ones, and are grouped round the internal saphenous vein; they are very large, drain the surface of the leg, and are usually in two parallel rows. The *inguinal glands* form the crossbar of the T (fig. 1), and drain part of the buttock, the surface of the abdomen below the umbilicus and the surface of the genital organs. The deep lymphatics of the leg drain into the *anterior tibial gland* on that artery, the *popliteal glands* in that space, and the *deep femoral glands* surrounding the common femoral vein.

Lymphatic Ducts.—The *thoracic duct* begins as an irregular dilatation known as the *receptaculum chyli,* opposite the first and second lumbar vertebrae, which receives all the abdominal lymphatics as well as those of the lower intercostal spaces. The duct runs up on the right of the aorta through the posterior mediastinum and then traverses the superior mediastinum to the left of the oesophagus. At the root of the neck it receives the lymphatics of the left arm and left side of the neck and opens into the beginning of the left innominate vein, usually by more than one opening.

The *right lymphatic duct* collects the lymphatics from the right side of the neck and thorax, the right arm, right lung, right side of the heart and upper surface of the liver; it is often represented by several ducts which open separately into the right innominate vein.

Haemolymph glands are structures which have only been noticed since 1884. They differ from lymphatic glands in their much greater vascularity. They assist the spleen in the destruction of red blood corpuscles, and probably explain or help to explain the fact that the spleen can be removed without ill effects. In man they extend along the vertebral column from the coeliac axis to the pelvis, but are specially numerous close to the renal arteries.

T. Lewis suggests that lymphatic and haemolymph glands should be classified in the following way:—

Haemolymph glands.	Haemal glands.	Simple.
		Specialized (Spleen).
	Haemal lymphatic glands.	1. Blood and lymph sinuses separate.
		2. Blood lymph sinuses.
		3. Other combined forms.
	Lymphatic glands.	

Details and references will be found in papers by T. Lewis, *J. Anat. and Phys.,* vol. xxxviii.; W. B. Drummond, *Journ. Anat. and Phys.,* vol. xxxiv.; A. S. Warthin, *Journ. Med. Research* (1901), and H. Dayton, *Am. Journ. of Med. Sciences* (1904). For further details of man's lymphatic system *see* Delamere, Poirier and Cuneo, *The Lymphatics,* trans. C. H. Leaf (London, 1903).

Embryology.—The lymphatic vessels are possibly developed by the hollowing-out of mesenchyme cells in the same way that the arteries are; these cells subsequently coalesce and form tubes. (*See* VASCULAR SYSTEM.) There is, however, a good deal of evidence to show that they are originally offshoots of the venous system. The lymphatic and haemolymph glands are probably formed by the proliferation of lymphocytes around networks of lymphatic vessels; the dividing lymphocytes form the lymphoid tissue, and eventually the network breaks up to form distinct glands into which blood vessels penetrate. If the blood vessels enlarge more than the lymphatic, haemolymph glands result, but if the lymphatic vessels become predominant ordinary lymphatic glands are formed. At an early stage in the embryo pig two thoracic ducts are formed, one on either side of the aorta, and the incomplete fusion of these may account for the division often found in man's duct. In the embryo pig, too, there have been found two pairs of lymph hearts for a short period.

See A. S. Warthin, *Journ. Med. Research,* vol. vii.; F. R. Sabin, *Am. Journ. of Anat.* (1902); J. P. McMurrich, *Development of the Human Body* (London, 1923), and Quain's *Anatomy,* vol. i. (London, 1908).

Comparative Anatomy.—A lymphatic system is recognized in all the Craniata, and in the lower forms (fishes and Amphibia); it consists chiefly of lymph spaces and sinuses in communication with the coelom. In fishes, for instance, there is a large *subvertebral lymph sinus* surrounding the aorta and another within the spinal canal. In Amphibia the subvertebral sinus is also found, and in the Anura (frogs and toads) there is a great *subcutaneous lymph sinus. Lymph hearts* are muscular dilatations of vessels and are found in fishes, amphibians, reptiles and bird embryos, and drive the lymph into the veins; they are not known in adult mammals.

In birds the thoracic duct is first recognized, and opens into both right and left precaval veins, as it always does in some mammals. In birds, however, some of the lymphatics open into the sacral veins, and it is doubtful whether true lymphatic glands ever occur. In birds and mammals lymphatic vessels become more definite and numerous and are provided with valves.

Haemolymph glands are present in mammals and birds, but have not been seen lower in the scale, though S. Vincent and S. Harrison point out the resemblance of the structure of the head kidney of certain Teleostean fishes to them (*Journ. Anat. and Phys.,* vol. xxxi.).

For further details *see* R. Wiedersheim, *Comparative Anat. of Vertebrates* (London, 1907). (F. G. P.)

LYMPHATIC SYSTEM, DISEASES OF. *Lymphadenitis* or inflammatory infection of the lymphatic glands is a condition characterized by hyperaemia of and exudation into the gland, which becomes redder, firmer and larger than usual. Three varieties may be distinguished: simple, suppurative and tuberculous. The cause is always the absorption of some toxic or infective material from the periphery. This may take place in several of the acute infectious diseases, notably in scarlet fever, mumps, diphtheria and German measles, or may be the result of poisoned wounds. The lymphatic glands are also affected in constitutional diseases such as syphilis. Simple lymphadenitis usually subsides of its own accord, but if toxins are produced in the inflamed area the enlargement is obvious and painful, while if pyogenic organisms are absorbed the inflammation progresses to suppuration.

Tuberculous lymphadenitis (scrofula) is due to the infection of the lymph glands by Koch's tubercle bacillus. This was formerly known as "King's Evil," as it was believed that the touch of the royal hand had power to cure it. It occurs most commonly in children and young adults. Some local focus of irritation is usually present. The ways in which the tubercle bacillus enters the body are much disputed, but catarrh of the mucous membranes is regarded as a predisposing factor, and the tonsils as a probable channel of infection. Any lymphoid tissue in the body may be the seat of tuberculous disease, but the glands of the neck are the most commonly involved. The course of the disease is slow and may extend over a period of years. The earliest manifestation is an enlargement of the gland and local formation of minute tubercles. It is possible in this stage for spontaneous healing to take place, but usually the disease progresses to caseation. Occasionally this stage may end in calcification, the gland shrinking and becoming hard; but frequently suppuration follows from liquefaction of the caseating material. Foci of pus occur throughout the gland, causing destruction of the tissue, so that the gland may become a single abscess cavity. If left to itself the abscess sooner or later bursts at one or several points, leaving ulcerated openings through which a variable amount of pus escapes. Temporary healing may take place, to be again followed by further breaking down of the gland. This condition, if untreated, may persist for years and may finally give rise to a general tuberculosis. The treatment consists mainly in improving the general health with good diet, sunlight or ultra-violet radiation, fresh air (particularly sea air), cod-liver oil and iron, and the removal of all sources of local irritation such as enlarged tonsils, adenoids, etc. Suppuration and extension of the disease may require operative measures, and removal of the glands *en masse* can now be done so as to leave only a slight scar.

In *Tabes mesenterica* (tuberculosis of the mesenteric glands), usually occurring in children, the glands of the mesentery and retroperitoneum become enlarged, and either caseate or occasionally suppurate. The disease may be primary or may be secondary to tuberculous disease of the intestines or to pulmonary phthisis. The patients are pale, wasted and anaemic, and the abdomen may be enormously enlarged. There is usually moderate fever, and thin watery diarrhoea. The caseating glands may liquefy and give rise to an inflammatory attack which may simulate appendicitis. Limited masses are amenable to surgical treatment and may be removed, while in the earlier stages constitutional treatment gives good results. Tuberculous peritonitis frequently supervenes on this condition.

Lymphadenoma (Hodgkin's disease), first fully described by Hodgkin in 1832, is characterized by a progressive enlargement of the lymphatic glands all over the body, and generally starts in the glands of the neck. The majority of cases occur in young adults, and preponderate in the male sex. The first symptom is usually enlargement of a gland in the neck, with generally progressive growth of the glands in the submaxillary region and axilla. The inguinal glands are early involved, and after a time the internal lymph glands follow. The enlargements are at first painless, but in the later stages symptoms are caused by pressure on the surrounding organs, and when the disease starts in the deeper structures the first symptoms may be pain in the chest and cough, pain in the abdomen, pain and oedema in the legs. The glands may increase until they are as large as eggs, and later may become firmly adherent one to another, forming large lobulated tumours. Increase of growth in this manner in the neck may cause obstructive dyspnoea and even death. In the majority of cases the spleen enlarges, and in rare instances lymphoid tumours may be found on its surface. Anaemia is common and is secondary in character; slight irregular fever is present, and soon a great and progressive emaciation takes place. The cases are of two types, the acute cases in which the enlargements take place rapidly and death may occur in two to three months, and the chronic cases in which the disease may remain apparently stationary. In acute lymphadenoma the prognosis is very unfavourable. Recovery sometimes takes place in the chronic type of the disease. Early surgical intervention has in some cases been followed by success. The application of X-rays is a valuable, though usually but temporary, method of treatment, superficial glands undergoing a rapid diminution in size. Of drugs arsenic is of the most service, and mercurial inunction has been recommended. It is probable that certain cases have been included under lymphadenoma which are in reality tuberculous.

Status lymphaticus (lymphatism) is a condition found in children and some adults, characterized by an enlargement of the lymphoid tissues throughout the body and more particularly by enlargement of the thymus gland. There is a special lowering of the patient's powers of resistance, and it has been said to account for a number of cases of sudden death. In all cases of status lymphaticus the thymus has been found enlarged. At birth the gland (according to Bovaird and Nicoll) weighs about 6 grammes, and does not increase after birth. In lymphatism it may weigh from 10 to 50 grammes. The clinical features are indefinite, and the condition frequently passes unrecognized during life. In most cases there is no hint of danger until the fatal syncope sets in, which may be after any slight exertion or shock, the patient becoming suddenly faint, gasping and cyanosed, and the heart stopping altogether before the respirations have ceased. The most trifling causes have brought on fatal issues, such as a wet pack (Escherich) or a hypodermic injection, or even a sudden plunge into water though the head is not immersed. The greater number of deaths occur during the administration of anaesthetics, which seem peculiarly dangerous to these subjects. When an attack of syncope takes place no treatment is of any avail.

Lymphangitis. In cases where the infective agent is very virulent there may be seen thin red lines in the skin tracking from the focus of infection towards the nearest group of lymphatic glands. These lines indicate the superficial lymphatics and the advancing edge travels often with great rapidity, reaching, for example, from the hand to the bend of the elbow in a few hours. The existence of lymphangitis is a sign of grave importance. (For the secondary invasion of lymphatic glands in cancer, *see* CANCER.)

LYNBROOK, village of Nassau county, New York, U.S.A., on south shore of Long Island, served by the Long Island railroad. It is a residential suburb and summer resort, with a population in 1940 of 14,557. The village was incorporated in 1911.

LYNCHBURG, a city of Virginia, U.S.A., within 15 mi. of the geological centre of Virginia, on the James river, 112 mi. W. by S. of Richmond, within the boundaries of Campbell county, but independent of it politically. It is on federal highways 29, 460 and 501; has an airport; and is served by the Chesapeake and Ohio, the Norfolk and Western and the Southern railways. The population was 30,070 in 1920 (28% Negroes); and was 44,541 in 1940 by the federal census. The city's terraced hills command fine views of mountain, river and valley scenery, reaching to the Blue Ridge, 20 mi. to the west, where the Blue Ridge parkway, an extension of the Skyline drive, is located. An elaborate viaduct of concrete adds to the beauty of river and valley. On elevated ground overlooking the river is the campus of Randolph-Macon Woman's college, one of the Randolph-Macon system of institutions (*see* ASHLAND, VA.). Lynchburg is the seat also of Lynchburg college (Christian; established 1903), Virginia Episcopal school, for boys, and the Virginia theological seminary and college for Negroes (Baptist). Twelve mi. north is Sweet Briar college for women (chartered 1901). Lynchburg is one of the largest markets in the U.S.A. for dark leaf tobacco, and it has numerous factories, with an output in 1940 estimated at $40,000,000. The boot and shoe industry, introduced in 1900, is the most important. The assessed valuation of property in 1940 was $41,841,000. The city was named after John Lynch, who inherited a large property there, and in 1757 established a ferry across the James. The settlement was established as a village by Act of Assembly in 1786, was incorporated as a town in 1805, and became a city in 1852. Since 1920 it has had a council-manager form of government. During the Civil War it was an important base of supplies for the Confederate army, and in June 1864, Union forces made an unsuccessful attempt to get possession. Appomattox Court House, where Lee surrendered to Grant, is 20 mi. east of the city.

LYNCH LAW, a term loosely applied to various forms of executing rough popular justice, or what is thought to be justice, for the punishment of offenders by a summary procedure, ignoring, or even contrary to, the strict forms of law. The origin of the name is obscure; different writers have attempted to trace it to Ireland, to England, to South Carolina and to Virginia. (*See* "The Real Judge Lynch," in the *Atlantic Monthly,* vol. lxxxviii., Boston, 1901.)

The practice has been common in all countries when unsettled conditions existed, or in threatened anarchy. In Europe early examples of such a practice are found in the proceedings of the Vehmgerichte in mediaeval Germany, and of Lydford law, gibbet law or Halifax law, Cowper justice and Jeddart justice in the thinly settled border districts of Great Britain. In later years it is found mainly in Russia, in south-eastern Europe and in the United States. Under the term "lynch law" in the 18th, 19th and 20th centuries it has come to be considered peculiarly American.

Within the United States the population expanded westward faster than well-developed civil institutions could follow, and on the frontier there were always desperadoes who lived by preying on the better classes. To suppress these outlaws resort was often made to lynch law. There was little necessity for it until the settlement crossed the Allegheny mountains, but the following instances of lynching in the East may be mentioned: (1) the mistreatment of Indians in New England and the middle Colonies in disregard of laws protecting them; (2) the custom found in various Colonies of administering summary justice to wife-beaters, idlers and other obnoxious persons; (3) the acts of the regulators of North Carolina, 1767–71; (4) the popular tribunals of the Revolutionary period, when the disaffection toward Great Britain weakened the authority of the civil governments and the war replaced them by popular governments, at a time when the hostilities between "patriots" and "tories" were an incentive to extra-legal violence. The entire United States thus had a heritage of extra-legal methods which, long after the Revolution, persisted in the drastic methods used in dealing with agitators among the negroes in the South and with the outlaws on the westward moving frontier.

The Watauga settlements and the "State" of Franklin furnished examples of lynch law procedure taking the place of government. Men trained in the rough school of the wilderness came to have more regard for quick, personal justice than for abstract justice and statutes; they were educated to defend themselves, to look to no law for protection or regulation. Consequently, they became impatient of legal forms and technicalities and appeal to statute law was discouraged. Thus were formed the habits of thought and action of the Western pioneers. Lynch law, not civil law, cleared the Western forests, valleys and mountain passes of horse and cattle thieves, and other outlaws. This was especially true of the States of the far West. H. H. Bancroft, the historian of *Popular Tribunals,* wrote in 1887 that "thus far in the history of these Pacific States far more has been done toward righting wrongs and administering justice outside the pale of law than within it." However, the lack of regard for law, fostered by the conditions described, led to a survival of the lynching habit after the necessity for it passed away. In parts of the Southern States, certain of the conditions of the West have prevailed since emancipation and reconstruction gave the former slaves freedom and temporary political supremacy and increased the friction between the races. The numerous protective societies of whites, 1865–76, culminating in the Ku Klux and White League movement, may be described as an application of lynch law. After reconstruction, with the increase of negro crimes, came an increase of lynchings, due to prejudice, to the fact that for some time after reconstruction the governments were weak, especially in the districts where the blacks outnumbered the whites, to the fact that negroes nearly always shield criminals of their own race against the whites, and to the occurrence of the crime of rape by negro men upon white women.

The *New York World* has collected statistics of lynching since 1885 and some interesting facts may be deduced from these tables. During the 41 years from 1885 to 1926, inclusive, the total number of persons lynched in the United States was 4,250, of whom 3,205 were negroes and 1,045 were whites; the annual number has been gradually decreasing during the last 30 years. The East is almost free from lynchings; of those in the West, most were white; of those lynched in the South, the larger numbers were blacks. Lynchings occur mostly during periods of idleness of the lower classes; in the summer more are lynched for crimes against the person and in the winter, especially in the West, for crimes against property; the principal causes for lynchings in the South are murder and rape; in the West, for murder and offences against property. Lynching decreases and disappears in a region as the population grows denser and civil institutions grow stronger; as better communications and good police make it harder to commit crime; and as public sentiment is educated to demand legal rather than illegal and irregular infliction of punishment for even the most horrible of crimes.

Bibliography.—J. E. Cutler, *Lynch Law* (New York, 1905), an admirable and unbiased discussion of the subject; H. H. Bancroft, *Popular Tribunals* (2 vols., San Francisco, 1887); C. H. Shinn, *Mining Camps: A Study in American Frontier Government* (New York, 1885); J. C. Lester and D. L. Wilson, *Ku Klux Klan* (New York, 1905); *New York World Almanac* (1928); "Our Lawless Heritage," in the *Atlantic Monthly* (Dec. 1928). (W. L. F.)

LYNDHURST, JOHN SINGLETON COPLEY, Baron (1772–1863), lord chancellor of England, was born at Boston, Massachusetts, on May 21, 1772. He was the son of John Singleton Copley, the painter. He was educated at a private school and Cambridge university, where he was second wrangler and fellow of Trinity. Called to the bar at Lincoln's Inn in 1804, he gained a considerable practice. In 1817 he was one of the counsel for Dr. J. Watson, tried for his share in the Spa Fields riot. On this occasion Copley so distinguished himself as to attract the attention of Castlereagh and other Tory leaders, under whose patronage he entered parliament as member for Yarmouth in the Isle of Wight. He afterwards sat for Ashburton, 1818–1826, and for Cambridge university 1826–1827. He was solicitor-general in 1819, attorney-general in 1824, master of the rolls in 1826 and lord chancellor in 1827, with the title of Lord Lyndhurst. Before being taken up by the Tories, Copley was a man of the most advanced views, a republican and Jacobin; and his accession to the Tories excited a good deal of comment, which he bore with the greatest good humour. He gave a brilliant and eloquent but by no means rancorous support to all the reactionary measures of his chief.

As solicitor-general he took a prominent part in the trial of Queen Caroline. To the great Liberal measures which marked the end of the reign of George IV. and the beginning of that of William IV. he gave a vigorous opposition. He was lord chief baron of the exchequer from 1831 to 1834. During the Melbourne administration from 1835 to 1841 he figured conspicuously as an obstructionist in the House of Lords. In these years it was a frequent practice with him, before each prorogation of parliament, to entertain the House with a "review of the session," in which he mercilessly attacked the Whig government. His former adversary Lord Brougham, disgusted at his treatment by the Whig leaders, soon became his most powerful ally in opposition; and the two dominated the House of Lords. Throughout all the Tory governments from 1827 Lyndhurst held the chancellorship

(1827–30 and 1834–35); and in the Peel Administration (1841–46) he resumed that office for the last time. As Peel never had much confidence in Lyndhurst, the latter did not exert so great an influence in the cabinet as his position and experience entitled him to do. But he continued a loyal member of the party. He died in London on Oct. 12, 1863.

Of Lord Lyndhurst as a judge opinions have differed; there is authority, including Selborne himself, for the view that he was not a just chancery judge. His heart was not in the business. But the qualities of a just chancellor in those days were of a very special order, and in the House of Lords he was more at home, though the estimate must stand that he was "a judge for the parties rather than a judge for the lawyers." His greatest moment in the House of Lords was his success in averting what would have been a disastrous precedent, the attempt of lay members to vote in an appeal to the House of Lords, theoretically permissible, but a violation of a strict Constitutional understanding (O'Connell's case Sept. 4, 1844). It may be added that the one element of the court of chancery that comes out of *Jarndyce* v. *Jarndyce* with any credit is the chancellor—Lyndhurst.

See *Lives of the Lord Chancellors of England,* vol. viii. (Lords Lyndhurst and Brougham), by Lord Campbell (1869). Campbell was a personal friend, but a political opponent. Brougham's *Memoirs; Greville Memoirs; Life of Lord Lyndhurst* (1883) by Sir Theodore Martin; J. B. Atlay, *The Victorian Chancellors* (1906).

LYNDSAY, SIR DAVID (*c.* 1490–*c.* 1555), Scottish poet, was the son of David Lyndsay of the Mount, near Cupar-Fife, and of Garmylton, near Haddington. He probably studied at St. Andrews university, on the books of which appears an entry "Da Lindesay" for the session 1508–09. He was engaged at court, first as an equerry, then as an "usher" to the young Prince James, afterwards James V. In 1522 he married Janet Douglas, a court seamstress, and seven years later was appointed Lyon King of Arms, and knighted. He was several times engaged in diplomatic business (twice on embassies abroad—to the Netherlands and France), and he was, in virtue of his heraldic office, a general master of ceremonies. After the death of James V., in 1542, he continued to sit in Parliament as commissioner for Cupar-Fife; and in 1548 he was member of a mission to Denmark which obtained certain privileges for Scottish merchants. There is reason to believe that he died in or about 1555.

Most of Lyndsay's literary work was written during the period of prosperity at court. His muse was occasional and satirical. He enjoyed a freedom of speech which is without parallel even in more secure times. He chastised all classes, from his royal master to the most simple. There is no evidence that he abjured Catholicism; yet his leading purpose was the exposure of its errors and abuses. His aid was readily accepted by the reforming party, and by their use of his work he shared with their leaders throughout many generations a reputation which is almost exclusively political and ecclesiastical.

Lyndsay's longer poems are *The Dreme* (1,134 lines), *The Testament and Complaynt of the Papynago* (1,190 lines), *The Testament of Squyer Meldrum* (1,859 lines), *Ane Dialog betwix Experience and ane Courteour of the Miserabyll Estait of the World* (6,333 lines), and *Ane Pleasant Satyre of the Thrie Estaitis* (over 4,000 lines). Lyndsay, the last of the Makars, used the forms of Chaucer, but his spirit is the revolutionary spirit of the Reformation. His nearest approach to Chaucer is in *The Testament of Squyer Meldrum,* which recalls the sketch of the "young squire"; but the reminiscence is verbal rather than spiritual. In *The Dreme,* the allegorical tradition survives only in the form. "Remembrance" conducts the poet over the old-world itinerary, but only to lead him to speculation on Scotland's woes and to an "Exhortatioun to the Kingis Grace" to bring relief. The tenor is well expressed in the motto from the Vulgate—*Prophetias nolite spernere. Omnia autem probate: quod bonum est tenete.*

This didactic habit is freely exercised in the long *Dialog* (sometimes called the *Monarche*), a universal history of the mediaeval type, in which the falls of princes by corruption supply an object lesson to the unreformed church of his day. The *Satyre* is more direct in its attack on ecclesiastical abuse; and its dramatic form permits more lively treatment. This piece is of great historical interest, being the only extant example of a complete Scottish morality. It is in respect of literary quality Lyndsay's best work, and in dramatic construction and delineation of character it holds a high place in this *genre.* The farcical interludes (in places too coarse for modern taste) supply many touches of genuine comedy; and throughout the play there are passages, as in the speeches of Veritie in the First Part and of Dame Chastitie in the "Interlude of the Sowtar and the Taylor," in which word and line are happily conceived. The *Testament of the Papyngo* (popinjay), drawn in the familiar mediaeval manner, is another tract for the time, full of admonition to court and clergy.

Of his shorter pieces, *The Complaynt and Publict Confessions of the Kingis Auld Hound, callit Bagsche, directit to Bawtie, the Kingis best belovit Dog, and his companyeonis,* and the *Answer to the Kingis Flyting* have a like pulpit resonance. The former is interesting as a forerunner of Burns's device in the "Twa Dogs." The *Deploratioun of the Deith of Queen Magdalene* is in the extravagant style of commemoration illustrated in Dunbar's Elegy on the Lord Aubigny. The *Justing betwix James Watsoun and Jhone Barbour* is a contribution to the popular taste for boisterous fun, in spirit, if not in form, akin to the *Christis Kirk on the Grene* series; and indirectly, with Dunbar's *Turnament* and *Of ane Blak-Moir,* a burlesque of the courtly tourney. Lyndsay approaches Dunbar in his satire *The Supplicatioun in contemptioun of syde taillis* ("wide" trains of the ladies), which recalls the older poet's realistic lines on the filthy condition of the city streets. In Lyndsay's *Descriptioun of Pedder Coffeis* (pedlars) we have an early example of the studies in vulgar life which are so plentiful in later Scottish literature. In *Kitteis Confessioun* he returns, but in more sprightly mood, to his attack on the church.

In Lyndsay we have the first literary expression in Scotland of the Renaissance. His interest lies on the theological side of the revival; he is in no sense a humanist, and he is indifferent to the artistic claims of the movement. Still he appeals to the principle which is fundamental to all. He demands first-hand impression. He feels that men must get their lesson direct, not from intermediaries who understand the originals no more "than they do the ravyng of the rukis." Hence his persistent plea for the vernacular, nowhere more directly put than in the *Dialog,* in the "Exclamatioun to the Redar, toucheyng the wrytting of the vulgare and maternall language." Though he is concerned only in the theological and ecclesiastical application of this, he undoubtedly stimulated the use of the vernacular in a Scotland which in all literary matters beyond the concern of the irresponsible poet still used the *lingua franca* of Europe.

A complete edition of Lyndsay's poetical works was published by David Laing in 3 vols. in 1879. This was anticipated during the process of preparation by a cheaper edition (slightly expurgated) by the same editor in 1871 (2 vols.). The E.E.T.S. issued the first part of a complete edition in 1865 (ed. J. Small). Five parts have appeared, four edited by J. Small, the fifth by J. A. H. Murray. For the bibliography *see* Laing's 3 vol. edition, *u.s.* iii., pp. 222 *et seq.,* and the E.E.T.S. edition *passim. See* also the editions by Pinkerton (1792), Sibbald (1803), and Chalmers (1806); and the critical accounts in Henderson's *Scottish Vernacular Literature* (1898), Gregory Smith's *Transition Period* (1900), and J. H. Millar's *Literary History of Scotland* (1903). A professional work prepared by Lyndsay in the Lyon Office, entitled the *Register of Scottish Arms* (now preserved in ms. in the Advocates' library), was printed in 1821 and reprinted in 1878. It remains the most authoritative document on Scottish heraldry.

(G. G. S.)

LYNEDOCH, THOMAS GRAHAM, 1ST BARON (1748–1843), British general, was the son of Thomas Graeme, laird of Balgowan, and was born on Oct. 19, 1748. Graham was travelling in the Mediterranean when he fell in with Lord Hood's fleet on its way to Toulon. He joined it as a volunteer, served on Lord Mulgrave's staff during the British occupation of Toulon, and returned, after the failure of the expedition, to Scotland, where he organized a regiment of infantry, the 90th Foot, Perthshire Volunteers (now 2nd Battalion Scottish Rifles). Graham's men were the first regiment in the army to be equipped and trained wholly as light infantry, though they were not officially recognized as such for many years. In the same year (1794) Graham became member of Parliament, in the Whig interests, for the county of Perth. He saw some active service in 1795 in "conjunct expeditions" of the army and navy, and in 1796, being then a brevet colonel, he was appointed British commissioner at the headquarters of the Austrian army in Italy. He then served in further "conjunct" operations in the Mediterranean. He sat for Perthshire in parliament until the year 1807. Graham was with Moore in Sweden in 1808 and also in Spain from 1808 to 1809, and he was present at Moore's death at the battle of Corunna. In 1809 he became a major-general, and after taking part in the disastrous Walcheren expedition he was promoted lieutenant-general and sent to Cadiz (1810).

In 1811, acting in conjunction with the Spanish army under General la Peña (*see* PENINSULAR WAR), he took the offensive, and won the brilliant action of Barossa (March 5). The victory was made barren of result by the timidity of the Spanish generals, who nevertheless claimed more than their share of the credit. One of the Spanish officers he called out, fought and disarmed, and after refusing with contempt the offer of a Spanish dukedom, he resigned his command in the south and joined Wellington in Portugal. His seniority as lieutenant-general made him second in command of Wellington's army. He took part in the siege of Ciudad Rodrigo, and commanded a wing of the army in the siege of Badajoz and the advance to Salamanca. In July 1812, his eyesight becoming seriously impaired, he went home, but rejoined in time to lead the detached wing of the army in the wide-ranging manoeuvre which culminated in the battle of Vittoria. Graham captured San Sebastian (Sept. 9, 1813). He then went home, but in 1814 accepted the command of a corps to be despatched against Antwerp. His assault on Bergen op Zoom was, however, disastrously repulsed (Feb. 3, 1814).

At the peace Graham was created Baron Lynedoch of Balgowan in the peerage of the United Kingdom, but refused the offered pension of £200 a year. In 1813 he proposed the formation of a military club in London, and though Lord St. Vincent considered such an assemblage of officers to be unconstitutional, Wellington supported it and the officers of the army and navy at large received the idea with enthusiasm. Lynedoch's portrait, by Sir T. Lawrence, is in possession of this club, the (Senior) United Service. In his latter years he resumed the habits of his youth, travelling all over Europe, hunting with the Pytchley so long as he was able to sit his horse, actively concerned in politics and voting consistently for liberal measures. At the age of ninety-two he hastened from Switzerland to Edinburgh to receive Queen Victoria when she visited Scotland after her marriage. He died in London on Dec. 18, 1843.

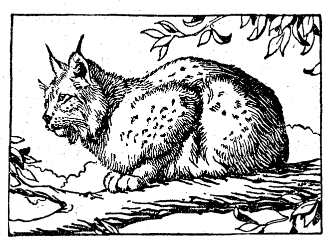
See biographies by John Murray Graham (2nd ed., Edinburgh, 1877) and Captain A. M. Delavoye (London, 1880); also the latter's *History of the 90th (Perthshire Volunteers)* (London, 1880), *Philipparts' Royal Military Calendar* (1820), ii. 147, and *Gentleman's Magazine*, new series, xxi. 197.

LYNN, city of Essex county, Massachusetts, U.S.A., on north shore of Massachusetts bay, 10m. N.E. of Boston. It is served by the Boston and Maine and the Eastern Massachusetts Street railways. The population (about 25% foreign-born) was 98,123 in 1940. The land area of 10.4 sq.mi. includes 2,500 ac. in parks and 3·5m. of fine beaches. High Rock, in the centre of the city, 190ft. above sea level, is surmounted by an observation tower 85ft. high, commanding magnificent views. The commerce of the harbour (436,780 tons in 1940) consists chiefly of incoming coal. From its earliest days Lynn has been a manufacturing centre. The manufacture of boots and shoes, its most important, and for many generations its most distinctive industry, was introduced in 1636. In 1939 the output of 87 shoe factories and allied plants making lasts, leather and findings, was valued at $15,267,262. There are two large plants of the General Electric company, established in 1883, which employ 12,000 persons; and some 400 smaller establishments, making 95 different kinds of commodities. The total factory output in 1939 was valued at $86,893,553; the assessed valuation of property was $132,781,015; and banking transactions in 1940 totalled $231,324,000. The mayoralty form of government was restored in 1918, displacing a commission form which had been in operation since 1910. Lynn was founded in 1629, organized as a village in 1631, and incorporated as a city in 1850. It was called Saugus at first, but was renamed in 1637 from Lynn Regis, Norfolk, the home of the pastor. The first smelting works in New England were established here in 1643. The boot and shoe industry developed steadily through the 17th and 18th centuries. The women's shoes made here had become famous by 1764, and in 1795 the output was 300,000 pairs. In 1900 and in 1905 Lynn ranked second among the cities of the United States in the value of the boots and shoes manufactured, but in 1923 it had dropped to sixth place, due to the dispersal of the industry and the rise of new centres in the middle west. Meanwhile various new industries were taking root, and Lynn has become a city of diversified products.

LYNTON and LYNMOUTH, seaside villages in Devonshire, England, on the Bristol channel; 17 mi. E. of Ilfracombe. Both are summer resorts. Lynmouth is at the mouth of the East and West Lyn rivers, whilst Lynton is on the cliff top 430 ft. above. The industries are fishing and a small coasting trade. Not far off are the Doone valley, made famous by R. D. Blackmore's novel *Lorna Doone,* part of the valley of the East Lyn (owned by the National Trust), here called Badgworthy water, and Watersmeet, where two streams, the East and West Lyn, join. The legend of the Doones, a 17th century band of outlaws, dates only from the early 19th century. Lynton is an urban district; pop. (est. 1938) 1,808. Area, 12 sq.mi.

LYNX, a genus of mammals of the family Felidae (*see* CARNIVORA). Amongst other fabulous properties attributed to this animal by the ancients was that of extraordinary powers of vision, whence the epithet "lynx-eyed."

Lynxes are found in the north temperate regions of both the Old and New World; they are smaller than leopards, and larger than true wild cats, with long limbs, short stumpy tail, ears tufted at the tip, and pupil of the eye linear when contracted. Their fur is generally long and soft, and always longish upon the cheeks. Their colour is light brown or grey, with generally darker spots. Their food consists of any mammals or birds which they can overpower. In Canada, the number of lynxes is governed each year by the number of hares, their chief diet, produced the previous year. They frequent rocky places and forests, being active climbers, and passing much of their time among the branches of the trees. Their skins are of considerable value in the fur trade. The northern lynx (*L. lynx*) of Scandinavia, Russia, northern Asia, and till lately of central Europe inhabited Britain during the Pleistocene age. The pardine lynx (*L. l. pardinus*) from southern Europe is very handsome, rufous above and white beneath. Several lynxes are found in North America; the most northerly is the Canadian lynx (*L. canadensis*); the bay lynx (*L. rufus*), with a rufous coat, ranges from southern Canada south to Mexico and lower California, represented by various races in this area.



THE NORTHERN LYNX (LYNX LYNX)

LYON, MARY MASON (1797–1849), American educator, was born on Feb. 28, 1797, on a farm near Buckland, Mass. She began to teach when she was 17, and in 1817, with earnings from spinning and weaving, she went to Sanderson academy, Ashfield, where the other pupils failed to keep within reciting distance of her. She supported herself there and at the other academies she attended by teaching, her desire to acquire and impart learning seeming insatiable. Her success as a teacher and administrator and the demand for the young women she trained were the beginning of her plan for "a permanent institution consecrated to the training of young women for usefulness . . . designed to furnish every advantage which the state of education in this country will allow . . . to put within reach of students of moderate means such opportunities that none can find better." She was aided in this effort by Edward Hitchcock, the geologist, with whom she had studied. This assistance, reinforced by her own enthusiasm and practical common sense secured for her plan the necessary financial support. In 1835 a site was selected near the village of South Hadley and Mt. Holyoke. In 1836 the school was incorporated as Mt. Holyoke Female seminary; and on Nov. 8, 1837, it opened with Mary Lyon as principal and Miss Eunice Caldwell as assistant, afterwards well known as Mrs. J. P. Cowles of Ipswich academy. Miss Lyon died at Mt. Holyoke on March 5, 1849, having served nearly 12 years as principal of the seminary, on a salary of $200 a year. Her work at Holyoke was an important step in the higher education of women in the United States.

See Edward Hitchcock, *Life and Labors of Mary Lyon* (1851); Beth B. Gilchrist, *Life of Mary Lyon* (1910); E. C. Adams and W. D. Foster, *Heroines of Modern Progress* (1913); Gamaliel Bradford, *Portraits of American Women* (Boston, 1919).

LYON, NATHANIEL (1818–1861), U.S. soldier, was born in Ashford, Conn., on July 14, 1818, and graduated at West point in 1841. He was engaged in the Seminole War and the war with Mexico. In 1851, while serving in California, he was promoted to captain, and two years later was ordered to the east, when he became an ardent opponent of "States' Rights" and slavery. He was stationed in Kansas and in Missouri on the eve of the Civil War. Lyon took an active part in organizing the Union party in Missouri, though greatly hampered at first by the federal government which feared to provoke hostilities and afterward by the military commander of the department, Gen. W. S. Harney. On Harney's temporary removal in April 1861, Lyon promptly assumed the command, mustered the Missouri contingent into the United States' service, and broke up the militia camp at St. Louis established by the secessionist governor of Missouri, Claiborne F. Jackson. In all this Lyon had co-operated closely with Francis P. Blair, Jr., who now obtained from President Lincoln the definitive removal of Harney and the assignment of Lyon to command the department of the west, with the rank of brigadier general. On Lyon's refusal to accede to the secessionists' proposal that the state should be neutral, hostilities opened in earnest, and Lyon, having cleared Missouri of small hostile bands in the central part of the state, turned to the southern districts, where a Confederate army was advancing from the Arkansas border. The two forces came to action at Wilson's Creek on Aug. 10, 1861. The Union forces, heavily outnumbered, were defeated, and Lyon himself was killed. He bequeathed almost all he possessed, some $30,000, to the war funds of the national government.

See A. Woodward, *Memoir of General Nathaniel Lyon* (Hartford, 1862); James Peckham, *Life of Lyon* (1866); T. L. Snead, *The Fight for Missouri* (1886). Also *Last Political Writings of General Nathaniel Lyon* (1862).

LYONNAIS, formerly a province of France, bounded on the north by Beaujolais, on the south and west by the Forez mountains, on the east by the Saône and the Rhone, which divided it from Bresse, Dombes and Dauphiné. In modern times it has formed the department of the Rhone. The history of Lyonnais is the history of its capital, Lyons (*q.v.*).

See P. Clerjon, *Histoire de Lyons* (1829–40), articles in the *Revue Lyonnaise* since 1881, and in the *Revue du Lyonnais* (1835–48).

LYONNESSE, LYONESSE, LEONNOYS or **LEONAIS,** a legendary country off the south coast of Cornwall, England. Lyonnesse is the scene of many incidents in the Arthurian romances, and especially in the romances of Tristran and Iseult. It also plays an important part in Cornish tradition and folklore. Early English chronicles, such as the *Chronicon e chronicis* of Florence of Worcester (d. 1118), described minutely and without a suggestion of disbelief the flourishing state of Lyonnesse, and its sudden disappearance beneath the sea. The legend may be a greatly exaggerated version of some actual subsidence of inhabited land. There is also a very ancient local tradition, apparently independent of the story of Lyonnesse, that the Scilly Islands formed part of the Cornish mainland within historical times.

See *Florentii Wigorniensis monachi Chronicon ex chronicis,* etc., ed. B. Thorpe (1848–49); also an article on "Lyonesse," dealing with the severance of the Scilly Islands, by O. G. S. Crawford, in *Antiquity* (March, 1927).

LYONS, EDMUND LYONS, Baron (1790–1858), British admiral, was born at Burton, near Christchurch, Hants., on Nov. 21, 1790. He entered the navy and served in the Mediterranean and afterward in the East Indies. In 1826 he commanded the "Blonde" frigate at the blockade of Navarino, and took part with the French in the capture of Kasteo Morea. From 1840 until 1853 Lyons was employed on the diplomatic service, being successively minister to Greece, Switzerland and Sweden. In the Crimean War he was second in command of the British fleet in the Black sea under Admiral Dundas, whom he succeeded in the chief command in 1854. His constant vigilance, his multifarious activity, and his suggestions and counsels were much more advantageous to the allied cause than his specific exploits. In 1855 he was created vice-admiral; in June 1856 he was raised to the peerage. He died on Nov. 23, 1858.

See Adam S. Eardley-Wilmot, R.N., *Life of Lord Lyons* (1898).

LYONS, SIR JOSEPH (1848–1917), British business man, was born in London on Sept. 29, 1848, and educated at a Jewish school. In early life he studied painting and exhibited at the Royal Institute, but by 1886 he had turned to business enterprises, in conjunction with the brothers Isidore (d. 1920) and Montague Gluckstein. This led to the foundation of the catering firm of J. Lyons and Co., Ltd., of which he became chairman. He began by catering at public exhibitions, and next opened tea shops in London, the first in 1894. Twenty years later these numbered more than 200 and provided cheap food for the large class of clerical workers and junior members of professions. Later he opened several restaurants of a more ambitious nature, as well as hotels, on the no-tipping principle. He was knighted in 1911, and died in London on June 22, 1917.

LYONS, RICHARD BICKERTON PEMELL LYONS, 1st Earl (1817–1887), British diplomatist, son of Baron Lyons, was born at Lymington on April 26, 1817. He entered the diplomatic service, and in 1859–64 was British minister at Washington, where, after the outbreak of the Civil War, the negotiations connected with the arrest of the Confederate envoys on board the British mail steamer "Trent" devolved upon him. After a brief service at Constantinople, he succeeded Lord Cowley in 1867 at the Paris embassy, where he remained for 20 years. In the war of 1870 he used his best efforts as a mediator, and accompanied the provisional government to Tours. He died on Dec. 5, 1887, whereupon the title became extinct.

See Lord Newton, *Lord Lyons. A Record of British Diplomacy* (2 vols., 1913).

LYONS (French Lyon) (lī'ons, Fr. lē-ōn), a famous city of eastern France, capital of the department of Rhône, lying 315 mi. S.S.E. of Paris, and 218 mi. N. by W. of Marseilles on the P.L.M. railway. Pop. (1936) 562,038. Lyons stands at the confluence of the Rhône and the Saône at an altitude of 540 to 1,000 ft. above sea level. The rivers, both flowing south, are separated on the north by the hill on which lies the populous working quarter of Croix-Rousse, then by the narrow tongue of land ending in the Perrache quarter, so called because it was reclaimed from the rivers in the 18th century by the sculptor Perrache. The peninsula thus formed is more than 3 mi. long and from 650 to 1,000 yd. broad, and is traversed lengthwise by the finest streets of the city, containing many of the chief buildings, the docks of the Saône, etc. Where it enters Lyons the Saône has on its right the faubourg of Vaise and on its left that of Serin, whence the ascent is made to the top of the hill of Croix-Rousse. Farther on, its right bank is bordered by the scarped heights of Fourvière, St. Irénée, Ste. Foy and St. Just, leaving room only for the quays and one or two narrow streets; this is the oldest part of the city. The river sweeps in a semicircle around this eminence (410 ft. above it) which is occupied by convents, hospitals and seminaries, and has at its summit the famous church of Notre-Dame de Fourvière, a centre of pilgrimage.

The Rhône, less confined than the Saône, flows swiftly in a wide channel, broken when the water is low in spring by pebbly islets. On the right hand it skirts first St. Clair, sloping upwards to Croix-Rousse, and then the districts of Terreaux, Bellecour and Perrache; on the left it has a low-lying plain, occupied by the quarters of Brotteaux and Guillotière, and the Parc de la Tête d'Or with a lake, zoological collection and very fine botanical and pharmaceutical gardens. It is defended from the Rhône by the Quai de la Tête d'Or. Brotteaux is a modern residential quarter. Guillotière to the south consists largely of workmen's dwellings, bordering wide, airy thoroughfares. To the east extend the manufacturing suburbs of Villeurbanne and Montchat, and extension into the plain of Dauphiné, southeast of the Rhône, is likely to continue.

The Rhône and the Saône are bordered by fine quays and crossed by 24 bridges—11 over the Rhône, 12 over the Saône, and 1 at the confluence. The Pont de la Guillotière over the Rhône preserves a portion of its mediaeval predecessor. The name, Notre-Dame de Fourvière, originally applied to a small chapel of the 9th century on the site of the old forum (*forum vetus*) from which it takes its name. It has often been rebuilt, the chief feature being a modern Romanesque tower surmounted by a cupola and statue of the Virgin. In 1872 a basilica was begun at its side in token of the gratitude of the city for having escaped occupation by the German troops; it was finished in 1894. Marble and mosaic have been lavishly used in the ornamentation of the interior and of the crypt. Round the apse runs a gallery with a fine view, from which, according to an old custom, a benediction is pronounced upon the town annually on Sept. 8.

The cathedral of St. Jean at the foot of the hill of Fourvière was begun in the 12th century, to the end of which the transept and choir belong; the gable and flanking towers of the west front were completed in 1480. A triple portal surmounted by a line of arcades and a rose window gives entrance to the church. Two additional towers, that to the north containing one of the largest bells in France, rise at the extremities of the transept. The nave and choir contain fine stained glass of the 13th and 14th centuries as well as good modern glass. The chapel of St. Louis or of Bourbon, to the right of the nave, is a masterpiece of Flamboyant Gothic. To the right and left of the altar stand two crosses preserved since the council of 1274 as a symbol of the union then agreed upon between the Greek and Latin churches. Adjoining St. Jean is the ancient Manécanterie or singers' house, much mutilated and frequently restored, but still preserving graceful Romanesque arcades along its front. St. Martin d'Ainay, on the peninsula, dates from the beginning of the 6th century and was subsequently attached to a Benedictine abbey. It was rebuilt in the 10th and 11th centuries and restored in modern times, and has a nave with four aisles, a transept and a choir with three semicircular apses. One tower is in the middle of the west front, another at the crossing; the four columns supporting the latter are said to have come from an altar to Augustus. A 12th century mosaic, a high altar with mosaic work and a beautifully carved confessional are among the works of art in the interior. St. Nizier, the first cathedral, is 15th century Gothic with a 16th century porch; its crypt is very ancient and in it St. Pothinus officiated.

The *hôtel de ville* (17th century) on the Place des Terreaux, the space filled in when the Perrache was reclaimed, has a good east façade. The south side of the square is occupied by the Palais des Arts, a 17th century Benedictine convent now accommodating the school of fine arts, the museums of painting and sculpture, archaeology and natural history, and the library of science, arts and industry. The museums have a very important collection of antiquities, rich in Gallo-Roman inscriptions, including the bronze tablets discovered in 1528, on which is engraved a portion of a speech delivered in A.D. 48, by the emperor Claudius, advocating the admission of citizens of Gallia Comata to the Roman senate. The "Ascension," a masterpiece of Perugino, is the chief treasure of the art collection. A special gallery contains the works of artists of Lyons, among whom are numbered Antoine Berjon, Meissonier, Paul Chenavard, Puvis de Chavannes. The Bourse (exchange) in the Rue de la République is a fine building and includes the *Musée historique des Tissus,* in which the history of the weaving industry is illustrated by nearly 400,000 examples. In the buildings of the *lycée* on the right bank of the Rhône are the municipal library and a collection of globes, among them the great terrestrial globe made at Lyons in 1701, indicating the great African lakes.

The Hôtel Dieu, the traditional founder of which was King Childebert (early 6th century) is housed in an 18th century building; its façade, fronting the west quay of the Rhône for more than 1,000 ft., was begun according to the designs of Soufflot, architect of the Panthéon at Paris. A fountain in the Place des Terreaux has a leaden group by Bartholdi representing the rivers on their way to the ocean.

Remains of Roman baths, tombs and a theatre are found in the St. Just quarter on the right bank of the Saône. Three ancient aqueducts on the Fourvière level, from Montromant, Mont d'Or and Mont Pilat, can still be traced. Magnificent remains of the latter work may be seen at St. Irénée and Chaponost. Traces also exist along the Rhône of a subterranean canal conveying the water of the river to a *naumachia* (lake for mimic sea fights). Agrippa made Lyons the starting point of the principal Roman roads throughout Gaul; and it remains an important road centre owing to its position on the natural highway from north to southeastern France. The Saône above the town and the Rhône below have large barge and steamboat traffic. The main P.L.M. railway line runs first through the station at Vaise, on the right bank of the Saône, and thence to that of Perrache, the chief station in the city. The line to Geneva has its station in the Brotteaux quarter, and the line of the eastern Lyonnais to St. Genix d'Aoste has a terminus at Guillotière; both these lines link up with the P.L.M. main line. The railway to Montbrison starts from the terminus of St. Paul in Fourvière and that to Bourg, Trévoux and the Dombes region from the station of Croix-Rousse. A less important line to Vaugneray and Mornant has a terminus at St. Just. Cable tramways (*ficelles*) run to the summits of the eminences of Croix-Rousse, Fourvière and St. Just.

Lyons has been one of the chief fortresses of France. It is the headquarters of the 14th army corps, the seat of an archbishop who holds the title of primate of the Gauls and also that of archbishop of Vienne, and of a prefect, a court of appeal, a court of assizes, tribunals of commerce and of first instance, and of two boards of trade arbitrators (*conseils de prud'hommes*). It is the centre of an *académie* (educational division) and has a university with faculties of law, letters, science and medicine and pharmacy. There are also Catholic faculties (*facultés libres*) of law, theology, science and letters, a school of fine arts founded in the 18th century to train competent designers for the textile manufactures, which has also done much for painting and sculpture; an army medical school, schools of drawing, agriculture, music, commerce (*école supérieure de commerce*), weaving, tanning, watchmaking and applied chemistry, and the *écoles La Martinière* for free instruction in science and art as applied to industry. The veterinary school, instituted in 1761, was the first of its kind in Europe; its laboratory for the study of comparative physiology is admirably equipped. Besides the *Académie des Sciences, Belles Lettres et Arts* (founded in 1700), Lyons possesses societies of agriculture, natural history, geography, horticulture, etc.

Derived from Italy, the silk industry rapidly developed, thanks to the monopoly granted to the city in 1450 by Charles VII and to the patronage of Francis I, Henry II and Henry IV. From time to time new kinds of fabrics were invented—silk stuffs woofed with wool or with gold and silver threads, shawls, watered silks, poplins, velvets, satinades, moirés, etc. In the beginning of the 19th century J. M. Jacquard introduced his famous loom by which a single workman was enabled to produce elaborate fabrics as easily as the plainest web, and by changing the "cartoons" to make the most different textures on the same looms. In the 17th century Lyons had 9,000 to 12,000 silk looms. After the revocation of the edict of Nantes the number sank to 3,000 or 4,000; but it rose again about 1801 to 12,000. In the mid 19th century silk weaving began to desert Lyons for the surrounding districts. The city remains the business centre for the trade and carries on accessory processes. The synthetic fibre industry also developed very largely around Lyons. Much natural silk is imported from the east and some from Italy. About one quarter of the city's population is engaged in the industry. The dyeing industry and the manufacture of chemicals have both developed considerably to meet the requirements of the silk trade. Large quantities of mineral and vegetable colouring matters are produced and there is besides a large output of glue, gelatine, superphosphates and phosphorus, all made from bones and hides, of picric, tartaric, sulphuric and hydrochloric acids, sulphates of iron and copper, and pharmaceutical and other chemical products.

Lyons does a large trade in metals, iron, steel and copper, and utilizes them in the manufacture of iron buildings, framework, bridges, machinery, railway material, scales, metal cables, pins and needles, copper-founding and the making of clocks and bronzes. Gold and silver-working is of importance, especially for embroidery and articles used in religious ceremonies. Other industries are those of printing, the manufacture of glass goods, of tobacco (by the State), the preparation of hides and skins (occupying 20,000 workmen), those connected with the miller's trade, the manufacture of various forms of dried flour-paste (macaroni, vermicelli, etc.), brewing, hat-making, the manufacture of chocolate, and the pork-butcher's industry. Apart from the dealings in silk and silk goods, trade is in cloth, coal and charcoal, metals and metal goods, wine and spirits, cheese and chestnuts. Four miles south-west of Lyons is Oullins (pop., 1936, 16,734) which has the important works of the P.L.M. railway.

Lyons is the seat of the Crédit Lyonnais, one of the chief banks of France; also of coal and metallurgical companies and gas companies, home and foreign.

HISTORY

The earliest Gallic people who occupied the territory at the confluence of the Rhône and the Saône were the Segusians. In 59 B.C. some Greek refugees from the banks of the Hérault, having obtained permission of the natives to establish themselves beside the Croix-Rousse, called their new town by the Gallic name Lugudunum (*q.v.*) or Lugdunum; and in 43 B.C. Lucius Munatius Plancus brought a Roman colony to Fourvière from Vienne. This settlement soon acquired importance, and was made by Agrippa the starting-point of four great roads. Augustus, besides building aqueducts, temples and a theatre, gave it a senate and made it the seat of an annual assembly of deputies from the sixty cities of Gallia Comata. At the same time the place became the Gallic centre for the worship of Rome and the emperor. Under the emperors the colony of Forum Vetus and the municipium of Lugdunum were united, receiving the *jus senatus*. The town was burnt in A.D. 59 and afterwards rebuilt in a much finer style with money given by Nero; it was also adorned by Trajan, Adrian and Antoninus.

After having been ravaged by the barbarians and abandoned by the empire, Lyons in 478 became capital of the kingdom of the Burgundians. It afterwards fell into the hands of the Franks, and suffered severely from the Saracens, but revived under Charlemagne, and after the death of Charles the Bald became part of the kingdom of Provence. From 1032 it was a fief of the emperor of Germany. Subsequently the authority over the town was a subject of dispute between the archbishops of Lyons and the counts of Forez; but the supremacy of the French kings was established under Philip the Fair in 1312. The citizens were constituted into a commune ruled by freely elected consuls (1320). In the 13th century two ecclesiastical councils were held at Lyons—one in 1245, presided over by Innocent IV., at which the emperor Frederick II. was deposed; the second, the oecumenical, under the presidency of Gregory X., in 1274, at which five hundred bishops met. Pope Clement V. was crowned here in 1305, and his successor, John XXII., elected in 1316. The Protestants obtained possession of the place in 1562; their acts of violence were fiercely avenged in 1572 after the St. Bartholomew massacre. Under Henry III. Lyons sided with the League; but it pronounced in favour of Henry IV. The executions of Henri d'Effiat, marquis of Cinq-Mars, and of François de Thou, who had plotted to overthrow Richelieu, took place on the Place des Terreaux in 1642. In 1793 the Royalists and Girondists, powerful in the city, rose against the Convention, but were compelled to yield to the army of the republic under General Kellermann after enduring a siege of seven weeks (October 10). Terrible chastisement ensued: the name of "Lyon" was changed to that of "Ville-affranchie"; the demolition of its buildings was set about on a wholesale scale; and vast numbers of the proscribed, whom the scaffold had spared, were butchered with grape shot. The town resumed its old name after the fall of Robespierre, and the terrorists in their turn were drowned in large numbers in the Rhone. Napoleon rebuilt the Place Bellecour, reopened the churches, and made the bridge of Tilsit over the Saône between Bellecour and the cathedral. In 1814 and 1815 Lyons was occupied by the Austrians. In 1831, 1834, 1849, 1870 and 1871 it was the scene of violent industrial or political disturbances. In 1840 and 1856 disastrous floods laid waste portions of the city. International exhibitions were held there in 1872 and 1894, the latter occasion being marked by the assassination of President Carnot. An annual international fair was established in 1916 at Lyons. A permanent exhibition building on the banks of the Rhone was erected and space for exhibitors was reserved on both sides of the road on the left bank of the river and in the square near the railway station.

Poland and soviet Russia were represented at the exhibition for the first time in 1923.

The Wilson bridge over the Rhone was opened in 1918.

See S. Charlety, *Histoire de Lyon* (Lyon, 1903); J. Godart, *L'Ouvrier en soie. Monographie du tisseur lyonnais* (Lyon, 1899); A. Vachet, *A travers les rues de Lyon* (Lyon, 1902); A. Steyert, *Nouvelle Histoire de Lyon et des provinces de Lyonnais, Forez, Beaujolais* (3 vols., Lyon, 1895–99).

LYONS, COUNCILS OF. The first Council of Lyons met at the summons of Pope Innocent IV in June and July of 1245 to deliberate on the conflict between Church and emperor, on the assistance to be granted to the Holy Land and the eastern empire, on measures of protection against the Tatars and on the suppression of heresy. Among these tasks the most important, in the eyes of the pope, was that the Council should lend him effectual aid in his labours to overthrow the emperor Frederick II. The condemnation of the emperor was a foregone conclusion and the objections of the emperor's representative, Thaddeus of Suessa, that the accused had not been regularly cited, that the pope was plaintiff and judge in one, and that therefore the whole process was anomalous, achieved as little success as his appeal to the future pontiff and to a truly oecumenical council. On July 17 the verdict was pronounced by Innocent IV, excommunicating Frederick and dethroning him on the grounds of perjury, sacrilege, heresy and felony.

All oaths of fealty sworn to him were pronounced null and void, and the German princes were commanded to proceed with the election of a new sovereign.

See J. D. Mansi, *Collectio conciliorum* (1759, etc.) tom. xxiii; C. G. Hefele, *Conciliengeschichte,* 2nd ed., vol. v, pp. 1,105–26 (1886); Fr. W. Schirrmacher, *Kaiser Friederich der Zweite* (Göttingen, 1859–65); A. Folz, *Kaiser Friedrich II. u. Papst Innocenz IV.* (Strasbourg, 1905).

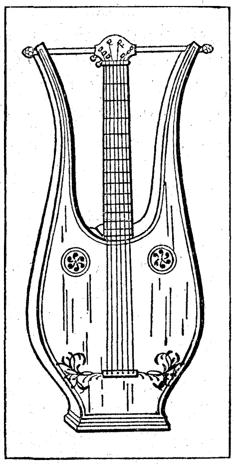
The second Council of Lyons met from May 7 to July 17, 1274, under the presidency of Pope Gregory X. Its chief result was the regulation that future elections to the papacy should be held by the college of cardinals in conclave (*q.v.*). It is also important through the appearance of representatives of the eastern emperor Michael VIII, who acknowledged the supremacy of the pope over the eastern Church.

See J. D. Mansi, *op. cit.*, tom. xxiv; C. G. Hefele, *op. cit.*, vol. vi p. 119 *seq.*

LYRA ("the Harp"), in astronomy, a constellation in the northern hemisphere. It contains Vega, the brightest star in the northern hemisphere and the fourth brightest star in the sky. The name Vega is a remnant of an Arabic phrase meaning "falling eagle"; Altair (in Aquila) is a similar remnant of "flying eagle." The star β Lyrae is an eclipsing variable with a period of 12.92 days; the system presents some abnormal features, perhaps owing to the very low densities of the two components. ϵ Lyrae is a double double; a binocular or even the unaided eye shows two stars which can only be loosely connected, and a small telescope resolves each of these into two components. The Ring nebula in Lyra (Messier 57) is the brightest example of this class of nebula.

LYRE, an ancient stringed musical instrument. The recitations of the Greeks were accompanied by it. Yet the lyre was not of Greek origin; no root in the language has been discovered for *λύρα,* although the special names bestowed upon varieties of the instrument are Hellenic. We have to seek in Asia the birthplace of the genus, and to infer its introduction into Greece through Thrace or Lydia. Notwithstanding the Hermes tradition of the invention of the lyre in Egypt, the Egyptians seem to have adopted it from Assyria or Babylonia.

The frame of the lyre consisted of a hollow body or sound-chest (*ἠχεῖον*). From this sound-chest were raised two arms (*πήχεις*), which were sometimes hollow and were bent both outward and forward. They were connected near the top by a cross-bar or yoke (*ζυγόν, ζύγωμα* or, from its having once been a reed, *κάλαμος*). Another crossbar (*μάλας, ὑπολύριον*), fixed on the sound-chest, formed the bridge which transmitted the vibrations of the strings. The deepest note was the farthest from the player; but, as the strings did not differ much in length more weight may have been gained for the deeper notes by thicker strings, as in the violin and similar modern instruments, or their tensions may have been slacker. The strings were of gut (*χορδή,* whence chord). They were stretched between the yoke and bridge, or to a tail-piece below the bridge. There were two ways of tuning, one was to fasten the strings to pegs which might be turned (*κόλλαβοι, κόλλοπες*); the other was to change the place of the string upon the crossbar; probably both expedients were simultaneously employed. The number of strings varied at different epochs, and possibly in different localities—four, seven and ten having been favourite numbers. They were used without a finger-board, no Greek description or representation having ever been met with that can be construed as referring to one. Nor was a bow possible, the flat sound-board being an insuperable impediment. The plectrum, however, was in constant use: it was held in the right hand to set the upper strings in vibration; at other times it hung from the lyre by a ribbon. The fingers of the left hand touched the lower strings (*ψάλλειν*).



FROM HENRY BODDINGTON, "CATALOGUE OF MUSICAL INSTRUMENTS"

THE CLASSICAL LYRE

With Greek authors the lyre has several distinct names; but it is difficult to connect these with anything like certainty with the different varieties of the instrument. Chelys (*χέλυς,* tortoise) may mean the smallest lyre, which, borne by one arm or supported by the knees, offered in the sound-chest a decided resemblance to that familiar animal. That there was a difference between lyre and cithara (*κιθάρα*) is certain, Plato and other writers separating them, while Hermes and Apollo had an altar at Olympia in common because the former had invented the lyre and the latter the cithara. Further, this difference has persisted ever since among the two distinct families of instruments descended from them. Thus in the lyre the sound-chest consisted of a vaulted back, in imitation of the tortoise, over which was directly glued a flat sound-board of wood or parchment. In the cithara (*q.v.*) the sound-chest was shallower, and the back and front were invariably connected by sides or ribs. These two methods of constructing the sound-chests of stringed instruments are essentially different; and to one or the other category every subsequent stringed instrument with a neck may be referred.

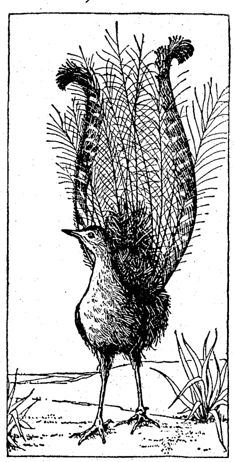
BY COURTESY OF THE METROPOLITAN MUSEUM OF ART

GREEK MUSE PLAYING THE LYRE

From a plaster cast modelled after an ancient bas-relief found in Icaria (Attica)

There is no evidence as to what the stringing of the Greek lyre was in the heroic age. Plutarch says that Olympus and Terpander used but three strings to accompany their recitation. As the four strings led to seven and eight by doubling the tetrachord, so the trichord is connected with the hexachord, or six-stringed lyre depicted on so many archaic vases. Before the Greek civilization had assumed its historic form, there was likely to have been great freedom and independence of different localities in the matter of lyre stringing. We may regard the Olympus scale, however, as consisting of two tetrachords, eliding one interval in each, for the tetrachord, or series of four notes, was very early adopted as the fundamental principle of Greek music, and its origin in the lyre itself appears sure. The basis of the tetrachord is the employment of the thumb and first three fingers of the left hand to twang as many strings, the little finger not being used on account of natural weakness. As a succession of three whole tones would form the disagreeable and untunable interval of a tritonus, two whole tones and a half-tone were tuned, fixing the tetrachord in the constant interval of the perfect fourth. This succession of four notes being in the grasp of the hand was called *συλλαβή,* just as in language a group of letters incapable of further reduction is called syllable. In the combination of two syllables or tetrachords the prototype of our modern diatonic scales resulted.

LYRE-BIRD, the name for Australian birds of the genus *Menura,* allied to the scrub-birds (*q.v.*). Somewhat smaller than a pheasant, the common species (*M. superba*) is remarkable for the three kinds of feathers composing the tail of the cock, giving the latter the appearance of an ancient lyre. It is very shy, inhabiting the thickest "bush." The cock displays on small hillocks, which he scratches up, and has a fine song. The food consists of insects, myriapods and snails. The nest is on or near the ground, closely woven of roots and fibres and lined with feathers. A single purplish-grey egg, blotched with purplish brown, is laid. The young bird is clad in dark down. *M. superba* inhabits New South Wales, south Queensland and Victoria. There are two other species, *M. victoriae,* having much the same range as the last, and *M. alberti,* which is more northerly. The plumage of all three is brown.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

THE LYRE-BIRD (MENURA SUPERBA)

LYRICAL POETRY, a general term for all poetry which is, or can be supposed to be, susceptible of being sung to the accompaniment of a musical instrument. In the earliest times it may be said that all poetry was of its essence lyrical. The primaeval oracles were chanted in verse, and the Orphic and Bacchic Mysteries, which were celebrated at Eleusis and elsewhere, combined, it is certain, metre with music. Homer and Hesiod are each of them represented with a lyre, yet, if any poetry can be described as non-lyrical, it is surely the archaic hexameter of the *Iliad* and the *Erga.* These poems were styled epic, in direct contra-distinction to the lyric of Pindar and Bacchylides, but inexactly, since it is plain that they were recited, with a plain accompaniment on a stringed instrument. However, the distinction between epical and lyrical, between *τὰ ἔπη,* what was said, and *τὰ μέλη,* what was sung, is accepted, and neither Homer nor Hesiod is among the lyrists. It is, however, as Hegel insists, the personal thought, or passion, or inspiration, which gives its character to lyrical poetry, while the metrical form is also to be taken into consideration. Since, as a rule, the lyric is short, its lines attain unusual speed and direction. It may be said that the lyric is a direct, arrow-like flight, a spontaneous flash of emotion which makes its own music.

There was an early distinction, soon accentuated in Greece, between the poetry chanted by a choir of singers, and the song which expressed the sentiments of a single poet. The latter, the *μέλος* or song proper, had reached a height of technical perfection in "the Isles of Greece, where burning Sappho loved and sung," as early as the 7th century B.C. That poetess, and her contemporary Alcaeus, divide the laurels of the pure Greek song of Dorian inspiration. By their side, and later, flourished the great poets who set words to music for choirs, Alcman, Arion, Stesichorus, Simonides and Ibycus, who lead us at the close of the 5th century to Bacchylides and Pindar, in whom the tradition of the dithyrambic odes reached its highest splendour of development. The practice of Pindar and Sappho, we may say, has directed the course of lyrical poetry ever since, and will, unquestionably, continue to do so. They discovered how, with the maximum of art, to pour forth strains of personal magic and music, whether in a public or a private way. The ecstasy, the uplifted magnificence, of lyrical poetry could go no higher than it did in the unmatched harmonies of these old Greek poets, but it could fill a much wider field and be expressed with vastly greater variety. This was proved even in their own age. The gnomic verses of Theognis were certainly sung; so were the satires of Archilochus and the romantic reveries of Mimnermus.

At the Renaissance, when the traditions of ancient life were taken up eagerly, and hastily comprehended, it was thought proper to divide poetry into a diversity of classes. The earliest English critic who enters into a discussion of the laws of prosody, William Webbe, lays it down, in 1586, that in verse "the most usual kinds are four, the heroic, elegiac, iambic and lyric." Similar confusion of terms was common among the critics of the 15th and 16th centuries, and led to considerable error. It is plain that a border ballad is heroic, and may yet be lyrical; here the word "heroic" stands for "epic." It is plain that whether a poem is lyrical or not had nothing to do with the question whether it is composed in an "iambic" measure. Finally, it is undoubted that the early Greek "elegies" were sung to an accompaniment on the flute. Thus a poem may be heroic, iambic, or elegiac, and at the same time, in all senses of the word, lyrical.

More difficulty is met with in the case of the sonnet, for although no piece of verse, when it is inspired by subjective passion, fits more closely with Hegel's definition of what lyrical poetry should be, yet the rhythmical complication of the sonnet, and its rigorous uniformity, seem particularly ill-fitted to interpretation on a lyre. When F. M. degli Azzi put the book of Genesis (1700) into sonnets, and Isaac de Benserade the *Metamorphoses* of Ovid (1676) into rondeaux, these eccentric and laborious versifiers produced what was epical rather than lyrical poetry, if poetry it was at all. But the sonnet as Shakespeare, Wordsworth and even Petrarch used it was a cry from the heart, a subjective confession, and although there is perhaps no evidence that a sonnet was ever set to music with success, yet there is no reason why that might not be done without destroying its sonnet-character.

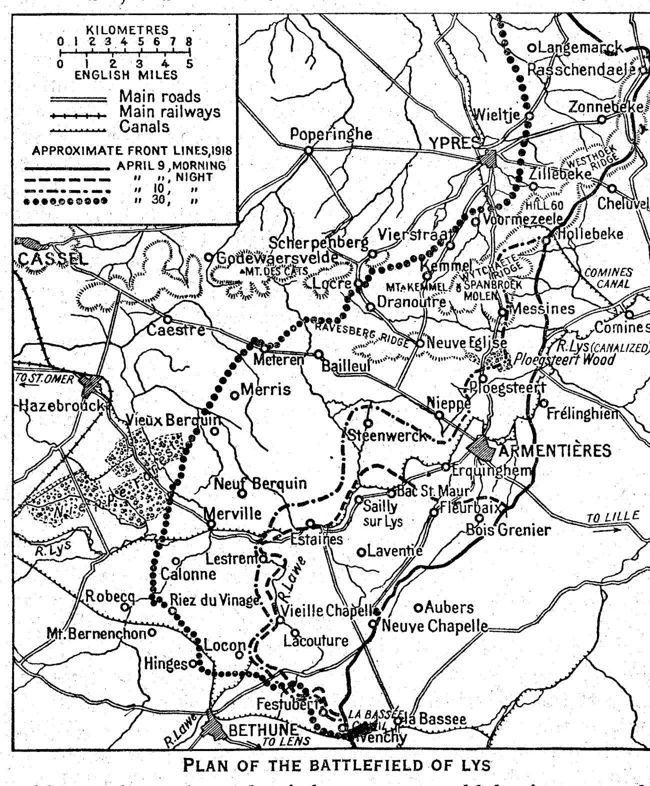
Jouffroy was perhaps the first aesthetician to see quite clearly that lyrical poetry is, really, nothing more than another name for poetry itself, that it includes all the personal and enthusiastic part of what lives and breathes in the art of verse, so that the divisions of pedantic criticism are of no real avail to us in its consideration. We recognize a narrative or epical poetry; we recognize drama; in both of these, when the individual inspiration is strong, there is much that trembles on the verge of the lyrical. But outside what is pure epic and pure drama, all, or almost all, is lyrical. Complexity of form, rhythmical and stanzaic, takes in most lyrics much of the place which was taken in antiquity by such music as Terpander is supposed to have supplied. In a perfect lyric by a modern writer the instrument is the metrical form, to which the words have to adapt themselves. There is perhaps no writer who has ever lived in whose work this phenomenon may be more fruitfully studied than it may be in the songs and lyrics of Shelley. The temper of such pieces as "Arethusa" and "The Cloud" is indicated by a form hardly more ambitious than a guitar; "Hellas" is full of passages which suggest the harp; in his songs Shelley touches the lute or viola da gamba, while in the great odes to the "West Wind" and to "Liberty" we listen to a verse-form which reminds us by its volume of the organ itself. On the whole subject of the nature of lyric poetry no commentary can be more useful to the student than an examination of the lyrics of Shelley in relation to those of the song-writers of ancient Greece.

See Hegel, *Die Phänomenologie des Geistes* (1807); T. S. Jouffroy, *Cours d'esthétique* (1843); W. Christ, *Metrik der Griechen und Römer* (2nd ed. 1879); John Drinkwater, *The Lyric* (1916).

LYS, BATTLE OF THE. In the general scheme of the great German offensive of 1918, the idea of breaking through the British-Portuguese front in French Flanders was considered by the German High Command. Although this scheme became secondary to the great offensive further south, the preparations for it were carried out, firstly in order to mislead the British and Allied headquarters, and secondly that the Germans might be able to revert quickly to it in case the Somme offensive should come to a standstill.

When on March 30 it became obvious that no further progress was possible in the southern battle area, the German Supreme Command decided to put into effect the Flanders attack, the preparations for which were nearly complete. Although they did not anticipate that they would be able to force a decision in this area, there were certain definite advantages to be obtained from a successful blow in the direction of St. Omer-Hazebrouck and the local situation favoured, in their opinion, the prospect of success. This was to be the second blow struck against the British army, a great proportion of which had already been employed on the southern front.

The abnormally dry weather gave good grounds for hope that the Lys valley would be practicable, a state of affairs which was not the case till much later in the spring in a normal year. The only lateral lines of communication in this sector of the British zone, other than the coast railway, ran through St. Pol-Lillers-Hazebrouck, and if the use of this could be denied to the British,



PLAN OF THE BATTLEFIELD OF LYS

problems of supply and reinforcement would be immeasurably complicated. It was above all important, in the view of the German Supreme Command, to retain the initiative, and to strike a second blow before the French could organize a counter-attack against the somewhat vulnerable southern flank of the salient which had been created by the success of the Somme offensive.

Plan of Attack.—The general plan of attack was that the main blow should be struck by Quast's VI. Army on the front between Armentières and the La Bassée canal, in the direction of Hazebrouck. If the VI. Army's attack met with sufficient success, the IV. Army under Arnim was to advance north of Armentières, which was to be made to fall by envelopment, with the eventual object of securing the heights stretching from Kemmel to Mt. des Cats, south of the Ypres-Poperinghe road. If this were achieved the British and Belgian positions in the Ypres salient and on the Yser would be threatened from the rear. The extension of the attack southwards was a secondary consideration, but it was hoped that at least the destruction of the important mining area south of Bethune might be achieved.

The forces available for the operation of the German VI. Army were four corps, from north to south, the Bavarian II. and German XIX., LV. and IV., to which were allotted nine divisions in the first line and five in corps reserve. Three more divisions were retained in army reserve. The subsidiary attack of the German IV. Army was to be delivered by the X. and XVIII. Res. Corps, with three divisions in the first and one in the second line.

The initial blow fell on the left of the I. and right of the II. British Armies, under Sir Henry Horne and Sir Herbert Plumer, the point of junction between which was, on April 9, the Lys, east of Armentières. The XI. Corps (British 55th and Portuguese 2nd Divs.) and the XV. Corps (40th and 34th Divs.) held the front from the La Bassée canal to the Lys, while the IX. Corps (25th, 19th and 9th Divs.) continued the line from the Lys to the Ypres-Comines canal. With the exception of the 55th, all these British divisions had already taken part in the southern battle and had been rapidly made up with reinforcements from home. Three more battle-worn divisions were in corps reserve. The 1st Portuguese division had been withdrawn from the line on April 5 and the 2nd was also to be relieved on April 9, but, pending their relief, it had taken over the whole corps sector.

The Battle Opens.—At about 4 A.M. on April 9 the battle opened with an intense bombardment of the whole front from Lens to Armentières, with both gas and high-explosive shell. The front trenches were subjected to a rain of high explosive, while battery positions, cross roads, headquarters and railheads far in rear were treated with both gas and high explosive. Armentières itself and the British position south of the La Bassée canal were deluged with mustard gas. The foggy morning made observation difficult, and, according to German accounts, the counter-bombardment was ineffective. Between 8 and 9 A.M. nine German divisions were launched against the two British and one Portuguese divisions. In the centre the weight of the attack of the German XIX. and LV. Corps overwhelmed the Portuguese 2nd Div., and both corps advanced steadily towards their objectives. The right of the Bavarian II. Corps was held firmly by the 40th Div., but the left of the Bavarians succeeded in advancing past the right flank of that division. On the British right the 55th Div. held stoutly on to Givenchy and north of that place withdrew slowly from the outpost position to the main line of resistance which ran just east of Festubert.

All available British reserves were hurried up; the reserve brigade of the 55th Div. was employed to form a defensive flank facing north, from Festubert to the Lawe. The 11th Cyclist Bn. and King Edward's Horse were rushed up to Lacouture and Vieille-Chapelle, and by their heroic resistance effectually prevented any extension of the break through to the south. The 51st and 50th Divs. were moved up from the back areas to the river Lawe and the neighbourhood of Estaires respectively. Meanwhile the 55th Div. continued to hold its position at Givenchy and Festubert throughout the day and in counter-attacks against elements of the enemy, which had penetrated into their position, captured over 750 prisoners. The magnificent fight put up by this division completely broke the attack of the Prussian IV. Corps.

On the northern flank of the battle, the Bavarian II. Corps succeeded eventually in occupying the forward posts of the right battalion of the 40th Div., and gradually worked their way northwards. By noon the division was forced back by pressure in front and flank to a position facing south from Bois Grenier through Fleurbaix to Sailly-sur-Lys. Owing to the rapid advance of the German centre the 50th Div. was unable to gain touch with the 40th, the right flank of which withdrew across the Lys at Bac St. Maur early in the afternoon. The remainder of this division, reinforced by troops of the 34th Div., successfully maintained their line covering the approaches to Erquinghem and Armentières from the south, till the evening.

The Saxon XIX. Corps had rapidly followed up the right of the 40th Div. and about 3 P.M. succeeded in passing small bodies of troops across the Lys at Bac St. Maur. During the night the Germans established themselves firmly on the north bank, in the gap between the 40th and 50th British Divisions.

On April 10 the attacks were renewed all along the line. Practically no progress was made by the IV. Corps on the left. It was only just before nightfall that the LV. Corps succeeded in gaining a footing on the west bank of the Lawe between Lestrem and Vieille-Chapelle. At Estaires the 50th Div. defended itself with great gallantry and inflicted very heavy casualties on the enemy in the street fighting which continued all day. It was only at nightfall that this division was forced to withdraw to a prepared position north and west of the town. East of Estaires the German Corps, which had now got up artillery in support of its infantry and machine guns, pushed back the thin British line to a position north of Steenwerck, where the arrival of reinforcements for a time effectually held up the German advance.

Extension of the Attack.—Meanwhile, after an intense preliminary bombardment of the British positions between Frélinghien and Hill 60 north of the Ypres-Comines canal, the German IV. Army about 5.30 A.M. attacked the British VIII. Corps. The outposts of the 25th and 19th Divs. were driven in and under cover of mist the German X. and XVIII. Res. Corps worked their way up the valleys of the Warnave and Douve rivers on the flanks of the British positions in Ploegsteert Wood and Messines. By midday the village of Ploegsteert, the south-east corner of the wood and Messines had been captured. During the afternoon the German attack succeeded in capturing the outpost position as far north as the Ypres-Comines canal, but was held up on the crest of the Wytschaete ridge and in front of Hollebeke by the 9th Division. The South African brigade of the same division retook Messines during the afternoon. This further success of the Germans, combined with the progress made by the right flank of the German VI. Army, gravely imperilled the situation of the 34th Div. which was holding the original line east of Armentières and had not been attacked. A withdrawal to the north bank of the Lys was therefore decided on, and was completed by 9:30 P.M. when the Lys bridges were destroyed.

On April 11 the attack was continued. The German IV. Corps again failed to make any progress between Givenchy and the Lawe river. North of Locon the British 51st and 50th Divs., weakened by continuous fighting, were slowly pushed back by the German LV. and XIX. Corps. The British divisions fought with the greatest gallantry, but bodies of German infantry worked their way through gaps in the attenuated line and by nightfall they had reached Neuf-Berquin and were in occupation of Merville. Further east progress was checked by a counter-attack of the 31st Div., which had arrived from the southern battlefield, but the Bavarian II. Corps pushed forward through Nieppe to Steenwerck. Slight progress was made by the German IV. Army between Nieppe and Messines.

Renewed Attacks.—During April 12 the arrival of reinforcements, mostly from the southern battle front, began to have its effect. The right flank of the British still held firm, but the German LV. Corps, attacking before dawn in the mist, broke through the left centre of the 51st Div., and reached Riez du Vinage, where their progress was checked by two batteries of artillery. The British 3rd Div. had come into action about Locon, which village was lost to the German LV. Corps, but the German advance was checked. The right flank of the same German Corps was checked in Calonne by the 61st Div., which, like the 3rd, had arrived from the Somme battle area.

Meantime the Bavarian II. and German XIX. Corps attacked between Vieux Berquin and Steenwerck. In spite of the gallant defence put up by the 29th and 31st Divs. they succeeded in forming a gap south-west of Bailleul, which enabled them to penetrate to and seize Merris. This gap was eventually blocked by a brigade of the 33rd Div. reinforced by a party of cyclists, a pioneer battalion and every available man from the local schools and reinforcement camps. Further north the 25th, 34th and 49th Divs. maintained their positions against all attacks.

During April 12 headquarters of Prince Rupert's group of armies issued orders for the continuance of the attack by the inner wings of the two armies, with the dual objectives of Hazebrouck and the range of hills north of Bailleul. The VI. Army was also to prepare to continue the pressure of their left wing towards Bethune. On April 13 the German attacks north of the Lys were continued with great vigour. On the left, elements of the LV. Corps, which had penetrated into the outskirts of the Nieppe forest, were driven back by the British 5th Div., which finally checked the German advance in this area. In the centre the German XIX. Corps continued to attack the 29th and 31st British Divs., now greatly diminished in strength by continuous fighting. Except at Vieux Berquin, which was captured by the Germans, who brought up guns to point blank range, those divisions carried out their instructions to hold their positions at all costs and cover the detrainment of the Australian 1st Division. The arrival of the Australians in the evening definitely closed the approach to Hazebrouck. Further north a succession of heavy attacks was repulsed.

Early on the morning of April 14 the British troops withdrew without interference to a new line in front of the Ravelsburg heights between Bailleul and Neuve Eglise. The latter village, after intense fighting all day, was finally captured by the Germans by midnight. Elsewhere all attacks were repulsed, and the British 4th Div., coming up, recaptured Riez Du Vinage. On April 15 the German attacks were renewed. By this time their troops had been reinforced by the Guard Res. Corps on the left wing of the IV. Army. The IX. Res. Corps had come in on the right of the IV. Corps, and the Bavarian III. Corps had replaced the Bavarian II. Corps. Heavy attacks developed during the day culminated in the capture of Bailleul and the Ravelsburg Ridge.

British Withdrawal.—On the night of April 15–16 a withdrawal of the British troops from the Ypres salient to a line east of Ypres through St. Julien and along the Westhoek and Wytschaete ridges was completed without interference. This move had been commenced on the night of the 12–13 by direction of British G.H.Q. in order to set free additional troops, and to forestall any plans the Germans might be entertaining for the extension of the battle front to the north. The withdrawal was well timed, as the Germans were preparing an offensive from the Houthulst forest, and the preparations were almost complete when the British withdrawal took place.

On April 16 strong local attacks were made at various points on the Meteren-Wytschaete front, all of which were repulsed by the 25th, 34th and 49th Divs., except on the extreme flanks, where both villages, after intense fighting, eventually fell into German hands. On the following day determined efforts to take Mt. Kemmel and to advance on the Meteren-Merris front were repulsed, and the Belgian army achieved a notable success in defeating a powerful assault against their right flank about the Ypres-Staden railway.

Meantime the Germans had been preparing to renew the attack on the British right flank, and on the 18th, after a very intense bombardment, the IV. and IX. Res. Corps advanced to the assault of the British positions about Givenchy-Festubert and Mt. Bernenchon-Hinges. On the British right they penetrated at certain points, but were thrown back by the 1st Div. which had relieved the 55th. Everywhere else they failed to obtain even an initial success. For nearly a week the battle died down. In the left centre of the British front French troops, which had been brought up from the south, relieved some of the wearied British divisions, and by the morning of the 21st had taken over the sector between Meteren and Spanbroekmolen.

New German Plan.—During this pause the German Higher Command readjusted their plan. On the 18th the Army Group suggested that the main operations should be abandoned, and it was finally decided on the 20th that further operations should be limited to the capture of Mt. Kemmel on the north, and the villages of Givenchy and Festubert on the south. No success whatever was obtained on the southern flank, but the attacks about Mt. Kemmel led to further bitter fighting.

At 3.30 A.M. on April 25 an intense bombardment was opened on the French and British positions extending from Bailleul to the Ypres-Comines canal. The main object of the attack was the capture of Kemmel hill by direct assault on the French, combined with an attack on the British right south of Wytschaete, intended to separate it from the French. The attack was entrusted to the XVIII. Res., Alpine and X. Res. Corps, to which were allotted nine divisions, five of which were fresh. Between 6 and 7 A.M. the German infantry advanced, supported by large numbers of squadrons of battle planes and bombers. After intense fighting they succeeded by 10 A.M. in wresting Kemmel hill and village from the French, detachments of whom, however, though surrounded, held out till late in the day. The weight of the initial attack on the British front fell on the 9th Div., who inflicted very heavy casualties on their enemy but by midday were forced back to Vierstraat. Further north the 21st Div., after a gallant resistance, was in the afternoon compelled to withdraw to a line Hill 60-Vormezeele.

On April 26, 27 and 28 local fighting continued without substantial alteration in the situation. During the night of April 26–27 the salient east of Ypres was further reduced by a withdrawal without interference to the line Pilkem-Zillebeke-Lake-Voormezeele.

The German final effort took place on April 29. The action started with a bombardment of exceptional intensity at 3.10 A.M. At 5 A.M. powerful attacks commenced against the French and British troops from west of Dranoutre to Voormezeele. After very heavy fighting the Germans gained a temporary success north of Locre, but were driven back by the French troops holding the sector. On the British front the positions held by the 21st, 49th and 25th Divs. were again and again attacked unavailingly by German infantry.

Results of the Battle.—Thus ended the battle of the Lys. The second great German offensive had succeeded in penetrating the British front on a front of about 20 m. to an extreme depth of about 12 miles. A large number of towns and villages had been taken and nearly 30,000 Allied prisoners and 450 guns had been captured. But the attack had failed to gain its main objects. The lateral railway communication between St. Pol and Hazebrouck was still intact. Except for the detached hill of Kemmel, the high ground dominating the Poperinghe-Ypres road still remained in Allied hands. A pronounced salient had been formed in the German front which was to cost them dear in the succeeding months. On the other hand, the British had been forced to abandon the almost equally pronounced salient east of Ypres, and with it all the ground which had been gained at so great a cost in the battle of Passchendaele the previous year. The losses on both sides had been very heavy. To achieve these results the Germans had employed 42 divisions, of which 33 were fresh; 25 British divisions were employed, of which only eight had not been engaged in the battle of the Somme.

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LYSANDER (Gr. *Λύσανδρος*), son of Aristocritus, Spartan admiral and diplomatist. Aelian (*Var. Hist.* xii. 43) and Phylarchus (*ap.* Athen. vi. 271 e) say that he was a *mothax, i.e.,* the son of a helot mother (*see* HELOTS), but this tradition is at least doubtful; according to Plutarch he was a Heraclid, though not of either royal family. He first appears as admiral of the Spartan navy in 407 B.C. The story of his influence with Cyrus the younger, his naval victory off Notium, his quarrel with his successor Callicratidas in 406, his appointment as ἐπιστολεύς in 405, his decisive victory at Aegospotami, and his share in the siege and capitulation of Athens belong to the history of the Peloponnesian War (*q.v.*). By 404 he was the most powerful man in the Greek world and set about completing the task of building up a Spartan empire in which he should be supreme in fact if not in name. Everywhere democracies were replaced by oligarchies, directed by bodies of ten men (δεκαρχίαι) under the control of Spartan governors (harmosts, ἁρμοσταί).

But Lysander's boundless influence and ambition, and the superhuman honours paid him, roused the jealousy of the kings and the ephors, and, on being accused by the Persian satrap Pharnabazus, he was recalled to Sparta. Soon afterwards he was sent to Athens with an army to aid the oligarchs and established the Council of Thirty on the same model as the other oligarchies he had set up throughout Greece; but Pausanias, one of the kings, followed him and brought about a restoration of democracy. On the death of Agis II., Lysander secured the succession of Agesilaus (*q.v.*), whom he hoped to find amenable to his influence. But in this he was disappointed. Though chosen to accompany the king to Asia as one of his 30 advisers (σύμβουλοι), he was kept inactive and his influence was broken by studied affronts, and finally he was sent at his own request as envoy to the Hellespont. He soon returned to Sparta to mature plans for overthrowing the hereditary kingship and substituting an elective monarchy open to all Heraclids, or even, according to another version, to all Spartiates. But his alleged attempts to bribe the oracles were fruitless, and his schemes were cut short by the outbreak of war with Thebes in 395. Lysander invaded Boeotia from the west, receiving the submission of Orchomenus and sacking Lebadea, but the enemy intercepted his despatch to Pausanias, who had meanwhile entered Boeotia from the south, containing plans for a joint attack upon Haliartus. The town was at once strongly garrisoned, and when Lysander marched against it he was defeated and slain. He was buried in the territory of Panopeus, the nearest Phocian city.

An able commander and an adroit diplomatist, Lysander was fired by the ambition to make Sparta supreme in Greece and himself in Sparta. To this end he shrank from no treachery or cruelty; yet, like Agesilaus, he was totally free from the characteristic Spartan vice of avarice, and died, as he had lived, a poor man.

See the biographies by Plutarch and Nepos; Xen. *Hellenica,* i. 5–iii. 5; Diod. Sic. xiii. 70 *sqq.*, 104 *sqq.*, xiv. 3, 10, 13, 81; Lysias xii. 60 *sqq.;* Justin v. 5–7; Polyaenus i. 45, vii. 19; Pausanias iii., ix. 32, 5–10, x. 9, 7–11; C. A. Gehlert, *Vita Lysandri* (Bautzen, 1874); W. Vischer, *Alkibiades und Lysandros* (Basel, 1845); O. H. J. Nitzsch, *De Lysandro* (Bonn, 1847); and the Greek histories in general. (M. N. T.)

LYSANIAS, tetrarch of Abilene (*see* ABILA) in the time of John the Baptist (Luke iii. 1). The only Lysanias mentioned in profane history as exercising authority in this district was executed in 36 B.C. by Mark Antony. He was the son of Ptolemy Mennaeus, the ruler of an independent state, of which Abilene formed only a small portion. According to Josephus (*Ant.* xix. 5, 1) the emperor Claudius in A.D. 42 confirmed Agrippa I. in the possession of "Abila of Lysanias" already bestowed upon him by Caligula. It is argued that this cannot refer to the Lysanias executed by Mark Antony, since his paternal inheritance must have been of far greater extent. It is therefore assumed by some authorities that the Lysanias in Luke (A.D. 28–29) is a younger Lysanias, tetrarch of Abilene only, one of the districts into which the original kingdom was split up after the death of Lysanias I. This younger Lysanias may have been a son of the latter, and identical with, or the father of, the Claudian Lysanias. On the other hand, Josephus knows nothing of a younger Lysanias, and it is suggested by others that he really does refer to Lysanias I.

LYSIAS (459?–380? B.C.), Attic orator, was born, according to Dionysius of Halicarnassus and the author of the life ascribed to Plutarch, in 459 B.C., a date obtained from the founding of Thurii in 444 B.C.; tradition says that Lysias went there at the age of 15. Cephalus, his father, was a native of Syracuse, and on the invitation of Pericles had settled at Athens. The opening scene of Plato's *Republic* is laid at the house of his eldest son, Polemarchus, in Peiraeus. The family were obviously well known to Plato.

At Thurii, a new foundation on the Tarentine gulf, Lysias began his studies in rhetoric under Tisias, according to tradition. The destruction of the Athenian expedition in 413 led to an anti-Athenian outburst, and the expulsion of Lysias and Polemarchus, who returned to Athens. There they settled as favoured aliens (ἰσοτελεῖς), Polemarchus in Athens itself and Lysias in Peiraeus, near their shield factory, a large concern employing 120 slaves. The attack of the Thirty Tyrants on the resident aliens in 404 was fatal to Polemarchus, and Lysias only just escaped from imprisonment by a large bribe. He took refuge in Megara; from there he gave assistance to the exiles, and in the restoration in 403 Thrasybulus moved to bestow the citizenship on him, a measure defeated on a technical objection. The recent disturbances had probably reduced Lysias to comparative poverty, and the rest of his life was spent in composing speeches for the law courts. Little is known of his personal life. He made his only personal appearance in 403, when he indicted Eratosthenes, one of the Tyrants. There is a tradition that he delivered his own *Olympiacus* at the festival of 388, to which Dionysius of Syracuse had sent a magnificent embassy. The speech is an appeal to Greece to deliver Sicily from Dionysius' tyranny. The latest speech we can date (*For Pherenicus*) belongs to 381 or 380. Lysias probably died in or soon after 380 B.C.

Lysias was a man of kindly and genial nature, warm in friendship, loyal to country, with a keen perception of character, and a fine though strictly controlled sense of humour. The literary tact which is so remarkable in the extant speeches is that of a singularly flexible intelligence, always obedient to an instinct of gracefulness. He owes his distinctive place to the power of concealing his art. It was obviously desirable that a speech written for delivery by a client should be suitable to his age, station and circumstances. Lysias was the first to make this adaptation really artistic. His skill can be best appreciated if we turn from the easy flow of his graceful language to the majestic emphasis of Antiphon, or to the self-revealing art of Isaeus. Translated into terms of ancient criticism, he became the model of the "plain style" (ἰσχνὸς χαρακτήρ, *genus tenue*). Greek rhetoric began in the "grand" style; then Lysias set an exquisite pattern of the "plain"; and Demosthenes might be considered as having effected an almost ideal compromise.

The vocabulary of Lysias is pure and simple. Most of the rhetorical "figures" are sparingly used—except such as consist in the parallelism or opposition of clauses, due to the still surviving influence of the Sicilian school. Lysias excels in vivid description; he has also a happy knack of marking the speaker's character by light touches. He has equal command over the "periodic" style (κατεστραμμένη λέξις) and the non-periodic or "continuous" (εἰρομένη, διαλελυμένη). His disposition of his subject-matter is always simple. The speech has usually four parts—introduction (προοίμιον), narrative of facts (διήγησις), proofs (πίστεις) and conclusion (ἐπίλογος). It is in the introduction and the narrative that Lysias is seen at his best. In his greatest extant speech —that *Against Eratosthenes*—and also in the fragmentary *Olympiacus,* he has pathos and fire; but these were not characteristic qualities of his work. In Cicero's estimate of the various Greek orators (*De Orat.* iii. 7, 28) the quality in which Lysias is supreme is *subtilitas* (refinement). Nor was it oratory alone to which Lysias rendered service; his work had an important effect on all subsequent Greek prose, by showing how perfect elegance could be joined to plainness. And his style has an additional charm for modern readers, because it is employed in describing scenes from the everyday life of Athens.

In literary and historical interest, the first place among his extant speeches belongs to that *Against Eratosthenes* (403 B.C.), one of the Thirty Tyrants, whom Lysias arraigns as the murderer of his brother Polemarchus. The speech is an eloquent and vivid picture of the reign of terror which the Thirty established at Athens; the concluding appeal, to both parties among the citizens, is specially powerful. Next in importance is the speech *Against Agoratus* (399 B.C.), one of our chief authorities for the internal history of Athens during the months which immediately followed the defeat at Aegospotami. The *Olympiacus* (388 B.C.) is a brilliant fragment, expressing the spirit of the festival at Olympia, and exhorting Greeks to unite against their common foes. The *Plea for the Constitution* (403 B.C.) is interesting for the manner in which it argues that the wellbeing of Athens—now stripped of empire—is bound up with the maintenance of democratic principles. The speech *For Mantitheus* (392 B.C.) is a graceful and animated portrait of a young Athenian ἱππεύς, making a spirited defence of his honour against the charge of disloyalty. The defence *For the Invalid* is a humorous character-sketch. The speech *Against Pancleon* illustrates the intimate relations between Athens and Plataea, while it gives us some picturesque glimpses of Athenian town life. The defence of the person who had been charged with destroying a *moria,* or sacred olive, places us amidst the country life of Attica. And the speech *Against Theomnestus* deserves attention for its curious evidence of the way in which the ordinary vocabulary of Athens had changed between 600 and 400 B.C.

Thirty-four speeches (three fragmentary) have come down under the name of Lysias; 127 more, now lost, are known from smaller fragments or from titles. The ἐρωτικός in Plato's *Phaedrus,* pp. 230 E-234 has generally been regarded as Plato's own work; however, the certainty of this conclusion will be doubted by those who observe (1) the elaborate preparations made in the dialogue for a recital of the ἐρωτικός which shall be *verbally exact* and (2) the closeness of the criticism made upon it. If the satirist were merely analysing his own composition, such criticism would have little point. Lysias is the earliest writer who is known to have composed ἐρωτικοί; it is as representing both rhetoric and a false ἔρως that he is the object of attack in the *Phaedrus.*

All mss. of Lysias yet collated have been derived, as H. Sauppe first showed, from the Codex Palatinus X. (Heidelberg). The next most valuable ms. is the Laurentianus C (15th century), which I. Bekker chiefly followed. Speaking generally, we may say that these two mss. are the only two which carry much weight where the text is seriously corrupt. In *Oratt.* i.–ix. Bekker occasionally consulted 11 other mss., most of which contain only the above nine speeches: viz., Marciani F, G, I, K (Venice); Laurentiani D, E (Florence); Vaticani M, N; Parisini U, V; Urbinas O.

Editio princeps, Aldus (Venice, 1513); by I. Bekker (1823) and W. S. Dobson (1828) in *Oratores Attici;* C. Scheibe (1852) and T. Thalheim (1901, Teubner series, bibl.); C. G. Cobet (4th ed., by J. J. Hartman, 1905); with variorum notes, by J. J. Reiske (1772). Editions of select speeches by J. H. Bremi (1845); R. Rauchenstein (1848, revised by C. Fuhr, 1880–81); H. Frohberger (1866–71); H. van Herwerden (1863); A. Weidner (1888); E. S. Shuckburgh (1882); A. Westermann and W. Binder (1887–90); G. P. Bristol (1892), M. H. Morgan (1895), C. D. Adams (1905), all three published in America. There is a special lexicon to Lysias by D. H. Holmes (Bonn, 1895). *See* also Jebb, *Attic Orators* (1893) and *Selections from the Attic Orators* (2nd ed., 1888) and F. Blass, *Die Attische Beredsamkeit* (2nd ed., 1887–98); W. L. Devries, *Ethopoiia. A rhetorical study of the types of character in the orations of Lysias* (Baltimore, 1892). (R. C. J.; X.)

LYSIMACHUS (*c.* 355–281 B.C.), Macedonian general, son of Agathocles, was a citizen of Pella in Macedonia. During Alexander's Persian campaigns he was one of his immediate bodyguard and distinguished himself in India. After Alexander's death he was appointed to the government of Thrace and the Chersonese. For a long time he was chiefly occupied with fighting against the Odrysian king Seuthes. In 315 he joined Cassander, Ptolemy and Seleucus against Antigonus, who, however, diverted his attention by stirring up Thracian and Scythian tribes against him. In 309, he founded Lysimachia in a commanding situation on the neck connecting the Chersonese with the mainland. He followed the example of Antigonus in taking the title of king. In 302 when the second alliance between Cassander, Ptolemy and Seleucus was made, Lysimachus, reinforced by troops from Cassander, entered Asia Minor, where he met with little resistance. On the approach of Antigonus he retired into winter quarters near Heraclea, marrying its widowed queen Amastris, a Persian princess. Seleucus joined him in 301, and at the battle of Ipsus Antigonus was slain. His dominions were divided among the victors, Lysimachus receiving the greater part of Asia Minor.

Feeling that Seleucus was becoming dangerously great, he now allied himself with Ptolemy, marrying his daughter Arsinoë. Amastris, who had divorced herself from him, returned to Heraclea. When Antigonus's son Demetrius renewed hostilities (297), during his absence in Greece, Lysimachus seized his towns in Asia Minor, but in 294 concluded a peace whereby Demetrius was recognized as ruler of Macedonia. He tried to carry his power beyond the Danube, but was defeated and taken prisoner by the Getae, who, however, set him free on amicable terms. In 288 Lysimachus and Pyrrhus invaded Macedonia, and drove Demetrius out of the country. Pyrrhus was at first allowed to remain in possession of Macedonia with the title of king, but in 285 he was expelled by Lysimachus.

Domestic troubles embittered the last years of Lysimachus's life. Amastris had been murdered by her two sons; Lysimachus treacherously put them to death. On his return Arsinoë asked the gift of Heraclea, and he granted her request, though he had promised to free the city. In 284 Arsinoë, desirous of gaining the succession for her sons in preference to Agathocles (the eldest son of Lysimachus), intrigued against him with the help of her brother Ptolemy Ceraunus; they accused him of conspiring with Seleucus to seize the throne, and he was put to death. This atrocious deed of Lysimachus aroused great indignation. Many of the cities of Asia revolted, and his most trusted friends deserted him. The widow of Agathocles fled to Seleucus, who at once invaded the territory of Lysimachus in Asia. Lysimachus crossed the Hellespont, and in 281 a decisive battle took place at the plain of Corus (Corupedion) in Lydia. Lysimachus was killed; after some days his body, watched by a faithful dog, was found on the field, and given up to his son Alexander, by whom it was interred at Lysimachia.

See Arrian, *Anab.* v. 13, vi. 28, Justin xv. 3, 4, xvii. 1; Quintus Curtius v. 3, x. 30; Diod. Sic. xviii. 3; Polybius v. 67; Plutarch, *Demetrius,* 31. 52, *Pyrrhus,* 12; Appian, *Syriaca,* 62; Thirlwall, *History of Greece,* vol. viii. (1847); J. P. Mahaffy, *Story of Alexander's Empire;* Droysen, *Hellenismus* (2nd ed., 1877); A. Holm, *Griechische Geschichte,* vol. iv. (1894); B. Niese, *Gesch. d. griech. u. maked. Staaten,* vols. i. and ii. (1893, 1899); J. Beloch, *Griech. Gesch.* vol. iii. (1904); Hünerwadel, *Forschungen zur Gesch. des Königs Lysimachus* (1900); Possenti, *Il Re Lisimaco di Tracia* (1901); Ghione, *Note sul regno di Lisimaco* (*Atti d. real. Accad. di Torino,* xxxix.); and MACEDONIAN EMPIRE. (E. R. B.)

LYSIPPUS, Greek sculptor, was head of the school of Argos and Sicyon in the time of Philip and Alexander of Macedon. He worked only in bronze. His works are said to have numbered 1,500, some of them colossal. He modified the canon of Polycleitus towards a slenderer type, and introduced an element of impressionism. Pliny (*N.H.* 34, 61) and other writers mention many of his statues. Among the gods he seems to have produced new and striking types of Zeus (probably of the Otricoli class), of Poseidon (compare the Poseidon of the Lateran, standing with raised foot), of the Sun-god and others. He made several statues of Hercules, stressing the motif of weariness exemplified in the later Farnese Hercules. Lysippus made many statues of Alexander the Great, and he became the court sculptor of the king, from whom and from whose generals he received many commissions. The extant portraits of Alexander vary greatly, and it is impossible to determine which among them go back to Lysippus. The remarkable head from Alexandria (*see* GREEK ART) has as good a claim as any.

As head of the great athletic school of the Peloponnese Lysippus naturally sculptured many athletes; a figure by him of a man scraping himself with a strigil was a great favourite of the Romans in the time of Tiberius (Pliny, *N.H.* 34, 61); and this has been usually regarded as the original copied in the Apoxyomenus of the Vatican (*see* GREEK ART). (P. G.)

See Collignon, *Lysippe* (Paris, 1905); P. Gardner, in *Jour. Hell. St.* (1905).

LYSIS OF TARENTUM (d. *c.* 390 B.C.), Greek philosopher. The friend and companion of Pythagoras, he has been credited with many of the works usually attributed to Pythagoras himself. Diogenes Laertius viii. 6 gives him three, and Mullach even assigns to him the *Golden Verses.* But it is generally held that these verses are a collection of lines by many authors.

LYSISTRATUS, a Greek sculptor of the 4th century B.C., brother of Lysippus of Sicyon. We are told by Pliny (*Nat. Hist.* 35, 153) that he followed a strongly realistic line, being the first sculptor to take impressions of human faces in plaster.

LYTE, HENRY FRANCIS (1793–1847), English divine and hymn-writer, was born near Kelso on June 1, 1793, and was educated at Enniskillen school and at Trinity college, Dublin. He took orders in 1815, and eventually settled, in 1823, in the parish of Brixham. He died at Nice on Nov. 20, 1847.

Lyte is remembered for his *Poems. chiefly Religious* (1833) and

The Spirit of the Psalms (1834). His best known hymns are "Abide with me!"; "Jesus, I my cross have taken"; "Praise, my soul, the King of Heaven." *See* his *Remains* (1850) with memoir.

LYTHAM ST. ANNES, a municipal borough and watering place in the parliamentary borough of Blackpool, Lancashire, England, on N. of Ribble estuary, $13\frac{1}{2}$ mi. west of Preston on the L.M.S.R. Pop. (est. 1938) 25,540. Area, 9.07 sq.mi. There are five public parks and an extensive promenade. The town was incorporated in 1922. A Benedictine cell was founded at Lytham in the 12th century, by Richard FitzRoger, lord of the manor.

LYTTELTON, ALFRED (1857–1913), British politician, was born Feb. 7, 1857, the youngest child and eighth son of the 4th Lord Lyttelton. His mother, daughter of Sir Stephen Glynne and sister of Mrs. W. E. Gladstone, died six months after his birth. All the eight boys were brought up to be keen cricketers, the cricket ground at Hagley, Worcs., their home, being close to the house; all went to Eton, and six were in the Eton eleven.

Alfred was the most famous cricketer of them all. Indeed for nearly all ball games he had an extraordinary aptitude. He excelled in football of three kinds, and in fives, racquets and especially tennis—holding the amateur championship for tennis from 1882 to 1896. At cricket he was equally good as a bat and as a wicket keeper. He went to Trinity college, Cambridge, and was called to the bar in 1881. In 1895 he became M.P. for Warwick and Leamington as a Liberal Unionist, retaining the seat till 1906, when he was defeated. After a few months' interval, he was returned for a London constituency, St. George's, Hanover Square.

He was appointed, in 1900, chairman of a commission to enquire into the various concessions which President Kruger and the Volksraad had granted in the Transvaal. In pursuance of the investigation he spent the autumn of 1900 in South Africa, and Lord Milner hoped to secure him as his successor. But it was as Colonial Secretary, in the Conservative Government of Balfour, in 1903, that his South African experience was utilised. He incurred much odium by sanctioning the scheme for importing Chinese coolies into South Africa in order to remedy the shortage of native labour and to restart the mines and thereby the whole economic machinery of South Africa.

He died on July 5, 1913, after an injury in a local cricket match.

See E. S. Lyttelton, *Alfred Lyttelton* (1923).

LYTTELTON, GEORGE LYTTELTON, 1ST BARON (1709–1773), English statesman and man of letters, born at Hagley, Worcestershire, was a descendant of the great jurist Sir Thomas Littleton (*q.v.*). He was the eldest son of Sir Thomas Lyttelton, 4th bart., (d. 1751). Lyttelton was educated at Eton and Oxford, and in 1728 set out on the grand tour, spending considerable periods at Paris and Rome. On his return to England he sat in parliament for Okehampton, Devonshire. From 1744 to 1754 he held the office of a lord commissioner of the treasury. In 1755 he succeeded Legge as chancellor of the exchequer, but in 1756 he quitted office, being raised to the peerage as Baron Lyttelton, of Frankley, in the county of Worcester. In the political crisis of 1765, before the formation of the Rockingham administration, it was suggested that he might be placed at the head of the treasury, but he declined. The closing years of his life were devoted chiefly to literary pursuits. He died on Aug. 22, 1773.

His *Works* were published by his nephew, G. E. Ayscough, in 1774. *See* Sir R. Phillimore's *Memoirs and Correspondence of Lord Lyttelton* (2 vols., 1845).

LYTTELTON, a borough of New Zealand, the port of Christchurch on the east coast of South Island, on an inlet on the north-western side of Banks Peninsula. Pop. (1936) 3,264. It is surrounded by abrupt hills rising to 1,600 ft., through which a railway communicates with Christchurch (8 m. north-west) by a tunnel $1\frac{3}{4}$ m. long. Great breakwaters protect the inner harbour, which has an area of 105 ac., with a low-tide depth of 20 to 33 feet. There is a graving dock accessible for vessels of 462 ft.×54 ft. beam. The produce of the rich agricultural district of Canterbury is exported, frozen or preserved. Lyttelton was the original settlement in this district (1850).

LYTTON, EDWARD GEORGE EARLE LYTTON, BULWER-LYTTON, 1ST BARON (1803–1873), English novelist and politician, the youngest son of General William Earle Bulwer of Heydon Hall and Wood Dalling, Norfolk, was born in London on May 25, 1803. He had two brothers, William (1799–1877) and Henry (1801–72), afterwards Lord Dalling (*q.v.*). Bulwer's father died when the boy was four years old. His mother, Elizabeth Barbara, daughter of Richard Warburton Lytton of Knebworth, Hertfordshire, after her husband's death settled in London. Bulwer was educated at private schools and at Trinity college and Trinity hall, Cambridge. Before he went to Cambridge he had published a volume of verse, and had fallen in love. The lady married another, to Bulwer's lasting grief. After leaving Cambridge he published some volumes of juvenilia which he afterward ignored.

Meanwhile he had begun to take his place in society, being already known as a dandy of considerable pretensions, who had acted as second in a duel and experienced the fashionable round of flirtation and intrigue. He purchased a commission in the army, only to sell it again without undergoing any service, and in Aug. 1827 married, in opposition to his mother's wishes, Rosina Doyle Wheeler (1802–82), an Irish beauty, niece and adopted daughter of General Sir John Doyle. She was a brilliant but passionate girl, and upon his marriage with her, Bulwer's mother withdrew the allowance she had hitherto made him. In the year of his marriage he published *Falkland,* and in 1828 *Pelham,* a novel for which he had gathered material during a visit to Paris in 1825. This intimate study of the dandyism of the age, was immediately popular, and gossip was busy in identifying the characters of the romance with the leading men of the time. In the same year he published *The Disowned,* following it up with *Devereux* (1829), *Paul Clifford* (1830), *Eugene Aram* (1832) and *Godolphin* (1833). All these novels were designed with a didactic purpose, somewhat upon the German model. To embody the leading features of a period, to show how a criminal may be reformed by the development of his own character, to explain the secrets of failure and success in life, these were the avowed objects of his art. Meanwhile he became a follower of Bentham, and in 1831 was elected member for St. Ives, Huntingdon. In 1836 he and his wife were legally separated. Three years later his wife published a novel called *Cheveley, or the Man of Honour,* in which Bulwer was bitterly caricatured, and in June 1858, when her husband was standing as parliamentary candidate for Hertfordshire, she appeared at the hustings and indignantly denounced him. She was placed under restraint as insane, but liberated a few weeks later. For years she continued her attacks upon her husband's character, and outlived him by nine years, dying at Upper Sydenham in March 1882.

After representing St. Ives, Bulwer was returned for Lincoln in 1832, and sat in parliament for that city for nine years. He spoke in favour of the Reform Bill, and secured the reduction of the newspaper stamp duties. His pamphlet, issued when the Whigs were dismissed from office in 1834, entitled "A Letter to a Late Cabinet Minister on the Crisis," led to an offer from Lord Melbourne of a lordship of the Admiralty, which he declined. He continued to write indefatigably. *Godolphin* was followed by *The Pilgrims of the Rhine* (1834), *The Last Days of Pompeii* (1834), and *Rienzi* (1835). These books were received with enthusiasm, and *Ernest Maltravers* (1837) and *Alice, or the Mysteries* (1838) were hardly less successful. In 1831 he became editor of the *New Monthly,* which, however, he resigned in the following year, but in 1841, the year in which he published *Night and Morning,* he started the *Monthly Chronicle,* a semi-scientific magazine, for which he wrote *Zicci,* an unfinished first draft afterwards expanded into *Zanoni* (1842). Simultaneously he was writing plays. In 1838 he produced *The Lady of Lyons,* a play which Macready made a great success at Covent Garden: in 1839 *Richelieu* and *The Sea Captain,* and in 1840 *Money.* All, except *The Sea Captain,* were successful, and this solitary failure he revived in 1869 under the title of *The Rightful Heir.* Of the others it may be said that, though they abound in examples of strained sentiment and false taste, they have nevertheless a certain theatrical *flair,* which has enabled them to survive a whole library of stage literature of greater sincerity and truer feeling. *The Lady of Lyons* and *Money* have long held the stage, and the latter has provided a good part for many comedians.

In 1838 Bulwer was created a baronet, and on succeeding to the Knebworth estate in 1843 added Lytton to his surname, under the terms of his mother's will. From 1841 to 1852 he had no seat in parliament, and spent much of his time in continental travel. His later historical romances are *The Last of the Barons* (1843), *Lucretia, or the Children of the Night* (1847), and *Harold, the last of the Saxon Kings* (1848). In the intervals between these he had produced a volume of poems in 1842, another of translations from Schiller in 1844, and a satire called *The New Timon* in 1846, in which Tennyson, who had just received a civil list pension, was bitterly lampooned. His most ambitious work in metre, a romantic epic entitled *King Arthur,* had no success. His best work in the novel was still to come. His historical novels are much better than it has been the fashion to think. In *The Caxtons* (1849) he turned to English society, and in *My Novel* (1853) and *Kenelm Chillingly* (1873) he gave an unrivalled picture of English society in the mid-Victorian era. Other late works are *A Strange Story* (1862), *The Coming Race* (1871) and *The Parisians* (1873).

In 1852 he entered the political field anew, and in the Conservative interest. He had differed from the policy of Lord John Russell over the corn laws, and now separated finally from the Liberals. He stood for Hertfordshire and was elected, holding the seat till 1866, when he was raised to the peerage as Baron Lytton of Knebworth. His eloquence gave him the ear of the House of Commons, and he often spoke with influence and authority. In 1858 he was appointed secretary for the colonies. In the House of Lords he was comparatively inactive.

See T. H. S. Escott, *Edward Bulwer, 1st Baron Lytton of Knebworth* (1910).

LYTTON, EDWARD ROBERT BULWER-LYTTON, 1ST EARL OF (1831–1891), English diplomatist and poet, was the only son of the 1st Baron Lytton. He was born in Hertford street, Mayfair, on Nov. 8, 1831. Robert Lytton went to Harrow in 1845, and then spent a year at Bonn with an English tutor. In 1850 he entered the diplomatic service as unpaid *attaché* to his uncle, Sir Henry Bulwer, who was then minister at Washington. His advance in the diplomatic service was continuous, his successive appointments being: as second secretary—1852, Florence; 1854, Paris; 1857, The Hague; 1859, Vienna; as first secretary or secretary of legation—1863, Copenhagen; 1864, Athens; 1865, Lisbon; 1868, Madrid; 1868, Vienna; 1873, Paris; as minister—1875, Lisbon. In 1887 he was appointed to succeed Lord Lyons as ambassador at Paris, and held that office until his death in 1891. In 1864, immediately before taking up his appointment at Athens, he married Edith, daughter of Edward Villiers, brother of the earl of Clarendon, and in 1873, upon the death of his father, he succeeded to the peerage and the estate of Knebworth in Hertfordshire.

Early in 1875 Lord Lytton declined an offer of appointment as governor of Madras, and in November of that year, at a critical moment, he was nominated governor-general of India by Disraeli. In Central Asia the advance of Russia had continued so steadily and so rapidly that Shere Ali, the amir of Afghanistan, had determined to seek safety as the vassal of the tsar. Lytton went out to India with express instructions from the British Government to recover the friendship of the amir if possible, and if not so to arrange matters on the north-west frontier as to be able to be indifferent to his hostility. For 18 months Lytton and his council made every effort to conciliate the friendship of the amir, but a Russian agent was established at Kabul, while the mission of Sir Neville Chamberlain was forcibly denied entrance into the amir's dominions. War began in Nov. 1878, and by the close of that year the forces prepared by Lytton for that purpose had achieved their task with extraordinary accuracy and economy. Shere Ali fled from Kabul, and once more it fell to the Indian Government to make provision for the future of Afghanistan. By the treaty of Gandamak in May 1879 Yakub Khan, a son of Shere Ali, was recognized as amir, the main conditions agreed upon being that the districts of Kuram, Pishin and Sibi should be "assigned" to British administration, and the Khyber and other passes be under British control; that there should be a permanent British Resident at Kabul, and that the amir should be subsidized in an amount to be afterwards determined upon. Considerable risk was run in trusting so much, and especially the safety of a British envoy, to the power and the goodwill of Yakub Khan. Sir Louis Cavagnari, the British envoy entered Kabul at the end of July, and was, with his staff, massacred in the rising which took place on Sept. 3. The war of 1879–80 immediately began, with the occupation of Kandahar by Stewart and the advance upon Kabul by Roberts, and the military operations which followed were not concluded when Lytton resigned his office in April 1880. (*See* INDIA: *History.*) Lytton resigned at the same time as the Beaconsfield Ministry, and his Afghan policy was revised by his successor.

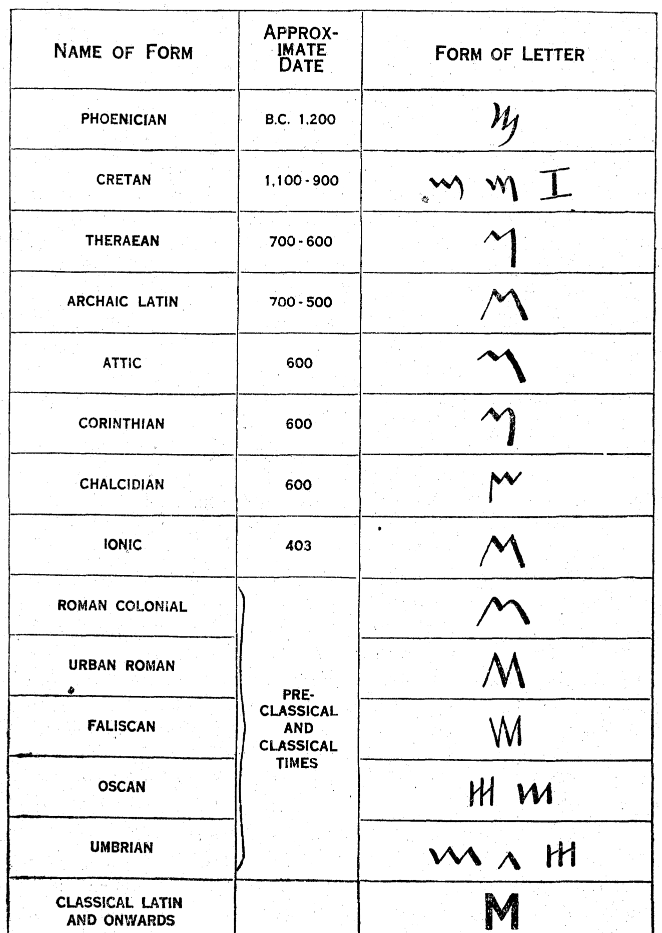
The two most considerable events of Lytton's viceroyalty, besides the Afghan wars, were the assumption by Queen Victoria of the title of empress of India (Jan. 1, 1877), and the famine which prevailed in various parts of India in 1876–78. He satisfied himself that periodical famines must be expected in Indian history, and that constant preparation during years of comparative prosperity was the only condition whereby their destructiveness could be modified. Accordingly he obtained the appointment of the famine commission of 1878, to enquire, upon lines laid down by him, into available means of mitigation. Their report, made in 1880, is the foundation of the later system of irrigation, development of communications, and "famine insurance." The equalization and reduction of the salt duty were effected, and the abolition of the cotton duty commenced, during Lytton's term of office, and the system of Indian finance profoundly modified by decentralization and the regulation of provincial responsibility, in all which matters Lytton enthusiastically supported Sir John Strachey, the financial member of his council.

Upon Lytton's resignation in 1880 an earldom was conferred upon him in recognition of his services as viceroy. He lived at Knebworth until 1887, in which year he was appointed to succeed Lord Lyons as ambassador at Paris. He died at Paris on Nov. 24, 1891. He was succeeded by his son (b. 1876) as 2nd earl.

Lytton is known as a poet under the pen-name of Owen Meredith. He wrote: *Clytemnestra, and other Poems* (1855); *The Wanderer* (1858); *Lucile* (1860); *Serbski Pesme, or National Songs of Servia* (1861); *Tannhäuser* (in collaboration with Julian Fane, 1861); *Chronicles and Characters* (1867); *Orval, or the Fool of Time* (1868); *Fables in Song* (2 vols., 1874); *Glenaveril, or The Metamorphoses* (1885); *After Paradise, or the Legends of Exile, and other Poems* (1887); *Marah* (1892); *King Poppy* (1892). The two last-mentioned volumes were published posthumously. A few previously unpublished pieces are included in a volume of *Selections* published, with an introduction by Lady Betty Balfour, in 1894. Besides his volumes of poetry, Lytton published in 1883 two volumes of a biography of his father.

The *Personal and Literary Letters of Robert, 1st Earl of Lytton,* were edited by Lady Betty Balfour (1906). For his viceroyalty *see* Lady Betty Balfour, *Lord Lytton's Indian Administration* (1899).

THE letter M corresponds to the Semitic (*mem*) and to the Greek (*mu*). Early Greek forms from Thera, Attica and Corinth closely resemble the early North Semitic, . The Lydian alphabet also had the form . These forms differ only in the direction of the writing. The Etruscan form was similar, but with an additional stroke, . The Ionic alphabet had the form and the Chalcidian . From the latter Latin took it in the form , from which the modern form derives. Curious forms occurred in the various Italic alphabets. Umbrian had or , Oscan , Faliscan . The rounded form appeared in the uncial writing of the fifth or sixth centuries A.D., . The cursive hands of the sixth century showed and on this was based the Carolingian . The modern minuscule does not differ essentially from the majuscule letter. The sound represented by the letter has been from the beginning the labial nasal. The nasals of all sounds are



THE DEVELOPMENT OF THE LETTER "M" FROM THE EARLIEST TIMES TO THE PRESENT DAY

least liable to change, a fact that is reflected in the consistent history of the letter. (B. F. C. A.)

MAASDORP, SIR ANDRIES FERDINAND STOCKENSTROM (1847–1931), was born at Malmesbury, Cape Colony, on Jan. 14, 1847, and educated at Graaff Reinet college, Cape Colony, and University college, London. He was called to the bar in 1871. He returned to Cape Colony, and from 1874 to 1878 was a member of the legislative assembly of Cape Colony, and from 1878 to 1897 solicitor-general. From 1900 he was a member of the Special Treason Court, until 1902, when he was appointed chief justice of the Orange River Colony (Orange Free State Province) division of the supreme court of South Africa. He resigned in 1919.

MAASIN, a municipality on the southwest coast of the province and island of Leyte, Philippine Islands, at the mouth of the Maasin river, 414 mi. from Manila. Pop. (1939) 29,264 of whom 14,745 were males and 9 whites. Maasin is a port for the export, by way of Cebu, of abacá (Manila hemp) and copra. The river valleys also produce cotton, pepper, tobacco, palay (rice), maize (corn) and tropical fruits. There are domestic manufactures of native cloth and pottery. Cebuano is the vernacular. Of the inhabitants aged 6 to 19 inclusive, 28·2% in 1939 attended school, and 55·6% of the population 10 years old and over was literate.

MAASSLUIS, a river port of Holland, on the New Waterway, 10 mi. by rail W. of Rotterdam; occupied by Germany in 1940. Pop. (1940) 9,244. It rose into importance as a fishing harbour towards the end of the 16th century, and its prosperity increased after the opening of the New Waterway (the Maas ship canal) from Rotterdam to the sea. Its industries are fishing, shipping and sailmaking. The fort erected in 1572 by Philip of Marnix, count of St. Aldegonde, was captured by the Spanish in 1573.

MAASTRICHT, a frontier town and the capital of the province of Limburg, Holland, on the left bank of the Maas at the influx of the Geer, 19 mi. by rail N.N.E. of Liége in Belgium, is the seat of a court. Pop. (1939) 67,609. Maastricht was originally the *traiectus superior* (upper ford) of the Romans, and was the seat of a bishop from 382 to 721. Having formed part of the Frankish realm, it was ruled after 1204 jointly by the dukes of Brabant and the prince-bishops of Liége. In 1579 it was besieged, taken and plundered by the Spaniards under the duke of Parma. It was taken by the French in 1673, 1748 and 1794. A small portion of the town, known as Wyk, lies on the right bank of the river. A stone bridge connecting the two replaced a wooden structure as early as 1280, and was rebuilt in 1683. Formerly a strong fortress, its ramparts were dismantled in 1871–78. The town-hall, completed in 1683, contains pictures and tapestry. The old town-hall (Oud Stadhuis), a Gothic building of the 15th century, is a museum of antiquities. The church of St. Servatius, founded by Bishop Monulphus in the 6th century, is the oldest church in Holland; according to one account it was rebuilt and enlarged as early as the time of Charlemagne. The late Romanesque church of Our Lady has two ancient crypts and a 13th century choir, but the nave suffered severely from a restoration in 1764. The original church of St. Martin (in Wyk) occupied the supposed site of an old heathen temple. The Protestant St. Janskerk, a Gothic building of the 13th and 15th centuries, with a fine tower, was formerly the baptistery of the cathedral. The town did not reap the full advantages of its situation till the opening of the railways between 1853 and 1865. At first a trade was carried on in wine, colonial wares, alcoholic liquors and salt; there are now manufactures of china, glass and crystal, also breweries, tobacco and cigar factories, and a trade in corn and butter.

A short distance south of Maastricht are the great sandstone quarries of Pietersberg, which were worked from the time of the Romans till the end of the 19th century, resulting in subterranean labyrinths covering an area of 15 mi. by 9 mi. In the time of the Spanish wars these underground passages served to hide the peasants and their cattle. At 5 mi. distance are the mediaeval castles of Amstenrade, Neubourg and Mheer. Maastricht was assaulted by the Germans, May 11, 1940—the second day of the invasion of the Low Countries.

MABILLON, JOHN (1632–1707), Benedictine monk of the Congregation of St. Maur (*see* MAURISTS), was the son of a peasant near Reims. In 1653 he became a monk in the abbey of St. Remi at Reims. In 1664 he was placed at St. Germain-des-Prés in Paris, the great literary workshop of the Maurists, where he lived and worked for twenty years, at first under d'Achery, with whom he edited the nine folio volumes of *Acta* of the Benedictine Saints. In Mabillon's Prefaces (reprinted separately) these lives were for the first time made to illustrate the ecclesiastical and civil history of the early middle ages. Mabillon's masterpiece was the *De re diplomatica* (1681; and a supplement, 1704) in which were first laid down the principles for determining the authenticity and date of mediaeval charters and manuscripts. It practically created the science of Latin palaeography. In 1685–86 Mabillon visited the libraries of Italy, to purchase mss. and books for the King's Library. On his return to Paris he was called upon to defend against de Rancé, the abbot of La Trappe, the legitimacy for monks of the kind of studies to which the Maurists devoted themselves: this called forth Mabillon's *Traité des études monastiques* and his *Réflexions sur la réponse de M. l'abbé de la Trappe* (1691–92), works embodying the ideas and programme of the Maurists for ecclesiastical studies.

Mabillon produced in all some twenty folio volumes and as many of lesser size, nearly all works of monumental erudition. He died on Dec. 26, 1707, in the midst of the production of the colossal Benedictine Annals.

The chief authority for his life is the *Abrégé de la vie de D.J.M.* (also in Latin), by Ruinart (1709). *See* also Tassin, *Hist. littéraire de la congr. de St. Maur* (1770), pp. 205–269. Of modern biographies the best are those of de Broglie (2 vols., 1888) and Bäumer (1892)—the former to be especially recommended. A brief sketch by E. C. Butler may be found in the *Downside Review* (1893). (E. C. B.)

MABINOGION (plural of Welsh *mabinogi*, from *mabinog*, a bard's apprentice), the title given to the collection of 11 Welsh prose tales (from the 14th-century Red Book of Hergest) published (1838) by Lady Charlotte Guest, newly tr'd. by T. P. Ellis and J. Lloyd, *The Mabinogion* (1929). (*See* WELSH LANGUAGE AND LITERATURE.)

MABUSE, JAN (*c.* 1472–*c.* 1534), the name adopted (from his birthplace, Maubeuge) by the Flemish painter Jan Gossaert, or Jenni Gossart, as he called himself when he matriculated in the gild of St. Luke, at Antwerp, in 1503. His most important early work extant is the "Adoration of the Kings" in the National Gallery, formerly at Castle Howard. Here he throws together some thirty figures on an architectural background, carefully elaborated and Romanesque in style. He surprises us by pompous costume. His figures, like pieces on a chess-board, are often rigid and conventional. The landscape which shows through the ruined architecture is adorned with towers and steeples in minute fashion. The picture is signed IENNINE GOS . . . and was probably painted for the Abbey of St. Adrian, Grammont. It is the work of a man trained in the old Flemish traditions. That he was an admirer of Van Eyck is shown by his picture in Madrid of "Jesus, the Virgin, and the Baptist," in Gothic framework. One of Mabuse's most distinguished works, the little triptych at Palermo was probably also painted at this early period. Carondelet, who was Mabuse's patron, was archbishop of Palermo and chancellor of Flanders, and he probably transferred the picture to Sicily. It is a wonderful piece of pictorial elaboration, containing features taken from Dürer. Another early work is the moonlight scene representing "The Agony in the Garden" in the Berlin Museum.

After a residence of a few years at Antwerp, Mabuse took service with Philip, bastard of Philip the Good, at that time lord of Somerdyk and admiral of Zeeland. One of his pictures had already become celebrated—a Descent from the Cross (50 figures), on the high altar of the monastery of St. Michael of Tongerloo. Philip of Burgundy ordered Mabuse to execute a replica for the church of Middelburg; and the value which was then set on the picture is apparent from the fact that Dürer came expressly to Middelburg (1521) to see it; and he noted in his diary that it was not so good in design as in execution. In 1568 the altar-piece perished by fire. In 1508 Mabuse accompanied Philip of Burgundy on his Italian mission; and by this accident an important revolution was effected in the art of the Netherlands. He not only brought home a new style, but he also introduced the fashion of travelling to Italy; and from that time till the age of Rubens and Van Dyck it was considered proper that all Flemish painters should visit the peninsula.

In the summer of 1509 Philip returned to the Netherlands, and, retiring to his seat of Suytburg in Zeeland, surrendered himself to the pleasures of planning decorations for his castle and ordering pictures of Mabuse and Jacopo de Barbari. Being in constant communication with the court of Margaret of Austria at Malines, he gave the artists in his employ fair chances of promotion. Barbari was made court painter to the regent, whilst Mabuse received less important commissions. Records prove that Mabuse painted a portrait of Leonora of Portugal, and other small pieces, for Charles V. in 1516. But his only signed pictures of this period are the Neptune and Amphitrite of 1516 at Berlin, the composition of which is taken from Dürer's famous engraving, and the Madonna, with a portrait of Jean Carondelet of 1517, at the Louvre, in both of which we clearly discern that Vasari only spoke by hearsay of the progress made by Mabuse in "the true method of producing pictures full of nude figures and poesies," for the types are ugly, though drawn delicately and modelled elaborately. Of similar type is the Hercules and Deianira dated 1517, in the Cook Collection at Richmond. In later forms of the same subject—the Adam and Eve at Hampton Court, or the other version of the same subject at Berlin—we observe more nudity, combined with realism.

Happily, Mabuse was capable of higher efforts. His St. Luke painting the portrait of the Virgin in Sanct Veit at Prague, and a variety of the same subject in the Vienna Museum, prove that travel had left many of Mabuse's fundamental peculiarities unaltered. His figures still retain the character of stone; his architecture, now in Italian Renaissance style, is as rich and varied, his tones are as strong as ever. But bright contrasts of gaudy tints are replaced by soberer greys; and a cold haze pervades the surfaces. In this form the Madonnas of Munich (1527) and Vienna, in the collection of Max Wassermann, Paris, and of E. Simon, Berlin, are fair specimens of his skill.

As early as 1523, when Christian II. of Denmark came to Belgium, he asked Mabuse to paint the likenesses of his dwarfs. In 1528 he requested the artist to furnish to Jean de Hare the design for his queen Isabella's tomb in the abbey of St. Pierre near Ghent. It was no doubt at this time that Mabuse completed the portraits of John, Dorothy and Christine, children of Christian II., of which replicas are at Hampton Court, at Wilton House, and at Longford Castle. It is as a portrait painter that Mabuse can be seen to the best advantage. His portraits of Carondelet in the collection of M. von Guttmann in Vienna, and L. Hirsch in London; of Marquise de Vere in the Gardner collection at Boston and others in the galleries of Copenhagen, London, Paris, Berlin, in the Cook collection, Richmond, in the Pratt collection, New York, are remarkable for their strength and plasticity. In his later portraits the rendering of the hands becomes remarkably expressive of the sitter's personality. Carondelet's portrait in Vienna formed part of a diptych. The opposite wing is now in the Tournay museum and carries a half-length of St. Donatian. This diptych is one of the most powerful works of Mabuse.

When Philip of Burgundy became bishop of Utrecht, and settled at Duerstede, near Wyck, in 1517, he was accompanied by Mabuse, who helped to decorate the new palace of his master. At Philip's death, in 1524, Mabuse designed and erected his tomb in the church of Wyck. He finally retired to Middelburg, where he took service with Philip's brother, Adolph, lord of Veeren.

See M. Gossart, *J. Gossaert* (Lille, 1902); E. Weiss, *J. Gossaert* (Pachim, 1913); M. Friedländer, *Van Eyck bis Bruegel* (1921); S. M. Conway, *The Van Eycks and their followers* (1921); and A. Segard, *Jean Gossart* (1923).

MAC, a Gaelic word meaning "son," and the distinguishing prefix in a large number of Scots and Irish personal names; frequently contracted to Mc and M' in the written form. Its use in forming Celtic patronymics is ancient in both Scots and Irish records, and may be compared with Welsh Ap (originally *mab* or *map,* the Brythonic equivalent of *mac*), Irish O' in such names as O'Donnell (Scots MacDonald and MacDonnell), and Anglo-Norman Fitz, etc. In the 8th century the Pictish king Angus MacFergus (Aonghas MacFhearghuis) prepared the way for the union of Picts and Scots, and in the following century Kenneth MacAlpin became the founder of the first dynasty to rule over a united Scotland; while Shakespeare's *Macbeth* has rendered familiar the name of MacAlpin's descendant two centuries later on the Scottish throne. The advent of the Norsemen, and their colonization of the Outer Isles from the Shetlands to the Isle of Man and Northern Ireland, accounts for a number of Celticized names of old Norse origin which now also make their appearance, such as the Gaelic *mac Amhlaibh, mac Mhanuis, mac Iamhair,* etc., from O. Norse Olaf or Olave, Magnus or Manus, Ivar or Ingvar, Thorketill, Lochlann, etc., whence the more familiar forms of Macaulay, MacManus, MacIvor, MacCorquodale, Maclachan are derived. Association of the prefix with English names, such as M'Ritchie, M'Dicken, M'Cutcheon, M'Watt (*i.e.*, Richardson, Dickinson, Hutchinson, Walter's son) is uncommon and always late in origin.

The Celtic names so formed are both fewer in number and more regular in structure than the wide diversity of forms and spellings that have been derived from them. Ferguson, Farquharson, Duncanson are more correctly rendered in the original "Fergus' son," or Fergusson, etc. (though using a prefix in place of a suffix). From *mac Aonghais,* son of Angus, come M'Ainsh, M'Innes, M'Quinness (Ir. M'Guinness), M'Neish; from *mac Coinneach,* son of Kenneth, M'Kinnie, M'Kenzie, M'Kenna, M'Whinnie; from *mac Eachainn,* son of Hector, come M'Kechnie, M'Geachie, M'Kichan; while Meikleham from M'Ilquham shows a still further process of change by ellipsis. (*Cf.* Welsh Map-Richard and Map-Rhys, which become Ap-Ritchard, Ap-Rhys, and finally Pritchard, Price and Bryce.) The conversion of the Gaelic inflected *mh* and *bh* into its equivalent sound of *v* is also common, as M'Vanish son of Manus, from MacMhanuis; M'Tavish, son of Thomas, from MacTamhais, etc. (*Cf.* Scott's Vic Ian Vor in *Waverley,* i.e., *Mhic Iain Mhór,* Son of Big John.)

Among the elements that enter into these name processes, besides the simple personal names, such as MacGregor, MacFarlane, MacAlister, from Gregory, Bartholomew (Gael. *Parlain*), Alexander (Gael. *Alasdair*), are names of crafts, rank, personal description, etc., such as Macduff from Gaelic *dubh,* dark, whence also M'Duffie, M'Phee, M'Fie; M'Dougall and M'Dowall from *dubh ghal* or Dugald, the dark stranger, MacFarquhar from *fhear char,* the dear man; MacKinnon, the fair born, and MacIntyre (*Mac an t-saoir*), son of the carpenter, besides a number of names of religious origin, such as M'Kellar, M'Nab, M'Gillespie, M'Taggart (*Mac an t-sagairt*), son of the prior, abbot, bishop, priest (another form of which is M'Millan, the bald or tonsured). Names incorporating initial Gil, Il, Le, etc., are derivatives from *gille* or *ghill',* a lad or servant, which is common to names of religious origin and in naming after saints, as M'Gilchrist (*Mac gille Chriosd*), M'Ilhose or Maclehose, M'Gillivray or M'Ilwraith, M'Lean, M'Clure, son of the servant of Christ, of Jesus, of judgment (bhràith), of John, and of the Book (*Leabhair*) or Bible. MacIntosh (*Mac an tòisch*), son of the chief, is an instance of a name of rank. In Celtic Scotland the *tòiseach* was the head of a district under the *maormaers* or stewards of the great provinces, who later became earls, while *tòiseach* is frequently translated thane in English, though without the English sense. Under the clan system which reached its greatest development later, it may be more exactly rendered the chief of the clan in a particular district. It is also owing to this community system that the use of the patronymic to decide relationship, at first of father and son, and by extension all children or descendants, became part of the social heritage and structure of the Scots, and took the place of the feudal relationships which spread elsewhere.

Bibliography.—A MacBain, *Outlines of Gaelic Etymology* (Stirling 1909); *Etymology of the Principal national names, personal names and surnames* (Stirling 1911); J. B. Johnston, *The Scottish Macs* (Paisley 1922); W. J. Watson, *The History of the Place Names of Scotland* (1926). *See* also under Clan; Tartan, etc. (W. D. M'C.)

MACABEBE, a municipality (with administrative centre and 18 *barrios* or districts) of the province of Pampanga, Luzon, Philippine Islands, on the Pampanga river, about 10 mi. above its mouth and about 25 mi. N.W. from Manila. Pop. (1939) 20,149. Macabebe was long a recruiting ground for the Spanish *guardia civil* and later for the Philippine scouts which formed an adjunct of the United States army in the archipelago. The inhabitants are traders who travel. Agriculture is also a leading industry, the principal crops being palay (rice) and sugar. Alcohol is distilled from the nipa palm and abacá (Manila hemp) and cotton fabrics are woven into cloth. Pampango is the vernacular. Of the inhabitants aged 6 to 19 inclusive, 40·8% in 1939 attended school; 58·8% of the population 10 years old and over was literate.

MACABRE, a term applied to a certain type of artistic or literary composition, characterized by a grim and ghastly humour, with an insistence on the details and trappings of death. Such a quality, deliberately adopted, is hardly to be found in ancient Greek and Latin writers, though there are traces of it in Apuleius and the author of the *Satyricon.* The outstanding instances in English literature are John Webster and Cyril Tourneur, with E. A. Poe and R. L. Stevenson. The word has gained its significance from its use in French, *la danse macabre,* for that allegorical representation, in painting, sculpture and tapestry, of the ever-present and universal power of death, known in English as the "Dance of Death," and in German as *Totentanz.* The typical form which the allegory takes is that of a series of pictures, sculptured or painted, in which Death appears, either as a dancing skeleton or as a shrunken corpse wrapped in grave-clothes to persons representing every age and condition of life, and leads them all in a dance to the grave. Of the numerous examples painted or sculptured on the walls of cloisters or church-yards through mediaeval Europe few remain except in woodcuts and engravings. Thus the famous series at Basel, originally at the Klingenthal, a nunnery in Little Basel, dated from the beginning of the 14th century. In the middle of the 15th century this was moved to the churchyard of the Predigerkloster at Basel, and was restored, probably by Hans Kluber, in 1568; the fall of the wall in 1805 reduced it to fragments, and only drawings of it remain. A Dance of Death in its simplest form still survives in the Marienkirche at Lübeck in a 15th century painting on the walls of a chapel. Here there are 24 figures in couples, between each is a dancing Death linking the groups by outstretched hands, the whole ring being led by a Death playing on a pipe. At Dresden there is a sculptured life-size series in the old Neustädter Kirchhoff, removed here from the palace of Duke George, in 1701, after a fire. At Rouen in the *aitre* (atrium) or cloister of S. Maclou there also remains a sculptured *danse macabre.* There was a celebrated fresco of the subject in the cloister of Old St. Paul's in London, and another in the now destroyed Hungerford chapel at Salisbury, of which a single woodcut, "Death and the Gallant," alone remains. Of the many engraved reproductions, the most celebrated is the series drawn by Holbein. Here the long ring of connected dancing couples is necessarily abandoned, and the Dance of Death becomes rather a series of *imagines mortis.*

Concerning the origin of this allegory in painting and sculpture there has been much dispute. It certainly seems to be as early as the 14th century, and has often been attributed to the overpowering consciousness of the presence of death due to the Black Death and the miseries of the Hundred Years' War. It has also been attributed to a form of the Morality, a dramatic dialogue between Death and his victims in every station of life, ending in a dance off the stage (see Du Cange, *Gloss., s.v.* "Machabaeorum chora"). The origin of the peculiar form the allegory has taken has also been found, somewhat needlessly and remotely, in the dancing skeletons on late Roman sarcophagi and mural paintings at Cumae or Pompeii, and a false connection has been traced with the "Triumph of Death," attributed to Orcagna, in the Campo Santo at Pisa.

The etymology of the word *macabre* is itself most obscure. According to Gaston Paris (*Romania,* xxiv., 131; 1895) it first occurs in the form *macabré* in Jean le Fèvre's *Respit de la mort* (1376), "Je lis de Macabré la danse," and he takes this accented form to be the true one, and traces it in the name of the first painter of the subject. The more usual explanation is based on the Latin name, *Machabaeorum chora.* The seven tortured brothers, with their mother and Eleazar (2 Macc. vi. vii.) were prominent figures on this hypothesis in the supposed dramatic dialogues. Other connections have been suggested, as for example with St. Macarius or Macaire, the hermit, who, according to Vasari, is to be identified with the figure pointing to the decaying corpses in the Pisan "Triumph of Death," or with an Arabic word *magbarah*, "cemetery."

See Peignot, *Recherches sur les danses des morts* (1826); Douce, *Dissertation on the Dance of Death* (1833); Massmann, *Litteratur der Totentänze* (1840); J. Charlier de Gerson, *La Danse Macabre des Stes Innocents de Paris* (1874); Seelman, *Die Totentänze des Mittelalters* (1893).

McADAM, JOHN LOUDON (1756–1836), Scottish inventor, who gave his name to the system of road-making known as "macadamizing," was born at Ayr, Scotland, on Sept. 21, 1756. In 1770 he went to New York, entering the counting-house of a merchant uncle. He returned to Scotland with a considerable fortune in 1783, and purchased an estate at Sauhrie, Ayrshire. The highways of Great Britain were at this time in a very bad condition, and McAdam, who was a road trustee in his district, at once began to consider how to effect reforms. At his own expense he began at Sauhrie, despite much opposition, a series of experiments in road-making. In 1798 he removed to Falmouth, where he had received a Government appointment, and continued his experiments there. His general conclusion was that roads should be constructed of broken stone (*see* ROADS AND STREETS). In 1815, having been appointed surveyor-general of the Bristol roads, he was able to put his theories into practice. In 1819 he published a *Practical Essay on the Scientific Repair and Preservation of Roads*, followed, in 1820, by the *Present State of Road-making*. In 1827 he was appointed by the Government general surveyor of roads. He died at Moffat, Dumfriesshire, on Nov. 26, 1836.

McADOO, WILLIAM GIBBS (1863–1941), American lawyer and politician, was born near Marietta, Ga., Oct. 31, 1863. He entered the University of Tennessee but did not finish his course. In 1882 he became clerk in the U.S. circuit court of Chattanooga, read law and three years later was admitted to the bar. He began practice in Chattanooga, but in 1892 removed to New York city. There he became interested in the problem of passenger transportation. In 1902 he formed the New York and New Jersey railroad company, which took over the abandoned Hudson river tunnel from Hoboken to New York, and in March, 1904, this tunnel was completed. In 1909 the tunnel under the Hudson river to downtown New York also was finished. He was a strong supporter of Woodrow Wilson for president, and on the latter's election he was appointed, in 1913, secretary of the Treasury. In this position he contributed largely to the working-out of the new Federal Reserve banks system.

After America's entrance into the War he was called upon to raise very large sums of money. He was successful in floating four Liberty Loans between May, 1917, and Oct., 1918, amounting in all to more than $18,000,000,000. He also secured the creation of a bureau of War Risk insurance for shipping, later extended to include life insurance for soldiers and sailors in the World War. When the railways were taken over by the Federal Government in 1917 he was appointed director-general. He favoured the League of Nations, woman suffrage and the prohibition amendment. He resigned the secretaryship of the Treasury in Dec., 1918, and the directorship of railways the following January. He then resumed the practice of law first in New York and later at Los Angeles. At the Democratic National Convention of 1920 and again at that of 1924 he was a prominent candidate for nomination for the presidency. On the first ballot on both occasions he received the highest number of votes but failed in each instance to win the nomination. He was elected United States Senator from California for the term 1933–39. He died Feb. 1, 1941.

McADOO, an anthracite-mining borough of Schuylkill county, Pennsylvania, U.S.A., on the Lehigh Valley and the Pennsylvania railways, 5 mi. S. of Hazleton. Pop. (1920) 4,674 (28% foreign-born white); in 1940 it was 5,127.

MACAIRE, a French *chanson de geste*. *Macaire* (12th century) and *La Reine Sibille* (14th century) are two versions of the story of the false accusation brought against the queen of Charlemagne, called Blanchefleur in *Macaire* and Sibille in the later poem. *Macaire* is only preserved in the Franco-Venetian *geste* of Charlemagne (Bibl. St. Mark ms. fr. xiii.). *La Reine Sibille* only exists in fragments, but the tale is given in the chronicle of Alberic Trium Fontium and in a prose version. *Macaire* combines two legends: that of the unjustly repudiated wife and that of the dog who detects the murderer of his master. (For the former motive *see* GENEVIÈVE OF BRABANT.) The second is found in Plutarch, *Script. moral.*, where a dog, like Aubri's hound, stayed three days without food by the body of its master, and subsequently attacked the murderers, thus leading to their discovery. The duel between Macaire and the dog is paralleled by an interpolation by Giraldus Cambrensis in a ms. of the *Hexameron* of St. Ambrose. Aubri's hound received the name of the "dog of Montargis," because a representation of the story was painted on a chimney-piece in the château of Montargis in the 15th century. The tale was early divorced from Carolingian tradition, and Jean de la Taille, in his *Discours notable des duels* (1607), places the incident under Charles V.

See *Macaire* (1866), edit. Guessard in the series of *Anc. poètes de la France;* P. Paris in *Hist. litt. de la France*, vol. xxiii. (1873); L. Gautier, *Épopées françaises*, vol. iii. (2nd ed., 1880); G. Paris, *Hist. poét. de Charlemagne* (1865); M. J. G. Isola, *Storie nerbonesi*, vol. i. (Bologna, 1877); F. Wolf, *Über die beiden . . . Volksbücher von der K. Sibille u. Huon de Bordeaux* (Vienna, 1857); and *Über die neuesten Leistungen der Franzosen* (Vienna, 1833).

McALESTER, a city of Oklahoma, U.S.A., 110 mi. S.E. of Oklahoma City, on federal highway 69; county seat of Pittsburg county. It is served by the Missouri-Kansas-Texas, the Pittsburg County and the Rock Island railways. Pop. 11,804 in 1930; (1940) 12,401 (89% native white and 11% Negroes), by federal census. It is the trade centre for an agricultural and coal-mining region; does a large wholesale and jobbing business; and has railway shops and other manufacturing industries. Its cotton gins and compresses handle 30,000 bales in a normal year, and the county mines much coal. There is a beautiful Masonic temple in the city. The state penitentiary is near, and headquarters for United States army officers and officials of the Bureau of Indian Affairs. The water supply is impounded in three lakes, one of which (5 mi. from the city) is one of the largest in the state (2,400 ac.) and a popular resort for fishing and camping. Settlement began in 1885. In 1906 the city of South McAlester (incorporated 1899) and the town of McAlester were consolidated, and in 1919 a commission-manager form of government was adopted.

McALLEN, a city of Hidalgo county, Texas, U.S.A., in the southeastern part of the state, 7 mi. from the International bridge over the Rio Grande at Reynosa (Mexico), on federal highway 83 and state highway 336, the "main street" of the region, which runs from Brownsville (60 mi. S.E.) to the western boundary of the county (20 mi. W.) through most of the important towns of the lower Rio Grande valley. It is served by the Missouri Pacific and the Southern Pacific railway systems. Pop. (1920) 5,331 (50% foreign-born white, largely from Mexico), 11,877 in 1940 by the federal census. A two-acre central plaza, palm-lined streets, poinsettias, ebonies and other semitropical trees and shrubs add charm to a well-planned city. It is the trading and shipping centre for an irrigated district devoted to citrus culture, especially grapefruit. When the city was chartered in 1911 most of the site was a desert of mesquite and cactus. McAllen is one of the two most important gateways to interior Mexico on the U.S. border. It leads the south as a combined vegetable and fruit canning centre. Bank deposits in 1941 totalled $2,200,978.

MACALPINE (or MACCABEUS), **JOHN** (d. 1557), Protestant theologian, was from 1532 to 1534 prior of the Dominican convent of Perth; but having in the latter year been summoned with Alexander Ales (*q.v.*) and others to answer for heresy before the bishop of Ross, he fled to England, where he was granted letters of denization on April 7, 1537, and married Agnes Macheson, a fellow-exile for religion; her sister Elizabeth became the wife of Miles Coverdale. The reaction of 1539 made England a doubtful refuge, and on Nov. 25, 1540 Macalpine matriculated at the university of Wittenberg. In 1542, being now known as Maccabeus, he became professor of theology at the university of

Copenhagen. Here he took a prominent part in building up the Lutheran Church of Denmark. A joint exposure by Plade and Macalpine of Osiander's errors was published in 1552 and reprinted at Leipzig and Copenhagen in 1768; and Macalpine was one of the four translators of Luther's German Bible into Danish. He died at Copenhagen on Dec. 6, 1557.

See *Dict. Nat. Biog.* and authorities there cited.

MACAO, a Portuguese colony on the coast of South China, on the west side of the entrance to the Canton river, opposite to and some 35 miles distant from Hong Kong island. It comprises the peninsula of Macao and the small islands of Taipa and Colôane: the area of the whole colony being about five square miles. On the peninsula, which is about three miles long and a mile broad, is situated the picturesque city of Macao, extending up a hill-side to overlook a fine bay. Its multi-coloured buildings reveal a quaint combination of Oriental and European features. The mean monthly temperature reaches 84° F. in July, but in no month falls below 60° F. Its tropical climate, with an annual rainfall of 60 in., is relieved by southwest sea breezes. This, with the 124 good schools, as well as the unrestricted gaiety, has attracted many well-to-do Chinese and European residents.

Direct trade by sea between Europe and China began through Portuguese enterprise as early as 1516. Macao was established in 1557 and is the oldest European outpost in the trade with China. It was an early centre of Jesuit missionary activity and in 1580 the bishopric of Macao, which includes also Timor (East Indies) and the Christians of Malacca and Singapore, was created; in 1680 the first governor was appointed, but the Portuguese remained largely under the control of the Chinese with whom there were constant disputes concerning the extent of Portuguese jurisdiction. A rental was paid for the peninsula until 1849, when the Portuguese abolished the Chinese customs house and declared the independence of the port. It was not however, until 1887 that China formally recognized Portuguese sovereign rights in a treaty whereby China confirmed the perpetual occupation and government of Macao and its dependencies by Portugal, which in turn undertook never to alienate Macao and its dependencies without the consent of China, and to co-operate in the work of the opium revenue at Macao on the same lines as Great Britain at Hong Kong. This did not put an end to disputes, and the delimitation of the colonial boundaries is still an unsettled question.

During the 18th century Macao was the chief centre in the Sino-European trade, but the rapid development of Hong Kong (ceded to Great Britain in 1842) was responsible for its decline as also was the rapid silting of Macao harbour. As a free port it remained a distribution centre for rice, fish, lumber, silk, piece goods and oil; but it also had an unenviable reputation for opium smuggling and gambling. The League of Nations' efforts reduced its opium trade value from $1,500,000 (U.S.) to about $200,000 (U.S.) before 1939. In 1939, after the capture of Canton and the closure of the Hong Kong-Kowloon border, Macao enjoyed briefly the available import and export trade of South China. The Lappa Customs figures are: Imports, 1938, $784,359 (U.S.), 1939, $3,184,288 (U.S.); Exports, 1938, $1,503,074 (U.S.), 1939 $2,384,425 (U.S.). In 1938, 6,406 vessels cleared the port, a total of more than 3,100,000 tons. Its fishing industry employed about 1,800 junks and 40,000 people, and distributed annually more than $750,000 (U.S.) worth of fish to neighbouring cities of the Canton delta. The great bulk of the fish exported is salted, and Macao's position as the second fish port in China is in large measure due to the imports of foreign salt, which is much cheaper than Chinese government-taxed salt. The chief manufactures are those of cement, preserves, fire-crackers, vegetable oil, and also metalworking.

In 1920 a definite scheme for harbour improvement was launched and a contract placed with the Netherlands Harbour Works. The construction of an artificial deepwater harbour began in 1923; and this entailed the dredging of a four-mile channel to the open sea. These harbour works were completed in 1926, having cost $10,000,000, and have led to the reclamation of 130 acres of land surface.

Pop. (1920) 83,894 (3,816 Portuguese); (1940) 374,737 (8,898 Portuguese). The so-called Macanese are descended from the original 1,000 Portuguese families, now with a dominance of Chinese blood through intermarriage. Revenue is derived from ground rents, industrial taxes, gambling and opium monopolies, and the 1942 budget was 46,798,761 escudos. The city, with its famous $1\frac{1}{2}$-mi. long Praia Grande, comprises a Chinese and a non-Chinese ward under separate administration. In March 1940, the Japanese army demanded Portuguese recognition of the near-by "puppet" government at Chungshan, the evacuation of Portuguese troops from the islands of Lappa and Wantsai, and the right of house-to-house search in Macao, etc. In Aug. 1943 Japanese troops seized the British steamer *Sian* in Macao, killing some 20 guards. In September they demanded the installation of Japanese "advisers" under the alternative of military occupation.

MACAQUE, a name for the monkeys of the mainly Asiatic genus *Macaca,* of which one species, the Barbary ape, inhabits North Africa and the rock of Gibraltar. Displaying great variation in the length of the tail, macaques are heavily built monkeys, with longer muzzles than their compatriots the langurs (*see* PRIMATES), and large naked callosities on the buttocks. They range over India and Ceylon, thence northward to Tibet, and eastwards to China, Japan, Formosa, and the Malay region. Mention of the more important species is made in the article PRIMATES. Like most monkeys, macaques go about in troops, each headed by an old male. They feed on seeds, fruits, insects, lizards, etc.; and several of the species are mainly terrestrial.

MACARA, SIR CHARLES WRIGHT (1845–1929), 1st Bart. (cr. 1911), English business man, was born on Jan. 11, 1845, at Strathmiglo, Fifeshire, and educated privately and at Edinburgh. From 1892 for 34 years he acted as chairman of the Manchester and district cotton employers' association, and was partly responsible for the Brooklands agreement which ended the strike of 1892. He has acted as president of various associations connected with the cotton trade, taking an active part in their work, and the establishment of the Industrial Council by the government in 1911 was largely due to his efforts. From 1912 to 1916 he was president of the Employers' Parliamentary Association, and in September 1922 was appointed chairman of the provisional emergency cotton committee, set up to consider the action to be taken in view of the state of the cotton trade. He died Jan. 2, 1929.

His many publications on social and industrial questions include: *Social and Industrial Reform* (1918); *Recollections* (1921); *Getting the World to Work* (1922); *Trade Stability and how to obtain it* (1925); *Modern Industrial Tendencies* (1926).

MACARONI, a preparation of a glutinous wheat originally peculiar to Italy, where it is an article of food of national importance (from dialectic Ital. *maccare,* to bruise or crush). The same substance in different forms is also known as *vermicelli, pasta* or Italian pastes, *spaghetti, taglioni, fanti,* etc. These substances are prepared from the hard, semi-translucent varieties of wheat which are largely cultivated in the south of Europe, Algeria and other warm regions, and distinguished by the Italians as *grano duro* or *grano da semolino.* These wheats are much richer in gluten and other nitrogenous compounds than the soft or tender wheats of more northern regions, and their preparations are more easily preserved. The various preparations are met with as fine thin threads (vermicelli), thin sticks and pipes (spaghetti, macaroni), small lozenges, stars, discs, ellipses, etc. (pastes). These various forms are prepared in a uniform manner from a granular product of hard wheat, which, under the name of semolina or middlings, is a commercial article.

The semolina is thoroughly mixed with boiling water and incorporated in a kneading machine, such as is used in bakeries, into a stiff paste or dough. It is then further kneaded by passing frequently between rollers or under edge runners, till a homogeneous mass has been produced which is placed in a strong steam-jacketed cylinder, the lower end of which is closed with a thick disc pierced with openings corresponding with the diameter or section of the article to be made. Into this cylinder an accurately fitting plunger or piston is introduced and subjected to very great pressure, which causes the stiff dough to squeeze out through the openings in the disc in continuous threads, sticks or pipes, as the case may be. Vermicelli is cut off in short bundles and laid on trays to dry, while macaroni is dried by hanging it in longer lengths over wooden rods in stoves or heated apartments through which currents of air are driven. It is only genuine macaroni, rich in gluten, which can be dried in this manner; spurious fabrications will not bear their own weight, and must, therefore, be laid out flat to be dried. In making pastes the cylinder is closed with a disc pierced with holes having the sectional form of the pastes, and a set of knives revolving close against the external surface of the disc cuts off the paste in thin sections as it exudes from each opening.

True macaroni can be distinguished by observing the flattened mark of the rod over which it has been dried within the bend of the tubes; it has a soft yellowish colour, is rough in texture, elastic and hard, and breaks with a smooth glassy fracture. In boiling it swells up to double its original size without becoming pasty or adhesive. It can be kept any length of time without alteration or deterioration.

MACARONICS, burlesque poetry, in which modern words with Latin endings are introduced into Latin verse, so as to produce a ridiculous effect. Sometimes Greek is used instead of Latin. The founder of the practice was Teofilo Folengo (1491–1544), whose mock-heroic *Liber Macaronicus* appeared in 1517. Folengo (*q.v.*) was a Benedictine monk, who escaped from his monastery and lived a dissolute life, supporting himself by his absurd verses, which he described as an attempt to produce in literature something like macaroni, a gross, rude and rustic mixture of flour, cheese and butter. His poem is a burlesque epic, containing an extraordinary medley of chivalrous feats, ridiculous and squalid adventures and satirical allegory. Its effect upon Rabelais was so extraordinary that no examination of *Pantagruel* can be complete without a reference to it. It was imitated in Italy by a number of minor poets; and in France Antonius de Arena published at Avignon in 1573 a burlesque account of Charles V.'s disastrous campaign in Provence. Folengo in Italy and Arena in France are regarded as the macaronic classics. Great popularity was achieved later by an anonymous macaronic, entitled *Funestissimus trepassus Micheli Morini,* who died by falling off the branch of an elm-tree:—

> De branche in brancham degringolat, et faciens pouf
> Ex ormo cadit, et clunes obvertit Olympo.

Molière employed macaronic verse in the ceremonial scene with the doctors in *Le Malade imaginaire*. Works in macaronic prose are rarer. An *Anti-Clopinus* by Antony Hotman may be mentioned and the *Epistolae obscurorum virorum* (1515).

The use of true macaronics has never been frequent in Great Britain, where the only prominent example of it is the *Polemo-Middinia* ascribed to William Drummond (*q.v.*). This describes a quarrel between two villages on the Firth of Forth, and Drummond shows great ingenuity in the tacking on of Latin terminations to his Lowland Scots vernacular.

See Ch. Nodier, *Du Langage factice appelé macaronique* (1834); F. W. Genthe, *Geschichte der Macaronischen Poesie* (Leipzig, Halle, 1836).

MACAROON, a small sweet cake made of egg white, pulverized or castor sugar, and either almonds or coconut. If nuts are used they are crushed or pounded to a paste, the sugar and paste worked together and the egg white added very gradually until the mixture is perfectly smooth and stiff enough to hold its own. The glaze that characterizes the macaroon is secured by brushing the top lightly with a little cold water.

MacARTHUR, ARTHUR (1845–1912), American general, was born at Springfield, Mass., on June 2, 1845. He served throughout the Civil War in the 24th Wisconsin Infantry, being advanced from lieutenant to major and lieutenant-colonel and in 1865, when but 20 years of age, he became colonel of the regiment. He was mentioned for "gallant and meritorious service" in the battles of Perryville, Stone River, Missionary Ridge, Dandridge, Franklin and in the Atlanta campaign, and received a Congressional Medal for bravery at Missionary Ridge. After the war he joined the regular army and from 1866 to 1886 was stationed in the South-west and participated in several Indian campaigns. When the Spanish-American War broke out he was commissioned brigadier-general of volunteers and sent to the Philippine Islands. He captured the town of Malate, which prepared the way for the taking of Manila. For this and other services he was commissioned major-general of volunteers. In 1899, under the direction of Gen. Otis, he commanded a division against Aguinaldo. Later in the year he was made commander of the department of Northern Luzon and succeeded Otis as governor-general. In 1901 he was made a major-general of the regular army and returned to the United States, where he commanded successively the departments of Colorado, the East, the Lakes, California and the Pacific. In 1905 during the Russo-Japanese War he was a special observer with the Japanese army. He retired, a lieut.-general, in 1909 and died at Milwaukee, Wis., on Sept. 5, 1912.

MacARTHUR, DOUGLAS (1880–), U.S. army officer, was born Jan. 26, 1880, in Little Rock barracks, Ark., the son of Lt. Gen. Arthur MacArthur (*q.v.*), and was graduated as first in his class from West Point in 1903. In World War I he advanced to brigadier general, led the 84th infantry brigade in the St. Mihiel salient, Sept. 1918 and was subsequently made commander of the 42nd (Rainbow) division. He was gassed and wounded in action. When he was made a major general in Jan. 1925, he was youngest of that rank in the U.S. army. He commanded the department of the Philippines, 1928–30, and was appointed U.S. chief of staff with rank of full general by President Hoover Nov. 21, 1930. In Oct. 1935, he retired as chief of staff to become military adviser to the Philippine government. On June 19, 1936, he was appointed field marshal of the Philippine army. He retired Dec. 31, 1937, but President Manuel Quezon retained him as head of all Filipino military and constabulary forces. President Roosevelt nominated MacArthur lieutenant general in command of U.S. and commonwealth forces in the Philippines, after the Philippine army was reincorporated into U.S. forces July 26, 1941. Following Japan's attack on the Philippines in Dec. 1941, MacArthur was renamed full general by Roosevelt. After slowing the Japanese advance on Manila, he executed a planned retreat into Bataan peninsula, where he beat off the assaults of an army many times the size of his own. At the direction of President Roosevelt he arrived in Australia March 17, 1942, to command the forces of the United Nations there.

MACARTHUR, MARY REID (1880–1921), British politician, was born Aug. 31, 1880, in Glasgow. In 1906 she founded a new general trade union for women—the National Federation of Women Workers. In 1914 she became secretary of the Central Committee for the Employment of Women. In 1911 she married W. C. Anderson, who was chairman of the Labour party in 1914 and M.P. for Attercliffe (Sheffield) from 1915–18. She died Jan. 1, 1921. *See* M. A. Hamilton, *Mary Macarthur* (1925).

MACARTNEY, GEORGE MACARTNEY, EARL (1737–1806), was born at Lissanoure, Antrim, Ireland, May 14, 1737. He was appointed envoy extraordinary to Russia in 1764. On his return he entered parliament, and became chief secretary for Ireland (1769–72). In 1775 he became governor of the Caribbee Islands (being created an Irish baron in 1776), and in 1780 governor of Madras, but he declined the governor-generalship of India, and returned to England in 1786. After being created Earl Macartney in the Irish peerage (1792), he was appointed the first envoy of Britain to China. Macartney was raised to the English peerage as a baron in 1796, and in the end of the same year was appointed governor of the newly acquired territory of the Cape of Good Hope. He died at Chiswick, Middlesex, on May 31, 1806, the title becoming extinct.

An account of Macartney's embassy to China, by Sir George Staunton, published in 1797, has been frequently reprinted. *See* J. Barrow, *Life and Writings of Lord Macartney* (1807); H. Macartney Robbins *Our First Ambassador to China* (1908).

MACASSAR, the chief port in the island of Celebes, Dutch East Indies, and capital of the Government of Celebes and its dependencies. (Also spelled Makassar; native *Mangkasar.*) The first Dutch settlement here was in 1607; it was known then as Vlaardingen. In 1618 the colonists were massacred, but in 1667 the power of the sultan of Macassar was shattered by the Dutch, who established themselves very firmly at Macassar, seizing the old fort built in the time of a Portuguese settlement, which was styled Fort Rotterdam, and the place was granted a coat-of-arms. After that time it was in Dutch occupation, until the Japanese seized it in 1942, and served as a useful base in the Dutch operations against the sultans of states in Celebes. It had always been a port of some importance, though retarded from natural growth by lack of harbour and wharf facilities. In this direction a very great change took place after 1925, and Macassar became a first-class port. Between the shore and a ridge of coral reefs, half a mile out, there is a safe anchorage in deep water; and for wharfage purposes a caisson quay, 1,340 metres in length, was built out into the sea, available at depths of from 9 to 10 metres at low tide. For the protection of the quay, a breakwater was constructed over the coral islands and the banks in front of the roadstead. Behind the quay, at the south end, there is a harbour for lighters, with a length of 280 metres, and there are storesheds for coal and petroleum. Figures for vessels entering the port in 1939 were 6,750,000 cu.m. net, with 1,011 steam and motor vessels and 7,382 sailing boats. The value of the imports was 15,970,000 guilders; of the exports, 16,495,000 guilders. Macassar deals with the trade of Celebes (excluding Menado), the Moluccas, New Guinea and the eastern islands of the Lesser Sunda group. The main commodities exported are copra, gums and resins, coffee and rattan; minor ones are kapok, ebony, maize, spices, hides and skins. It is normally the great centre for distribution of imports from Europe, America, India and the far east and destined for Celebes, the Moluccas, Lesser Sundas and New Guinea, which are transhipped here, and it is in steamer communication with the leading ports of the world and all the ports of the archipelago, with the latter mainly by means of the service of the Dutch Royal Packet Navigation company.

Macassar town, pop. (1930) 84,855 (3,447 Europeans and Eurasians, and 15,963 foreign Asiatics, many of them Chinese, some Arabs), is picturesque, seen from the sea. Parallel roads run from the harbour along by the sea, through old Macassar and China-town, to the old Fort Rotterdam, facing which there is a large green square around which are grouped official buildings, business premises, a large club, the residence of the governor and, on the square, a monument in memory of the officers and men who fell in the last expedition to South Celebes. The newer part of the town is well laid out. In the neighbourhood, which is very picturesque—the forest-clad hills of Maros and the beautiful water-fall of Bantimurung are not far distant—is the grave of Dipa Negoro, leader of the Java rebellion of 1825, who was exiled and died here. A steam tramway runs from Macassar to Takalar (47 kilometres), and good roads link up the capital with the hinterland. The port was invaded and occupied by the Japanese in Feb. 1942. (E. E. L.; X.)

The natives, the Mangkassaras, are a branch of the Malay race similar to if not identical with the Bugis (*q.v.*) of Sumatra.

MACAULAY, THOMAS BABINGTON MACAULAY, BARON (1800–1859), English historian, essayist and politician, was born at Rothley Temple, Leicestershire, on Oct. 25, 1800. His father Zachary Macaulay (1768–1838), had been governor of Sierra Leone, and was in 1800 secretary to the chartered company which had founded that colony; an ardent philanthropist, he was one of the group who worked for the abolition of the slave trade, and he edited the abolitionist organ, the *Christian Observer,* for many years. Before Thomas was eight years of age he had written a *Compendium of Universal History,* and a romance in the style of Scott, in three cantos, called *The Battle of Cheviot.* A little later he composed a long poem on the history of Olaus Magnus, and a vast pile of blank verse entitled *Fingal, a Poem in Twelve Books.* Young Macaulay was sent to a private school, then, in October 1818, he went to Trinity college, Cambridge, where he afterwards became a fellow. He gained in 1824 a college prize for an essay on the character of William III. He also won a prize for Latin declamation and a Craven scholarship, and wrote the prize poems of 1819 and 1821.

In 1826 Macaulay was called to the bar and joined the northern circuit. But he spent many more hours under the gallery of the house of commons than in the court. His first public speech, made at an anti-slavery meeting in 1824, was described by the *Edinburgh Review* as "a display of eloquence of rare and matured excellence." In Aug. 1825 began Macaulay's connection with the *Edinburgh Review,* which was at this time an organ of the growing opinion which leant towards reform, and a literary tribunal from which there was no appeal. His essay on Milton (Aug. 1825), so crude that the author afterwards said that "it contained scarcely a paragraph such as his matured judgment approved," established at once his great literary reputation. The sudden blaze of popularity kindled by this single essay, is partly to be explained by the dearth of literary criticism in England at that epoch. For, though a higher note had already been sounded by Hazlitt and Coleridge, the public mind was still satisfied with the feeble appreciations of the *Retrospective Review,* or the dashing and damnatory improvisation of Wilson in *Blackwood* or Jeffrey in the *Edinburgh.* Still it seems surprising that a social success so signal should have been the consequence of a single article. The explanation is that the writer of the article on Milton was also a brilliant talker. At the university Macaulay had been pre-eminent for inexhaustible talk and genial companionship among a circle of such brilliant young men as Charles Austin, Romilly, Praed and Villiers. He now displayed these gifts on a wider stage. He was courted and admired by the most distinguished personages of the day. He was admitted at Holland House, where Lady Holland listened to him with deference, and scolded him with a circumspection which was in itself a compliment. Samuel Rogers spoke of him with friendliness and to him with affection.

Macaulay now began to aspire to a political career. But commercial disaster fell on the house of Babington and Macaulay, and the son saw himself compelled to work for his livelihood. His Trinity fellowship of £300 a year expired in 1831; he could make at most £200 a year by writing; and a commissionership of bankruptcy, which was given him by Lord Lyndhurst in 1828 was swept away in 1830. Macaulay was reduced to such straits that he had to sell his Cambridge gold medal. In Feb. 1830 he entered the House of Commons for the "pocket borough" of Calne, offered to him by Lord Lansdowne. The offer was accompanied by the express assurance that the patron had no wish to interfere with Macaulay's freedom of voting. Macaulay made his maiden speech on April 5, 1830, on the second reading of the bill for the Removal of Jewish Disabilities. In June the king died and parliament was dissolved; the revolution took place in Paris. Macaulay, who was again returned for Calne, visited Paris, eagerly enjoying a first taste of foreign travel. On March 1, 1831 the Reform Bill was introduced, and on the second night of the debate Macaulay made the first of his reform speeches, of which Sir Robert Peel said that "portions were as beautiful as anything I have ever heard or read." On the triumph of Earl Grey's cabinet, and the passing of the Reform Act in June 1832, Macaulay, whose eloquence had signalized every stage of the conflict, became one of the commissioners of the board of control, and applied himself to the study of Indian affairs. Giving his days to India and his nights to the House of Commons, he could only devote a few hours to literary composition by rising at five in the morning. Between Sept. 1831 and Dec. 1833 he furnished the *Edinburgh Review* with eight important articles, besides writing his ballad on the Armada.

In the first Reform parliament, Jan. 1833, Macaulay took his seat as one of the two members for the new borough of Leeds. He replied to O'Connell in the debate on the address, meeting the great agitator with high, but not intemperate, defiance. In July he defended the Government of India bill in a speech of great power, and he was instrumental in getting the bill through committee without unnecessary friction. When the abolition of slavery came before the house as a practical question, Macaulay had the prospect of having to surrender office or to vote for a modified abolition, viz., twelve years' apprenticeship, which was proposed by the ministry, but condemned by the abolitionists. He placed his resignation in Lord Althorp's hands, and spoke against the ministerial proposal. But the sense of the house was so strongly expressed as unfavourable that, finding they would be beaten if they persisted, the ministry gave way, and reduced apprenticeship to seven years, a compromise which the abolition party accepted; and Macaulay remained at the board of control. He then (1834) accepted a seat in the supreme council of India, created by the new India Act. The salary of the office was fixed at £10,000, out of which he calculated to be able to save £30,000 in five years.

Macaulay's appointment to India occurred at the critical moment when the government of the company was being superseded by government by the Crown. At this juncture there was more need of statesmanship directed by general liberal principles than of a practical knowledge of the details of Indian administration. The part he took in India has been described as "the application of sound liberal principles to a government which had till then been jealous, close and repressive." He vindicated the liberty of the press; he maintained the equality of Europeans and natives before the law; and as president of the committee of public instruction he inaugurated the system of national education. Macaulay was appointed president of a commission to inquire into Indian jurisprudence. The draft of a penal code which he submitted became the basis of the Indian criminal code.

In 1838 Macaulay and his sister Hannah, who had married Charles Trevelyan in 1834, returned to England. He at once entered parliament as member for Edinburgh. In 1839 he became secretary for war, with a seat in the cabinet in Lord Melbourne's ministry. His acceptance of office diverted him for a time from prosecuting the plan he had already formed of a great historical work. But in less than two years the Melbourne ministry fell. In 1842 appeared his *Lays of Ancient Rome*, and in the next year he collected and published his *Essays*. He returned to office in 1846, in Lord John Russell's administration, as paymaster-general. In the sessions of 1846–1847 he spoke only five times, and at the general election of July 1847 he lost his seat for Edinburgh. The balance of Macaulay's faculties had now passed to the side of literature. At an earlier date he had relished crowds and the excitement of ever new faces; as years went forward, and absorption in the work of composition took off the edge of his spirits, he recoiled from publicity.

He retired into private life with a sense of relief. He gradually withdrew from general society, but he still enjoyed close and constant intercourse with a circle of the most eminent men that London then contained. At that time social breakfasts were in vogue. Macaulay himself preferred this to any other form of entertainment. Of these brilliant reunions nothing has been preserved beyond the names of the men who formed them—Rogers, Hallam, Sydney Smith, Lord Carlisle, Lord Stanhope, Nassau Senior, Charles Greville, Milman, Panizzi, G. C. Lewis, Van de Weyer. His biographer thus describes Macaulay's appearance and bearing in conversation: "Sitting bolt upright, his hands resting on the arms of his chair, or folded over the handle of his walking-stick, knitting his eyebrows if the subject was one which had to be thought out as he went along, or brightening from the forehead downwards when a burst of humour was coming, his massive features and honest glance suited well with the manly sagacious sentiments which he set forth in his sonorous voice and in his racy and intelligible language. To get at his meaning people had never the need to think twice, and they certainly had seldom the time."

In these years he was working with unflagging industry at the composition of his *History*. His composition was slow, his corrections both of matter and style endless; he spared no pains to ascertain the facts. He sacrificed to the prosecution of his task a political career, House of Commons fame, the allurements of society. The first two volumes of the *History of England* appeared in Dec. 1848. The success was in every way complete beyond expectation. The sale of edition after edition, both in England and the United States, was enormous.

In 1852, when his party returned to office, he refused a seat in the cabinet, but the city of Edinburgh returned him at the head of the poll at the general election in July of that year. He had hardly accepted the summons to return to parliamentary life before fatal weakness betrayed itself in deranged action of the heart; from this time forward till his death his strength continued steadily to sink. He was oppressed by the thought that the great work to which he had devoted himself would remain a fragment. Once again, in June 1853, he spoke in parliament, and with effect, against the exclusion of the master of the rolls from the House of Commons, and at a later date in defence of competition for the Indian civil service. But he was aware that he made these efforts at the cost of more valuable work.

In Nov. 1855 vols. iii. and iv. of the *History* appeared and obtained a vast circulation. Within a generation of its first appearance upwards of 140,000 copies of the *History* were printed and sold in the United Kingdom alone; and in the United States the sales were on a correspondingly large scale. The *History* was translated into German, Polish, Danish, Swedish, Hungarian, Russian, Bohemian, Italian, French, Dutch and Spanish. Flattering marks of respect were heaped upon the author by foreign academies. His pecuniary profits were (for that time) on a scale commensurate with the reputation of the book: the cheque he received for £20,000 has become a landmark in literary history.

In May 1856 he quitted the Albany, in which he had passed fifteen happy years, and went to live at Holly Lodge, Campden Hill, then, before it was enlarged, a tiny bachelor's dwelling, but with a lawn whose unbroken slope of verdure gave it the air of a considerable country house. In the following year (1857) he was raised to the peerage by the title of Baron Macaulay of Rothley. But his health was every year visibly failing. In the House of Lords he never spoke. Gradually he had to acquiesce in the conviction that his physical energies would not carry him through the reign of Anne; and, though he brought down the narrative to the death of William III., the last half-volume wants the finish and completeness of the earlier portions. He died on Dec. 28, 1859. On Jan. 9, 1860 he was buried in Westminster Abbey.

Lord Macaulay never married. A man of warm domestic affections, he found their satisfaction in the attachment and close sympathy of his sister Hannah, the wife of Sir Charles Trevelyan. Her children were to him as his own. Macaulay was a steadfast friend, and no act inconsistent with the strictest honour and integrity was ever imputed to him. When a poor man, and when salary was of consequence to him, he twice resigned office rather than make compliances for which he would not have been severely blamed. In 1847, when his seat in parliament was at stake, he would not be persuaded to humour, to temporize, even to conciliate. He had a keen relish for the good things of life, and desired fortune as the means of obtaining them; but there was nothing mercenary or selfish in his nature. When he had raised himself to opulence, he gave away with an open hand, not seldom rashly. His very last act was to write a letter to a poor curate enclosing a cheque for £25. The purity of his morals was not associated with any tendency to cant.

The life of Macaulay was eminently happy. Till the closing years (1857–1859), he enjoyed life with the full zest of healthy faculty, happy in social intercourse, happy in the solitude of his study, and equally divided between the two. For the last fifteen years of his life he lived for literature. His writings were remunerative to him far beyond the ordinary measure, yet he never wrote for money. He lived in his historical researches; his whole heart and interest were unreservedly given to the men and the times of whom he read and wrote. His command of literature was imperial. Beginning with a good classical foundation, he made himself familiar with the imaginative, and then with the historical, remains of Greece and Rome. He went on to add the literature of his own country, of France, of Italy, of Spain. He learnt Dutch enough for the purposes of his history. He read German, but for literature of the northern nations he had no taste, and of the erudite labours of the Germans he had little knowledge and formed an inadequate estimate. The range of his survey of human things had other limitations more considerable still. All philosophical speculation was alien to his mind; nor did he seem aware of the degree in which such speculation had influenced the progress of humanity. A large—the largest—part of ecclesiastical history lay outside his historical view. Of art he confessed himself ignorant, and even refused a request to furnish a critique on Swift's poetry to the *Edinburgh Review.* He declared that Lessing's *Laocoon,* or Goethe's criticism on Hamlet, "filled" him "with wonder and despair."

Of the marvellous discoveries of science which were succeeding each other day by day he took no note; his pages contain no reference to them. It has been told already how he recoiled from the mathematical studies of his university. These deductions made, the circuit of his knowledge still remains very wide—as extensive perhaps as any human brain is competent to embrace. His literary outfit was as complete as has ever been possessed by any English writer; and, if it wants the illumination of philosophy, it has an equivalent resource in a practical acquaintance with affairs, with administration, with the interior of cabinets, and the humour of popular assemblies. Nor was the knowledge merely stored in his memory; it was always at his command. Whatever his subject, he pours over it his stream of illustration, drawn from the records of all ages and countries. His *Essays* are not merely instructive as history; they are, like Milton's blank verse, freighted with the spoils of all the ages. As an historian Macaulay has not escaped the charge of partisanship. He was a Whig; and in writing the history of the rise and triumph of Whig principles in the latter half of the 17th century he identified himself with the cause. But the charge of partiality, as urged against Macaulay, means more than that he wrote the history of the Whig revolution from the point of view of those who made it. When he is describing the merits of friends and the faults of enemies his pen knows no moderation. He has a constant tendency to glaring colours, to strong effects, and will always be striking violent blows. He is not merely exuberant but excessive. There is an overweening confidence about his tone; he expresses himself in trenchant phrases, which are like challenges to an opponent to stand up and deny them. His propositions have no qualifications. Uninstructed readers like this assurance, as they like a physician who has no doubt about their case. But a sense of distrust grows upon the more circumspect reader as he follows page after page of Macaulay's categorical affirmations about matters which our own experience of life teaches us to be of a contingent nature. We inevitably think of a saying attributed to Lord Melbourne: "I wish I were as cocksure of any one thing as Macaulay is of everything." Macaulay's was the mind of the advocate, not of the philosopher; it was the mind of Bossuet, which admits no doubts or reserves itself and tolerates none in others, and as such was disqualified from that equitable balancing of evidence which is the primary function of the historian. (M. Pa.; X.)

Macaulay's whole works were collected in 1866 by his sister, Lady Trevelyan, in 8 vols. The first four volumes are occupied by the *History;* the next three contain the *Essays,* and the *Lives* which he contributed to the *Encyclopædia Britannica.* In vol. viii. are collected his *Speeches,* the *Lays of Ancient Rome,* and some miscellaneous pieces. The "life" by Dean Milman, printed in vol. viii. of the edition of 1858–1862, is prefixed to the "People's Edition" (4 vols., 1863–1864). Messrs. Longmans, Green & Co. published a complete edition, the "Albany," in 12 vols., in 1898. There are numerous editions of the *Critical and Historical Essays,* separately and collectively; they were edited in 1903 by F. C. Montagu.

The Life and Letters of Lord Macaulay (2 vols., 1876), by his nephew, Sir George Otto Trevelyan, is one of the best biographies in the English language. His long correspondence with T. F. Ellis, which was utilized by Trevelyan in preparing the life, but only in part, was presented by Ellis's grandson to Trinity college, Cambridge, together with some unpublished poems and translations. The life (1882) in the "English Men of Letters" series was written by J. Cotter Morison. For further criticism, *see* Hepworth Dixon, in his *Life of Penn* (1841); John Paget, *The New Examen: Inquiry into Macaulay's History* (1861) and *Paradoxes and Puzzles* (1874); Walter Bagehot, in the *National Review* (Jan. 1856), reprinted in his *Literary Studies* (1879); James Spedding, *Evenings with a Reviewer* (1881), discussing his essay on Bacon; Sir L. Stephen, *Hours in a Library,* vol. ii. (1892); Lord Morley, *Critical Miscellanies* (1877), vol. ii.; Lord Avebury, *Essays and Addresses* (1903); Thum, *Anmerkungen zu Macaulay's History of England* (Heilbronn, 1882). A bibliography of German criticism of Macaulay is given in G. Körting's *Grd. der engl. Literatur* (4th ed., Münster, 1905).

MACAW, any of about 18 species of very large, very long-tailed, magnificent parrots (*q.v.*) confined to Central and South America, and having brilliant, contrasted colours, naked space around the eye and a powerful hooked beak used to crack very hard palm nuts. They are named for eating the violet-perfumed oil-nuts of the macaw palm (*Acrocomia*) of Brazil. They fly well, have loud, harsh, screaming voices and are popular in zoological gardens. They are gregarious but monogamous. They lay two white eggs in hollow trees. They constitute two genera in the subfamily Psittacinae.

Most species belong to the genus *Ara,* with naked lores, the important species taking their names from their principal colours. The blue and yellow macaw (*A. ararauna*), eastern Panama to east-central Brazil and northern Paraguay, is blue with yellow-orange underparts; the red, blue and yellow macaw (*A. macao*), 33 in., tropical Mexico to tropical Brazil, is scarlet with blue and yellow on the wings; the red, blue and green macaw (*A. chloroptera*), eastern Panama to the Argentine Chaco and Misiones, is darker red with green instead of yellow on the wing; the green macaw (*A. militaris*), 27 in., tropical Mexico to tropical Bolivia, has blue back, rump, wings and tail. Several species, all extinct, once inhabited Cuba and the Isle of Pines, Martinique, Guadalupe and Jamaica. The little light-green *A. severa,* 17.5 in., lives in northern South America; *A. spixii,* 22 in., of eastern Brazil, is nearly uniform blue. Several other species, nearly uniform cobalt, hyacinthine or greenish blue, belong to the genus *Anodorhynchus,* with feathered lores. The hyacinthine macaw (*A. hyacinthinus*), nearly 3 ft., about ponds in dense forests of interior Brazil, lays its two eggs in a hole excavated in a bank; the green-blue macaw (*A. glaucus*) is found in Paraguay, Uruguay and southeastern Brazil, but the home of the rare Lear's macaw (*A. leari*) of Brazil has not been located. (G. F. Ss.)

MACBETH, king of Scotland (d. 1058), was the son of Findlaech, *mormaer* or hereditary ruler of Moreb (Moray and Ross), who had been murdered by his nephews in 1020. He probably became mormaer on the death of Malcolm, one of the murderers, in 1029, and he may have been one of the chiefs (the Maclbaethe of the *Saxon Chronicle*) who submitted to Canute in 1031.

Marianus records that in 1040 Duncan, the grandson and successor of Malcolm king of Scotland, was slain by Macbeth. Duncan had shortly before been defeated by Thorfinn, the Norwegian earl of Orkney and Caithness, and it was perhaps this event which tempted Macbeth to seize the throne. As far as is known he had no claim to the crown except through his wife Gruach, who appears to have been a member of the royal family. Macbeth was a generous benefactor to the church, and according to S. Berchan, his reign was a time of prosperity. More than one attempt was made by members of the Scottish royal family to recover the throne; in 1045 by Crinan, the lay abbot of Dunkeld, son-in-law of Malcolm II, and in 1054 by Duncan's son Malcolm with the assistance of Siward, earl of Northumbria, himself a connection of the ousted dynasty. In 1057 Malcolm and Siward again invaded Scotland and defeated Macbeth, who was slain at Lumphanan. Macbeth is chiefly famous as the central figure of Shakespeare's great tragedy.

See W. F. Skene, *Chronicles of the Picts and Scots* (1867) and *Celtic Scotland* (1876); Sir J. Rhys, *Celtic Britain* (1904).

MACBETH, ROBERT WALKER (1848–1910), British painter, was born at Glasgow on Sept. 30, 1848. He studied art at the Royal Scottish Academy, and in 1871 came to London where he was for some time on the staff of the *Graphic.* Both as painter and etcher he was very popular. He died at Golders Green on Nov. 1, 1910. Among his best-known works are "Dunster Castle" (1895); "The End of a Good Day" (1897); and "Naval Manoeuvres" (1899).

McBRIDE, SIR RICHARD, K.C.M.G., 1912 (1870–1917), Canadian politician, was born at New Westminster on Dec. 15, 1870, and was educated first in that city and later at Dalhousie university, Halifax, Nova Scotia. He was called to the Canadian bar in 1892, and entered the British Columbian parliament as member for Dewdney in 1898. In 1900 he became minister of mines and in 1902 leader of the Opposition. In June 1903 he became prime minister for the province and retained that position until 1915, when he became agent-general for British Columbia in London. He died in London on Aug. 6, 1917.

MACCABEES, the name (in the plural) of a distinguished Jewish family dominant in Jerusalem in the 2nd century B.C. According to 1 Macc. ii. 4, the name Maccabaeus (Gr. Μακκαβαῖος, Heb. מַקָּבִי) was originally the distinctive surname of Judas, third son of the Jewish priest Mattathias, who struck the first blow for religious liberty during the persecution under Antiochus IV. (Epiphanes). Subsequently, however, it obtained a wider significance, having been applied first to the kinsmen of Judas, then to his adherents, and ultimately to all champions of religion in the Greek period. It is now customary to apply it only to the sons and descendants of Mattathias. As, however, according to Josephus (*Ant.* xii. 6.1), this brave priest's great-great-grandfather was called *Hasmon,* the family is more correctly designated by the name of the Hasmonaeans or Asmoneans. If Maccabee (*maqqābi*) is the original form of the name, the most probable derivation is from the Aramaic *maqqābā* (Heb. מַקֶּבֶת Judg. iv. 21, etc.)="hammer." The surname "hammerer" might have been applied to Judas either as a distinctive title pure and simple or symbolically as in the parallel case of Edward I., "Scotorum *malleus.*"

The Maccabaean revolt was caused by the attempt of Antiochus IV. (Epiphanes), king of Syria (175–164 B.C.), to force Hellenism upon Judaea (*see* SELEUCID DYNASTY; HELLENISM). In Dec. 168 sacrifice was offered to Zeus upon an idol altar ("the abomination of desolation," Dan. x. 27) erected over the great altar of burnt-offering. The issue of an important edict ordaining the erection of heathen altars in every township of Palestine, and the appointment of officers to deal with recusants, brought matters to a crisis. At Modin, Mattathias, an aged priest, not only refused to offer the first sacrifice, but slew an apostate Jew who was about to step into the breach. Having thus given the signal for rebellion, he then with his five sons took to the mountains. Many, including the Hasīdīm (=the pious), who had constituted themselves champions of the Law, thereupon flocked to his standard, and set themselves to revive Jewish rites and to uproot Paganism from the land. In 166 Mattathias died, after charging his sons to give their lives for their ancestral faith, and nominating Judas Maccabaeus as their leader in the holy campaign.

The military genius of Judas made this the most stirring chapter in Israelitish history. In quick succession he overthrew the Syrian generals Apollonius, Seron and Gorgias, and after the regent Lysias had shared the same fate at his hands he restored the Temple worship (165). These exploits dismayed his opponents and kindled the enthusiasm of his friends. When, however, Lysias returned in force to renew the contest, Judas had to fall back upon the Temple mount, and escaped defeat only because the Syrian leader was obliged to hasten back to Antioch in order to prevent a rival from seizing the regency. Under these circumstances Lysias unexpectedly guaranteed to the Jews their religious freedom (162). But though they had thus gained their end, the struggle did not cease; it merely assumed a new phase. The Hasīdīm indeed were satisfied, and declined to fight longer, but the Maccabees determined not to desist until their nation was politically as well as religiously free. In 161 Judas defeated Nicanor at Adasa, but within a few weeks thereafter, in a heroic struggle against superior numbers under Bacchides at Elasa, he was himself cut off. If in his brother Jonathan the cause which Judas had espoused did not possess so brilliant a soldier, it had in him an astute diplomatist who knew how to exploit the internal troubles of Syria. With all his cunning, Jonathan walked into a trap at Ptolemais, was made prisoner and ultimately slain (143). The leadership now devolved upon Simon, the last survivor of the sons of Mattathias, who succeeded in negotiating a treaty whereby the political independence of Judaea was at length secured in May 142. In the following year he was by popular decree invested with absolute powers, being appointed leader, high priest and ethnarch. As these offices were declared hereditary in his family, he became the founder of the Hasmonaean dynasty. The first year of his reign (Seleucid year 170=143–142 B.C.) was made the beginning of a new era, and the issue of a Jewish coinage betokened the independence of his sovereignty. Under Simon's administration the country enjoyed signal prosperity, but in 135 he and two of his sons were murdered by Ptolemy his son-in-law, who had an eye on the supreme power. Simon's third son, John Hyrcanus, warned in time, succeeded in asserting his rights as hereditary head of the state. The Maccabaean struggle thus gave fresh life to the Jewish nation.

After the death of Antiochus VII. Sidetes in 128 left him a free hand, Hyrcanus (135-105) soon carved out for himself a large and prosperous kingdom, which, however, was rent by internal discord owing to the antagonism developed between the rival parties of the Pharisees and Sadducees. Hyrcanus was succeeded by his son Aristobulus, whose reign of but one year was followed by that of his brother, the warlike Alexander Jannaeus (104–78). The new king's Sadducean proclivities rendered him odious to the populace, which rose in revolt, but only to bring upon itself a savage revenge. The accession of his widow Salome Alexandra (78-69) witnessed a complete reversal of the policy pursued by Jannaeus, for she chose to rule in accordance with the ideals of the Pharisees. Her elder son, Hyrcanus II., a pliable weakling, was appointed high priest; her younger son, the energetic Aristobulus, who chafed at his exclusion from office, seized some 20 strongholds and with an army bore down upon Jerusalem. At this crisis Alexandra died, and Hyrcanus agreed to retire in favour of his masterful brother. A new and disturbing element now entered into Jewish politics in the person of the Idumaean Antipater, who for selfish ends deliberately made mischief between the brothers. An appeal to M. Aemilius Scaurus, who in 65 came into Syria at the legate of Pompey, led to the interference of the Romans, the siege of Jerusalem by Pompey and the vassalage of the Jews (*q.v.*). Repeated but fruitless attempts were made by the Hasmonaeans and their patriotic supporters to throw off the Roman yoke. At length, in 40, the Parthians set up as king Antigonus, sole surviving son of Aristobulus. Through the execution of Antigonus by M. Antonius (Mark Antony) in 37 B.C. the Hasmonaean dynasty became extinct.

BIBLIOGRAPHY.—1 and 2 Macc. and Josephus are the main sources for the Maccabaean history. Besides the numerous modern histories of Israel (*e.g.* those by Dérenbourg, Ewald, Stanley, Stade, Renan, Schürer, Kent, Wellhausen, Guthe), *see* also Madden, *Coins of the Jews* (1881), H. Weiss's *Judas Makkabaeus* (1897), and the articles in the *Ency. Bib.*, Hastings's *Dict. Bible,* the *Jewish Encyclopedia.* Among more popular sketches are Moss's *From Malachi to Matthew* (1893); Streane's *The Age of the Maccabees* (1898); Morrison's *The Jews under Roman Rule;* W. Fairweather's *From the Exile to the Advent* (1901); E. R. Bevan's *Jerusalem under the High Priests* (1904); C. M. Grant's *Between the Testaments* (1918); also articles JEWS; SELEUCID DYNASTY. (W. F.)

MACCABEES, BOOKS OF, the name given to several Apocryphal books of the Old Testament. The Vulgate contains two books of Maccabees which were declared canonical by the council of Trent (1546) and found a place among the Apocrypha of the English Bible. Three other books of this name are extant. Book iii. is included in the Septuagint but not in the Vulgate. Book iv. is embraced in the Alexandrian, Sinaitic and other mss. of the Septuagint, as well as in some mss. of Josephus. A "Fifth" book is contained in the Ambrosian Peshitta, but it seems to be merely a Syriac reproduction of the sixth book of Josephus's history of the *Jewish War.* None of the books of Maccabees are contained in the Vatican (B); all of them are found in a Syriac recension.

1 Maccabees was originally written in Hebrew, but is preserved only in a Greek translation. It probably dates from about the beginning of the 1st century B.C. As it supplies a detailed and accurate record of the 40 years from the accession of Antiochus Epiphanes to the death of Simon (175–135 B.C.), without doubt the most stirring chapter in Jewish history, the book is one of the most precious historical sources we possess. In its careful chronology, based upon the Seleucid era, in the minuteness of its geographical knowledge, in the frankness with which it records defeat as well as victory, in the restraint with which it speaks of the enemies of the Jews, in its command of details, it bears on its face the stamp of genuineness. Although written in the style of the historical books of the Old Testament the work is characterized by a religious reticence which avoids even the use of the divine name, and by the virtual absence of the Messianic hope. The observance of the law is strongly urged, and the cessation of prophecy deplored (iv. 46; xiv. 41). There is no allusion either to the immortality of the soul or to the resurrection of the dead. Many scholars are of opinion that the unknown author was a Sadducee, but all that can be said with certainty is that he was a Palestinian Jew devotedly attached to the national cause.

2 Maccabees, the epitome of a larger work in five books by one Jason of Cyrene, deals with the same history as its predecessor, except that it begins at a point one year earlier (176 B.C.), and stops short at the death of Nicanor (161 B.C.), thus covering a period of only 15 years. Originally written in excellent Greek, from a pronouncedly Pharisaic standpoint, it was possibly directed against the Hasmonaean dynasty. It shows no sympathy with the priestly class. Both in trustworthiness and in style it is inferior to 1 Maccabees. In spite of its obvious defects, however, it forms a useful supplement to the first book. The writer's interests are religious rather than historical. The eschatology of 2 Maccabees is singularly advanced, for it combines the doctrine of a resurrection with that of immortality. It is worthy of note that the Roman Church finds support in this book for its teaching with reference to prayers for the dead and purgatory (xii. 43 *seq.*). An allusion to Jeremiah as "he who prayeth much for the people and the holy city" (xv. 14) it likewise appeals to as favouring its views respecting the intercession of the saints. Neither of Jason's work nor of the epitomizer's can the precise date be determined. The changed relations with Rome (viii. 10, 36) prove, however, that the latter was written later than 1 Maccabees; and it is equally clear that it was composed before the destruction of Jerusalem A.D. 70.

3 Maccabees, although purporting to be an historical narrative, is really an animated, if somewhat vapid, piece of fiction written in Greek somewhere between 100 B.C. and A.D. 70, and apparently preserved only in part. It has no connection with the Hasmonaeans, but is a story of the deliverance experienced by the Egyptian Jews from impending martyrdom at the hands of Ptolemy IV. Philopator, who reigned in the century previous to the Maccabaean rising (222–205 B.C.). The title is of later origin and rendered possible only by the generalization of the name Maccabees so as to embrace all who suffered for the ancestral faith. The purpose of the writer was evidently to cheer his Egyptian brethren during some persecution at Alexandria. Although the book was favourably regarded in the Syrian it was apparently unknown to the Latin Church. Among the Jews it was virtually ignored.

4 Maccabees differs essentially from the other books of this name. While it does not itself aim at being a history, it makes striking use of Jewish history for purposes of edification. It bears, moreover, a distinctly philosophical character, and takes the form of a "tractate" or discourse, addressed to Jews only, upon "the supremacy of pious reason over the passions." The material is well arranged and systematically handled.

The book is written in a cultured, if somewhat rhetorical, Greek style, and unmistakably coloured by the Stoic philosophy. The four cardinal virtues are represented as forms of wisdom, which again is inseparable from the Mosaic law. That the writer owes no slavish adherence to any philosophical system is plain from his independent treatment of the affections. Although influenced by Hellenism, he is a loyal Jew, earnestly desirous that all who profess the same faith should adhere to it in spite of either Greek allurements or barbaric persecution. It is not to reason as such, but only to *pious* reason (*i.e.,* to reason enlightened and controlled by the divine law), that he attributes lordship over the passions. While in his zeal for legalism he virtually adopts the standpoint of Pharisaism, he is at one with Jewish Hellenism in substituting belief in the soul's immortality for the doctrine of a bodily resurrection. The name of the author is unknown. He was, however, clearly a Hellenistic Jew, probably resident in Alexandria or Asia Minor. The date of composition cannot be definitely fixed. Most likely it is a product of the Herodian period.

5 Maccabees. On this *see* above.

BIBLIOGRAPHY.—C. J. Ball's *Variorum Apocrypha* will be found specially useful by those who cannot conveniently consult the original Greek. Among commentaries see those of C. L. W. Grimm (1853–1857), E. C. Bissell on 1, 2 and 3 Macc. in Lange-Schaff's commentary, 1880 (the whole Apocrypha being embraced in one volume, and much of the material being transferred from Grimm); G. Rawlinson on 1 and 2 Macc. in the *Speaker's Commentary* (1888; much useful matter, but marred by too frequent inaccuracy); Zöckler, on 1, 2 and 3 Macc. (1891; slight and unsatisfactory); W. Fairweather and J. S. Black on 1 Macc., in the *Cambridge Bible for Schools* (1897); E. Kautzsch on 1 and 3 Macc., Kamphausen on 2 Macc., Deissmann on 4 Macc. in *Die Apok. u. Pseudepigr. des Alt. Test.* (1898 ed. by E. Kautzsch, a most serviceable work for the student of apocryphal literature) and Oesterley (1M.), Moffatt (2M.) and Emmet (3M.) in *Apocrypha and Pseudepigrapha* (ed. Charles). Brief but useful introductions to all the four books of Maccabees are given in E. Schürer's *Geschichte des Jüdischen Volkes im Zeitalter Jesu Christi* (Eng. tr. of earlier edition, 1886–1890).

See also R. H. Charles, *Between the Old and New Testaments,* pp. 198–202, 218 seq. (1914), and A. A. Bevan in *Journ. Theol. Stud.,* Jan. 1929. (W. F.)

MacCARTHY, DENIS FLORENCE (1817–1882), Irish poet, was born in Dublin on May 26, 1817, and educated there, and at Maynooth. His earlier verses appeared in *The Dublin Satirist,* and in 1843 he became a regular contributor of political verse to the recently founded *Nation.* He also took an active part in the Irish political associations. In 1846 he edited *The Poets and Dramatists of Ireland* and the *Book of Irish Ballads.* His collected *Ballads, Poems and Lyrics* (1850), including translations from nearly all the modern languages, took immensely with his countrymen on account of their patriotic ring. In 1853 he began a number of translations from the Spanish of Calderon's dramas, which won him a medal from the Royal Spanish Academy. He was granted a civil list pension for his literary services. He died in Ireland on April 7, 1882. His works include *The Bellfounder* (1857); *Under-glimpses* (1857); and *The Early Life of Shelley* (1871).

M'CARTHY, JUSTIN (1830–1912), Irish politician, historian and novelist, was born in Cork on Nov. 22, 1830, and was educated there. He worked on the staff of the *Northern Daily Times* (1853–59); the *Morning Star* (1860–68), being its editor for four years; and the *Daily News* (1870, etc.). He represented Co. Longford in parliament as a Liberal and Home Ruler from 1879 to 1885; North Longford, 1885–86; Londonderry, 1886–92; and North Longford from 1892 to 1900. He was chairman of the Anti-Parnellites from the fall of C. S. Parnell in 1890 until Jan. 1896; but his nationalism was of a temperate and orderly kind, and though his personal distinction singled him out for the chairmanship during the party dissensions of this period, he was in no active sense the political leader. His real bent was towards literature. His earliest publications were novels, some of which, such as *A Fair Saxon* (1873), *Dear Lady Disdain* (1875), *Miss Misanthrope* (1878), *Donna Quixote* (1879), were excellent. His most important work is his *History of Our Own Times* (vols. i.–iv., 1879–80; vol. v., 1897), which treats of the period between Queen Victoria's accession and her diamond jubilee. He also began a *History of the Four Georges* (1884–1901), of which the latter half was written by his son, Justin Huntly M'Carthy (1860–1936), the author of various clever novels, plays, poetical pieces and short histories. Justin M'Carthy died at Folkestone on April 24, 1912. His publications include biographies of Sir Robert Peel (1891), Pope Leo XIII. (1896) and W. E. Gladstone (1898); *Modern England* (1898); *The Reign of Queen Anne* (1902) and *Reminiscences* (2 vols., 1899).

McCLELLAN, GEORGE BRINTON (1826–1885), American soldier, was born at Philadelphia, Pa., on Dec. 3, 1826. He was educated at the University of Pennsylvania preparatory school, and in July, 1846, graduated from West Point with such high rank that he was attached to the corps of engineers. In September of that year he was despatched to Mexico, where he served under Gen. Winfield Scott and was breveted for gallantry. At the close of the Mexican War he was assigned to West Point as instructor in practical engineering, and in 1851 superintended the construction of Ft. Delaware. In 1852 he served in the Red river expedition, and in 1853–54 was on duty in Washington Territory and Oregon as an engineer officer.

In the spring of 1855 he was directed to visit Europe, with two other officers, and to report upon the art of war. The commission witnessed the siege of Sevastopol, in the Crimea, and visited many countries and military establishments. Upon its return, McClellan not only furnished an able report under the title *Armies of Europe* (republished 1862), but also designed (1856) a saddle which was adopted by the army, and afterwards known as "the McClellan." In Jan. 1857, when captain in the 1st cavalry, he resigned his commission and accepted the position of chief engineer of the Illinois Central railroad. He was later made vice president, and subsequently president, of the Ohio and Mississippi Railroad Company. In May 1860 he married Ellen Mary Marcy, and established his residence at Cincinnati, O., where he was living at the outbreak of the Civil War. Offering his services to the Union, he was commissioned major-general of Ohio Volunteers on April 23, 1861, and on May 4, was made major-general in the army of the United States. He was placed in command of the department of the Ohio, and acting upon his own initiative, on May 26, despatched a small force across the Ohio river at Philippi. He dispersed the Confederates early in June, and, following this success by a rapid advance, secured control of so much territory for the Union cause, that the State of West Virginia was separated from the Old Dominion, of which it had been a component part. This was the first successful campaign in the war between the States, and gave him such immediate popularity that he was dubbed "Little Mac: the Young Napoleon."

On July 22, McClellan was directed to turn over his command to the next in rank and to proceed to Washington, where he arrived July 26, 1861. He was there informed by President Lincoln that he had been placed in charge of the troops at the capital, and was directed speedily to bring order out of chaos. This he did, and the spirit of demoralization which obsessed the Federals after the disastrous defeat at First Bull Run quickly disappeared. With the assistance of his engineers, he soon had a ring of earthen fortifications and redoubts thrown about the city, and by drill and disciplinary measures whipped the raw levies into excellent shape before the spring of 1862. Then the so-called army of the Potomac was transported to Fortress Monroe by steamer, and began an advance upon Richmond by way of the peninsula which lies between the York and James rivers.

The Confederates delayed the march at Big Bethel, Yorktown, and Williamsburg, and although, by May 31, McClellan's forces were within seven miles of the Confederate capital, they were in a very bad strategical position, because the Chickahominy river—with its treacherous swamp land—divided the two wings of the army. To McClellan's great disappointment, the President had detained Gen. McDowell with 40,000 men to cover Washington, which made his numbers about equal to those of the Confederates. Gen. Banks in the Shenandoah valley was watching "Stonewall" Jackson's remarkable "foot cavalry," but by defeating Banks and threatening Washington, Jackson kept McDowell's division from re-enforcing McClellan. Jackson himself joined the Confederates defending their capital. Meanwhile, President Lincoln called Maj.-Gen. John Pope from the West, placing him in command of the combined armies of Banks and Frémont in the valley, and McDowell at Fredericksburg. These forces were advanced towards the Rappahannock.

McClellan was checked at the battle of Seven Pines, or Fair Oaks, where Gen. Johnston, who directed the Confederates, was wounded, and Gen. Robert E. Lee took command of the army. Seeing the advantage of attacking a portion of McClellan's divided detachments, the new commander (with the assistance of Jackson's corps) precipitated a furious assault upon the Union right wing. Then followed the terrible "Seven Days'" fighting, in which McClellan was compelled to retreat (June 26 to July 1) to the James river; ending the backward movement and change of base (from White House on the Pamunkey to Harrison's Landing on the James) at Malvern Hill, under the protection of the Union gunboats. By a petulant telegram (June 28) the defeated commander incurred the everlasting displeasure of the secretary of War, and by an ill-advised letter to the president from Harrison's Bar, engendered a similar feeling among the members of the cabinet. Yet, after his army had been transported to Alexandria and sent to the aid of Pope, who was signally defeated at Cedar mountain and Second Bull Run, so great was the need of his assistance that he was called to Washington by Gen. Halleck (military adviser of the President) and verbally ordered to take charge of all the troops retreating to the city. In this President Lincoln concurred.

The Federals were soon well in hand, but there was immediate work for them to do, as Lee had crossed the Potomac, invaded Maryland and seized Hagerstown and Fredericksburg. McClellan put the Union forces in motion towards the invaders, and on Sept. 13, 1862, had the good fortune to come into possession of an order issued by the Confederate chieftain which had been found by a private of the 27th Indiana Volunteers, wrapped securely around three cigars. This fully disclosed his plans. An immediate and rapid advance was ordered; the Confederates were driven through the Blue Ridge at Turner's and Fox's gaps and pursued to Antietam creek, near Sharpsburg, Md., where they offered battle. Although the Confederate army consisted of but 41,500 men, and the Union force was approximately 81,176, McClellan not only fought the battle in detail, engaging not more than two of his six corps simultaneously, but he even held two corps out of the battle almost entirely. On the 18th the Union troops were not permitted to attack, and on the next day Lee safely retreated across the Potomac at Shepherdstown. McClellan's unwillingness to risk battle in spite of superior numbers, coupled with his great delay in following the retreating Confederates so exasperated the authorities in Washington with his conduct of the campaign that he was subsequently removed from the position of commander-in-chief of the army of the Potomac (Nov. 5 1862). Major-Gen. Burnside was appointed to succeed him, and he was never afterwards tendered a command.

In 1864, McClellan became the Democratic presidential candidate upon a platform which denounced the war as a failure and proposed negotiations with the South for peace, but, as a patriotic soldier, he repudiated the platform although accepting the nomination. At the polls Abraham Lincoln was overwhelmingly reelected president, as a result of which McClellan soon sailed for Europe, after resigning his commission in the army. Upon his return, the former leader took up his residence in New York city, where (1868–69) he was engaged in superintending the construction of an experimental floating battery. In 1871–72 he was engineer-in-chief of the City of New York's department of docks. Removing to Orange, N.J. (1877–81), he was elected governor of New Jersey upon the Democratic ticket. Although offered a second nomination, he refused it, and spent his later years in travelling abroad and preparing his memoirs. He died suddenly of heart disease, on Oct. 29, 1885, at Mayfield, Orange, New Jersey. Bronze equestrian statues at Philadelphia and Washington have been erected to this popular but unfortunate general, who always held the affectionate regard of the enlisted men.

BIBLIOGRAPHY.—Besides *McClellan's Own Story,* published posthumously by W. C. Prime in 1887, Gen. McClellan was the author of *Exploration of the Red River of Louisiana in the year 1852* (1853); *Report on the Several Pacific Railroad Explorations* (1855); *European Cavalry* (1861); *Regulations and Instructions for the Field Service of the U.S. Cavalry in time of war* (1861); *Armies of Europe* (1862); *Manual of Bayonet Exercise* (1862); *Letter to President Lincoln* (1862); *Letter to the Secretary of War* (1862); *Complete Report of the Organization and Campaigns of the Army of the Potomac* (1864); *Letter of Acceptance and West Point Oration* (1864); and *McClellan's Mexican War Diary,* not published until 1917. He wrote also a series of articles on the Russo-Turkish War for *The North American Review. See* memoir in the preface of *McClellan's Own Story;* Wakenfield Addey, *Little Mac and How he became a Great General* (1864); P. S. Michie, *General McClellan* in the "Great Commanders" series (1901); J. H. Campbell, *A Vindication of the Military Career of General McClellan* (1916); Capt. T. G. Frothingham, "The Peninsula Campaign" and "The Crisis of the Civil War: Antietam," in *Proceedings of the Massachusetts Historical Society,* vol. lvi. and lvii.

(C. H. L. J.)

McCLERNAND, JOHN ALEXANDER (1812–1900), American soldier and lawyer, was born in Breckinridge county, Ky., on May 30, 1812. He was admitted to the bar in Shawneetown, Ill., in 1832; in the same year served as a volunteer in the Black Hawk War, and in 1835 founded the *Shawneetown Democrat,* which he thereafter edited. As a Democrat he served in 1843–51 and in 1859–61 as a representative in Congress, where in his first term he vigorously opposed the Wilmot Proviso, but in his second term was a strong unionist. He resigned from Congress, raised in Illinois the "McClernand brigade," and was commissioned (May 17, 1861) brigadier-general of volunteers. He was second in command at the battle of Belmont (Missouri) in Nov. 1861, and commanded the right wing at Ft. Donelson. In March 1862 he became a major-general of volunteers, and at Shiloh he commanded a division. Early in January, 1863, at Milliken's Bend, McClernand, who had been placed in command of one of the four corps of Grant's army, superseded Sherman as the leader of the force that was to move down the Mississippi against Vicksburg. On Jan. 11 he took Arkansas Post. During the rest of the Vicksburg campaign there was much friction between McClernand and his colleagues; he undoubtedly intrigued for the removal of Grant; it was Grant's opinion that at Champion's Hill (May 16) he was dilatory; and on June 18 he was relieved of his command. President Lincoln, who saw the importance of conciliating a leader of the Illinois War-Democrats, restored him to his command in 1864, but McClernand resigned in November of that year. He died in Springfield, Ill., on Sept. 20, 1900.

MACCLESFIELD, CHARLES GERARD, 1st Earl of (*c.* 1618–1694), of an old Lancashire family, commanded a brigade at Edgehill, and, distinguishing himself at Newbury (1643) and Newark (1644) he was given chief command in Wales. His severity made him unpopular and he was removed the following year, but was retained in command of the king's guard during the march from Wales to Oxford, and thence to Hereford and Chester. In 1645 he was created Baron Gerard of Brandon, Suffolk, but soon after was dismissed for his protest against the supersession of Sir R. Willis. After Charles' capitulation at Oxford (1646) he went abroad, where he remained until the Restoration. In 1660 he returned at the head of the Life Guards; his estates were restored and he received a pension. Gerard was created earl of Macclesfield and Viscount Brandon in 1679, but his relations with Monmouth led to an order for his arrest in 1684. He escaped abroad, but returned with William III. in 1688 as commander of his body guard. He was made a privy councillor and president of the council of Welsh marches, 1689. He died on Jan. 7, 1694.

His eldest son, Charles, 2nd earl of Macclesfield, (*c.* 1659–1701), born in France, was naturalized in England. He was concerned in the intrigues of Monmouth, and in 1685 was sentenced to death after the Rye House plot, but was pardoned. In 1698 Macclesfield was divorced from his wife Anna, daughter of Sir Richard Mason of Sutton, by act of parliament, the first occasion on which a divorce was so granted without a previous decree of an ecclesiastical court. The countess was the mother of two children, known by the name of Savage, whose reputed father was Richard Savage, 4th Earl Rivers (d. 1712). The poet Richard Savage (*q.v.*), claimed that he was the younger of these children.

In 1721 the title of earl of Macclesfield was revived in favour of Thomas Parker (*c.* 1666–1732), who became a barrister. In 1710 he took part in the proceedings against Sacheverell, and was appointed lord chief justice, and in 1718 he became lord chancellor. Corruption was alleged and in 1725 he was impeached, found guilty and heavily fined. He died in 1732.

Macclesfield's only son, George (*c.* 1697–1764), was celebrated as an astronomer and prominent in introducing the new style of dates (1752). He was president of the Royal Society and died on March 17, 1764.

See Lord Clarendon, *History of the Rebellion,* edit. by W. D. Macray; E. B. G. Warburton, *Memoirs of Prince Rupert and the Cavaliers* (3 vols., 1849); *State Papers of John Thurloe* (7 vols., 1742); J. R. Phillips, *Memoirs of the Civil War in Wales and the Marches, 1642–49* (2 vols., 1874); and the duke of Manchester, *Court and Society from Elizabeth to Anne* (2 vols., 1864). For Lord Chancellor Macclesfield, *see* Lord Campbell, *Lives of the Lord Chancellors and Keepers of the Great Seal* (1845–69).

MACCLESFIELD, market town, municipal borough, Macclesfield parliamentary division, Cheshire, England, 166 mi. N.W. of London, on the L.M.S. and L.N.E. railways. Pop. (est. 1938) 36,350. Area 6.97 sq.mi. It stands on the river Bollin in a deep gorge with heights up to 1,000 ft. on the east. The bleak upland country retains its ancient name of Macclesfield forest. The church of St. Michael was founded in 1278, and in 1740 was partly rebuilt and enlarged. Connected with the church are two chapels, of which Rivers chapel belonged to a college of secular priests founded in 1501. The free grammar school, founded in 1502, was refounded in 1552. The old buildings were sold in 1750 and new buildings opened in 1856. There are also technical and art schools. The county lunatic asylum is here. Originally the trade of Macclesfield was principally in twist and silk buttons, but this developed into the manufacture of all kinds of silk. Also there are manufactures of upholsterers' trimmings and extensive breweries; while stone quarries, as well as coal-mines, are worked in the neighbourhood. Recreation grounds include Victoria park, South park and Peel park, in which are preserved the old market cross and stocks. Water communication is provided by the Macclesfield canal. The populous suburb of Sutton, extending S.S.E. of the town, is partly included in the borough.

Before 1066, Macclesfield (Makesfeld, Mackerfeld, Macclesfeld, Meulefeld, Maxfield) was held by Edwin, earl of Mercia, and in the Domesday Survey it is in the lands of the earl of Chester. The names Jordangate, Chestergate and Wallgate bear witness to 13th century fortifications. In the 15th century Henry Stafford, duke of Buckingham, had a fortified manor-house here; its traces remain. The earliest of the many charters, granted by Edward, prince of Wales, in 1261, constituted Macclesfield a free borough with a merchant guild. In 1684 Charles II issued a new charter, which continued until the Municipal Reform act, 1835. The earliest mention of a market is in 1617. In the charter of 1666 a market is included among the privileges confirmed to the borough. The charter of Elizabeth (1564) granted an annual fair in June and Charles II (1684) granted fairs in April and September. Except for January, April and September fairs are now held monthly, the chief being "Barnaby" in June, when the town keeps a week's holiday. Macclesfield borough sent two members to parliament in 1832 for the first time. In 1880 it was disfranchised, and in 1885 was merged in the county division of Macclesfield. The manufacture of silk-covered buttons began in the 16th century, and flourished until the early 18th. The first silk mill was erected about the year 1755, and silk manufacture on a large scale was introduced about 1790. The manufacture of cotton began in Macclesfield about 1785.

M'CLINTOCK, SIR FRANCIS LEOPOLD (1819–1907), British naval officer and Arctic explorer, was born at Dundalk, Ireland, on July 8, 1819. During the year 1848 he joined the Arctic expedition under Sir James Ross in search of Sir John Franklin's ships, as second lieutenant of the "Enterprise." In the second search expedition (1850) he was first lieutenant of the "Assistance," and in the third (1854) he commanded the "Intrepid." The direction which the search should follow had at last been learnt from the Eskimo, and M'Clintock accepted the command of the expedition on board the "Fox," fitted out by Lady Franklin in 1857, which succeeded in its object in 1859 (*see* Franklin, Sir John). Later he sounded the North Atlantic for the electric cable. He was one of the principal advisers in the preparations for the Antarctic voyage of the "Discovery" under Captain Scott. He died on Nov. 17, 1907.

See Sir C. R. Markham, *Life of Admiral Sir Leopold M'Clintock* (1909); and his own *Voyage of the "Fox" in the Arctic Seas* (1859).

McCLINTOCK, JOHN (1814–1870), American Methodist Episcopal theologian and educator of Scottish-Irish descent, was born in Philadelphia, Pa., on Oct. 27, 1814. Because of his father's financial embarrassment he worked before going to college and kept up his senior studies at the University of Pennsylvania while doing active pastoral work. After his graduation in 1835 he taught in Dickinson college for 12 years. He edited *The Methodist Quarterly Review* (1848–56), and in 1867, at the wish of Daniel Drew, was president of the newly established Drew Theological seminary at Madison, N.J., where he died on March 4, 1870. An able preacher, orator and teacher, and a remarkably versatile scholar, McClintock by his editorial and educational work probably did more than any other man to raise the intellectual level of American Methodism. He put into practice the scholarly methods of the new German theology of the day—not alone by his translation with Charles E. Blumenthal of Neander's *Life of Christ* (1847), and of Bungener's *History of* *the Council of Trent* (1855), but by his own noteworthy project, McClintock and Strong's *Cyclopaedia of Biblical, Theological and Ecclesiastical Literature* (1867–81; supplement, 1885–87). Among McClintock's other publications are *Sketches of Eminent Methodist Ministers* (1853), *Living Words* (1871) and *Lectures on Theological Encyclopaedia and Methodology* (1873). *See* G. R. Crooks, *Life and Letters of the Rev. Dr. John McClintock* (1876).

McCLOSKEY, JOHN (1810–1885), U.S. cardinal, was born in Brooklyn, N.Y., on March 20, 1810. He graduated at Mt. St. Mary's college, Emmitsburg, Md., in 1827, studied theology there, was ordained a priest in 1834, and in 1837, after two years in the college of the Propaganda at Rome, became rector of St. Joseph's, New York city. In 1844 he was consecrated bishop of Axieren *in partibus,* and was made coadjutor to Bishop Hughes of New York, with the right of succession; in 1847 he became bishop of the newly created see of Albany; and in 1864 he succeeded to the archdiocese of New York, then including New York, New Jersey and New England. In April 1875 he was invested as a cardinal, with the title of Sancta Maria supra Minervam, being the first U.S. citizen to receive this dignity. He attended the conclave of 1878, but was too late to vote for the new pope. He died in New York city on Oct. 10, 1885.

See J. M. Farley, "Life of Cardinal McCloskey," U.S. Cath. Hist. Soc. *Records and Studies* (vol. i–ii, 1899–1901); J. J. Walsh, *Our American Cardinals* (1926).

M'CLURE, SIR ROBERT JOHN LE MESURIER (1807–1873), English Arctic explorer, born at Wexford, Ireland, on Jan. 28, 1807, the posthumous son of one of Abercrombie's captains, served as mate of the "Terror" in the expedition (1836–37) commanded by Captain (afterward Sir) George Back. He joined the Franklin search expedition (1848–49) under Sir J. C. Ross as first lieutenant of the "Enterprise," and on the return of this expedition was given the command of the "Investigator" in the new search expedition (1850–54) which was sent out by way of Bering strait to co-operate with another from the northwest. In this voyage he completed (1850) the work connected with the discovery of a northwest passage.

See Admiral Sherard Osborn, *The Discovery of a North-West Passage* (1856); and his own *Voyages* (2 vols. 1884).

McCOMB, a city of Pike county, Mississippi, U.S.A., on federal highway 51 and the Illinois Central railway system, 60 mi. S.E. of Natchez. Pop. (1920) 7,775 (22% Negroes); 9,898 in 1940 by the federal census. It is a shipping point for cotton, corn, garden truck and cattle, and has railway shops, textile and lumber mills. The city was incorporated in 1872.

McCONNELL, FRANCIS JOHN (1871–), U.S. Methodist bishop, was born at Trinway, Ohio, Aug. 18, 1871. He graduated at Ohio Wesleyan university and later studied at Boston university, receiving the degrees of S.T.B. and Ph.D. In 1895 he entered the Methodist ministry and was pastor successively at Chelmsford, Newton Upper Falls, Ipswich and Cambridge, all in Massachusetts, and in 1903–09 at the New York Avenue Methodist church in Brooklyn. From 1909 to 1912 he was president of De Pauw university. He was elected bishop in 1912 and served for a number of years in Mexico and afterward in the Pittsburgh district. In the latter region he entered actively into a study of industrial conditions and problems. As chairman of the Commission of Inquiry appointed by the Interchurch World Movement organization he pushed the investigation resulting in the *Report on the Steel Strike of 1919* which was influential in abolishing the 12-hour day and seven-day week in the steel industry. He is the author of many magazine articles and books, among the latter being *Personal Christianity* (1914); *Democratic Christianity* (1919); *The Preacher and the People* (1922); *The Christlike God* (1927); and *Christianity and Coercion* (1933).

McCOOK, ALEXANDER McDOWELL (1831–1903), U.S. soldier, was born in Columbiana county, O., on April 22, 1831. He graduated at the U.S. military academy in 1852, served against the Apaches and Utes in New Mexico in 1853–57, and in April 1861 became colonel of Ohio volunteers. He served in the first battle of Bull Run; commanded a brigade in Kentucky in the winter of 1861, a division in Tennessee and Mississippi early in 1862, and the 1st corps in Kentucky in October of the same year; was in command of Nashville in November and December of that year; and was then engaged in Tennessee until after the battle of Chickamauga. He retired in 1895, a major-general.

His father, Daniel McCook (1798–1863), killed at Buffington's island during Gen. John H. Morgan's raid in Ohio, and seven of his eight brothers (three of whom were killed in battle) all served in the Civil War; this family and that of John McCook (1806–1865), Daniel's brother, who served as a volunteer surgeon in the Civil War, are known as the "fighting McCooks"—four of John's sons served in the army and one in the navy.

His brother, Henry Christopher McCook (1837–1911), was a pastor, but he is best known as an entomologist. He wrote *The Mound-making Ants of the Alleghanies* (1877); *The Natural History of the Agricultural Ants of Texas* (1879); *Tenants of an Old Farm* (1884); *American Spiders and their Spinning-work* (1889–93); *Nature's Craftsmen* (1907); *Ant Communities* (1909).

McCOOK, a city of southern Nebraska, U.S.A., on the Republican river, federal highways 6, 34 and 183, and the Burlington (railway) route, 280 mi. W.S.W. of Omaha; the county seat of Redwillow county, and the trade centre for the surrounding farming and stock-raising country. The population was 4,303 in 1920 (91% native white) and was 6,212 in 1940 by the federal census. The city was founded in 1883 and incorporated in 1886.

McCORD, LOUISE SUSANNA CHEVES (1810–1879), U.S. author, daughter of Langdon Cheves and Mary Elizabeth Dulles Cheves, was born Dec. 3, 1810, in Charleston, S.C. A member of a colonial family, her ancestry was Scotch, Irish and Huguenot. In her early years in South Carolina Louise McCord studied French and music for young girls. Her education was continued at Grimshaw's school in Philadelphia. Before her formal presentation to society in Philadelphia and Washington, D.C., native linguists were employed to perfect her in the languages. Later, under tutors selected for her brothers, she studied mathematics and kindred branches.

In association with her father and his intimate circle of public men of the state, Miss Cheves became deeply interested in the history of the U.S. Her attitude toward slavery was that the Negro was being civilized in his contact with the white Christian races of the United States. She contributed political and other essays to the *Southern Quarterly Review* in 1853 and, in 1848, published a translation of Frederic Bastiat's *Sophismes Economiques,* which influenced all of her views. Other literary efforts included a volume of poems, *My Dream,* and a five-act, blank verse drama, *Gaius Gracchus.* In 1840 Louise Cheves was married to David James McCord, a lawyer of distinction. After his death she spent two years abroad and, on her return, made her home in Columbia, S.C. During the Civil War Mrs. McCord was active in relief work; on the death of her son, Capt. Langdon Cheves McCord, in the 2nd battle of Manassas, she gave much of her time to nursing sick soldiers and other hospital work. After the Civil War Mrs. McCord removed to Charleston, S.C., where she died in Nov. 1879. She was buried with honours in Magnolia cemetery of that city.

See C. A. Mauchope, *The Writers of South Carolina* (1910); *Library of Southern Literature* (vol. viii, 1907); *Dictionary of American Biography* (vol. xi). (E. Row.)

MacCORMAC, SIR WILLIAM, Bart. (1836–1901), Irish surgeon, was born at Belfast on Jan. 17, 1836. He studied at Belfast, Dublin and Paris. After practice in Belfast and war service in France (1870) and Serbia (1876) he became (1881) assistant surgeon at St. Thomas's hospital, London. He was one of the first to apply Listerian methods in surgery and was a pioneer in operating for intraperitoneal rupture of the bladder (1886). He was president of the Royal College of Surgeons no less than five times. In 1897 he was surgeon-in-ordinary to the prince of Wales. In 1899 he was Hunterian orator. He died at Bath on Dec. 4, 1901.

McCORMACK, JOHN (1884–1945), tenor, was born at Athlone, Eire, on June 14, 1884. At the age of nine he faced his first audience when he sang at the Marists Brothers school. He was educated at Summerhill college, Co. Sligo. He won the prize at the Irish music festival, *Feis Ceoil,* and went to the U.S. on a short singing tour, returning to Dublin to sing before going to Italy where he studied under Sabatini. At his second attempt Cleofonte Campanini gave him his opportunity at Covent Garden, where he made his début in *Cavalleria Rusticana,* Oct. 15, 1907, his success the following year leading to presentation to King Edward and Queen Alexandra. Oscar Hammerstein engaged him for the Manhattan Opera house where he made his New York début in *Traviata,* Nov. 10, 1909. He afterward sang with the Chicago-Philadelphia Opera company, the Chicago Grand Opera company and the Metropolitan Opera company. In 1911 he toured Australia with Melba in Italian opera. After two further operatic seasons in the U.S., 1912, and Australia, 1913, he turned to the concert stage where he achieved extraordinary popularity as a ballad singer. He became a citizen of the United States in 1919. In 1921 he was made Knight commander of the orders of St. Gregory the Great and of the Holy Sepulchre by Pope Benedict XV, and in 1928 he was made a count in the papal peerage. McCormack died Sept. 16, 1945, in Dublin.

McCORMICK, CYRUS HALL (1809–1884), U.S. inventor of grain-harvesting machinery, was born in Rockbridge Co. (Va.), U.S.A., on Feb. 15, 1809. His father was a farmer who had invented numerous labour-saving devices for farm-work, but after repeated efforts had failed in his attempts to construct a successful grain-cutting machine. In 1831, Cyrus, then 22 years old, took up the problem, and after careful study constructed a machine which was successfully employed in the late harvest of 1831 and patented in 1834. The McCormick reaper, after further improvements, proved a complete success; and in 1847 the inventor removed to Chicago, where he manufactured his machines. He died in Chicago on May 13, 1884.

See Herbert N. Casson, *Cyrus Hall McCormick: his Life and Work* (1909).

McCORMICK, ROBERT RUTHERFORD (1880–), American editor, was born in Chicago (Ill.), July 30, 1880. Graduating from Yale university in 1903, he studied law at Northwestern university and was admitted to the Illinois bar in 1907. He was active in Chicago civic circles from 1904 to 1910. In 1910 he became associated with his cousin, Joseph Medill Patterson, as co-editor and publisher of the *Chicago Tribune,* being president of the Chicago Tribune company. Under their direction the *Tribune* enormously increased its circulation and advertising. The beautiful Tribune tower, built after extended architectural competition, symbolizes the paper's success. After service in World War I, McCormick and his cousin, in 1921, started the illustrated *Daily News* in New York.

McCOSH, JAMES (1811–1894), Scottish philosophical writer, born of a Covenanting family in Ayrshire, on April 1, 1811, became a minister, and took part in the Free Church movement of 1843. He was professor at Queen's college, Belfast (1852–68), and president of the college of New Jersey, Princeton (1868–88). He died on Nov. 16, 1894.

His chief works are: *Method of Divine Government, Physical and Moral* (Edinburgh, 1850, frequently republished in New York); *The Typical Forms and Special Ends in Creation* (Edinburgh, 1855; new editions, New York, 1867–80); *Intuitions of the Mind inductively investigated* (1860; 3rd rev. ed., 1872); *An Examination of Mr. J. S. Mill's Philosophy* (1866; enlarged 1871, several eds.).

McCOY, SIR FREDERICK (1823–99), C.M.G. (1886), K.C.M.G. (1891), British palaeontologist, the son of Dr. Simon McCoy, was born in Dublin in 1823, and was educated for the medical profession. In collaboration with Sedgwick he prepared *A Synopsis of the Classification of the British Palaeozoic Rocks, with a Systematic Description of the British Palaeozoic Fossils in the Geological Museum of the University of Cambridge* (1855). After four years in Belfast he became professor of natural science in the University of Melbourne, where he lectured for upwards of thirty years. He established the National museum of Natural History and Geology in Melbourne, of which he was director; and becoming associated with the geological survey of Victoria as palaeontologist, he issued a series of decades entitled *Prodromus of the Palaeontology of Victoria.* He also issued the *Prodromus of the Zoology of Victoria.* He was elected F.R.S. in 1880. He died in Melbourne on May 16, 1899.

M'CRIE, THOMAS (1772–1835), Scottish historian and divine, was born at Duns in Berwickshire in Nov. 1772. He studied in Edinburgh university, and in 1796 he was ordained minister of the Second Associate Congregation, Edinburgh. In 1806, M'Crie seceded from the "general associate synod," and formed the "constitutional associate presbytery," afterwards merged in the "original seceders." He was deposed by the associate synod, and his congregation withdrew with him and built another place of worship in which he officiated until his death. M'Crie studied the history, constitution and polity of the churches of the Reformation, and published *The Life of John Knox, containing Illustrations of the History of the Reformation in Scotland* (1811), which exercised an important influence on public opinion at the time. He died on Aug. 5, 1835.

MACCULLOCH, HORATIO (1805–1867), Scottish landscape painter, was born in Glasgow. He studied for a year under John Knox, a Glasgow landscape-painter, was then engaged at Cumnock to paint the ornamental lids of snuff-boxes, and afterwards went to Edinburgh where Lizars, the engraver, employed him to colour book illustrations. At Glasgow he was employed to paint several large pictures for the decoration of a public hall in St. George's place. MacCulloch's works form an interesting link between the old world of Scottish landscape and the new. From 1829 he exhibited regularly in the Royal Scottish academy's exhibition till his death on June 24, 1867.

A volume of photographs from his landscapes, with a biographical notice by Alexander Fraser was published in Edinburgh in 1872.

McCULLOCH, HUGH (1808–1895), U.S. financier, was born at Kennebunk (Me.) Dec. 7, 1808. He was educated at Bowdoin college, studied law in Boston, and in 1833 began practice at Ft. Wayne (Indiana). He was cashier and manager of the Ft. Wayne branch of the old state bank of Indiana from 1835 to 1857, and president of the new state bank from 1857 to 1863. He was selected by Secretary Chase as comptroller of the currency in 1863 to put the new National Banking act of 1862 into operation. He was appointed secretary of the treasury by President Lincoln in 1865, and was continued in office by President Johnson until the close of his administration in 1869. In accordance with his suggestion, an act was passed (March 12, 1866), authorizing the withdrawal from circulation of greenbacks as a preliminary to the resumption of specie payments, but it met with strong opposition and was repealed on Feb. 4, 1868, after only $48,000,000 had been withdrawn. McCulloch went to England, and spent six years (1870–76) as a member of the banking firm of Jay Cooke, McCulloch and Co. From Oct. 1884 until the close of President Arthur's term of office in March 1885 he was again secretary of the treasury.

He died at his home near Washington (D.C.) May 24, 1895.

M'CULLOCH, SIR JAMES (1819–1893), Australian statesman, was born in Glasgow. He went to Melbourne to open a branch of Dennistoun Brothers. In 1854 he was nominated to the legislative council, and was returned for Wimmera in the legislative assembly. In 1857–58 he was minister of trade and customs, and in 1859–60, treasurer. On the defeat of the third O'Shanassy ministry in June 1862 he became premier and chief secretary. M'Culloch's ministry was involved in a struggle with the council, over the ministerial policy of protection. A tariff was tacked to an appropriation bill, which the council rejected three times. M'Culloch had the support of Australia, and of the governor, Sir Charles Darling, who was recalled by the home government for partisanship. A long and bitter struggle between the two chambers over a grant of £20,000 to Lady Darling, which was also tacked to an appropriation bill, ended in 1868 when M'Culloch, who had resigned, resumed office with different colleagues. He resigned in 1869, when he was knighted, but formed a third ministry in 1870. In June 1871 he resigned again and held the office of agent-general for Victoria in London until 1873, was created K.C.M.G. in 1874 and, returning to the colony, formed his fourth ministry in 1875. After his defeat in 1877 he returned to England, where he died at Ewell, Surrey, on Jan. 30, 1893.

MACCULLOCH, JOHN (1773–1835), Scottish geologist, was born in Guernsey. Graduating at Edinburgh in 1793 as M.D. he became chemist to the Board of Ordnance in 1803, and in 1814 was appointed geologist to the trigonometrical survey. Two years later he became president of the Geological society, and in 1820 was elected F.R.S. His chief work was carried out in Scotland, where he examined the structure of the range of western islands. His geological map of Scotland was published soon after his death on Aug. 21, 1835.

M'CULLOCH, JOHN RAMSAY (1789–1864), British economist and statistician, was born at Whithorn, Wigtownshire, on March 1, 1789. In 1818–19 he edited the *Scotsman.* His articles on economic questions in that paper and in various reviews, and the publication of his *Principles of Political Economy* (1825) led to his appointment in 1828 as professor of political economy at London university. He held this office until 1832, and in 1838 became comptroller of H.M. Stationery Office, where he introduced useful reforms. M'Culloch died in London on Nov. 11, 1864. He was intimate with John Stuart Mill and his circle, but remained a Whig pure and simple. His *Dictionary of Commerce and Commercial Navigation* (1832) and his *Statistical Account of the British Empire* (1837) are monumental.

McCULLOUGH, JOHN EDWARD (1837–1885), American actor, was born in Coleraine, Ireland, on Nov. 2, 1837. He went to America at the age of 16, and made his first appearance on the stage at the Arch street theatre, Philadelphia, in 1857. In support of Edwin Forrest and Edwin Booth he played second rôles in Shakespearian and other tragedies, and Forrest left him by will all his prompt books. Virginius was his greatest success, although even in this part and as Othello he was coldly received in England (1881). In 1884 he broke down physically and mentally, and he died in an asylum at Philadelphia on Nov. 8, 1885.

MACCUNN, HAMISH (1868–1916), Scottish musical composer, was born at Greenock, the son of a shipowner, and was educated at the Royal College of Music. His first success was with the overture *Land of the Mountain and Flood* in 1887 at the Crystal Palace, and this was followed by other compositions, with a characteristic Scottish colouring. From 1888 to 1894 he was a professor at the Royal College of Music. His opera *Jeanie Deans* was produced at Edinburgh in 1894. He was for some years conductor to the Carl Rosa Opera company, and subsequently to other companies. His opera *Diarmid* was produced at Covent Garden in 1897, and his other music includes cantatas, overtures, part-songs, instrumental pieces and songs, all markedly Scottish in type. He died in London on Aug. 2, 1916.

MACDONALD, ALEXANDRE (1765–1840), duke of Taranto and marshal of France, was born at Sedan on Nov. 17, 1765, of an old Jacobite family, and was related to Flora Macdonald. In 1785 he joined the legion supporting the revolutionary party in Holland against the Prussians, and then received a commission in the French army. He supported the Revolution, and was appointed aide-de-camp to General Dumouriez. He refused to desert to the Austrians with Dumouriez, and was rewarded with the rank of general of brigade. He took part in Pichegru's invasion of Holland (1795), served as general of division on the Rhine and in Italy (1797), became first French governor of Rome, and later reconstituted the kingdom of Naples as the Parthenopaean Republic. His resistance against Suvarov's attack in northern Italy gained him the position of governor of Versailles, where he acquiesced in the events of the 18th Brumaire. In 1800 he received the command of the army in Switzerland, and his march (1800–01) over the Splügen Pass, is as noteworthy as Bonaparte's famous passage of the St. Bernard before Marengo. After some years as French plenipotentiary in Denmark, he became (1809) military adviser to Eugène Beauharnais, viceroy of Italy. For his share in the victory over the Austrians at Wagram Napoleon made him marshal of France and duke of Taranto. After serving in Spain (1810) and Russia (1812), he invaded Silesia in 1813, and was defeated by Blücher at Katzbach (*see* NAPOLEONIC CAMPAIGNS). Napoleon presented him with the sabre of Murad Bey for his fidelity, and directed him to submit to the new régime. At the Restoration he was made a peer of France, and became chancellor of the Legion of Honour (1815–31) and major-general of the royal bodyguard (1816). From 1830 his life was spent in retirement at Courcelles-le-Roi (Seine-et-Oise), where, greatly respected, he died on Sept. 7, 1840.

See Mathieu Dumas *Evènements militaires;* Ségur, *Lettre sur la campagne du Général Macdonald dans les Grisons en 1800 et 1801* (1802), and *Eloge* (1842); his memoirs were published in 1892 (Eng. trans. *Recollections of Marshal Macdonald*).

MACDONALD, SIR CLAUDE MAXWELL (1852–1915), British soldier and diplomatist, was born on June 12, 1852, the son of Major-General J. D. Macdonald. He was educated at Uppingham and Sandhurst, and in 1872 entered the army (74th Highlanders). He took part in the Egyptian campaign of 1882, and was appointed military attaché to Sir Evelyn Baring (afterwards earl of Cromer), serving in the Suakin expedition of 1884–85. He left the post of military attaché in 1887, and after a year as consul-general at Zanzibar went to the Niger Territories for the Foreign Office. In 1891 he became first commissioner and consul-general in the Oil Rivers Protectorate, where he successfully established a stable government, and was responsible for many administrative reforms. Macdonald retired from the army in 1896, and was appointed British minister at Peking, and during the critical period which followed secured for England the leases of Wei-Hai-Wei and of the Hong-Kong extension. He also obtained many other useful concessions, including the opening of the West river to trade, and the non-alienation of the Yangtze region. During the Boxer rising of 1900 he organized the defence of the legations. In Oct. 1900 Macdonald was appointed the first British ambassador to Tokyo, and gave valuable service to the British government during the Russo-Japanese War. He was admitted to the privy council in 1906 in recognition of his work in connection with the Anglo-Japanese agreement of Aug. 1905 (ended in 1921). He died in London on Sept. 10, 1915.

MACDONALD, FLORA (1722–1790), Jacobite heroine, was the daughter of Ranald Macdonald of Milton, in the island of South Uist (Hebrides). In June 1746 Prince Charles Edward (*q.v.*) took refuge, after the battle of Culloden, in Benbecula in the Hebrides, where she was living, and his companion, Captain O'Neill, sought her help. She obtained a pass to the mainland for herself, a manservant, an Irish spinning maid, Betty Burke, and a boat's crew of six men. The prince was disguised as Betty Burke. The party landed at Portree and escaped. The boatmen's talk afterwards brought suspicion on Flora and she was arrested and imprisoned in the Tower. She was afterwards allowed to live outside under the guard of a gaoler, and when the Act of Indemnity was passed in 1747 she was left at liberty. In 1750 she married Allen Macdonald of Kingsburgh and they emigrated to America (1773). He served the British government in the War of Independence, and was taken prisoner. His wife returned home in 1779, and died on March 5, 1790.

See A. C. Ewald, *Life and Times of Prince Charles Edward* (1886); A. MacGregor, *The Life of Flora Macdonald* (1882, later ed. 1901); W. Foly, *Flora Macdonald in Uist* (1886). The so-called *Autobiography* of Flora Macdonald (1870) is not authentic.

MACDONALD, GEORGE (1824–1905), Scottish novelist and poet, was born at Huntly, Aberdeenshire, the son of a farmer, and a direct descendant of a family that suffered in the massacre of Glencoe. Macdonald's youth was passed in Huntly, in an atmosphere strongly impregnated with Calvinism. He took his degree at Aberdeen university, and then studied at Highbury college, in London, for the Congregational ministry. After some years in the Congregational ministry at Arundel and in Manchester, and a short visit to Algiers, he settled in London and adopted the profession of literature. He wrote: *Within and Without* (1856), a dramatic poem; *Poems* (1857), and the "faerie romance" *Phantastes* (1858). His first conspicuous success was achieved in 1862 with *David Elginbrod,* the forerunner of a number of popular novels, which include *Alec Forbes of Howglen* (1865), *Annals of a Quiet Neighbourhood* (1866), *Robert Falconer* (1868), *Malcolm* (1875), *The Marquis of Lossie* (1877) and *Donal Grant* (1883). He also wrote some stories for the young and several volumes of sermons. In 1877 he was given a civil list pension. He died on Sept. 18, 1905. His verse is homely and direct, and marked by religious fervour. As a portrayer of Scottish peasant-life he was the precursor of a large school.

MACDONALD, SIR HECTOR ARCHIBALD (1852–1903), British soldier, was born of humble parentage at Muir of Allan-Grange, Ross-shire, Scotland. In 1870 he enlisted in the 92nd (Gordon) Highlanders, and distinguished himself in the Afghan War of 1879, in the first Boer War of 1880–81, and at Majuba. In 1885 he served under Sir Evelyn Wood in the reorganization of the Egyptian army, and took part in the Nile Expedition of that year. In 1889 he received the D.S.O. for his conduct at Toski. Seven years later he commanded a brigade of the Egyptian army in the Dongola Expedition, and after his achievements in the final battle of Omdurman (1898) was promoted colonel and made an aide-de-camp to the queen. He became popularly known as "Fighting Mac." In 1899 he was promoted major-general, and appointed to a command in India. In December 1899 he was called to South Africa to command the Highland Brigade, and in 1901 he was made a K.C.B. In 1902 he commanded the troops in Ceylon, but on March 25, 1903, he committed suicide in Paris.

MACDONALD, JAMES RAMSAY (1866–1937), British politician, was born on Oct. 12, 1866, at Lossiemouth, a little fishing village on the Moray Firth. His father was a labourer, his first home a "but and a ben." At Drainie board school he received an elementary education and continued as a pupil teacher. Coming to London at 18, he worked at 12/6d. a week as a clerk. He continued his own education by evening classes, laboratory work and incessant reading. A breakdown in health ended his scientific career, and sent him to journalism.

MacDonald's experience and reading made him a convinced socialist. He joined, in 1894, the Independent Labour Party, founded by Keir Hardie, and in 1895 stood, unsuccessfully, for Southampton. As a member of the London county council he completed his training for public service, and, after his marriage, in 1896, with Margaret Ethel Gladstone, niece of Lord Kelvin, made frequent journeys abroad. In 1897 he paid his first visit to Canada and the United States; in 1902 he went to South Africa; in 1906, travelled through the Pacific to Australia and New Zealand; in 1910, visited India, whither he returned in 1913 and 1914 as a member of the royal commission on the civil service. He also attended the (Second) Socialist International.

Three main stages may be noted in his political career: the creation of the Labour Party, the World War and the Labour Government. In the 'nineties, the great trade unions still stood aloof from politics, or were satisfied with a vague alliance with the Liberal Party. The propaganda of the Independent Labour Party, with which he was prominently associated, was directed to convincing the unions of the need of a political party for labour; in 1899 the Trades Union Congress was induced to set up a committee to consider parliamentary action. Out of this came the Labour Representation committee, of which MacDonald was secretary. Thanks largely to his energy, patience and tenacity, the hostility of some unions and the apathy of others was broken down and a Labour party came into being in 1900. After the return of 29 M.P.s, run by the Labour Representation committee in 1906, the battle was won; the party became an effective force. But it was only in 1918 that MacDonald's ideas were fully realized. The party was reorganized and thrown open to all classes, and in 1928 had over 3,500,000 members.

Elected as M.P. for Leicester in 1906, by 1911 he was leader of the Labour Party in the House of Commons. A constructive critic of Grey's foreign policy, he opposed, on Aug. 4, 1914, the view that there was an "obligation of honour" to go to war. The speech was an agreed one, but the majority of the party broke away. He had already refused suggestions of office; he now resigned his leadership. He was denounced in public and private, and had to face the fact that his views were not accepted by the nation at war. In 1918 he lost his seat at Leicester, and in 1921 failed to get in for East Woolwich.

Although out of the House of Commons till late in 1922, his influence on opinion steadily grew. By 1922, the party took his view of the Peace treaties, and resisted the tendencies that split nearly every Labour Party abroad. In 1912, he had opposed the demand for the substitution of industrial ("direct") for parliamentary action in his book *Syndicalism;* in 1919, when, under the stimulus of Russian events, this demand reappeared as the Communist doctrine of violent revolution, he wrote *Parliament and Revolution* and *Parliament and Democracy,* in which he gave a definite and logical lead against the tactics of violence and championed parliamentary democracy. The 1922 election registered his moral ascendancy. Labour, with 140 members, was the second party in the state, and he himself, returned for Aberavon, was chosen by his colleagues leader of the opposition.

After the sudden election of 1923, he came back with 192 followers. With the authorization of the National Labour Party and the Trades Union congress MacDonald declared that Labour would take office, if given the chance, in order to render national service. On Jan. 21, 1924, he accordingly moved a vote of no confidence in the Unionists, which was carried with Liberal support. Next day the king called upon him to form a Government. The first Labour cabinet was announced on Jan. 24, and on Feb. 12 the new prime minister set out its general programme in the House of Commons. In this, the first item was the settlement of a disturbed Europe; with this supreme object in view, he added the post of foreign secretary to his premiership.

The unsettled state of Europe, aggravated through the occupation of the Ruhr, was a primary cause of distress and unemployment in Britain. British prestige had fallen low: relations between Britain and France were bad, between France and Germany threatening. The reparations question blocked the way. In letters to Poincaré, published on Feb. 4 and March 3, MacDonald, with firm friendliness, set out the British point of view, and had soon created a new atmosphere, one of confidence and hope. When, on April 13, the experts committee on reparations issued a unanimous report, he at once accepted it on the part of Britain as a basis for settlement. In May, Poincaré was replaced by the Radical Herriot, who in June came over to London to discuss the European position with MacDonald. Friendship with Italy had been assisted by the handling of Jubaland.

On July 16, 1924, an allied conference assembled in London, over which he presided, for the specific purpose of putting the experts' report into operation. Within a fortnight, agreement had been reached and the German delegates called in. On Aug. 16 the London Settlement, the first negotiated agreement since the war, was initialled. By mutual consent, the experts' plan was put in effect, and the reparation problem thus lifted out of the political sphere. France, at the same time, agreed to evacuate the Ruhr within a year and certain towns at once. Negotiations for an Anglo-German commercial treaty, since signed, were initialled. In September MacDonald and Herriot attended the fifth assembly of the League of Nations at Geneva, and there submitted a plan, the Protocol, for the elimination of private war and the submission of all disputes to arbitration, after general mutual disarmament.

In the House of Commons, meantime, the difficulties of the government's minority position were growing. Philip Snowden's budget met with general approval; a housing act was passed, and the machinery for the relief of unemployment improved. But when MacDonald sought to complete his peace work by making treaties with Russia, whose *de jure* recognition had been an early act as foreign secretary, the Liberals broke away. In October the Government was defeated on a motion, calling for a select committee, on their dropping of the prosecution of J. R. Campbell, editor of the Communist *Workers' Weekly.* In the general election, then declared, the press was exceedingly hostile, and Labour was identified with Bolshevism. Polling took place on Oct. 29; as a result the Conservatives came back with a great majority. The Labour vote went up by over a million, but its representation was reduced to 150. On Nov. 4 MacDonald resigned, and resumed his leadership of the opposition. His party, in conference in 1925, confirmed his leadership.

The confidence of the Party was justified by the results of the general election of May 1929. The final results gave Labour 290 seats as against 259 Conservative, 57 Liberals and 9 Independents. Baldwin resigned and the King sent for MacDonald. His cabinet included: Sankey (lord chancellor), Parmoor (lord president), J. H. Thomas (Privy seal and deputy leader in House of Commons), P. Snowden (exchequer), A. Henderson (foreign affairs), J. R. Clynes (home office), Sidney Webb (Lord Passfield) (colonies and dominions), Shaw (war), Wedgwood Benn (India), Thomson (air), A. V. Alexander (admiralty), W. Graham (board of trade), C. P. Trevelyan (education), A. Greenwood (health), Noel-Buxton (agriculture), Margaret Bondfield (labour), G. Lansbury (first Comm. of Works), W. Adamson (Scotland) and O. Mosley (Duchy of Lancaster).

A year later, in June 1930, Mr. Thomas was transferred to the Dominions Office which in view of the approaching Imperial Conference was separated from the Colonies: Mr. Hartshorn becoming Lord Privy Seal, and Dr. Addison Minister of Agriculture.

MacDonald at once resumed the peace work begun in 1924. The Optional Clause was signed in Sept. 1929 and the evacuation of the Rhineland secured, while normal relations with Russia were resumed. His visit to the U.S.A. paved the way for the Naval Treaty of April 1930, carrying out limitation of all categories, as between Britain, the U.S. and Japan, and reaching agreement on many points also with France and Italy. Work at home—a new Pensions Act, a new Unemployment Insurance Act, a Coal Mines Bill—was overshadowed by the mounting unemployment figures due to the world-wide slump. To help in dealing with this great issue MacDonald appointed an Economic Advisory Committee, and, in the summer of 1930, invited the "emergency" co-operation of the other parties.

MacDonald's contribution to British political history cannot be measured unless it is noted that he made the Labour Party, which he assisted to create, the vehicle of a new political philosophy. His socialism has modified opinion over a wider range than that of professed adherents.

On the formation of the National Government in 1931, when most of his socialistic colleagues resigned, MacDonald remained prime minister, retaining this office after the general election of that year. He presided over the Lausanne Conference, 1932, and the World Economic Conference, 1933. In June 1935, for reasons of health, he resigned the premiership to Stanley Baldwin, but remained in the cabinet as lord president of the council. He died Nov. 9, 1937 in mid-Atlantic enroute to South America for a rest.

MacDonald's views on socialism can best be studied in his books. Among them the more important are: *Socialism and Society* (1905); *Socialism and Government* (1909); *The Awakening of India* (1911); *The Socialist Movement* (1911); *Syndicalism* (1912); *The Social Unrest* (1913); *National Defence* (1917); *Parliament and Revolution* (1919); *Parliament and Democracy* (1919); *The Government of India* (1919); *A Policy for the Labour Party* (1920); and *Socialism, Critical and Constructive* (1921). In addition, his biography of his wife, *Margaret Ethel MacDonald* (1912); and a volume of essays and travel pictures, *Wanderings and Excursions* (1925) may also be mentioned. *See* C. W. Mullins, *The Patriotism of Ramsay MacDonald and Others* (1916); L. N. Le Roux, *J. Ramsay MacDonald, Sa vie, son oeuvre et sa pensée* (1919); "Iconoclast" (M. A. Hamilton) *The Man of Tomorrow, J. Ramsay MacDonald* (1923); *J. Ramsay MacDonald, 1923–25* (1925); H. Tracey, *From Doughty Street to Downing Street. The Rt. Hon. J. Ramsay MacDonald, M.P.* (1924); J. Bardoux, *J. Ramsay MacDonald* (1924); G. Glasgow, *MacDonald as Diplomatist* (1924); U. D. C. *The Diplomacy of Ramsay MacDonald* (1925). (M. A. H.)

MACDONALD, SIR JOHN ALEXANDER (1815–1891), first premier of the dominion of Canada, was born in Glasgow on Jan. 11, 1815, the third child of Hugh Macdonald (d. 1841), a native of Sutherlandshire. The family emigrated to Canada in 1820, settling first at Kingston, Ontario. At the age of fifteen Macdonald entered a law office; he was called to the bar in 1836, and began practice in Kingston, with immediate success.

In 1844 Macdonald was elected to the provincial assembly as Conservative member for Kingston. A sentence in his first address to the electors strikes the dominant note of his public career: "I therefore need scarcely state my firm belief that the prosperity of Canada depends upon its permanent connection with the mother country, and that I shall resist to the utmost any attempt (from whatever quarter it may come) which may tend to weaken that union." In 1847 he was made receiver-general with a seat in the executive council.

One of the first acts of the Reform government which succeeded that of which Macdonald was a member was to pass the Rebellion Losses Bill. In the controversy on the British connection which followed that event, Macdonald helped to found a British-American league, having for its object the confederation of all the provinces, the strengthening of the connection with the mother country, and the adoption of a national commercial policy. He remained in opposition from 1848 till 1854, holding together under difficult circumstances an unpopular party with which he was not entirely in sympathy. The two great political issues of the time were the secularization of the clergy reserves in Ontario, and the abolition of seigniorial tenure in Quebec. Both of these reforms Macdonald long opposed, but when successive elections had proved that they were supported by public opinion, he brought about a coalition of Conservatives and moderate reformers for the purpose of carrying them. Out of this coalition was gradually developed the Liberal-conservative party, of which until his death Macdonald continued to be the most considerable figure, and which for more than forty years largely moulded the history of Canada. From 1854 to 1857 he was attorney-general of Upper Canada, and then, on the retirement of Colonel Taché, he became prime minister.

At this critical period of Canadian history a proposal was made for a coalition of parties in order to carry out a broad scheme of British-American confederation. Macdonald, at the head of a representative delegation from Ontario and Quebec, met the public men of the maritime provinces in conference at Charlottetown in 1864, and the outline of confederation then agreed upon was filled out in detail at a conference held at Quebec soon afterwards. The actual framing of the British North America Act, into which the resolutions of these two conferences were consolidated, was carried out at the Westminster Palace Hotel in London, during December 1866 and January 1867, by delegates from all the provinces working in co-operation with the law officers of the Crown, under the presidency of Lord Carnarvon, then secretary of state for the colonies. Macdonald took the leading part in all these discussions, and he thus naturally became the first premier of the Dominion. He was made a K.C.B. in recognition of his services to the empire.

The difficulties of organizing the new Dominion, the questions arising from diverse claims and the various conditions of the country, called for infinite tact and resource on the part of the premier. Federal rights were to be safeguarded against the provincial governments, always jealous of their privileges. The pledge made at confederation with regard to the building of the Intercolonial railway to connect the maritime provinces with those of the St. Lawrence was fulfilled. The North-West Territories were secured as a part of confederated Canada by the purchase of the rights of the Hudson's Bay Company, and the establishment of Manitoba as a province in 1870. Canada's interests were protected during the negotiations which ended in the Treaty of Washington in 1871, and in which Macdonald took a leading part as one of the British delegates. In this year British Columbia entered the confederation, one of the provisions of union being that a transcontinental railroad should be built within ten years. This was declared by the opposition to be impossible. It was possible only to a leader of indomitable will. Charges of bribery against the government in connection with the contract for the building of this line led to the resignation of the cabinet in 1874, and for four years Macdonald was in opposition.

During the summer of 1876 he travelled through Ontario addressing the people on the subject of a commercial system looking to the protection of native industries. This was the celebrated "National Policy," which had been in his thoughts as long ago as the formation of the British-American League in 1850. The government of Alexander Mackenzie refused to consider a protection policy, and determined to adhere to Free Trade, with a tariff for revenue only. On these strongly defined issues the two parties appealed to the people in 1878. The Liberal party was almost swept away, and Macdonald, on his return to power, put his policy into effect with a thoroughness that commanded the admiration even of his opponents, who, after long resistance, adopted it on their accession to office in 1896. He also undertook the immediate construction of the Canadian Pacific railway, which had been postponed by the former government. The line was begun in 1880, and finished in November 1885—an achievement which Macdonald ranked among his greatest triumphs.

During the remaining years of his life his efforts at administration were directed mainly towards the organization and development of the great North-West. From 1878 until his death in 1891 Macdonald retained his position as premier of Canada, and his history is practically that of Canada (*q.v.*). For forty-six years of a stormy political life he remained true to the cardinal policy that he had announced to the electors of Kingston in 1844. "A British subject I was born; a British subject I will die," says his last political manifesto to the people of the Dominion. At his advanced age the anxiety and excitement of the contested election of 1891 proved too great. On May 29, he suffered a stroke of paralysis and died on June 6.

A condensed biography by G. R. Parkin forms one of the "Makers of Canada" series (Toronto, 1907; new ed., 1909). *See* also Sir J. Pope, *The Day of Sir John Macdonald* (Toronto, 1915).

MACDONALD, JOHN SANDFIELD (1812–1872), Canadian statesman, was born at St. Raphael, Glengarry county, Ontario, on Dec. 12, 1812. He was admitted to the bar in 1840, and settled in Cornwall. In 1841 he was elected to the Canadian parliament for Glengarry, which seat he held for 16 years. In 1842 he joined the Reformers in the cry for constitutional government, and from 1852 to 1854 was Speaker of the house. He was always uncertain in his party allegiance, and often attacked George Brown, the Liberal leader. In 1862 he was called on by Lord Monck, the governor-general, to form a ministry, which by manifold shifts held office till Feb. 1864. In the debates on federation he opposed the measure, but on its passage was in 1867 entrusted by the Conservatives with the task of organizing the provincial Government of Ontario. He ruled the province with economy and efficiency, but was defeated in Dec. 1871 by the Liberals, resigned the premiership, and died on June 1, 1872.

MACDONELL, SIR JOHN (1846–1921), British jurist, was born at Brechin, Forfarshire, on Aug. 11, 1846, and was educated at the universities of Aberdeen and Edinburgh. In 1901 he was made Quain professor of comparative law in the University of London and he was president of the society of public teachers of law (1912–13), a member of several royal commissions, and editor, for many years, of *The Journal of Comparative Legislation and International Law*. In 1913 he was elected a fellow of the British Academy and in 1914 was created K.C.B. Besides editing the *State Trials* (1887), the *Civil Judicial Statistics* (from 1894) and the *Criminal Judicial Statistics* (from 1900), he published works on the subjects of capture at sea and the law of master and servant, and was the author of many papers on international law. He was also for 40 years a leader writer on *The Times*, London. He died in London on March 17, 1921.

MACDONNELL or **MACDONELL, ALESTAIR** (*i.e.,* ALEXANDER), **RUADH** (*c.* 1725–1761), chief of Glengarry, a Scottish Jacobite. The family was a branch of the clan Macdonald. Alestair ran away when a boy and entered the Royal Scots, a regiment in the French service, being sent to Scotland as a Jacobite agent in 1744. He was in France in Jan. 1745 when Prince Charles Edward landed in Scotland. Later in the year he was captured at sea while bringing help to the prince, and imprisoned for 22 months in the Tower. He then went abroad, but in 1749 he was again in London, and is believed to have acted as spy to the British Government, under the name of Pickle, enabling a close watch to be kept on the prince and on the Jacobite conspiracies. He died on Dec. 23, 1761.

See Andrew Lang, *Pickle the Spy* (1897), and *The Companions of Pickle* (1898).

MacDONNELL, ANTONY PATRICK (1844–1925), Indian and Irish administrator, was born in Co. Mayo on March 7, 1844, and educated at Athlone and at Queen's college, Galway. He entered the Indian Civil Service in 1864, and was sent to Bengal in 1865. His book, *Food Grain Supply and Famine Relief in Bihar and Bengal,* dealt with his experiences during the Bengal famine of 1873. He held successively the posts of secretary to the Bengal Government, home secretary, acting chief commissioner of Burma, chief commissioner of the Central Provinces (1890), member of the Government of India, and lieutenant-governor of the united provinces of Agra and Oudh. His particular interest was in the agrarian policy of India, and he was responsible for many reforms in the legislation affecting native tenants and cultivators. His six years' administration of the Central Provinces proved him to be a capable administrator, but his determined methods led to many misunderstandings with his subordinates. He experienced difficulties with the natives also on his introduction of Nagri (Hindi) script in place of Urdu in the courts, and Muslim political agitation has been traced to this cause. In 1897 MacDonnell personally organized the relief measures during the serious famine, and in 1901, just before the end of his term of office, he was made president of the Famine commission, and drew up the report which has become a standard authority. In Jan. 1903 he became member of the Indian Council, and of the privy council.

MacDonnell was then made under-secretary for Ireland, but with special powers over administration. His tenure of office at first appeared successful, but Wyndham, the chief secretary, was forced to resign on the question of Lord Dunraven's Devolution Act, of which MacDonnell was one of the principal authors. MacDonnell remained in office until 1908, but his special powers were annulled. On his resignation he was raised to the peerage as Lord MacDonnell of Swinford. In the House of Lords he took an active part for many years in the discussion of Irish and Indian problems, and in Aug. 1920 he attended the Irish Peace Conference in Dublin. He died on June 9, 1925, the peerage becoming extinct.

MACDONNELL, ARTHUR ANTHONY (1854–1930), English Sanskrit scholar, was born on May 11, 1854, and educated at Göttingen and at Corpus Christi college, Oxford. From 1880 to 1900 he was Taylorian teacher of German at Oxford, and from 1888 to 1899 deputy professor of Sanskrit. In 1922 he was appointed Stephanos Nirmalendu Ghosh lecturer on Comparative Religion at Calcutta.

His numerous publications include: critical editions of the *Sarvānukramani* and the *Anuvakānukramanī,* with Shadgurucishya's commentary (1886); *A History of Sanskrit Literature* (1900); the *Brihaddevata,* the first translation and critical edition (2 vols. 1904); Sanskrit and Vedic Grammars, and numerous articles.

MACDONNELL, SORLEY BOY (*c.* 1505–1590), Scoto-Irish chieftain, son of Alexander Macdonnell, lord of Islay and Kintyre (Cantire), was born at Ballycastle, Co. Antrim. From an ancestor who had married Margaret Bisset, heiress of the district on the Antrim coast known as the Glynns (or Glens), he inherited a claim to the lordship of that territory; and he was one of the most powerful of the Scottish settlers in Ulster whom the English Government tried to bring into subjection. He took an active part in the tribal warfare between his own clan and the MacQuillins, and by defeating the latter at Glenshesk in 1558, acquired the lordship of the Route. He was now too powerful to be neglected by Elizabeth and her ministers, who were also being troubled by his great contemporary, Shane O'Neill. Elizabeth aimed at fomenting the rivalry between the two men, and came to terms sometimes with the one and sometimes with the other. Shane O'Neill defeated Sorley Boy near Coleraine in 1564; in 1565 he invaded the Glynns, and at Ballycastle won a decisive victory, in which James Macdonnell and Sorley Boy were taken prisoners. James soon afterwards died, but Sorley Boy remained O'Neill's captive till 1567, when Shane was murdered by the Macdonnells at Cushendun (*see* O'NEILL). After the massacre of his family by the English in 1575, Sorley Boy made a successful raid on Carrickfergus and re-established his power in the Glynns and the Route. His position was further strengthened by an alliance with Turlough Luineach O'Neill, and by a formidable immigration of followers from the Scottish islands. In 1585 he regained possession of Dunluce castle. Sir John Perrot reluctantly opened negotiations with Sorley Boy, who in 1586 made submission to Elizabeth's representative. He obtained a grant to himself and his heirs of all the Route country between the rivers Bann and Bush, with certain other lands to the east, and was made constable of Dunluce castle. For the rest of his life he gave no trouble to the English Government.

See G. Hill, *An Historical Account of the Macdonnells of Antrim* (1873); R. Bagwell, *Ireland under the Tudors* (3 vols., 1885–90); *Calendar of State Papers: Carew MSS.* i., ii. (6 vols., 1867–73); D. Gregory, *History of the Western Highlands and Isles of Scotland 1493–1625* (1881); Sir J. T. Gilbert, *History of the Viceroys of Ireland* (1865).

MACDONOUGH (măk-dŏn′ō), **THOMAS** (1783–1825), American sailor, born in Delaware, his father being an officer of the Continental Army, entered the U.S. Navy, 1800. During his long service as a lieutenant he took part in the bombardment of Tripoli, and on a subsequent occasion showed great firmness in resisting the seizure of a seaman as an alleged deserter from the British Navy, his ship at the time lying under the guns of Gibraltar. When war with England broke out, in 1812, he was ordered to cruise in the lakes between Canada and the United States, with his headquarters on Lake Champlain. He was instrumental in saving New York and Vermont from invasion by his brilliant victory of Lake Champlain gained on Sept. 11, 1814, with a flotilla of 14 vessels carrying 86 guns, over Capt. George Downie's 16 vessels and 92 guns. For this important achievement New York and Vermont granted him estates, and Congress gave him a gold medal.

MacDOWELL, EDWARD ALEXANDER (1861–1908), American musical composer, was born in New York city on Dec. 18, 1861. His parents, who were Irish, had emigrated to America from Belfast shortly before the boy's birth. He had a varied education in music, first under Spanish-American teachers, and then in Europe, at Paris (Debussy being a fellow pupil), Stuttgart, Wiesbaden and Weimar, where he was chiefly influenced by Joachim, Raff and Liszt. From 1879 to 1887 he lived in Germany, teaching and studying, and also appearing as solo pianist at important concerts. In 1884 he married Marian Nevins, of New York. He returned to America in 1888, and settled in Boston until 1896 when he was made professor of music at Columbia university, New York. This post he resigned in 1904, and in 1905 overwork and insomnia resulted in a complete cerebral collapse. He died on Jan. 24, 1908. MacDowell's work gives him perhaps the highest place among American composers. Deeply influenced by modern French models and by German romanticism, full of poetry and "atmosphere," and founded on the "programme" idea of composition, it is essentially creative in the spirit of a searcher after delicate truths of artistic expression. His employment of touches of American folk-song, suggested by Indian themes, is characteristic. This is notably the case with his orchestral *Indian Suite* (1896) and *Woodland Sketches* for the piano.

See Lawrence Gilman, *Edward MacDowell* (1906).

McDOWELL, IRVIN (1818–1885), American soldier, was born in Columbus, O., on Oct. 15, 1818. He was educated in France, and graduated at the U.S. military academy in 1838. From 1841 to 1845 he was instructor, and later adjutant, at West Point. He won the brevet of captain in the Mexican War at the battle of Buena Vista, and served as adjutant-general, chiefly at Washington, until 1861, being promoted major in 1856. While occupied in mustering volunteers at the capital, he was made brigadier-general in May, 1861, and placed in command during the premature Virginian campaign of July, which ended in the defeat at Bull Run. Under McClellan he became a corps commander and major-general of volunteers (March 1862). When the Peninsular campaign began McDowell's corps was detained against McClellan's wishes, sent away to join in the fruitless chase of "Stonewall" Jackson in the Shenandoah valley, and eventually came under the command of Gen. Pope, taking part in the disastrous campaign of Second Bull Run. Involved in Pope's disgrace, McDowell was relieved of duty in the field (Sept. 1862), and served on the Pacific coast 1864–68. He became, on Meade's death in 1872, major-general of regulars, and commanded various divisions until his retirement in 1882. As a commander he was uniformly unfortunate. Undoubtedly he was a faithful, unselfish and energetic soldier, and in patriotic sympathy with the administration. It was his misfortune to be associated with the first great disaster to the Union cause, and finally to be involved in the catastrophe of Pope's campaign. That he was perhaps too ready to accept great risks at the instance of his superiors is the only just criticism to which his military character was open. He died in San Francisco on May 4, 1885.

See James Kendall Hosmer, *The Appeal to Arms, 1861–63,* in "American Nation" series, vol. xx. (1907).

MACDUFF, small burgh and seaport, Banffshire, Scotland, on the Deveron, 1 mi. E. of Banff and 50¼ mi. N.W. of Aberdeen by the L.N.E.R. Pop. (est. 1938) 3,283. The site was formerly occupied by the fishing village of Doune, but after its purchase by the 1st earl of Fife, about 1732, the name was altered to Macduff by the 2nd earl. In honour of its constitution as a burgh in 1783 he rebuilt the market cross in front of the parish church. Behind it is a World War I memorial in the shape of a tower 70 ft. high. The harbour is safer and more accessible than that of Banff. The inhabitants are chiefly employed in the herring fishery. Grain and fish are exported and coal imported. A stone bridge across the Deveron connects with Banff. Good bathing, a bracing climate and a mineral well attract numerous visitors.

McDUFFIE, GEORGE (*c.* 1788–1851), an American statesman, of South Carolina, was the son of John and Jane McDuffie, energetic, intelligent and unspoiled Scots who had migrated to Georgia after the Revolution. George was born about 1788 or 1790 (authorities differ) near Augusta. In 1804 Calhoun and Wilson, of Augusta, employed him as a clerk; and in 1810 William Calhoun, brother of James and John C. Calhoun (*q.v.*) took him into his family and sent him to Willington academy. George McDuffie justified the expectations of his patron. He graduated from South Carolina college in 1813, was called to the bar in 1814, and after a brief period of preliminary experience in law and politics entered into a partnership with Col. Eldred Simkins, of Edgefield, who possessed a good library and large practice. He secured election to the State Legislature in 1818, and to Congress in 1821.

In the national House of Representatives he won distinction and served continuously on important committees until 1834. While the Calhoun influence was strong upon him, George McDuffie maintained a vigorous intellectual independence which displayed itself in facile writing, strong debating, and an intense, rapid and fiery but logical oratory; also, in his gradual change from liberal construction to strict construction he was in advance of his contemporaries. In the end he was a free trader after the heart of Thomas Cooper, a believer in the right of revolution like Patrick Henry, supporting nullification on revolutionary rather than on constitutional grounds, and an opponent of internal improvements. But he was the leader of "the bank interest" in the house. In 1834 he denounced the Jackson administration, retired from Congress, and served as governor of South Carolina, 1834–36, with marked effectiveness, giving particular attention to the compilation of the statute laws of the State and to the reorganization of South Carolina college. He did something to promote Southern "direct trade with Europe," and while in England in the spring of 1839 was invited by J. B. Smith to participate in free trade activities of the Anti-Corn Law League, but this he declined.

In Dec. 1842 George McDuffie was elected to the U.S. Senate, where he helped to bring about the annexation of Texas, the "amicable adjustment" of the Oregon question with Great Britain and the passage of the low Walker tariff of 1846, displacing the high Whig tariff of 1842 almost in conjunction with the repeal of the British corn laws. Indeed, his bust was sent with Calhoun's to the Free Trade Hall at Manchester during this period of intimate relations between the free traders of both countries. McDuffie's public services practically ended with these adjustments in Anglo-American relations; for an old wound in the spine received in a duel in 1822 compelled him to resign his seat in the

Senate, Aug. 17, 1846. He died at Cherry Hill, in the Sumter district of South Carolina, on March 11, 1851. He had married in 1829, but his wife had died within a year, leaving him an only daughter, Mary, who became the wife of Gen. Wade Hampton.

There is no biography of George McDuffie, but *see* J. B. O'Neall, *Bench and Bar of South Carolina,* ii. (1859), 463–468; and D. F. Houston, *Nullification in South Carolina* (1896), *passim* which still contains the best sketches and estimates available. (T. P. Ma.)

MACE, originally a weapon of offence, made of iron, steel or latten, capable of breaking through the strongest armour. The mace was carried in battle by mediaeval bishops (Odo of Bayeux is represented on the Bayeux tapestry as wielding one) instead of the sword, so as to conform to the canonical rule which forbade priests to shed blood. The earliest *ceremonial* maces, as they afterwards became, though at first intended to protect the king's person, were those borne by the serjeants-at-arms, a royal body-guard established in France by Philip II., and in England probably by Richard I. By the 14th century a tendency towards a more decorative serjeant's mace, encased with precious metals, is noticeable. The history of the civic mace (carried by the serjeants-at-mace) begins about the middle of the 13th century, though no examples of that period are in existence to-day. Ornamented civic maces were considered an infringement of one of the privileges of the king's serjeants, who, according to the Commons' petition in 1344, were alone deemed worthy of having maces enriched with costly metals. This privilege was, however, granted to the serjeants of London, and later to those of York (in 1396), Norwich (in 1403–4) and Chester (in 1506). Maces covered with silver are known to have been used at Exeter in 1387–8; two were bought at Norwich in 1435, and others for Launceston in 1467–8. Several other cities and towns had silver maces in the next century, and in the 16th they were almost universally used. As the custom of having serjeants' maces ceased (about 1650), the large maces, borne before the mayor or bailiffs, came into general use. Thomas Maundy was the chief maker of maces during the Commonwealth. He made the mace for the House of Commons in 1649, which is the one at present in use there, the original head having been replaced by one with regal symbols at the Restoration. There are two maces in the House of Lords, the earliest dating from the reign of William III. The eight large and massive silver-gilt maces of the serjeants-at-arms, kept in the jewel-house at the Tower of London, are also of the type which was almost universally adopted, with slight differences, at the Restoration. The civic maces of the 18th century follow this type, with some modifications in shape and ornamentation. The historic silver maces of the 18th century include the one of 1753 at Norfolk, Virginia, and that of 1756 of the State of South Carolina, both in the United States of America.

Among other maces, more correctly described as staves, in use at the present time, are those carried before ecclesiastical dignitaries and clergy in cathedrals and parish churches and the maces of the universities. At Oxford there are three of the second half of the 16th century and six of 1723–24, while at Cambridge there are three of 1626 and one of 1628, but altered at the Commonwealth and again at the Restoration. The silver mace with crystal globe of the lord high treasurer of Scotland, at Holyrood palace, was made about 1690. The remarkable mace or sceptre of the lord mayor of London is of crystal and gold and set with pearls; the head dates from the 15th century, while the mounts of the shaft are early mediaeval.

Bibliography.—Jewitt and Hope, *Corporation Plate and Insignia of Office,* etc. (2 vols., 1895); J. R. Garstin, *Irish State and Civic Maces,* etc. (1898); E. Alfred Jones, *Old Plate at the Tower of London* (1908). (E. A. J.; X.)

MACEDO, JOSE AGOSTINHO DE (1761–1831), Portuguese poet and prose writer, was born at Beja of plebeian family, and became professed as an Augustinian in 1778, but owing to his turbulent character he spent a great part of his time in prison, and was constantly being transferred from one convent to another. In 1792 he was unfrocked, but by the aid of powerful friends he obtained a papal brief which gave him the status of a secular priest. In a short time he was recognized as the leading pulpit orator of the day, and in 1802 he became one of the royal preachers. Macedo was the first Portuguese writer of didactic and descriptive poetry, the best example of which is his notable transcendental poem *Meditation* (1813). In 1814 he produced *Oriente,* an insipid epic dealing with the same subject as the *Lusiads*—Gama's discovery of the sea route to India. Macedo founded and wrote for a large number of journals, and the tone and temper of these and his political pamphlets induced his leading biographer to name him the "chief libeller" of Portugal. His overweening ambition led to his famous conflict with Bocage (*q.v.*), whose poem *Pena de Talião* was perhaps the hardest blow Macedo ever received. His malignity reached its height in a satirical poem in six cantos, *Os Burros* (1812–14), in which he pilloried by name men and women of all grades of society, living and dead, with the utmost licence of expression. The odes on Wellington and the emperor Alexander show true inspiration, and the poems in his *Lyra anacreontica,* addressed to his mistress, have merit.

See *Memorias para la vida intima de José Agostinho de Macedo* (ed. Th. Braga, 1899); *Cartas e opusculos* (1900); *Censuras á diversas obras* (1901).

MACEDONIA, a stretch of territory in the Balkan peninsula which till the outbreak of the Balkan wars was included in European Turkey. Since Macedonia has never been a political or administrative unit in modern times it is impossible to assign precise boundaries. About its general position there is no doubt. Between the western edge of the Rhodope upland, that is broadly the western frontier of Bulgaria, and the hills which stretch from the Šar mountains southwards to the Pindus range lies an area in which extensive depression has occurred. To the south, in the Gulf of Salonika, the sinking of the land has been sufficient to submerge it below sea-level, but north of the Gulf the depression has been partial and incomplete. At no very distant date, geologically speaking, it was sufficient to lead to the flooding of large tracts by fresh water, giving rise to extensive lakes. Some of these lakes remain, but the rivers, particularly the Vardar and its affluents, have been able to cut down the bounding sills sufficiently to drain many of these earlier lakes, and leave in their place level, fertile basins.

The zone of depression is not confined to the area directly north of the Gulf of Salonika but is continued to the east in the area between the Rhodope upland and the Aegean, where it includes the basin of Seres in the lower Struma valley, the basins of Drama and Kavalla further east, and others. The eastern limit, that is the boundary between Macedonia and Thrace in this coastal strip, is usually taken as the River Mesta, though some writers extend Macedonia as far eastward as the lower course of the river Maritza.

The northern frontier of Macedonia is the Crna Gora, the western the mountains on the Albanian frontier beginning with the Šar Planina and continuing S. of L. Prespa to Mt. Grammos. Here the boundary may be said to swing south-east along the right bank of the river Vistritza to reach the sea at Mt. Olympus. To the east of the Crna Gora the boundary is the edge of the Rhodope upland, or more precisely it is formed successively by the Osogov, Maleš and Pirin Mts., with a somewhat artificial eastern limit on the lower course of the Mesta. On the Aegean coast the Khalkidike peninsula with its three prongs is included.

The area so limited is not, however, a unit, but falls into an eastern and western section. The division line is a belt of mountain country having as important elements the Nidže Planina to the south-east of Bitolj (Monastir), which includes the peak of Kajmakčalan on the present Serbian-Greek frontier, and the Babuna Mts. to the north. To the west of this mountain tract the basins cover a smaller area than the surrounding mountains, so that the impression produced is that of a hill country. The basins also lie at a comparatively high level, that of Lake Prespa at about 3,000 ft., and since the climate approaches the continental type, with summer rains and often copious winter snowfall, the chief crops are cereals, while the extensive pastures support large flocks. The fish of the lakes also afford an accessory food-supply. Among the chief basins are the Ohrid (Okhrida) and Prespa, which retain the original lakes; that of Pelagonia containing the town of

Bitolj, which has been drained by the Upper Černa; that of Morichovo along the lower Černa; that of Debar on the Black Drim, and so on.

The eastern section presents striking contrasts. Here the basins are at a lower level, their floors sinking as the Aegean is approached. A whole series, from the basin of Skoplje and the Ovče Polje ("sheep field") in the north to the Campania of Salonika in the south are strung along the River Vardar, and are traversed by an important line of communication. Even those grouped round the distinct river system of the Struma have direct and open communication with the Vardar series, this ease of communication marking a contrast with the relative isolation of the western basins, sunk in the hill country.

Because depression has been greatest near the Aegean, Mediterranean influences penetrate towards the interior here, affecting both the climate and the crops. Thus irrigation is often necessary for summer crops, and has been practised for a prolonged period. The prevailing cereals of the west give place to a much greater variety of products, including the vine, the mulberry for silk production, and fruit-trees, especially the fig, as well as crops like cotton, tobacco, poppy, red peppers, maize, rice, and a great number of vegetables.

The Political Problem.—The foregoing facts form the basis of the problem of Macedonia; for Macedonia is rather a political problem than a geographical entity. But to them must be added a note on Salonika, at once the chief city of Macedonia and yet not, strictly speaking, Macedonian; for it owes its importance to causes wider than purely local ones. Under the Turks a mainly Jewish population handled here the import and export trade of a large part of the peninsula. As the Turk retreated, however, the town became an object of desire to Serbia and Bulgaria, both seeking outlets to open water, and to Greece, jealous of the control of Aegean trade. All three also, after the annexation of Bosnia and Hercegovina, feared a further advance on the part of Austria-Hungary.

In Turkish, as in Byzantine times, the high basins of the west, and much more the lower and more productive ones of the Vardar-Struma region, made Macedonia a highly-valued possession. Since the great highway which follows the Vardar valley is continued along the seaboard through Thrace to Constantinople, it was a relatively easy matter to hold it, so long as military power was unimpaired. Further, the fact that some of the main routes of the peninsula pass through Macedonia made it essential that any empire based on Constantinople should hold the region, altogether apart from its productivity. It is sufficient to note that Albania, Bosnia, Hercegovina and Old Serbia could only be reached from the Turkish capital through Macedonia.

In Turkish times the Christian cultivators of the basins felt the full weight of Turkish misrule, all the more because escape was impossible, the over-lords being widely spread along the lines of the highways. The question of the actual composition of the population was a difficult one, even before it was complicated by propaganda on the part of the nationalities concerned, and forced or voluntary movements. There was, and still is in places, a considerable Muslim element, not necessarily ethnically Turkish, but sharing in the privileges of the ruling race. Since the mountainous country in the west was no barrier to the Albanians, who appear to prefer hilly areas, and since further the Turkish administration showed little desire to interfere either with Albanian raiding or Albanian settlement at the expense of the Macedonian peasants, there was a considerable Albanian element.

The nomadic Vlachs, moving with their flocks from the high pastures in the warmer season to the low-lying ones near the Aegean in the colder one, found in Macedonia a region peculiarly fitted to their mode of life. Neither here nor elsewhere in the peninsula, however, do they enter to any extent into the nationality problem, being easily assimilated, and having no contiguous homeland to serve as a centre of propaganda. Even in Turkish times there appears to have been a considerable infiltration of Greek peasants from the south, especially in those areas which approximate in climate, natural vegetation and cultivated crops the Greek lands proper. Here also, as elsewhere, the Greeks tended to be town dwellers, owing to their instinct for trade. The mass of the peasant cultivators are generally believed to have always been Bulgarian or modified Bulgarian. A true Serb element was probably never large, but the memories of mediaeval Serbia and of the heroic if unavailing stand made by the Serbs against the first advance of the Turks gave Serbia a sentimental claim, and the Serbs also assert that the greater part of the population is modified Slav rather than truly Bulgarian.

Division.—Absence of physical unity in Macedonia, and of focal point, combined with its value to Turkey, made it impossible that the Macedonians could free themselves as did Serbia, Greece and Bulgaria. When Turkish power crumbled unexpectedly under a combined attack it was inevitable that the victors should quarrel over the spoil in Macedonia. The Balkan wars, followed by World War I, led to a division of the area between Greece and Serbia, to the exclusion of Bulgaria. The Serbo-Greek frontier ran from the southeast end of Lake Prespa in a northeasterly direction to the neighbourhood of Lake Dojran where it met the frontier between Greece and Bulgaria. Thus southern Macedonia became Greek, and northern Macedonia Serbian. In Greek Macedonia the interchange of populations between Turkey and Greece resulted in increased homogeneity, and the necessity for settling the large number of immigrants led Greece to make great efforts to develop the resources of the region. In Serbian Macedonia the number of true Serbs was apparently small, and though the Muslims there continued to emigrate to Asia Minor, the characteristic unrest of the area prior to World War II did not die down, so that the Macedonian problem was not wholly solved.

Bitolj, the largest town, had a population of 80,000 in 1912, which fell to 45,000 in 1914, and at the last census before World War II was only 33,024 (March 31, 1931). The attempts to Slavize the Bulgarian element in Serbian Macedonia apparently led to a recrudescence of anti-Serb feeling, but it has to be remembered that Serbia was now merged in the much greater kingdom of Yugoslavia, which had serious problems to face elsewhere, and had comparatively little energy to spare for Macedonia. Serbian Macedonia also was of far less importance to Yugoslavia than was Greek Macedonia to the new Greece.

As a result of the German conquest of Yugoslavia and Greece in 1941, Bulgarian troops occupied the whole of Macedonia and incorporated it into Bulgaria.

Bibliography.—Brailsford, *Macedonia* (1906); Cvijić, *La Péninsule Balkanique* (1918); Bouchié de Belle, *La Macédoine et les Macédoniens* (1922); Ancel, *Peuples et Nations des Balkans* (1926, bibl. French only); J. H. Schultze, *Neugriechenland: eine Landeskunde Ostmakedoniens* (Gotha, 1937).

HISTORY

Early History.—(For the history of ancient Macedonia, *see* Macedonian Empire.) Soon after its conquest by the Romans, Macedonia was constituted a province (146 B.C.); on the partition of the Roman empire, it was assigned to the eastern branch. The original Thraco-Illyrian inhabitants were largely, though not wholly, Latinized or Graecized; Latin was chiefly spoken in the north, Greek near the coast, where Greek colonies were numerous. Invasions of Goths, Huns, Vandals and Avars, from the 4th century on, left no permanent mark on the country, beyond devastating it; but the Slavs, who entered the Balkans in the 5th and 6th centuries, colonized nearly all Macedonia, a few spots only remaining Greek. It was invaded by the Bulgars under their tsar, Krum (802–814) and became part of the first Bulgarian empire under Symeon (893–927), with the exception of Salonika and the seaboard; but in 963, on the decay of the Bulgarian empire, the Slavs of Macedonia, under the comes Nikola, revolted and made themselves independent. The third ruler of Nikola's dynasty, Tsar Samuel, founded a second "Bulgarian" empire, which extended over much of the Balkans with its capital at Prespa; but on his death, in 1014, Macedonia, which had been partially Bulgarized, came again under Byzantium. Various Asiatic elements were now introduced into the population; Turkish immigrants, afterwards known as Vardariotes, the first of their race to appear in Macedonia, had been settled near Salonika in the 9th century; colonies of Petchenegs, Uz and Cumans (all three Turkish tribes of kindred origin) were established in the succeeding centuries. About this period appeared the first traces of the Albanians, who were probably descendants of Thracian tribes; and of the Vlachs (*q.v.*), who are mentioned in the 9th, more frequently the 10th century, and in the 12th founded the State of "Great Walachia" in Thessaly. In 1185 William of Sicily captured and sacked Salonika. After the capture of Constantinople in 1204, the Latin kingdom of Thessalonica was bestowed on Boniface of Montferrat, who held it until expelled in 1223 by Theodore Angelus, despot of Epirus, who styled himself emperor of Thessalonica, and ruled over almost all Macedonia. He was defeated in 1230 by the Bulgarian tsar, Ivan Asen II (*see* ASEN), who reincorporated northern and central Macedonia in the second Bulgarian or Bulgaro-Vlach empire; the remainder of Macedonia being absorbed in the Nicean (Byzantine) empire in 1246. The power of Bulgaria declined rapidly on the extinction of the direct line of Asenidae. Northwestern Macedonia came again under the despotate of Epirus. Meanwhile the Serbian state was growing strong. Stephen Uroš II Milutin took Skoplje, made it his capital, and conquered northwest Macedonia; and Stephen Dušan (1331–55) conquered all Macedonia, except Salonika, with Thessaly, Epirus and parts of Bulgaria. Northern Macedonia was known henceforward as "Old Serbia."

Macedonia Under the Turks.—Most of Macedonia came under Turkish rule in 1371; Prilep in 1373, Serres in 1385. After the final defeat of the Balkan Slavs at Kossovo, its fate was sealed. Salonika was taken in 1387, and again in 1391–1407. It was finally taken, after a seven years' Venetian occupation, in 1430, and its inhabitants massacred. The towns in the Struma valley were yielded to the Turks by John VII. Palaeologos in 1424. Large tracts of land were distributed among the Ottoman chiefs; a system of feudal tenure was developed by Mohammed II (1451–81), each fief furnishing a certain number of armed warriors. The Christian peasant owners remained on the lands assigned to the Muslim feudal lords, to whom they paid a tithe. The condition of the subject population was deplorable from the first, and became worse during the period of anarchy which coincided with the decadence of the central power in the 17th and 18th centuries despite efforts to improve it by the grand viziers Mohammed and Mustafa Koprülü. The country was policed by the janissaries (*q.v.*). Numbers of the peasant proprietors were ultimately reduced to serfdom, working as labourers on the farms of the Muslim beys. Towards the end of the 18th century many of the local governors became practically independent; western Macedonia fell under the sway of Ali Pasha of Iannina; at Serres, Ismail Bey maintained an army of 10,000 men and exercised a beneficent despotism. The reforms embodied in the Hatt-i-Sherif of Gulhané (1839) and in the Hatt-i-humayun (1856), in both of which the perfect equality of races and religions was proclaimed, remained a dead letter; the first "Law of the Vilayets" (1864), reforming the local administration, brought no relief, while depriving the Christian communities of certain rights which they had hitherto possessed. Under the Turkish sway, the ethnological conditions of Macedonia were still further complicated. Large colonies of true Turks were settled in it. The Albanians spread eastward and northeastward and occupied much land in western Macedonia; the Serb element, which had been strengthened under tsar Dušan, was weakened by the great northward migrations of 1691 and 1740. The national consciousness of Serbs and Bulgarians alike suffered a heavy blow when the patriarchates of Okhrida and Peć, which had been the chief centres of their intellectual life, were abolished in 1767 and their dioceses subordinated to the oecumenical patriarch in Constantinople with the result that the spiritual control of the Christian peoples of the Balkans became vested solely in the Phanariot Greeks. Among other racial elements which now became prominent in Macedonia should be mentioned the Spaniole Jews of Salonika; while smaller colonies of Armenians, gypsies and Circassians were to be found.

Racial Propaganda.—In the 19th century the national consciousness of the Christian races of the Balkans began to reawaken. Serbia, after her liberation, paid little attention to Macedonia, being from the first more interested in her relations with the southern Slavs of Bosnia and Austro-Hungary. The Bulgarian national movement, however, though later in date, extended from the first over Macedonia. In their endeavour to shake off the spiritual yoke of the Phanariots, some of the Bulgar leaders even secured the recognition by the pope of a Catholic Uniate Church of Bulgaria; but the plan broke down owing to Russian opposition. Russia, on the other hand, supported the Bulgarian agitation in favour of a national orthodox exarchate; and an exarch was, in fact, appointed by firman of Feb. 28, 1870, with jurisdiction over 15 dioceses, including Niš, Pirot and Veles. Other districts might be subject to the exarch should two-thirds of the inhabitants so desire. Many of the Macedonian dioceses declared for the exarchate, others refraining, either for national reasons or from religious scruples, the oecumenical patriarch having excommunicated the exarch and all his flock without delay. Only in 1891 did the Porte, at the instance of Stambulov, issue the exequatur for Bulgarian bishops at Okhrida and Skoplje. Veles and Nevrokop followed in 1894, Monastir, Strumnitsa and Debar in 1898.

In pursuance of her then policy, Russia dictated the inclusion of all Macedonia, except Salonika and the Chalkidic peninsula, under the treaty of San Stefano (1878). The treaty of Berlin, however, left Macedonia under Turkish rule, but provided for the introduction of reforms analogous to those contained in the Cretan Organic statute of 1868. A rival project put forward by the Porte itself, the "Law of the Vilayets," was never adopted. Meanwhile the deplorable misgovernment under Abdul Hamid evoked a ceaseless agitation in the country, supported by the neighbouring states, partly out of sympathy, but increasingly with the object of securing at least parts of Macedonia for themselves.

The first and most energetic of these movements was the Bulgarian. Based at first on the activities of its bishops, reinforced soon after by the establishment of "commercial agents" at Salonika, Skoplje, Monastir and Serres, it made rapid progress among the Slavonic population, both among that which truly felt itself Bulgarian and among others who welcomed this, the sole protection which they could receive from any Slavonic power. In 1893 Bulgaria had 554 schools in Macedonia, with 30,267 pupils; in 1900, 785 schools, including 5 gymnasia and 58 secondary schools, with 39,892 pupils. This movement was entirely legal; but in 1893 various secret revolutionary societies were set on foot in Macedonia, and similar bodies organized as legal corporations in Bulgaria in 1894. The fall of Stambulov in that year and the reconciliation of Bulgaria with Russia encouraged the revolutionaries in the belief that Russia would attempt to restore the frontiers of San Stefano. In 1895 the "Supreme Macedo-Adrianopolitan Committee" was formed in Sofia and forthwith dispatched armed bands into northern Macedonia, one of which, under Boris Sarafov, temporarily occupied Melnik, but was soon expelled. Dissensions among the leaders paralyzed activities after this first failure for some five years. Meanwhile the local Macedonian societies were welded by Gruev and Delchev into the formidable "Internal Macedonian Revolutionary Organization," or I.M.R.O., which maintained an *imperium in imperio* in Macedonia with its own police, courts and civil administration. Avoiding co-operation with the revolutionaries, this organization proclaimed the ideal of "Macedonia for the Macedonians," for which it tried to win the sympathies of the other nationalities. These had, however, now initiated their own movements. The oldest was the Vlach, whose first serious champion was the priest Apostol Margarites, founder of a gymnasium at Monastir in 1866. Subsequently some 40 Rumanian national schools were started in Macedonia, being financed from Bucharest. A *millet* for the establishment of a Rumanian bishopric at Monastir was granted by the Porte on May 23, 1905. The Greek religious and educational movement was, of course, already well organized; but the progress of the Bulgarian movement was viewed with alarm, and in 1896 the Ethnike Hetairia (*see* GREECE) sent numerous bands into southern Macedonia with the aim of bringing about a war with Turkey. During the Graeco-Turkish War (*q.v.*), Macedonia remained quiet, Bulgaria and Serbia refraining from intervention under pressure from the powers. The Greek reverses benefited the Bulgarian movement; but on discovering a hidden Bulgarian arms depot, the Turks changed their attitude. Serbia realized her mission in Macedonia comparatively late, but a very vigorous and successful propaganda opened about 1890 in northern Macedonia, and in 1902 the Serbs, after a prolonged conflict with the Greeks, secured the appointment of a Serb, Mgr. Firmilian, to the archbishopric of Skoplje. The unrest increased steadily. In 1902 an effort was made to provoke a rising round Monastir by two Bulgars, Col. Yankov and Gen. Tsontchev.

European Intervention.—The state of Macedonia now necessitated European intervention. The Austrian and Russian governments drew up a plan of reforms. The Porte promulgated a rival plan in Nov. 1902, but on Feb. 21, 1903, Austria and Russia presented identical notes demanding the introduction of their reforms, which included the employment of "foreign specialists" to reorganize the *gendarmerie*. The Bulgarian government, under pressure from Russia, now suppressed the Bulgar committees, arrested the leaders, and confiscated the funds; but the Internal Organization was unreachable and pursued its plans for an insurrection. On Aug. 2 a general revolt broke out in the Monastir district, with sporadic risings elsewhere. It was suppressed by the end of September. The Austrian and Russian governments now drew up a fresh plan of reforms (the "Mürzsteg plan") which, however, by its program of a future readjustment of frontier on ethnological lines, proved a direct stimulus to murder and propaganda by the Christian populations. European officers were put in charge of the local authorities and the reorganization of the *gendarmerie*. Little was effected. In 1905 the powers, after a naval demonstration outside the Dardanelles, forced Turkey to agree to the establishment of an international financial commission; but again small progress was made, while band activity increased. Austria having disagreed with Russia, Great Britain now joined Russia in drawing up the "Reval program" of 1908 for fresh reforms. Immediately afterwards, the Young Turk revolt broke out in the Monastir district. Anticipating the voluntary introduction of reforms by the new Turkish government the powers suspended the Reval program and withdrew their military officers from Macedonia.

Unfortunately, the hopes placed in the Young Turks soon proved delusive. The state of Macedonia grew worse than ever. Indeed, an additional complication was introduced in the shape of an Albanian national movement. This had been impossible under the earlier Turkish regime, and even now the Albanian Muslims, who had more to fear from their Christian neighbours than from their Turkish co-religionists, were inclined to side with the latter in the frequent conflicts; a fact which resulted in their national aspirations afterwards receiving less than justice.

The Balkan Wars and World War I, 1912–18.—The treaties drawn up between Bulgaria and Serbia in 1912 provided for the partition of Macedonia, assigning to Bulgaria "the territory east of the Rhodope mountains and the river Struma" and to Serbia that "north and west of the Sar mountains." In the first and second Balkan Wars of 1912–13, Macedonia was the theatre of heavy fighting. The result of them was that Bulgaria, now at variance with her former allies, received only a small rectification of her frontier in the northeast of Macedonia. The Greek frontier stretched from the Mesta, thus including the rich tobacco plantations of Kavalla, to Kenali near Monastir, which became Serbian. In the west a new state of Albania was created.

The result of the disappearance of the Turk from Macedonia was thus to turn the animosity of the Christian Balkan States (to include Albania) against each other—an animosity enhanced by the savagery committed by all parties during the fighting and even behind the battle fronts. The task of reorganizing and repairing the work of Turkish neglect, which had extended over five centuries, was also an extremely difficult one for nations hampered, as the Serbs and Greeks were, by lack of experience and financial stringency. Little progress had been made either towards restoring the economic prosperity of the country, or in assuaging the discontent of the large sections of the population which felt themselves Bulgarian or Albanian, when World War I broke out in 1914. On Oct. 14, 1915, Bulgaria entered the war on the side of the Central Powers in the hope of gaining a large part of Macedonia. She speedily captured Štip, Radovište, Veles and Skoplje, and compelled the evacuation of Monastir. Allied troops which had landed at Salonika on Oct. 5 made small initial progress, and in May 1916 Bulgaria occupied all eastern Macedonia. Afterwards, the Allies, later assisted by Greek troops, were able to advance, and in 1918 to carry through a successful offensive, an armistice being signed on Sept. 29, 1918.

The peace settlement of 1919 left the Graeco-Serb frontier of 1913 unchanged, but gave both of these states, especially Greece, considerable accessions of territory at the expense of Bulgaria, while Greece also secured western Thrace. Provisions were made for the protection of racial minorities, but no active measures taken to ensure their enforcement.

Macedonia Under Greek and Yugoslav Rule.—The problems presented by Greek and Serb Macedonia proved very different. After the disastrous campaign undertaken by Greece in Asia Minor in 1922, some 1,500,000 Greek refugees entered Greece from Asia Minor and eastern Thrace. A scheme for the settlement of these refugees was undertaken by the League of Nations in 1923–24, a Refugee Loan of £10,000,000 being issued under the auspices of the League, while an international commission undertook the work of settlement. A large proportion of the refugees were settled in western Thrace and Macedonia with amazingly good results. A large stable peasant population was established, new villages founded, agriculture improved, waste areas drained and made fertile, and in spite of initial difficulties it seemed likely that Greek Macedonia would soon be raised to a pitch of prosperity such as it had, perhaps, never known. Treaties for the exchange of population were arranged with the neighbouring states, with the result that after a short time the racial question almost disappeared, over 90% of the population being Greek.

A number of Turks and Bulgars also left Yugoslav Macedonia (now known as South Serbia); but no general exchange was arranged for the Slavonic population, which was claimed by the Yugoslavs as Serb. While here, too, material prosperity increased, the efforts made by the Yugoslav officials to Serbize the population, their severe repression of Bulgar national feeling and their refusal to allow Bulgar schools, soon led to tension. The old Internal Organization was revived under Todor Alexandrov (*q.v.*) in 1920. This body became more formidable than ever, its leaders conducting a campaign of terrorism in Macedonia from their fastnesses in the mountains round Petritch in Bulgaria. It was so formidable a force in Bulgaria itself, where it enjoyed general sympathy, that the Bulgar governments were generally powerless against it; thus after Stambolisky (*q.v.*) had attempted to make terms with Yugoslavia, Alexandrov declared "irrevocable hostility" against his government, which was soon after overthrown and Stambolisky murdered (1923). A long series of incidents took place on the Yugoslav and Greek frontiers, keeping the Balkans in perpetual unrest. In 1924, however, the organization split over the question whether Russian help should be accepted. Alexandrov was murdered on Aug. 31, 1924, and an internecine feud commenced, in which many of the leaders lost their lives. Although the Revolutionary Organization gradually lost a good deal of sympathy, even in Bulgaria, its activities, after a period of quiescence, revived, band warfare being replaced, in 1927, by bomb outrages and the state of Macedonia, the most disturbing factor in the Balkans, was as far off peace as ever. One single disturbing factor was removed; the nomad Vlachs, whose livelihood was threatened by the more stable conditions, were received in large numbers by Rumania and settled there. In 1928 the principal issue of Macedonia agitation—an autonomous Macedonia or union with Bulgaria—again flared up in new violence. The leader of the pro-Bulgarian party, General Alexander Nicholoff Protogueroff, was killed. The large majority of Macedonians was for an independent Macedonia or an autonomous part of a Balkan federation and for a democratic-civilian leadership against a military pro-Bulgarian federation. The Macedonian agitation continued to play a large part in Bulgarian domestic policy. With the Bulgarian-Yugoslav *rapprochement* in the '30s the Macedonian agitation was controlled by Bulgaria. But the events of April

1941 gave Bulgaria the opportunity to annex the whole of Macedonia. At the same time the leaders of the Macedonian revolutionary movement were amnestied in Bulgaria.

Bibliography.—The majority of works on Macedonia are inaccurate, generally with intention. *See* however, "Odysseus," *Turkey in Europe* (1900); Peace Handbooks, No. 21, *Macedonia* (1920); G. Weigand, *Ethnographie von Makedonien* (Leipzig, 1924); *Greek Refugee Settlement* (League of Nations, Geneva, 1926); W. Miller, *The Ottoman Empire and its Successors, 1801–1927* (3rd ed., 1927) (bib.); S. R. Ladas, *The Exchange of Minorities: Bulgaria, Greece and Turkey* (1932); A. Wurfbain, *L'Echange Gréco-Bulgare des Minorités Ethniques* (Geneva, 1930); H. Baerlein, *A Difficult Frontier: Yugoslavs and Albanians* (London, 1922). *See* also S. Evtimoff, "Die mazedonische Frage," *Zeitschrift für Politik*, xx, 324–348. The Greek case may be studied in Nikolaides, *La Macédoine* (1899); the Bulgarian in Ischerkov, *Les Slaves de Macédoine* (1908); the Serb in T. G. Georgevitch, *Macedonia* (1918). *See* also *Pro Macedonia* (1927); G. Bazhdaroff, *The Macedonian Question Yesterday and Today* (Sofia, 1926); J. Ivanoff, *La Question Macédonienne* (Paris, 1920).

MACEDONIAN ARMY. The army created by Philip of Macedon, the military instrument used by his son Alexander the Great in the conquest of the Persian empire, though based on the old Doric hoplite phalanx, was so superior to it that the genius of the great Macedonian cannot be appreciated without a comparison with the older organization.

The Early Greek Army.—The phalanx was the natural tactical formation for a military citizen levy, that is, a body of men whose training and tactics had to be of the simplest nature. Battles always took place on level ground, and normally in narrow valleys where the only manoeuvre possible was a forward or backward movement to drive the enemy out of the valley or into his city, or village, situated in it. Generally speaking, sieges were but holding operations carried out in order to enable the valley to be ravaged, for the economic attack was the main object of early Greek warfare. Except in Thessaly and Macedonia, cavalry was practically unknown until after the Persian wars, and though the bow was an old and respected weapon, used on occasion, as in the Plataea campaign (479 B.C.), it was not suited to a raw citizen force, since a bowman required a far more intensive training than a hoplite.

The phalanx formed a compact tactical body of files of men in varying depth. A file of eight men seems to have constituted the normal number, but frequently this was varied according to the personal predilection of the general from two to as many as twenty-five. In a phalanx of eight deep only two ranks were engaged, the rear ranks constituting a reserve for the replacement of casualties; also their object was to exercise physical and moral pressure on the leading two. The phalanx was based on two principles, producing opposite effects—depth which gave weight, and length which allowed for outflanking. Normally, depth was preferred to length because of the difficulty of moving a long line forward, especially if the ground was rough or at all broken.

The difficulty of harmonizing these two principles is clearly seen in the formation made use of by Miltiades in the battle of Marathon, 490 B.C. He was faced by the Persian army, which not only was numerically superior to his own but which possessed a strong cavalry force. The battlefield was a narrow plain flanked by two streams, but his phalanx if maintained eight ranks deep would have provided too narrow a front for him to rest its flanks on these obstacles. He, therefore, weakened the centre by thinning it to probably four ranks, leaving the flanks at their normal depth. When the two armies clinched, the Grecian centre was driven in but not broken; the result of this was a double envelopment of the Persians, and their defeat.

All hoplites wore armour, for it was recognized that a man without armour was not equal to one wearing it. This armour consisted of a large oval shield, helmet, breastplate and greaves, weighing 57 lb. The offensive weapons were a strong Doric spear from 6 to 10ft. in length, and a sword. The total weight carried by the hoplite was 72 lb., an impossible load for either long or rapid marches; consequently we find that each hoplite was accompanied by a slave who acted as shield-bearer, and who took part in the engagement as a lightly armed soldier; he was also a forager and a pillager.

The weak points of the phalanx were its flanks. Should the enemy succeed in attacking a flank whilst the front was engaged, the phalanx was lost. The flanking files were not only incapable of resisting an attack, but if forced to halt and face the enemy they immediately compelled the entire phalanx to stand still. When phalanx met phalanx this defect was not serious; but when, as in the Persian wars, the Greeks were confronted by cavalry

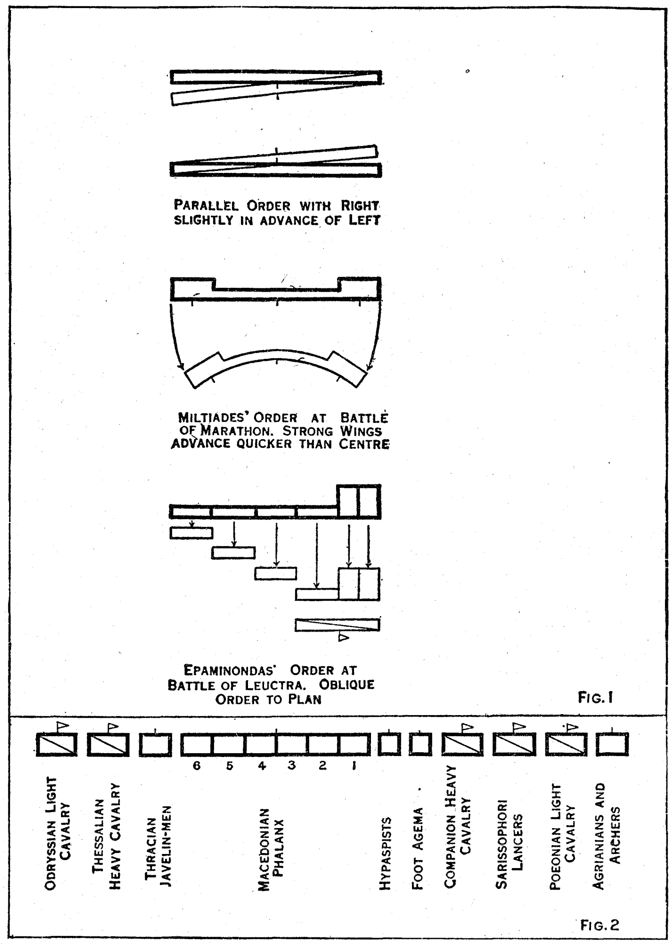


FIG. 1 SHOWS THE BATTLE ORDER OF THE GREEK PHALANXES WHILE FIG. 2 IS THE TYPICAL LINE OF BATTLE ADOPTED BY BOTH PHILIP OF MACEDON AND ALEXANDER

the danger of a charge against an exposed flank became obvious, and the result of this was a slow but noticeable interest taken in the cavalry arm. In the normal battle between hoplites, it generally happened that both sides tended to bear somewhat to their right; since each man felt that his right side was the less protected, consequently he tried to approach the enemy from the right. The tactical consequence of this was the development of an oblique order of attack, the value of which was first fully grasped by Epaminondas, and made use of by him at the battles of Leuctra (371 B.C.) and Mantineia (362 B.C.). This famous general was a true artist of war, since he understood how to combine infantry and cavalry according to the value of the ground fought over. So great was his discovery of refusing one wing and concentrating his main blow in the other, that his tactics formed not only the model for Alexander but for Frederick the Great as well.

Organization of the Macedonian Army.—The tactical conception as expounded by Epaminondas was adopted and developed by Philip of Macedon. Macedonia consisted mainly of plains, and had but a small urban population. The majority of the peasants were shepherds and too poor to maintain hoplite armour, consequently their spearmen, or peltasts, were lightly and indifferently equipped; they carried a light round shield, a tunic of leather or quilted linen, several javelins and a sword. These men when required formed the national levy, but the main arm relied upon by the kings of Macedonia was a body of mounted nobles. From these two elements Philip set to work to refashion his army.

Philip, when a hostage in Thebes, the city of Epaminondas, had learnt to appreciate the strength and weakness of trained mercenaries; their discipline was magnificent but they were lacking in patriotism. On his return to his kingdom, he determined to model his troops on what was then a new idea, namely, a highly-trained and disciplined standing army. This force being patriotic and disciplined would possess both the virtue of the old militiaman and the skill of the trained mercenary. As he already possessed the best cavalry in Greece, if he could now raise an efficient force of infantry, and combine these two arms scientifically, he would create for himself an instrument more powerful than that of any city or state in Greece. The system he worked on is not fully known, but much of it can be discovered from an analysis of the army commanded by his son, for it was only towards the close of Alexander's reign that changes in Philip's organization were made. First Philip took the Spartan phalanx as his model, but in place of looking upon it as an offensive force, he organized it as a stable base from which offensive action could be developed by his cavalry. This protective base he armed with a pike called the sarissa, which was in length double, or nearly double, that of the Spartan weapon, which at this time was about 10½ft. long. This lengthening of the pike may be compared to increasing the range of a modern rifle, for it meant that the enemy armed with the short pike would be outranged. It is true that the sarissa was a clumsy offensive weapon, but, as far as can be gathered, Philip never intended it as such; what, apparently, he aimed at was the establishment on the battlefield of an impenetrable wall of spikes, a mobile fortress upon which his cavalry could pivot and manoeuvre. This protective tactical base was organized into six divisions, each consisting of about 5,000 men. Each of these men, as in the Spartan phalanx, was allowed one or more servants who were lightly armed and could be employed for forays, raids and operations in hilly country.

To the phalanx Philip attached two cavalry wings, mobile arms which could hit out from it; the right wing was in idea offensive, and the left defensive. The main strength of the right lay in the Macedonian cavalry—the Companions—and of the left in the Thessalian cavalry, the second best cavalry in the army. As both these forces of cavalry were mainly for shock action, Philip added to each wing bodies of light cavalry; normally, the Sarissophori, or Lancers, and the Paeonians were allotted to the right wing, and the Odryssian cavalry to the left. Between the cavalry of the right wing and the right of the phalanx Philip inserted a "joint" of highly trained and armoured infantry known as the Hypaspists, of which a picked body constituted the Agema, or Royal Foot Guards, just as a selected regiment of the Companion cavalry, the cavalry Agema, were the Royal Horse Guards. This armoured infantry carried the short pike and were not protective troops like those of the phalanx, the Pezetaeri, but mobile offensive troops which normally, when the cavalry of the right wing charged forward, simultaneously protected the cavalry's left flank and the right flank of the phalanx. Should the charge of the heavy cavalry succeed, the Hypaspists, under cover of the cavalry on their right flank and the phalanx on their left, could take advantage of the enemy's disorder and work into his shattered front. The only point of weakness remaining was the right, or outer, flank of the right wing cavalry, which Philip protected by a body of skilled light infantry, the Agrianians, archers and the Thracian javelin-men.

A comparison between the Macedonian organizations and those of the Spartans and, later on, the Thebans under Epaminondas, shows clearly the genius of Philip. In the Spartan phalanx tactics were little more than push of pike, in which drill and courage generally won the day. In Epaminondas's battle order is seen clearly the idea of concentration of force against a weak point, but the blow is still delivered by infantry and is consequently slow, the Theban cavalry being no more than a protective force to the decisive infantry attack. In Philip's order organization is scientific. First, the moral element is not only based on discipline but on patriotism; secondly, the protective element is fully developed in the armoured and sarissa-armed Pezetaeri and the light infantry; thirdly, the offensive element is represented by the Hypaspists; and fourthly, the mobile element by the cavalry. Nor was this all, for these elements were so combined as to form a single co-operative organization, probably the most wonderful ever devised by a single man, and one much more scientifically perfect than any existing to-day. In the attack, the tactical base is the phalanx, for it can engage the enemy and hold him, and whilst the left wing guards the left flank of the phalanx the right wing can punch out from it with terrific force. The Hypaspists assault, and do not merely hold; the heavy cavalry charge, and do not merely wash round the enemy, and they can do so because their outer flank is well protected by light infantry, who are secured against being ridden over by light cavalry who not only are ever ready to support them, but who, by swarming round the enemy's left wing and rear, pin down his initiative. By means of this superb organization Alexander won victory after victory. Not only was he never defeated, but whether he fought on the plains or in the mountains, his army proved itself equally adaptable to the work it was asked to carry out. That it never failed him is the greatest possible proof of the organizing genius of his father.

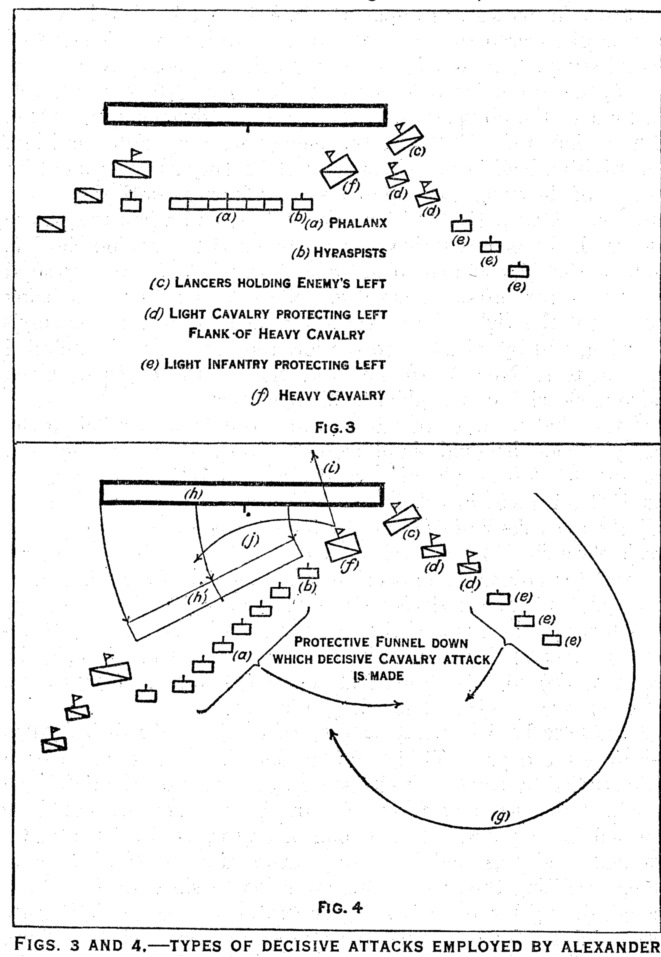
The Tactics of Alexander the Great.—The tactics developed from Philip's organization by Alexander were multiform, especially in his lesser campaigns. In his great battles, however, may be discovered two tactical constants which are deserving of careful study. The first is the rear attack on the enemy, and the second, the protection of this attack. The rear attack was developed out of the oblique order. The phalanx advancing in echelon with its left refused struck the enemy with its right division. This division held in its grip such of the enemy as confronted it; the rest of the enemy, unopposed, moved forward until they came into contact with the divisions on its left, and when they were also fixed, the enemy's right wing attempted to envelop the left flank of the Macedonian phalanx, but was held off by repeated charges of the left-wing cavalry. Whilst this action was being fought out the right-wing cavalry smashed through the enemy's left wing, and by wheeling to the left took the enemy's obliqued front in rear. Now as to the protection of the decisive attack which is closely connected with this operation.

If the phalanx were to advance in a solid line parallel to the enemy's front, it could simultaneously fix the enemy's front and protect the left flank of the decisive attack. (*See* fig. 3). But if it advances in echelon (*a*) (*see* fig. 4) it can protect not only the inner flank of (*f*) but also its rear should an enemy attack break through (*g*) the archers and javelin-men (*e*). Similarly (*d*) and (*e*) advancing in echelon with their left forward, protect the right flank of the decisive attack. The rapid advance of (*f*) pulls forward the right of the phalanx and the left of (*e*) forming a protective funnel for the charge and probably forcing the enemy at (*h*) to (*h′*). Should attack of (*f*) towards (*i*) succeed, (*f*) can move by (*j*) and attack (*h′*) in rear.

The Siege Train and Artillery of the Macedonian Army.—Before the days of Philip of Macedon siege warfare had been little studied by the Greek city states, consequently the defensive remained the stronger form of war. Until fortresses could be stormed there was small likelihood of any centralization of government, and this had been the outstanding curse of Greece. Philip, realizing this, turned his attention to siege warfare, and, though during his reign his siege operations were not uniformly successful, no fortress, even the immensely strong city of Tyre, successfully withstood the engineering ability of his son. In the Macedonian army there was established a special corps of engineers equipped with all the necessary machinery for carrying out sieges, and for crossing rivers. At the siege of Tyre, movable towers, rams and floating battery were used, and in India a pontoon train was added to the army so that the Indus, Jhelum and other rivers could rapidly be crossed. Though siege artillery had long been known in the east, Philip introduced field artillery in the form of wagon-carried catapults and ballistae, of which Alexander made frequent use in his mountain campaigns and in river-crossing operations. It was quite as much due to the Macedonian siege train as to the field army that Alexander was able to overthrow the Persian empire, for all its more important cities were strongly fortified.

Command and Administration of the Macedonian Army.—Though little information is forthcoming on the interior economy of the Macedonian army, it is known that its command rested absolutely in the hands of Philip, and after him in those of Alexander. This was an enormous advantage, since in most of the Greek states generals were elected yearly, and frequently more than one was placed in supreme command. Philip is reported to have said: "I envy the good luck of the Athenians; each year they are able to find ten men fit to command their armies, whilst I have only been able to find Parmenio to lead mine." Lack of unity of command was the ruin of Athens.

When Alexander ascended the throne of Macedon, in every sense, he was commander-in-chief. Under him came two deputy chiefs—Parmenio and Antipater. The first represented the military and the second the civil government, for whilst Parmenio accompanied Alexander to Asia, Antipater was left at home as viceroy. In battle Alexander commanded the right wing and Parmenio the left. For his personal staff Alexander had seven aides-de-camp, or *Somatophylaxes,* who were frequently appointed to command special detachments. Of his administrative directors and officers next to nothing is known, but those services



FIGS. 3 AND 4.—TYPES OF DECISIVE ATTACKS EMPLOYED BY ALEXANDER THE GREAT

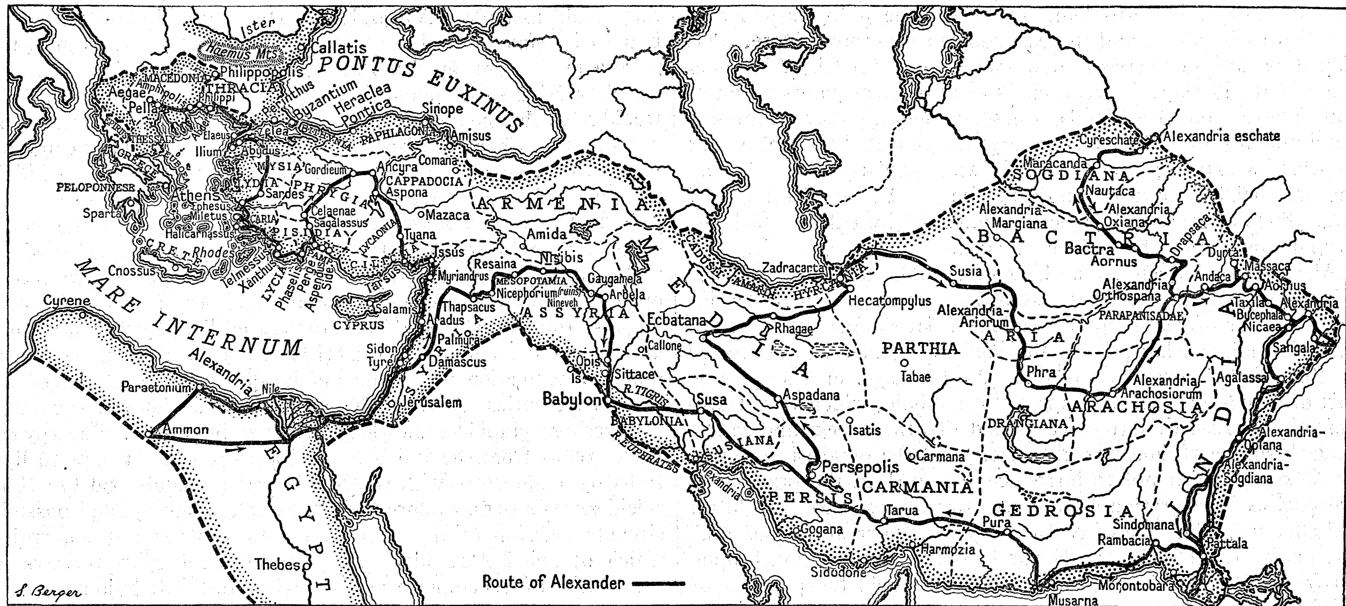
which to-day would fall under the quartermaster-general's and adjutant-general's departments, and the ordnance and medical services, must have been highly organized, otherwise it would have been impossible for him to maintain the army in Asia. To do so demanded most careful supply work and security of the lines of communication, for whilst he was in Babylonia, Persia and India, thousands of recruits were sent out to him as well as great quantities of arms and armour. To despatch reinforcements and stores across land from Greece to the Indus and beyond would require even to-day the highest administrative ability, and without these reinforcements Alexander could not have continued his conquests. Eventually, when he reached the Sutlej, the abandonment of a further advance was probably due as much to the immense time it took to supply and reinforce his army as to any other cause.

The Decline of the Macedonian Army.—The decline of the Macedonian military organization took place during the latter campaigns of Alexander, the main reason being that Greece was unable to supply him with a sufficiency of recruits. He consequently had largely to rely on Asiatics whose tactics were mainly based on projectile weapons—the javelin and the arrow. Arrian informs us that shortly before his death he reorganized his army, creating a phalanx 16 men deep, the first three ranks and the last consisting of Macedonians armed with the sarissa, and the 12 middle ranks of Persians armed with bows and javelins. This organization would appear to be a latter-day invention as are most of the tactics and drill attributed to the Macedonians by Aelian, Arrian and Vegetius.

During the wars of the Diadochi, though generalship was frequently of a high order, and strategical combinations were far more intricate than in the days of Philip and Alexander, the decline, and eventually the decay, of the Macedonian army was rapid and pronounced, until under Ptolemy II. (309–246 B.C.) we find a return to the old horde system, for according to Appian this monarch possessed an army of 200,000 infantry, 40,000 cavalry, 300 elephants and 2,000 war chariots, and a fleet of 1,500 warships and 2,000 transports. Efficiency and organization had once again been replaced by numbers and mass. There were three immediate reasons for this decline. The first was the sudden loss of Alexander's genius; the second, the imitation of his actions without understanding them, and the third the immense influx of gold from Persia. The first two have been patent to military history, the third was exceptional, and is, consequently, of particular interest.

The influence of gold on the art of war of this period was a twofold one: first, it placed mercenary service more than ever on a commercial footing; and, secondly, through the stimulus it gave to science and industry, projectile weapons began to replace shock. From the death of Alexander onwards for some 50 years the money he intended to spend on the reconstruction of his empire was expended on war, in which mercenaries were sold and bought, frequently on the battlefields themselves, as if they were commodities. Though this did not necessarily destroy the discipline of the soldiers, leadership rapidly deteriorated, and the heroism of Alexander, which was the soul of his generalship, was replaced by a more intellectual form of command, the leader of men evolving into the diplomatic commander of armies. When the campaigns of such a man as Eumenes are examined, the change is astonishing. He is as crafty as a fox, in fact is an epitome of his age. Not only does he have to keep his plans secret from his men, but even the enemy they are to battle with. Witness the artfulness of Seleucus at the battle of Ipsus; he rides round his enemy, but he does not charge home; he can charge, but he refrains from doing so until he has won over the deserters. What is seen in all these subtler actions is the replacement of the old physical attack by the moral attack but without changing the physical means. Blows give way to suggestions, and are aimed at the brain rather than the body. It is an occult transformation of military power, but once the clue is found, the change is clearly discernible, and becomes more and more so until, under Hannibal, it is developed to so high a pitch that his presence in any quarter of Italy paralyses Roman action.

The other influence of gold was the founding of great cities such as Alexandria, in which was collected the intellect of the age. Gold-power was transformed into brain-power, and, as these were warring times, warfare became more and more mechanized, muscle being supplemented by machinery. It has often been asserted by historians that the introduction of war engines caused a decadence in the art of war. This is only a half-truth, for the decline of the Macedonian system was due not to the introduction of elephants and artillery, but to generalship which took little notice of them, and which attempted to use men against



MAP OF THE MACEDONIAN EMPIRE AND THE ROUTE OF ALEXANDER THE GREAT OF MACEDONIA IN HIS SERIES OF MILITARY VICTORIES (334–323 B.C.)

them in the same manner as before their adoption. Valour was thus destroyed, not by invention but by stupidity. It was because so many generals of this epoch did not understand the influence of new weapons on tactics and *moral* that a decadence set in, and not because these weapons were more powerful than the older ones. Intelligence was the foundation of Philip's military system, and lack of it destroyed it rather than such weapons as the Polybolos of Dionysius, an arrow-throwing "machine-gun," or the cross-bow of Ctesibius, which was geared by pistons working in cylinders filled with compressed air. (J. F. C. F.)

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MACEDONIAN EMPIRE, the name generally given to the empire founded by Alexander the Great of Macedon in the countries now represented by Greece and European Turkey, Asia Minor, Egypt, Syria, Persia and eastwards as far as northern India. The present article falls naturally into two main divisions—I. The reign of Alexander. II. The period of his successors, the "Diadochi" and their dynasties.

I. THE REIGN OF ALEXANDER

At the beginning of the 4th century B.C. two types of political association confronted each other in the lands of the Eastern Mediterranean—the Persian monarchy with its huge agglomeration of subject peoples, and the Greek city-state. Each had a different principle of strength. The Persian monarchy was strong in its size, in the mere amount of men and treasure it could dispose of under a single hand; the Greek state was strong in its *moral,* in the energy and discipline of its soldiery. But the smallness of the single city-states and their unwillingness to combine prevented this superiority in quality from telling destructively upon the bulk of the Persian empire. The future belonged to any power that could combine the advantages of both systems, could make a state larger than the Greek city, and animated by a spirit equal to that of the Greek soldier. This was achieved by the kings of Macedonia. The work, begun by his predecessors, of consolidating the kingdom internally and making its army a fighting-machine of high power was completed by the genius of Philip II. (359–336 B.C.), who at the same time by war and diplomacy brought the Greek states of the Balkan peninsula generally to recognize his single predominance. At the synod of Corinth (337) Philip was solemnly declared the captain-general (*στρατηγὸς αὐτοκράτωρ*) of the Hellenes against the king of Persia, and in 334 his son and successor Alexander delivered his attack at the head of an army composed both of Macedonians and contingents from the allied Greek states. Before this force the Persian monarchy went down, and when Alexander died eleven years later (323) a Macedonian empire which covered all the territory of the old Persian empire, and even more, was a realized fact.

System of Government.—The conquered empire presented Alexander with a system of government ready-made, which it was natural for the new masters to take over. For the Asiatic provinces and Egypt, the old Persian name of *satrapy* (*see* SATRAP) was still retained. The governors appointed by Alexander were, in the west of the empire, exclusively Macedonians; in the east, members of the old Persian nobility were still among the satraps at Alexander's death.

Alexander had at first trusted Persian grandees more freely in this capacity, till the ingrained oriental tradition of misgovernment so declared itself that to three more provinces at least Macedonians had been appointed before his death. In the case of certain provinces, possibly in the empire generally, Alexander established a double control. The financial administration was entrusted to separate officials; we hear of such in Lydia, Babylonia and notably in Egypt. Higher financial controllers seem to have been over groups of provinces, and Harpalus over the whole finances of the empire, with his seat in Babylon. Again, the garrisons in the chief cities, such as Sardis, Babylon, Memphis, Pelusium and Susa, were under commands distinct from those of the provinces. The old Greek cities of the motherland were not formally subjects of the empire, but sovereign states, which assembled at Corinth as members of a great alliance, in which the Macedonian king was included as a member and held the office of captain-general. Of course, in fact, the power of the king was so vastly superior that the Greek cities were in reality subject to his dictation, even in so intimate a matter as the readmission of their exiles, and might be obliged to receive his garrisons. Within the empire itself, the various communities were allowed, subject to the interference of the king or his officials, to manage their own affairs. Alexander is said to have granted the Lydians to be "free" and "to use the laws of the ancient Lydians," whatever exactly these expressions may mean. So too in Egypt, the native monarchs were left as the local authorities. Especially to the gods of the conquered peoples Alexander showed respect. In Egypt and in Babylon he appeared as the restorer of the native religions to honour after the unsympathetic rule of the Persians. The temple of Marduk in Babylon which had fallen began to rise again at his command. It is possible, but not probable, that he offered sacrifice to Yahweh in Jerusalem. In Persia, the native aristocracy retained their power, and the Macedonian governor adopted Persian dress and manners. A new factor introduced by Alexander was the foundation of Greek cities at all critical points of intercourse in the conquered lands. These, no doubt, possessed municipal autonomy with the ordinary organization of the Greek state; to what extent they were formally and regularly controlled by the provincial authorities we do not know. The empire included large tracts of mountain or desert, inhabited by tribes, which the Persian government had never subdued.

Alexander, who set out as king of the Macedonians and captain-general of the Hellenes, assumed after the death of Darius the character of the oriental great king. He adopted the Persian garb, including a head-dress, the *diadema,* which was suggested by that of the Achaemenian king. We hear also of a sceptre as part of his insignia. The pomps and ceremonies which were traditional in the East were to be continued. To the Greeks and Macedonians such a régime was abhorrent, and the opposition roused by Alexander's attempt to introduce among them the practice of *proskunesis* (prostration before the royal presence) was bitter and effectual. The title of *chiliarch,* "commander of a thousand," *i.e.,* of the royal body-guard, was conferred by Alexander upon his friend Hephaestion. The Greek Chares held the position of chief usher. Another Greek, Eumenes of Cardia, was chief secretary. The figure of the eunuch, so long characteristic of the oriental court, was as prominent as ever.

Alexander, however, who impressed his contemporaries by his sexual continence, kept no harem. The number of his wives did not go beyond two, and the second, the daughter of Darius, he did not take till a year before his death. In closest contact with the king's person were the seven, or latterly eight, body-guards, Macedonians of high rank, including Ptolemy and Lysimachus, the future kings of Egypt and Thrace. The institution, which the Macedonian court before Alexander had borrowed from Persia, of a corps of pages composed of the young sons of the nobility, continued to hold an important place in the system of the court and in Alexander's campaigns.

Macedonian Army.—The army of Alexander was an instrument which he inherited from his father Philip. (*See* MACEDONIAN ARMY.)

Later modifications in the army system were closely connected with Alexander's general policy, in which the fusion of Greeks and Asiatics held a prominent place. He had himself, as we have seen, assumed to some extent the guise of a Persian king. The most striking declaration of his ideals was the marriage feast at Susa in 324, when a large number of the Macedonian nobles were induced to marry Persian princesses, and the rank and file were encouraged to take Eastern wives. Among the schemes registered in the state papers was one for transplanting large bodies of Asiatics into Europe and Europeans into Asia, for blending the peoples of the empire by intermarriage into a single whole.

Divine Honours.—High above all the medley of kindreds and tongues, untrammelled by national traditions, invested with the glory of achievements in which the old bounds of the possible seemed to fall away, stood in 324 the man Alexander. Was he a man? The question was explicitly suggested by the report that the Egyptian priest in the oasis had hailed him as the son of Ammon. The Egyptians had ascribed deity to their kings, and were ready enough to add Alexander to the list. It is also not unlikely that the Persian kings had received some form of divine worship. (L. Taylor, *Journ. Hellenic Studies,* 1927, p. 153, ff.) From the Greeks he certainly received such honours. It has been supposed that in offering such worship the Greeks showed the effect of "Oriental" influence, but certainly we have not to look outside the Greek circle of ideas to explain it. As early as Aeschylus (*Supp.* 991) the proffering of divine honours was a form of expression for intense feelings of reverence or gratitude towards men which naturally suggested itself—as a figure of speech in Aeschylus, but the figure had been translated into action before Alexander not in the well-known case of Lysander only (*cf.* the case of Dion, Plut. *Dio.* 29). Among educated Greeks rationalistic views of the old mythology had become so current that they could assimilate Alexander to Dionysus without supposing him to be supernatural, and to this temper the divine honours were a mere form, an elaborate sort of flattery. Did Alexander merely receive such honours? Or did he claim them himself? It would seem that he did. We have well-authenticated utterances of Attic orators when the question of the cult of Alexander came up for debate, which seem to prove that an intimation of the king's pleasure had been conveyed to Athens.

Commerce and Discovery.—A new life entered the lands conquered by Alexander. Human intercourse was quickened to a degree not before known. Commercial enterprise now found open roads between the Aegean and India; the new Greek cities made stations in what had been for the earlier Greek traders unknown lands; an immense quantity of precious metal had been put into circulation which the Persian kings had kept locked up in their treasuries. At the same time Alexander himself sought to win fresh geographical knowledge, to open new ways. The voyage of Nearchus from the Indus to the Euphrates was meant to link India by a waterway with the Mediterranean lands. So too Heracleides was sent to explore the Caspian; the survey, and possible circumnavigation of the Arabian coasts was the last enterprise which occupied Alexander. The improvement of waterways in the interior of the empire was not neglected, the Babylonian canal system was repaired, the obstructions in the Tigris removed. The reports of the *βηματισταί* Baeton and Diognetus, who accompanied Alexander's army, gave a more exact knowledge of the geographical conformation of the empire. Greek natural science was enriched with a mass of new material from the observations of the philosophers who went with Alexander; on the other hand, attempts were made to acclimatize the plants of the motherland in the foreign soil.

The accession of Alexander brought about a change in the monetary system of the kingdom. With the conquest of Asia, Alexander conceived the plan of issuing a uniform coinage for the empire. Gold had fallen from the diffusion of the Persian treasure, and Alexander struck coins in both gold and silver on the Attic standard, leaving their relation to adjust itself by the state of the market. This imperial coinage was designed to break down the monetary predominance of Athens.

II. AFTER ALEXANDER

The external fortunes of the Macedonian empire after Alexander's death must be briefly traced before its inner developments be touched upon.[1] There was, at first, when Alexander suddenly died in 323, no overt disruption of the empire. The dispute between the Macedonian infantry and the cavalry (*i.e.,* the commonalty and the nobles) was as to the person who should be chosen to be the king, although it is true that either candidate, the half-witted son of Philip II., Philip Arrhidaeus, or the posthumous son of Alexander by Roxana, opened the prospect of a long regency exercised by one or more of the Macedonian lords. The compromise, by which both the candidates should be kings together, was, of course, succeeded by a struggle for power among those who wished to rule in their name. During a period of confused warfare, which lasted, with intervals, for forty years, the family of Alexander was wholly destroyed; the endeavour of Antigonus, satrap of Phrygia, and of his son Demetrius, to establish a new imperial dynasty, was frustrated by the former's defeat and death at the battle of Ipsus (301 B.C.); and a similar and all but successful attempt by Seleucus, governor of Syria, ended in his assassination (280 B.C.)

About 275 B.C. a horde of Celtic warriors from the Danube lands who had crossed over into Asia Minor after a series of devastating forays in Macedonia and Greece, took possession of the central plateau and there formed a federation of tribal kingdoms known as Galatia. In Cappadocia two Persian houses, relics of the old aristocracy of Achaemenian days, had carved out principalities, one of which became the kingdom of Pontus and the other the kingdom of Cappadocia (in the narrower sense); the former regarding Mithradates (281–266) as its founder, the latter being the creation of the second Ariarathes (?302–?281). Ar-

[1]For details *see* separate articles on the chief generals.

menia, never effectively conquered by the Macedonians, was left in the hands of native princes, tributary only when the Seleucid court was strong enough to compel. In India, Seleucus had in 302 ceded large districts on the west of the Indus to Chandragupta, who had arisen to found a native empire which annexed the Macedonian provinces in the Punjab.

Whilst the Antigonid kingdom remained practically whole till the Roman conquest ended it in 168 B.C., and the house of Ptolemy ruled in Egypt till the death of Cleopatra in 30 B.C., the Seleucid empire perished by a slow process of disruption. The eastern provinces of Iran went in 240 or thereabouts, when the Greek Diodotus made himself an independent king of Bactria (*q.v.*) and Sogdiana, and Tiridates, brother of Arsaces, a "Scythian" chieftain, conquered Parthia (so Arrian, but *see* PARTHIA). Armenia was finally lost in 190, when Artaxias founded a new native dynasty there. Native princes probably ruled in Persia before 166 (*see* PERSIA). In southern Syria which had been won by the house of Seleucus from the house of Ptolemy in 198, the independent Jewish principality was set up in 143. About the same time Media was totally relinquished to the Parthians. Babylonia was Parthian from 129. In 64 the last shadow of Seleucid rule vanished, when Syria was made a Roman province by Pompey. From this time Rome formally entered upon the heritage of Alexander as far as the Euphrates, but many of the dynasties which had arisen in the days of Macedonian supremacy were allowed to go on for a time as client states.

Restoration of Despotism.—The Macedonians of Alexander were not mistaken in seeing an essential transformation of their national monarchy when Alexander adopted the guise of an oriental great king. Transplanted into this foreign soil, the monarchy became an absolute despotism, unchecked by a proud territorial nobility and a hardy peasantry on familiar terms with their king. The principle which Seleucus is reported to have enunciated, that the king's command was the supreme law, was literally the principle of the new Hellenistic monarchies in the East. But the rights belonging to the Macedonian army as Alexander inherited it did not altogether disappear. Like the old Roman people, the Macedonian people under arms had acted especially in the transference of the royal authority, conferring or confirming the right of the new chief, and in cases of the capital trials of Macedonians. In the latter respect the army came regularly into function under Alexander, and in the wars which followed his death; and in Macedonia, although the power of life and death came *de facto* into the hands of the Antigonid king, the old right of the army to act as judge was not legally abrogated. The right of the army to confer the royal power was still symbolized in the popular acclamation required on the accession of a new king, and at Alexandria in troubled times we hear of "the people" making its will effective in filling the throne, although it is here hard to distinguish mob-rule from the exercise of a legitimate function. Where it is a case of delegating some part of the supreme authority, as when Seleucus I. made his son Antiochus king for the eastern provinces, we find the army convoked to ratify the appointment. So too the people is spoken of as appointing the guardians of a king during his minority. Nor was the power of the army a fiction. The Hellenistic monarchies rested, as all government in the last resort must, upon the loyalty of those who wielded the brute force of the state, and however unlimited the powers of the king might be in theory, he could not alienate the goodwill of the army with impunity. The right of primogeniture in succession was recognized as a general principle; a woman, however, might succeed only so long as there were no male agnates.

The practice by which the king associated a son with himself, as secondary king, dates from the very beginning of the kingdom of the successors; Antigonus on assuming the diadem in 306 caused Demetrius also to bear the title of king. In the Seleucid kingdom the territorial expanse of the realm made the creation of a distinct subordinate government for part of it a measure of practical convenience. The king's government was carried on by officials appointed by him and responsible to him alone. Government at the same time, as an oriental despotism understands it, often has little in view but the gathering in of the tribute and compulsion of the subjects to personal service in the army or in royal works, and if satisfied in these respects will leave much independence to the local authorities. In the loosely-knit Seleucid realm it is plain that a great deal more independence was left to the various communities—cities or native tribes—than in Egypt, where the conditions made a bureaucratic system so easy to carry through. In their outlying possessions the Ptolemies may have suffered as much local independence as the Seleucids; the internal government of Jerusalem, for instance, was left to the high priests. In so far as the older Greek cities fell within their sphere of power, the successors of Alexander were forced to the same ambiguous policy as Alexander had been, between recognizing the cities' unabated claim to sovereign independence and the necessity of attaching them securely. In Asia Minor, the "enslavement" and liberation of cities alternated with the circumstances of the hour, while the kings all through professed themselves the champions of Hellenic freedom, and were ready on occasion to display munificence toward the city temples or in public works, such as might reconcile republicans to a position of dependence. Antiochus III. went so far as to write on one occasion to the subject Greek cities that if any royal mandate clashed with the civic laws it was to be disregarded. How anxious the Pergamene kings, with their ardent Hellenism, were to avoid offence is shown by the elaborate forms by which, in their own capital, they sought to give their real control the appearance of popular freedom. A similar problem confronted the Antigonid dynasty in the cities of Greece itself, for to maintain a predominant influence in Greece was a ground-principle of their policy. Demetrius had presented himself in 307 as the liberator, and driven the Macedonian garrison from the Peiraeus; but his own garrisons held Athens thirteen years later, when he was king of Macedonia, and the Antigonid dynasty clung to the points of vantage in Greece, especially Chalcis and Corinth, till their garrisons were finally expelled by the Romans in the name of Hellenic liberty.

Commerce.—The new movement of commerce initiated by the conquest of Alexander continued under his successors, though the break-up of the Macedonian empire in Asia in the 3rd century and the distractions of the Seleucid court must have withheld many advantages from the Greek merchants which a strong central government might have afforded them. It was along the great trade-routes between India and the West that the main stream of riches flowed then as in later centuries. One of these routes was by sea to south-west Arabia (Yemen), and thence up the Red sea to Alexandria. This was the route controlled and developed by the Ptolemaic kings. Between Yemen and India the traffic till Roman times was mainly in the hands of Arabians or Indians; between Alexandria and Yemen it was carried by Greeks. The west coast of the Red sea was dotted with commercial stations of royal foundation from Arsinoë north of Suez to Arsinoë in the south near the straits of Bab-el-Mandeb. From Berenice on the Red sea a land-route struck across to the Nile at Coptos; this route the kings furnished with watering stations. That there might also be a waterway between Alexandria and the Red sea, they cut a canal between the Delta and the northern Arsinoë. It was Alexandria into which this stream of traffic poured and made it the commercial metropolis of the world. We hear of direct diplomatic intercourse between the courts of Alexandria and Pataliputra, *i.e.*, Patna. An alternative route went from the Indian ports to the Persian gulf, and thence found the Mediterranean by caravan across Arabia from the country of Gerrha to Gaza; and to control it was no doubt a motive in the long struggle of the Ptolemaic and Seleucid houses for Palestine, as well as in the attempt of Antiochus III. to subjugate the Gerrheans. Or from the Persian gulf wares might be taken up the Euphrates and carried across to Antioch; this route lay altogether in the Seleucid sphere. With Iran Antioch was connected most directly by the road which crossed the Euphrates at the Zeugma and went through Edessa and Antioch-Nisibis to the Tigris. The trade from India which went down the Oxus and then to the Caspian does not seem to have been considerable. From Antioch to the Aegean the land high-road went across Asia Minor by the Cilician gates and the Phrygian Apamea.

Finance.—Of the financial organization of the Macedonian kingdoms we know practically nothing, except the case of Egypt. Here the papyri and ostraca have put a large material at our disposal; but the circumstances in Egypt[1] were too peculiar for us to generalize upon these data as to the Seleucid and Antigonid realms. That the Seleucid kings drew in a principal part of their revenues from tribute levied upon the various native races, distributed in their village communities as tillers of the soil goes without saying. In districts left in the hands of native chiefs these chiefs would themselves exploit their villages and pay the Seleucid court tribute. To exact tribute from Greek cities was invidious, but Seleucid kings often did so. Sometimes, no doubt, this tribute was demanded under a fairer name, as the contribution of an ally, like the *Γαλατικά* levied by Antiochus I. The royal domains, again, and royal monopolies, such as salt-mines, were a source of revenue. As to indirect taxes, like customs and harbour dues, while their existence is a matter of course, their scale, nature and amount is quite unknown to us. Whatever the financial system of the Antigonid and Seleucid kingdoms may have been, it is clear that they were far from enjoying the affluence of the Ptolemaic. During the first Seleucid reigns indeed the revenues of Asia may have filled its treasuries, but Antiochus III. already at his accession found them depleted, and from his reign financial embarrassment, coupled with extravagant expenditure, was here the usual condition of things. Perseus, the last of the Antigonid house, amassed a substantial treasure for the expenses of the supreme struggle with Rome, but it was by means of almost miserly economies.

Special officials were naturally attached to the service of the finances. Over the whole department in the Seleucid realm there presided a single chief. How far the financial administration was removed from the competence of the provincial governors, as it seems to have been in Alexander's system, we cannot say. Seleucus at any rate, as satrap of Babylonia, controlled the finances of the province and so, in the Ptolemaic system, did the governor of Cyprus.

With the exception of Ptolemaic Egypt, the Macedonian kingdoms followed in their coinage that of Alexander. Money was for a long while largely struck with Alexander's own image and superscription; the gold and silver coined in the names of Antigonid and Seleucid kings and by the minor principalities of Asia, kept to the Attic standard which Alexander had established. Only in Egypt Ptolemy I. adopted, at first the Rhodian, and afterwards the Phoenician, standard, and on this latter standard the Ptolemaic money was struck during the subsequent centuries. Money was also struck in their own name by the cities in the several dynasties' spheres of power, but in most cases only bronze or small silver for local use.

Court Customs.—In language and manners the courts of Alexander's successors were Greek. Even the Macedonian dialect, which it was considered proper for the kings to use on occasion, was often forgotten. The oriental features which Alexander had introduced were not copied. There was no *proskunesis* (or certainly not in the case of Greeks and Macedonians), and the king did not wear an oriental dress. The symbol of royalty, it is true, the *diadem,* was suggested by the head-band of the old Persian kings but, whereas, that had been an imposing erection, the Hellenistic diadem was a simple riband. The king's state dress was the same in principle as that worn by the Macedonian or Thessalian horsemen, as the uniform of his own cavalry officers. Its features were the broad-rimmed hat, the cloak, and the high-laced boots. There were other traces in the Hellenistic courts of the old Macedonian tradition besides in dress. One was the honour given to prowess in the chase. Another was the fashion for the king to hold wassail with his courtiers, in which he unbent to an extent scandalous to the Greeks, dancing or indulging in routs and practical jokes.

The prominent part taken by the women of the royal house was a Macedonian characteristic. The history of these kingdoms furnishes a long list of queens and princesses who were ambitious and masterful politicians, of which the great Cleopatra is the last and the most famous. The kings after Alexander, with the exception of Demetrius Poliorcetes and Pyrrhus, are not found to have more than one legitimate wife at a time, although they show unstinted freedom in divorce and the number of their mistresses. The custom of marriages between brothers and sisters, agreeable to old Persian as to old Egyptian ethics, was instituted in Egypt by the second Ptolemy when he married his full sister Arsinoë Philadelphus. It was henceforth common, though not invariable, among the Ptolemies. At the Seleucid court there seems to be an instance of it in 195, when the heir-apparent, Antiochus, married his sister Laodice. The style of "sister" was given in both courts to the queen, even when she was not the king's sister in reality. The "friends" of the king are often mentioned. It is usual for him to confer with a council of his "friends" before important decisions, administrative, military or judicial. They form a definite body about the king's person, admission into which depends upon his favour alone, and is accorded, not only to his subjects, but to aliens, such as the Greek refugee politicians (*e.g.,* Hegesianax, Athen. iv. 155b; Hannibal and the Aetolian Thoas take part in the councils of Antiochus III.). The friends (at any rate under the later Seleucid and Ptolemaic reigns) were distinguished by a special dress and badge of gold analogous to the stars and crosses of modern orders. The dress was of crimson; this and the badges were the king's gift, and except by royal grant neither crimson nor gold might, apparently, be worn at court. The order of friends was organized in a hierarchy of ranks, which were multiplied as time went on. As to Macedonia, whatever may have been the constitution of the court, it is implied that it offered in its externals a sober plainness in comparison with the vain display and ceremonious frivolities of Antioch and Alexandria. The position of a friend did not carry with it necessarily any functions; it was in itself purely honorary. The ministers and high officials were, on the other hand, regularly invested with one or other of the ranks specified. The chief of these ministers is denoted *επὶ τῶν πραγμάτων* and he corresponds to the *vizier* of the later East. All departments of government are under his supervision, and he regularly holds the highest rank of a kinsman. When the king is a minor, he acts as guardian or regent. Over different departments of state we find a state secretary. Under each of these great heads of departments was a host of lower officials, those, for instance, who held to the province a relation analogous to that of the head of the department of the realm. Beside the officials concerned with the work of government we have those of the royal household: (1) the chief-physician; (2) the chief-huntsman; (3) the maître d' hôtel; (4) the lord of the queen's bedchamber. As in the older oriental courts, the high positions were often filled by eunuchs.

It was customary, as in Persia and in old Macedonia, for the great men of the realm to send their children to court to be brought up with the children of the royal house. Those who had been so brought up with the king were styled his *σύντροφοι.* As under Alexander, so under his successors, we find a corps of *βασιλικοὶ παῖδες.* They appear as a corps, 600 strong, in a triumphal procession at Antioch.

Hellenism.—All the Hellenistic courts felt it a great part of prestige to be filled with the light of Hellenic culture. A distinguished philosopher or man of letters would find them bidding for his presence, and most of the great names are associated with one or other of the contemporary kings. Antigonus Gonatas, bluff soldier-spirit that he was, heard the Stoic philosophers gladly, and, though he failed to induce Zeno to come to Macedonia, persuaded Zeno's disciple, Persaeus of Citium, to enter his service. Nor was it philosophers only who made his court illustrious, but poets like Aratus. The Ptolemaic court, with the museum attached to it, is so prominent in the literary and scientific history of the age that it is unnecessary to give a list of the philosophers, the men of letters and science, who at one time or other ate at King Ptolemy's table. One may notice that the first Ptolemy himself made a contribution of some value to historical literature in his account of Alexander's campaigns; the fourth Ptolemy not only instituted a cult of Homer but himself published tragedies;

[1]For Ptolemaic Egypt, *see* PTOLEMIES and EGYPT.

and even Ptolemy Euergetes II. issued a book of memoirs. The Pergamene court was in no degree behind the Ptolemaic in its literary and artistic zeal. The notable school of sculpture connected with it is treated elsewhere (*see* GREEK ART); to its literary school we probably owe in great part the preservation of the masterpieces of Attic prose, and two of its kings (Eumenes I. and Attalus III.) were themselves authors. The Seleucid court did not rival either of the last named in brilliance of culture; and yet some names of distinction were associated with it. Under Antiochus I. Aratus carried out a recension of the *Odyssey,* and Berossus composed a Babylonian history in Greek. Under Antiochus III. Euphorion was made keeper of the library at Antioch. Antiochus IV., of course, the enthusiastic Hellenist, filled Antioch with Greek artists and gave a royal welcome to Athenian philosophers. Even in the degenerate days of the dynasty, Antiochus Grypus, who had been brought up at Athens, aspired to shine as a poet. The values recognized in the great Hellenistic courts and the Greek world generally imposed their authority upon the dynasties of barbarian origin. The Cappadocian court admitted the full stream of Hellenistic culture under Ariarathes V. One of the kings called Nicomedes in Bithynia offered immense sums to acquire the Aphrodite of Praxiteles from the Cnidians, and to a king Nicomedes the geographical poem of the Pseudo-Scymnus is dedicated. Even Iranian kings in the last century B.C. found pleasure in composing, or listening to, Greek tragedies, and Herod the Great kept Greek men of letters beside him and had spasmodic ambitions to make his mark as an orator or author.

Deification.—The offering of divine honours to the king which we saw begin under Alexander, became stereotyped in the institutions of the succeeding Hellenistic kingdoms. Alexander himself was after his death the object of various local cults, like that which centred in the shrine near Erythrae. His successors in the first years after his death recognized him officially as a divinity, except Antipater, and coins began to be issued with his image. At Alexandria the state cult of him seems to have been instituted by the second Ptolemy, when his body was laid in the *Sema.* The successors themselves received divine honours. Such worship might be the spontaneous homage of a particular Greek community, like that offered to Antigonus by Scepsis in 311, to Antigonus and Demetrius by Athens in 307, to Ptolemy I. by the Rhodians in 304, or by Cassandreia to Cassander, as the city's founder; or it might be organised and maintained by royal authority. The first proved instance of a cult of the latter kind is that instituted at Alexandria by the second Ptolemy for his father soon after the latter's death in 283–282, in which later 279–278, he associated his mother Berenice also, the two being worshipped together as θεοὶ σωτῆρες. Antiochus I. followed the Ptolemaic precedent by instituting at Seleucia-in-Pieria a cult for his father as Seleucus Zeus Nicator. So far we can point to no instance of a cult of the living sovereign (though the cities might institute such locally) being established by the court for the realm. This step was taken in Egypt after the death of Arsinoë Philadelphus (271), when she and her still-living brother-husband, Ptolemy II. began to be worshipped together as θεοὶ ἀδελφοί. After this the cult of the reigning king and queen was regularly maintained in Greek Egypt, side by side with that of the dead Ptolemies. Under Antiochus II. (261–246) a document shows us a cult of the reigning king in full working for the Seleucid realm, with a high priest in each province, appointed by the king himself; the document declares that the Queen Laodice is now to be associated with the king. The official surname of Antiochus II., *Theos,* suggests that he himself had here been the innovator. Thenceforward, in the Hellenistic kingdoms of the East the worship of the living sovereign became the rule, although it appears to have been regarded as given in anticipation of an apotheosis which did not become actual till death. In the Pergamene kingdom at any rate, though the living king was worshipped with sacrifice, the title θεός was only given to those who were dead. The Antigonid dynasty, simpler and saner in its manners, had no official cult of this sort. The divine honours offered on occasion by the Greek cities were the independent acts of the cities.

Army.—The armies of Alexander's successors were still in the main principles of their organization similar to the army with which Alexander had conquered Asia. During the years immediately after Alexander the very Macedonians who had fought under Alexander were ranged against each other under the banners of the several chiefs. The most noted corps of veterans, Argyraspides, played a great part in the first wars of the successors, and covered themselves with infamy by their betrayal of Eumenes. As the soldiers of Alexander died off, fresh levies of home-born Macedonians could be raised only by the chief who held the motherland. The other chiefs had to supply themselves with Macedonians from the numerous colonies planted before the break-up of the empire in Asia or Egypt, and from such Macedonians they continued for the next two centuries to form their phalanx. The breed—at least if the statement which Livy puts into the mouth of a Roman general can be relied on—degenerated greatly under Asiatic and Egyptian skies; but still old names like that of *pezetairoi* attached to the phalangites, and they still wielded the national *sarissa.* The latter weapon in the interval between Alexander and the time of Polybius had been increased to a length of 21ft., a proportion inconsistent with any degree of mobility; once more indeed the phalanx of the 2nd century seems to have become a body effective by sheer weight only and disordered by unevenness of ground. The Antigonid kings were never able from Macedonian levies to put in the field a phalanx of more than 20,000 at the utmost; Antigonus Doson took with him to Greece (in 222) one of 10,000 only. The phalanx of Antiochus III. at Raphia numbered 20,000, and Ptolemy Philopator was able at the same time to form one of 25,000 men. The royal footguards were still described in Macedonia in 171 as the *agema.* So too the old name of "Companions" was kept up in the Seleucid kingdom for the Macedonian cavalry, and divisions of rank in it were still indicated by the terms *agema* and royal squadron. The Antigonid and Seleucid courts had much valuable material at hand for their armies in the barbarian races under their sway. The Balkan hill-peoples of Illyrian or Thracian stock, the hill-peoples of Asia Minor and Iran, the chivalry of Media and Bactria, the mounted bowmen of the Caspian steppes, the camel-riders of the Arabian desert, could all be turned to account. Iranian troops seem to have been employed on a large scale by the earlier Seleucids. At Raphia, Antiochus III. had 10,000 men drawn from the provinces, armed and drilled as Macedonians, and another corps of Iranians numbering 5,000 under a native commander. The experiment of arming the native Egyptians on a large scale does not seem to have been made before the campaign of 217, when Ptolemy IV. formed corps of the Macedonian pattern from Egyptians and Libyans. From this time native rebellions in Egypt are recurrent. To the troops drawn from their own dominions the mercenaries which the kings procured from abroad were an important supplement. These were mainly the bands of Greek *condottieri,* and even for their home-born troops Greek officers of renown were often engaged. The other class of mercenaries were Gauls, and from the time of the Gallic invasion of Asia Minor in 279 Gauls or Galatians were a regular constituent in all armies. They were a weapon apt to be dangerous to the employer, but the terror they inspired was such that every potentate sought to get hold of them. The elephants which Alexander brought back from India were used in the armies of his successors, and in 302 Seleucus procured a new supply. Thenceforward elephants, either brought fresh from India or bred in the royal stables at Apamea, regularly figured in the Seleucid armies. The Ptolemies supplied themselves with this arm from the southern coasts of the Red sea, where they established stations for the capture and shipping of elephants. Scythed chariots such as had figured in the old Persian armies were still used by the Greek masters of Asia, at any rate till the battle of Magnesia. The Hellenistic armies were distinguished by their external magnificence. They made a greater display of brilliant metal and gorgeous colour than the Roman armies, for instance. The description given by Justin of the army which Antiochus Sidetes took to the East in 130 B.C., boot-nails and bridles of gold, gives an idea of their standard of splendour.

During the 3rd century B.C. Egypt was the greatest sea power of the eastern Mediterranean, and maintained a large fleet. Its control of the Aegean was, however, contested not without success by the Antigonids, who won the two great sea-fights of Cos (*c.* 256) and Andros (227), and wrested the overlordship of the Cyclades from the Ptolemies. Of the numbers and constitution of the Antigonid fleet we know nothing. At the Seleucid court in 222 the admiral appears as a person of high consideration; in his war with Rome Antiochus III. had 107 decked battleships on the sea at one time.

Macedonian Rule.—To their native subjects the Seleucid and Ptolemaic kings were always foreigners. It was considered wonderful in the last Cleopatra that she learnt to speak Egyptian. Natives were employed, as we have seen, in the army, and Iranians are found under the Seleucids holding high commands. Native cults the Hellenistic kings thought it good policy to patronize. Antiochus I. began rebuilding the temple of Nebo at Borsippa. Antiochus III. bestowed favours on the temple at Jerusalem. Even if the documents in Joseph *Arch.* xii. §§138 *seq.* are spurious, their general views of the relation of Antiochus III. and Jerusalem is probably true.

The Macedonian kingdoms, strained by continual wars, increasingly divided against themselves, falling often under the sway of prodigals and debauchees, were far from realizing the Hellenic idea of sound government as against the crude barbaric despotisms of the older East. Yet, in spite of all corruption, ideas of the intelligent development of the subject lands, visions of the Hellenic king, as the Greek thinkers had come to picture him, haunted the Macedonian rulers, and perhaps fitfully, in the intervals of war or carousal, prompted some degree of action. Treatises "concerning kingship" were produced as a regular thing by philosophers, and kings who claimed the fine flower of Hellenism could not but peruse them. Strabo regards the loss of the eastern provinces to the Parthians as their passage under a government of lower type, beyond the sphere of Hellenic *ἐπιμέλεια.*

In the organization of the administrative machinery of these kingdoms, the higher power of the Hellene to adapt and combine had been operative; they were organisms of a richer, more complex type than the East had hitherto known. It was thus that when Rome became a world-empire, it found to some extent the forms of government ready made, and took over from the Hellenistic monarchies a tradition which it handed on to the later world.

For the events which brought the Macedonian empire into being *see* ALEXANDER III., THE GREAT. For detailed accounts of the separate dynasties into which it was divided after Alexander's death, *see* SELEUCID DYNASTY, ANTIGONUS, PERGAMUM, etc., and for its effect on the spread of Hellenic culture *see* HELLENISM.

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MACEDONIUS, (1) bishop of Constantinople in succession to Eusebius of Nicomedia, was elected by the Arian bishops in 341, while the orthodox party elected Paul, whom Eusebius had superseded. Paul was banished; and Macedonius was recognized as patriarch in 342. Compelled by the intervention of Constans in 348 to resign the patriarchate in favour of his former opponent, he was reinstalled in 350. He then took vengeance on his opponents by a general persecution of the adherents of the Nicene Creed. In 359, on the division of the Arian party into Acacians (or pure Arians) and semi-Arians or Homoiousians, Macedonius adhered to the latter, and in consequence was expelled from his see by the council of Constantinople in 360. He now became avowed leader of the sect of Pneumatomachi, Macedonians or Marathonians, whose distinctive tenet was that the Holy Spirit is but a being similar to the angels, subordinate to and in the service of the Father and the Son, the relation between whom did not admit of a third. He did not long survive his deposition.

See the Church Histories of Socrates and Sozomen; Art. in *Dict. Chr. Biog.;* F. Loofs in Herzog-Hauck's *Realencyk.;* H. M. Gwatkin, *Arianism.*

MACEDONIUS, (2) bishop of Constantinople (*fl.* 510), a strict Chalcedonian who vainly opposed the fanaticism of the monophysite Severus and was deposed in 513.

MACEIÓ or **MACAYÓ,** a city and port of Brazil and capital of the State of Alagoas, about 125 mi. S.S.W. of Pernambuco, in lat. 9° 39′ 35″ S., long. 35° 44′ 36″ W. of Greenwich. Population (1940) of the city 85,949 and of the total municipal area 91,358. The city stands at the foot of low bluffs, about a mile from the shore line. The water-side village of Jaraguá, the port of Maceió, is practically a suburb of the city. South of the port is the shallow entrance to the Lagoa do Norte, or Lagoa Mundaú, a saltwater lake extending inland for some miles. Maceió is attractively situated in the midst of large plantations of coconut and *dendé* palms, though the broad sandy beach in front and the open sunburned plain behind give a barren character to its surroundings. The heat is moderated by the south-east trade winds, and the city is considered healthful. The public buildings are mostly constructed of broken stone and mortar, plastered outside and covered with red tiles, but the common dwellings are generally constructed of *tapia*—rough trellis-work walls filled in with mud. The lighthouse, situated on a small hill near the middle of the town, is a conspicuous landmark. A light tramway connects the city and port, and a railway—the Great Western—connects the two with various interior towns and with Pernambuco. The port is formed by a stone reef running parallel with and a half-mile from the shore line, within which vessels of light draft find a safe anchorage, except from southerly gales. Ocean-going steamers anchor outside the reef. The exports consist principally of sugar, cotton and rum (*aguardiente*). Maceió dates from 1815 when a small settlement there was created a "villa." In 1839 it became the provincial capital and was made a city by the provincial assembly.

McENTEE, JERVIS (1828–1891), American artist, was born at Rondout, New York, July 14, 1828, and was a pupil of Frederick E. Church. He was made an associate of the National Academy of Design, New York, in 1860, and a full academician in 1861. In 1869 he visited Europe, painting much in Italy. He was identified with the Hudson River school, and excelled in pictures of autumn scenery. He died at Rondout (N.Y.), Jan. 27, 1891.

MACER, AEMILIUS, of Verona, Roman didactic poet, author of two poems, one on birds (*Ornithogonia*), the other on the antidotes against the poison of serpents (*Theriaca*), imitated from the Greek poet Nicander of Colophon. According to Jerome, he died in 16 B.C. It is possible that he wrote also a botanical work. The extant hexameter poem *De viribus* (or *virtutibus*) *herbarum,* ascribed to Macer, is a mediaeval production by Odo Magdunensis, a French physician.

See R. Unger, *De Macro Nicandri imitatore* (Friedland, 1845).

MACERATA, city of the Marches, Italy, chief town of the province of Macerata and a bishop's see, 44 mi. by rail south of Ancona. Pop. (1936), 14,460 (town), 26,708 (commune). Crowning a hill 1,020 ft. above sea level, with a picturesque mass of buildings enclosed by walls and towers, Macerata looks out over the Adriatic. Besides the university (1290) with about 125 students in 1939, Macerata has a communal library founded by Leo XII., containing a small but choice collection of early pictures, and in the municipal buildings, a collection of antiquities from Helvia Ricina. Close by is the elegant Loggia dei Mercanti, by Giuliano da Maiano (1485–91). There is an enormous amphitheatre for *pallone,* a favourite ball game.

The first mention of the *castellum* of Macerata is in a document of 1022; and in 1138 it was formed into a commune. Nicholas IV. (1287–1292) made it the seat of the governors of the Marches. It was enclosed in the 13th century by a line of walls more than $2\frac{1}{2}$ m. in circuit. It remained faithful to the popes, and was rewarded by many privileges. Though in 1797 the inhabitants opened their gates to the French, two years afterwards, the city was stormed and pillaged. The bishopric of Macerata dates from the suppression of the see of Recanati (1320).

MACEWEN, SIR WILLIAM (1848–1924), Scottish surgeon, was born on June 22, 1848, at Rothesay, and educated at Glasgow university. In 1892 he was made regius professor of surgery in the university. In 1922 he was president of the British Medical association. Macewen was a firm supporter of the methods of Lister, and experimented on the disinfecting of drainage tubes and absorbable ligatures. He advanced the practice of bone grafting and became famous for his operative treatment of *genu valgum.* His paper on the surgery of the brain and spinal cord marked him as a pioneer of modern cerebral surgery. He died on March 22, 1924. His best known works are *Osteotomy* (1880), *Atlas of Head Sections* (1893), *Pyogenic Diseases of the Brain and Spinal Cord* (1893), *The Growth of Bone* (1912); and "Brain Surgery" in *Brit. Med. Journal* (1922).

See obituary notices in the *Lancet* and *Brit. Medical Journal* for March 29, 1924.

MACFARREN, SIR GEORGE ALEXANDER (1813–1887), English composer, was born in London on March 2, 1813, and entered the Royal Academy of Music in 1829. His *Chevy Chase* overture was written as early as 1836, and in a single night. In 1837 Macfarren was appointed a professor at the academy, and wrote his *Romeo and Juliet* overture. In 1838 he brought out *The Devil's Opera,* one of his best works. In 1845 he became conductor at Covent Garden. A gradual failure of his eyesight led to total blindness in 1865. He succeeded Sterndale Bennett as principal of the Royal Academy of Music in Feb. 1875, and in March became professor of music in Cambridge university. His theoretical works, such as the *Rudiments of Harmony,* and the treatise on counterpiont, will probably be remembered longer than many of his compositions, which included a number of oratorios. He was knighted in 1883, and died suddenly in London on Oct. 31, 1887.

An excellent memoir by H. C. Banister appeared in 1891.

McGEE, THOMAS D'ARCY (1825–1868), Irish-Canadian politician and writer, second son of James McGee, a coastguard, was born at Carlingford, Co. Louth, on April 13, 1825. He early showed a remarkable aptitude for oratory. At the age of 17 he emigrated to the United States, and by his writing and public speaking in Boston attracted the attention of O'Connell. Before he was 20 he returned to London to become parliamentary correspondent of the *Freeman's Journal,* and shortly afterward London correspondent of the *Nation,* to which he also contributed a number of poems. In 1846 he became one of the moving spirits in the "Young Ireland" party, and contributed two volumes to the "Library of Ireland." On the failure of the movement in 1848 McGee escaped in the disguise of a priest to the United States where between 1848 and 1853 he established two newspapers, the *New York Nation* and the *American Celt.*

In 1857 McGee, driven from the United States by the scurrilous attacks of the extreme Irish revolutionaries, took up his abode in Canada, and was admitted to the bar of the province of Lower Canada in 1861. At the general election in 1858 he was returned to parliament as the member for Montreal, and for four years he was regarded as a powerful factor in the house. On the formation of the Sandfield-Macdonald-Sicotte administration in 1862 he accepted the office of president of the council. When the cabinet was reconstructed a year later the Irish were left without representation, and McGee sought re-election as a member of the opposite party. In 1864 he was appointed minister of agriculture in the administration of Sir E. P. Taché, and he served the country in that capacity until his death. He actively supported the policy of federation and was elected a member of the first Dominion parliament in 1867. On April 7, 1868, he was shot by an assassin as he was about to enter his house at Ottawa. His utterances against the Fenian invasion are believed to have been the cause of the crime for which P. J. Whelan was executed.

McGee's principal works are: *A Popular History of Ireland* (3 vols., 1862–69); *Irish Writers of the Seventeenth Century* (Dublin, 1846); *Historical Sketches of O'Connell and his Friends* (Boston, 1844); *Memoirs of the Life and Conquests of Art McMurrogh, King of Leinster* (Dublin, 1847); *Memoir of C. G. Duffy* (Dublin, 1849); *A History of the Irish Settlers in North America* (Boston, 1851); *History of the Attempts to establish the Protestant Reformation in Ireland* (Boston, 1853); *Life of Edward Maginn, Coadjutor Bishop of Derry* (New York, 1857); *Catholic History of North America* (Boston, 1854); *Canadian Ballads and Occasional Pieces* (New York, 1858); *Notes on Federal Governments Past and Present* (Montreal, 1865); *Speeches and Addresses, chiefly on the Subject of the British American Union* (1865); *Poems,* edited by Mrs. M. A. Sadleir with introductory memoir (New York, 1869). *See* Fennings Taylor, *The Hon. Thomas D'Arcy McGee* (Montreal, 1867); J. K. Foran, *Thomas D'Arcy McGee as an Empire Builder* (Ottawa, 1904); H. J. O'C. French, *A Sketch of the Life of the Hon. T. D. McGee* (Montreal).

McGILLIVRAY, ALEXANDER (c. 1739–1793), American Indian chief, was born near the site of the present Wetumpka, in Alabama. His father was a Scotch merchant and his mother the daughter of a French officer and an Indian "princess." Through his father's relatives in South Carolina, McGillivray received a good education, but at the age of 17 he returned to the Muscogee Indians, who elected him chief. During the Revolutionary War, as a colonel in the British army, he incited his followers to attack the western frontiers of Georgia and the Carolinas. Georgia confiscated some of his property, and after the peace of 1783 McGillivray remained hostile. Though still retaining his British commission, he accepted one from Spain, and during the remainder of his life used his influence to prevent American settlement in the southwest. So important was he considered that in 1790 President Washington sent an agent who induced him to visit New York. Here he was persuaded to make peace in consideration of a brigadier-general's commission and payment for the property confiscated by Georgia; and with the warriors who accompanied him he signed a formal treaty of peace and friendship. He then went back to the Indian country, but remained hostile to the Americans until his death. He was one of the ablest Indian leaders of America and at one time wielded great power —having 5,000 to 10,000 armed followers. Before he died he saw that he was fighting in a losing cause, and, changing his policy, endeavoured to provide for the training of the Muscogees in the white man's civilization. McGillivray was polished in manners, of cultivated intellect, was a shrewd merchant, and a successful speculator; but he had many savage traits, being noted for his treachery, craftiness and love of barbaric display.

See Harry Lincoln Sayler, *American Romance in the South* (1908).

MACGILLIVRAY, WILLIAM (1796–1852), Scottish naturalist, was born on Jan. 25, 1796, at Aberdeen, where he studied medicine at King's college. In 1823 he became assistant professor of natural history in Edinburgh and in 1831 curator of the museum of the Royal College of Surgeons, a post which he resigned in 1841 to become professor of natural history and botany in Marischal college, Aberdeen. He died at Aberdeen on Sept. 4, 1852.

Macgillivray's larger works, which exhibit his industry and extensive knowledge, include biographies of A. von Humboldt, and of zoologists from Aristotle to Linnaeus, a *History of British Quadrupeds,* a *History of the Molluscous Animals of Aberdeen, Banff and Kincardine,* a *Manual of British Ornithology,* and an excellent *History of British Birds* (5 vols. 1837–52). His *Natural History of Deeside* was posthumously published by command of Queen Victoria (1850).

McGILL UNIVERSITY: *see* UNIVERSITIES.

MacGOWAN, KENNETH (1888–), U.S. author was born in Winthrop, Mass., on Nov. 30, 1888. He was graduated at Harvard in 1911 and between 1910 and 1924 wrote dramatic criticism for various newspapers and magazines, including the Boston *Transcript,* the Philadelphia *Public Ledger,* the New York *Tribune,* the New York *Globe, Vogue* and the *Theatre Arts Monthly.* He was also editor of the last named publication from 1919–25. He was director of the Provincetown Players in 1924, of the Greenwich Village theatre, New York city, in 1925 and of the Actors' theatre in 1927. He became associated with RKO-Radio Pictures in 1932, was associate producer with that concern from 1933–35 and served in the same capacity for the Twentieth Century-Fox Film corporation after 1935. His published works include *The Theatre of Tomorrow* (1921); *Continental Stagecraft* (with Robert Edmond Jones, 1922); *Masks and Demons* (with Herman Rosse, 1923); *Footlights Across America* (1929).

MacGREGOR, JOHN ["ROB ROY"] (1825–1892), Scottish canoeist, traveller and philanthropist, son of General Sir Duncan MacGregor, K.C.B., was born at Gravesend on Jan. 24, 1825. He was educated at Trinity college, Dublin, and

Trinity college, Cambridge, and was called to the bar in 1851. He travelled in Europe, Egypt, Palestine, Russia, Algeria and America. MacGregor was the pioneer of British canoeing. In 1865 he started on a long canoeing cruise in his "Rob Roy" canoe, making a prolonged water tour through Europe, a record of which he published in 1866 as *A Thousand Miles in the Rob Roy Canoe*. He made similar voyages in later years in Norway, Sweden and Denmark, the North sea and Palestine. Another voyage, in the English channel and on French waters, was made in a yawl. He died at Boscombe, July 16, 1892.

McGUFFEY, WILLIAM HOLMES (1800–1873), U.S. educator, was born in western Pennsylvania, three miles from West Alexandria, on Sept. 23, 1800. The immediate ancestors of William Holmes McGuffey migrated to America in 1774. The parents of William were Scotch-Irish who moved westward from their early home in eastern Pennsylvania to the newly opened lands in western Pennsylvania soon after the conquest of these lands from the Indians. In 1802 McGuffey's parents moved into the primeval forests of the Ohio Territory four miles north of the present city of Youngstown.

With little home and school instruction he mastered the school arts and began teaching in the subscription rural schools of Ohio when he was 13 years of age in a community near the present city of East Liverpool. During spare time and vacations through his 11 years of teaching in Ohio and Kentucky he continued his education intermittently under private tutors, in Greersburg academy and in Washington college. He entered Washington college in 1819 and received from this institution his A.B. degree with honours in 1826.

McGuffey came to Miami university, Oxford, O., as instructor in ancient languages in Nov. 1825, and during his 11 years at Miami took great interest in public education. He assisted the teachers of the elementary schools of the community in teaching methods and in new improved school texts, especially readers, establishing in his own home a model school of the neighbourhood children.

In 1835 he contracted with Truman and Smith of Cincinnati to compile four school readers, two of which were published in 1836 and the third and fourth in 1837. These readers became all but the universal readers in the expanding common schools of the great empire of the Mississippi and the south. By 1925, 122,000,000 McGuffey textbooks had been sold.

From 1836 to 1839 he was president of Cincinnati college and from 1839 to 1843 president of Ohio university, Athens, O. McGuffey was one of the three founders of the common school system of Ohio. In 1845 he was elected to the chair of mental and moral philosophy in the University of Virginia, Charlottesville, which position he eminently filled until his death, May 4, 1873.

In 1827 he married Harriet Spinning of Dayton, to which union were born five children, three boys and two girls. The girls alone reached maturity, married and reared families. Upon the death of his first wife, McGuffey married Laura Howard, the daughter of Dr. Howard, dean of the medical school of the University of Virginia. One daughter, who died at the age of four, was born of this union.

MACH, ERNST (1838–1916), Austrian physicist and psychologist, was born on Feb. 18, 1838, at Turas in Moravia, and studied at Vienna. He was professor of mathematics at Gratz (1864–67), of physics at Prague (1867–95), and of physics at Vienna (1895–1901). In 1879 and 1880 as *Rector Magnificus* he fought against the introduction of Czech instead of German in the Prague university. In 1901 he was made a member of the Austrian house of peers. He died on Feb. 9, 1916. In philosophy he began with a strong predilection for the physical side of psychology, and at an early age he came to the conclusion that all existence is sensation, and, after a lapse into noumenalism under the influence of Fechner's *Psychophysics,* finally adopted a universal physical phenomenalism. The ego he considers not an entity sharply distinguished from the non-ego, but merely, as it were, a medium of continuity of sensory impressions. His whole theory appears to be vitiated by the confusion of physics and psychology.

Mach's works include: *Die Mechanik in ihrer Entwickelung* (Leipzig, 1883; rev. ed., 1908; Eng. trans., T. J. McCormack, 1902); *Beiträge zur Analyse d. Empfindungen* (Jena, 1886; 5th ed., 1906, entitled *Die Analyse d. Empfindungen*); *Leitfaden d. Physik für Studierende* (Prague, 1881, in collaboration); *Populärwissenschaftliche Vorlesungen* (3rd ed., Leipzig, 1903); *Die Prinzipien d. Wärmelehre* (2nd ed., 1900); *Erkenntnis und Irrtum* (Leipzig, 1905).

MACHADO, BERNADINO (1851–1944), Portuguese statesman, was born at Rio de Janeiro on July 28, 1851. An ardent patriot, a man of unfailing courtesy, unchallenged character and courage, he became a professor at Coimbra university and entered parliament in 1882. In 1893 he held office for a few months as minister of public works. Four years later he espoused openly the cause of republicanism, and his election in March 1906 as Republican deputy for Lisbon was made the occasion of a Republican demonstration which resulted in the downfall of the government. After the revolution in Oct. 1910, Machado became minister of foreign affairs in the provisional government of the republic. He became premier on Feb. 4, 1914, and held office until Dec. 13. Under his guidance and despite German intrigue Portugal proclaimed on Aug. 7 her loyalty to the British Alliance, and on Nov. 23, committed herself to participation in military operations. On Aug. 6, 1915, Machado succeeded Dr. Theophilo Braga as president. On Dec. 15, 1917, he was banished by the insurgents. On March 2, 1921, he became premier of a coalition ministry, but in consequence of a military *coup d'etat* he resigned on May 20. He served as president again from Dec. 1925–June 1926 when a revolution removed him from power. On Feb. 25, 1927, charged with complicity in an abortive insurrection, he was ordered to leave Portugal. He returned after an amnesty was granted to him and other political exiles in May 1936 and died in Oporto, April 29, 1944. (J. Sw.; X.)

MACHAIRODUS, the typical genus of the extinct Machairodontinae or sabre-tooth tigers.. In this group, usually regarded as a subfamily of the Felidae, the upper canines were enlarged into long daggerlike tusks, while the lower canines are quite small and like incisor teeth. The form and processes of the skull and jaws were much modified in adaptation to the purposes for which these tusks were used, to stab and slash with widely gaping jaws. These animals were adapted to prey upon large thick-skinned short-necked herbivora.

Machairodus, properly speaking, applies to the later Tertiary sabre-tooths typified by the species found in the Lower Pliocene of Eppelsheim, Germany, and elsewhere in the later Tertiary faunas of Europe, Asia, Africa and America. The name was formerly in general use for the larger and more specialized sabre-tooths found in the Pleistocene, better separated as a distinct genus *Smilodon.* This genus ranged throughout North and South America with allies in Europe. The largest species, *Smilodon neogaeus* from South America, equalled the European bear in size, with limbs and feet shorter than in the lion but more massive and with larger claws, the tail quite short and small. The tusk is 1 in. wide and projects 5 to 6 in. from its socket. Many skeletons of a smaller species (*S. californicus*) have been obtained from the asphalt beds of La Brea, Los Angeles, Calif. (W. D. M.; X.)

MACHAR, JAN SVATOPLUK (1864–), Czech poet, was born at Kolin on Feb. 29, 1864. His early works, such as *Confiteor,* consist of sentimental verses written under the influence of Lermontov, Heine and De Musset. He turned his attention to social and political satire. *Magdalena* (1894), *Warriors of God* (1895–96), *Golgotha* (1901), *In the Glow of the Hellenic Sun* (1906) and *The Poison from Judaea* are titles which indicate Machar's sceptical and anticlerical point of view. He traced the chief personalities in history, from the earliest times to the Napoleonic era and beyond. In prose, as in poetry, Machar is incisive. *The Jail* (1918) graphically describes his imprisonment by Austria during World War I.

MACHAULT D'ARNOUVILLE, JEAN BAPTISTE DE (1701–1794), French statesman, was the son of a lieutenant of police. After two years as intendant of Hainaut, he succeeded

Orry de Fulvy as controller-general of the finances in Dec. 1745. In order to reorganize the finances after the War of the Austrian Succession, he proposed to replace the old tax of a tenth, which was evaded by many of the clergy and nobility, by a universal tax of a twentieth, but failed to carry the measure in face of opposition though retaining his office until July 1754, when he became minister of marine. He gained the ill-will of Madame de Pompadour by opposing the alliance with Austria, and she obtained his disgrace on Feb. 1, 1757. In 1794 he was arrested as a suspect, and died in prison at the age of 93.

MACHAUT or **MACHAULT, GUILLAUME DE** (*c.* 1300–1377), French poet and musician, was born in the village of Machault near Réthel in Champagne, and died at Reims in April 1377. Machaut tells us that he served for 30 years as secretary to the adventurous John of Luxembourg, king of Bohemia, while holding, at the same time, various ecclesiastical positions at Verdun (1332), Arras (1333) and Reims. He followed John of Bohemia to Russia and Poland, and, though of peaceful tastes himself, saw 20 battles and 100 tourneys. When John was killed at Crécy in 1346 Machaut was received at the court of Normandy, and on the accession of John the Good to the throne of France (1350) he received an office which enabled him to devote himself thenceforth to music and poetry. Machaut wrote about 1348 in honour of Charles III., king of Navarre, a long poem much admired by contemporaries, *Le Jugement du roi de Navarre.* When Charles was thrown into prison by his father-in-law, King John, Machaut addressed him a *Confort d'ami* to console him for his enforced separation from his young wife, then aged 15. This was followed about 1370 by a poem of 9,000 lines entitled *La Prise d' Alexandrie,* one of the last chronicles cast in this form. Its hero was Pierre de Lusignan, king of Cyprus. Machaut is best known for the strange book telling of the love affair of his old age with a young and noble lady long supposed to be Agnes of Navarre, sister of Charles the Bad; Paulin Paris in his edition of the *Voir dit* (*Historie vraie*) identified her as Perronne d'Armentières, a noble lady of Champagne. In 1362, when Machaut must have been at least 62 years of age, he received a rondeau from Perronne, who was then 18, and wished to play Laura to his Petrarch. The romance ended with Perronne's marriage and Machaut's desire to remain her *doux ami.* Its subject and length are deterrent to modern readers. Machaut with Deschamps marks a distinct transition. The *trouvères* had been impersonal. It is difficult to gather any details of their personal history from their work. Machaut and Deschamps wrote of their own affairs, and the next step in development was to be the self-analysis of Villon. Machaut was also a musician. He composed a number of motets, songs and ballads, also a mass supposed to have been sung at the coronation of Charles V. This was translated into modern notation by Perne, who read a notice on it before the Institute of France in 1817.

E. Hoepffner, in editing Machaut's works, rightly says that they exercised a powerful and lasting influence on the literary development of the 14th century. As a lyric poet, if he did not actually create the fixed forms, such as the ballade, chant-royal, virelai, rondeau and lay, which prevailed up to the 16th century, it was he who ensured their triumph. And he inaugurated the new lyrical art. It is true that he was profoundly influenced by the *Roman de la Rose,* but he introduced a personal, individual note hitherto lacking. Machaut was undoubtedly the master of a new school. Froissart and Deschamps, Christine de Pisan, Oton de Cranson, even Chaucer, all studied and imitated him. In the second half of the 15th century, he was forgotten, and was not rediscovered till the 18th century, by Lebeuf and the abbé Rive.

Machaut's *Oeuvres choisies* were edited by P. Tarbé (Reims and Paris, 1849). There are good modern editions of his longer poems in his *Oeuvres* (edit. E. Hoepffner, 3 vols., 1908, 1911, 1921); and of his *Poésies lyriques* (edit. V. Chichmaref, 1909). *See* also F. G. Fétis, *Biog. universelle des musiciens . . .* (1862), and E. Travers, *Instruments de musique au XIV^{e} siècle d'après Guillaume de Machaut* (1882).

MACHIAVELLI, NICCOLÒ (1469–1527), Italian statesman and writer, was born at Florence on May 3, 1469. His ancestry claimed blood relationship with the lords of Montespertoli, a fief situated between Val di Pesa and Val d'Elsa, at no great distance from the city. Niccolò's father, Bernardo (b. 1428), followed the profession of a jurist. He held landed property worth something like £250 a year in English money. His son, though not wealthy, was never wholly dependent upon official income.

Of Niccolò's early years and education little is known. His works show wide reading in the Latin and Italian classics, but it is almost certain that he had not mastered the Greek language. To the defects of Machiavelli's education we may, in part at least, ascribe the peculiar vigour of his style and his speculative originality. He is free from the scholastic trifling and learned frivolity which tainted the rhetorical culture of his century. He made the world of men and things his study, learned to write his mother-tongue with idiomatic conciseness, and nourished his imagination on the masterpieces of the Romans.

Official Life.—The year of Charles VIII.'s invasion and of the Medici's expulsion from Florence (1494) saw Machiavelli's first entrance into public life. He was appointed clerk in the second chancery of the commune under his old master, the grammarian, Marcello Virgilio Adriani. Early in 1498 Adriani became chancellor of the republic, and Machiavelli succeeded as second chancellor and secretary. This post he retained for 14 years—until 1512. The masters he had to serve were the *dieci di libertà e pace,* who, though subordinate to the *signoria,* exercised a separate control over the departments of war and the interior. They sent their own ambassadors to foreign powers, transacted business with the cities of the Florentine domain, and controlled the military establishment of the commonwealth. Machiavelli was fully occupied in the correspondence of his bureau, in diplomatic missions, and in the organization of a Florentine militia. The first of his many missions to petty courts of Italy was in 1499, when he negotiated the continuance of a loan to Catherine Sforza, countess of Forlì and Imola. In 1500 Machiavelli travelled into France, to deal with Louis XII. about the affairs of Pisa. These embassies were the school in which Machiavelli formed his political opinions, and gathered views regarding the state of Europe and the relative strength of nations. They introduced him to the subtleties of Italian diplomacy, and extended his observation over races very different from the Italians. He acquired principles and settled ways of thinking which later he expressed in writing.

In 1502 Machiavelli married Marietta Corsini, with whom, in spite of his own infidelities, he lived on good terms; she bore him several children, and survived him twenty-six years. In the same year Piero Soderini was chosen gonfalonier for life, in accordance with certain changes in the constitution of the state, which were intended to bring Florence closer to the Venetian type of government. Machiavelli suggested military reforms which Soderini adopted, and finally was involved in ruin by his fall.

In October 1502 he was sent, much against his will, as envoy to the camp of Cesare Borgia, in Romagna, and it was Machiavelli's duty to wait upon and watch him. He witnessed the intrigues which culminated in Cesare's murder of his disaffected captains. From Machiavelli's official letters, and from his tract upon the *Modo che tenne il duca Valentino per ammazzar Vitellozzo Vitelli,* we are able to appreciate the relations between the two men, and the growth in Machiavelli's mind of a political ideal based upon his study of the duke's character. Machiavelli conceived the strongest admiration for Cesare's combination of audacity with diplomatic prudence, for his adroit use of cruelty and fraud, for his self-reliance, avoidance of half-measures, employment of native troops, and firm administration in conquered provinces. More than once, in letters to his friend Vettori, no less than in the pages of the *Principe,* Machiavelli expressed his belief that Cesare Borgia's methods of conquest, the cementing of a new state out of scattered elements, and the dealing with false friends or doubtful allies, was worthy of commendation and imitation. Cesare Borgia became idealized in his reflective but imaginative mind. That Machiavelli separated the actual Cesare Borgia, whom he afterwards saw ruined and contemptible at Rome, from his radiant Duca Valentino, is probable.

Military Studies.—On his return to Florence early in January 1503, Machiavelli turned his mind to the existing conditions of military service in Italy. He was familiar with the disadvantages of the use of professional captains of adventure and mercenary troops. The bad faith of the condottiere Paolo Vitelli (beheaded at Florence in 1499) had deeply impressed him. In the war with Pisa he had observed the insubordination and untrustworthiness of soldiers gathered from the dregs of different districts, serving under irresponsible commanders. From Livy he learned to admire the Roman system of employing armies raised from the body of the citizens; and Cesare Borgia's method of gradually substituting the troops of his own duchy for aliens and mercenaries showed him that the plan was feasible. He now determined, with the support of Soderini, to furnish Florence with a national militia. Early in 1503 Machiavelli drew up for Soderini a speech, *Discorso sulla provisione del danaro,* in which the necessity of liberal expenditure on defence was expounded upon principles of sound political philosophy. Between this date and the last month of 1506 Machiavelli worked out memorials on the subject for his office, and suggested the outlines of a new military organization. On Dec. 6, 1506, his plan was approved by the *signoria,* and a special ministry, called the *nove di ordinanza e milizia,* was appointed with Machiavelli as secretary. The country districts of the Florentine dominion were now divided into departments, and levies of foot soldiers were made in order to secure a standing militia. A commander-in-chief was found in Don Micheletto, Cesare Borgia's cut-throat and assassin. The appointment illustrates a radical infirmity in Machiavelli's genius. His scheme in itself was inspired by principles of political wisdom and by the purest patriotism. But he failed to perceive that such a ruffian as Micheletto could not inspire the troops of Florence with patriotism and a healthy moral tone. Here, as elsewhere, he was insensible to ethical considerations.

Meanwhile Alexander VI. had died suddenly of fever, and Julius II. had ascended the papal chair. The duke of Valentinois had been checked in mid-career of conquest. The collapse of the Borgias threw Central Italy into confusion; and Machiavelli had, in 1505, to visit the Baglioni at Perugia and the Petrucci at Siena. In the following year he accompanied Julius upon his march through Perugia into the province of Emilia, to subdue the rebellious cities of the Church. Upon these embassies Machiavelli represented the Florentine *dieci.* Meanwhile the war for the recovery of Pisa dragged on. Machiavelli had to attend the camp and provide for levies amid his many other occupations. Yet in the autumn of 1504 he began his *Decennali,* or *Annals of Italy,* a poem composed in rough terza rima. About the same time he composed a comedy *Le Maschere,* now lost, on the model of Aristophanes.

At the end of 1507 European affairs diverted Machiavelli from his duties in organizing the new militia. Maximilian was arranging for his coronation in Rome, and was levying subsidies from the imperial burghs. The Florentines thought his demands excessive, and Machiavelli was sent to his court in December. He travelled by Geneva, through Switzerland, to Bozen (Bolzano), where he found the emperor. This journey enabled him to study the Swiss and the Germans in their homes; his report on it is among his most effective political studies, remarkable for his concentrated effort to realize the exact political weight of the German nation, and to penetrate the causes of its strength and weakness. He attempts to grasp the national character as a whole, and to deduce practical conclusions. The same qualities are noticeable in his *Ritratti delle cose di Francia,* which he drew up after an embassy to Louis XII. at Blois in 1510. These French notes are more scattered than the German report. But they reveal the same imaginative penetration into the very essence of national existence.

Machiavelli returned from Germany in June 1508. Chiefly through his exertions the Pisan war was terminated by the surrender of Pisa in June 1509. Meanwhile the league of Cambrai had disturbed the peace of Italy, and Florence found herself in a perilous position between Spain and France. Soderini's government grew weaker. The Medicean party lifted up its head. To the league of Cambrai succeeded the Holy League. The battle of Ravenna was fought, and the French retired from Italy. The cardinal Giovanni de' Medici, who was present at the battle of Ravenna, brought a Spanish army into Tuscany. Prato was sacked in the August of 1512. Florence, in extreme terror, deposed the gonfalonier Soderini, and opened her gates to the Medici.

Fall of Machiavelli.—The government on which Machiavelli depended had fallen, never to rise again. The national militia in which he placed unbounded confidence had proved inefficient to protect Florence. His political and personal enemies regarded him with jealousy as the ex-gonfalonier's right-hand man. He showed no repugnance to a change of masters, and began to make overtures to the Medici. The *nove della milizia* were, however, dissolved; and on Nov. 7, 1512, Machiavelli was deprived of his appointments. He was exiled from Florence and confined to the dominion for one year, and on Nov. 17 was prohibited from setting foot in the Palazzo Pubblico. He was implicated in the conspiracy of Pier Paolo Boscoli in February 1513, though he had no share in it, because his name was found upon a memorandum dropped by Boscoli. He was racked, and only released upon Giovanni de' Medici's election to the papacy in March 1513. When he left his dungeon he retired to a farm near San Casciano. His political career, now at an end, left him with only disappointment and annoyance. Losing his emoluments, he could barely support his family.

He had lived a continuously active life. Much as he enjoyed the study of the Latin and Italian classics, literature was not his business; nor had he looked on writing as more than an occasional amusement. He was now driven in upon his books for the employment of a restless temperament; and to this irksomeness of enforced leisure may be ascribed the production of the *Principe,* the *Discorsi,* the *Arte della guerra,* the comedies, and the *Historie fiorentine.* His letters to Vettori paint a man of vigorous intellect and feverish activity, dividing his time between studies and vulgar dissipation. It is very difficult to understand the spirit in which the author of the *Principe* sat down to exchange obscenities with the author of the *Sommario della storia d'Italia.* This coarseness of taste did not blunt his intellectual sagacity. His letters on public affairs in Italy and Europe, especially those which he meant Vettori to communicate to the Medici at Rome, are marked by extraordinary fineness of perception, and philosophical breadth.

Il Principe.—In retirement at his villa near Percussina, a hamlet of San Casciano, Machiavelli completed the *Principe* before the end of 1513. This famous book is an analysis of the methods whereby an ambitious man may rise to sovereign power. It appears to have grown out of the *Discorsi sopra la prima deca di Tito Livio,* begun at an earlier date, but only finished later.

Cast in the form of comments on the history of Livy, the *Discorsi* are really an inquiry into the genesis and maintenance of states. The *Principe* is an offshoot from the main theme of the *Discorsi,* setting forth Machiavelli's views at large and in detail upon the nature of principalities, the method of cementing them, and the qualities of a successful autocrat. Being more limited in subject and more independent as a work of literary art, this essay detaches itself from the main body of the *Discorsi,* and has attracted far more attention. In the *Principe* its author had more than a speculative aim in view, and brought it forth to serve a special crisis. Machiavelli judged the case of Italy so desperate that salvation could only be expected from the intervention of a powerful despot. The unification of Italy in a state protected by a national army was the cherished dream of his life; and the peroration of the *Principe* shows that he meant this treatise to have a direct bearing on the problem, though the book was by no means exclusively directed to that end. Together with the *Discorsi,* the *Principe* contains the speculative fruits of his experience and observation combined with his deductions from Roman history. The two works form a coherent body of opinion, not systematically expressed, it is true, but based on the same principles, involving the same conclusions, and directed to the same philosophical end. That end is the analysis of the conception of the state, studied under two main types, republican and monarchical. Up to the date of Machiavelli, modern political philosophy had always presupposed an ideal. Mediaeval speculation took the Church and the Empire for granted, as divinely appointed institutions. Thinkers differed only as Guelfs and Ghibellines, as leaning on the one side to papal, on the other to imperial supremacy. No new substantial philosophy of any kind had emerged from humanism; the political lucubrations of the scholars of the Renaissance were, like their ethical treatises, for the most part rhetorical. Still the humanists created a new medium for the speculative faculty. Simultaneously with the revival, Italy had passed into the "age of despots." The yoke of the Empire had been shaken off. The Church had taken rank among Italian tyrannies. Principalities and sovereign cities claimed autocratic jurisdiction. These separate despotisms owned no common social tie, were founded on no common *ius* or right, but were connected in a network of conflicting interests and changeful diplomatic combinations. A keen and positive political intelligence emerged in the Italian race. The reports of Venetian and Florentine ambassadors at this epoch contain the first germs of an attempt to study politics from the point of view of science.

At this moment Machiavelli intervenes. He was aware that the strongholds of mediaeval thought must be abandoned, and that the ruins of mediaeval institutions furnished no basis for solid political edifices. His originality consists in having extended the positive intelligence of his century from the sphere of contemporary politics and special interests to man at large regarded as a political being. He founded the science of politics for the modern world, by concentrating thought upon its fundamental principles. He began to study men, not in the isolation of one century, but as a whole in history. He drew his conclusions from the nature of mankind itself, "ascribing all things to natural causes or to fortune." In this way he restored a method which had been neglected since the days of Aristotle. Machiavelli's conception of the modern state marked the close of the middle ages, and anticipated the next phase of European development. His prince prefigured the monarchs of the 16th and 17th centuries, the monarchs whose motto was *L'état c'est moi!* His doctrine of a national militia foreshadowed conscription. The remedies which he suggested for Italian decadence, in the perorations of the *Principe* and the *Arte della guerra,* have since been applied in the unification of Italy. Machiavelli saw clearly the ruin of his country, and burned to save Italy and set her in her place among the powerful nations; his very limitations and mistakes were due to an absorbing passion for the state of which he dreamed. Concentrating his attention on the one necessity for organizing a powerful coherent nation, Machiavelli forgot that men are more than political beings. He neglected religion, or regarded it as part of the state machinery. He judged private virtue to be the basis of all healthy national existence; but in the realm of politics he subordinated morals to political expediency. He held that the people, as distinguished from the nobles and the clergy, were the pith and fibre of nations; yet this same people had to become wax in the hands of the politician —their commerce and their comforts, the arts which give a dignity to life and the pleasures which make life liveable, neglected—their very liberty subordinated to the one tyrannical conception. To this point the segregation of politics from every other factor which goes to constitute humanity had brought him; and this makes us feel his world a wilderness. Yet isolation of the subject matter of this science was essential at the outset, just as the science of economics had first to make a rigid severance of wealth from other units. Only gradually have we recognized that political economy has unavoidable points of contact with ethics.

Machiavelli thought of dedicating the *Principe* to one of the Medicean princes, but without result. The Medici, as yet at all events, could not employ Machiavelli, and had not in themselves the stuff to found Italian kingdoms.

Other Works.—Machiavelli, meanwhile, was reading his *Discorsi* to a select audience in the Rucellai gardens. Towards the year 1519 both Leo X. and his cousin, the cardinal Giulio de' Medici, thought it necessary to give Florence at least a semblance of self-government. They applied to several politicians, among others to Machiavelli, for advice in the emergency. The result was a treatise in which he deduced practical conclusions from the past history and present temper of the city, blending these with his favourite principles of government in general. He earnestly admonished Leo, for his own sake and for Florence, to found a permanent and free state system for the republic. The year 1520 yielded the *Arte della guerra* and the *Vita di Castruccio.*

The first of these is a methodical treatise, setting forth Machiavelli's views on military matters, digesting his theories respecting the superiority of national troops, the inefficiency of fortresses, the necessity of relying upon infantry in war, and the comparative insignificance of artillery. The peroration contains a noble appeal to the Italian liberator of his dreams, and a parallel from Macedonian history, which, read by the light of this century, sounds like a prophecy of Piedmont.

The *Vita di Castruccio* was composed at Lucca, whither Machiavelli had been sent on a mission. Dealing freely with the outline of Castruccio's career, as he had previously dealt with Cesare Borgia, he sketched his own ideal of the successful prince. Cesare Borgia had entered into the *Principe* as a representative figure rather than an actual personage; so now conversely the theories of the *Principe* assumed the outward form of Castruccio.

In the same year, 1520, Machiavelli received a commission from the officers of the *Studio pubblico* to write a history of Florence. He left a portion of it finished, with a dedication to Clement VII., when he died in 1527. The *Historie fiorentine* is not so much a chronicle of Florentine affairs, from the commencement of modern history to the death of Lorenzo de' Medici in 1492, as a critique of that chronicle from the point of view adopted by Machiavelli in his former writings. But the *History of Florence* is not a mere political pamphlet. It is the first attempt in any literature to trace the vicissitudes of a people's life in their logical sequence, deducing each successive phase from passions or necessities inherent in preceding circumstances, reasoning upon them from general principles, and inferring corollaries for the conduct of the future. In form it is modelled upon Livy. The style of the whole book is nervous, vivid, free from artifice and rhetoric. Machiavelli had formed for himself a prose style, equalled by no one but by Guicciardini in his minor works; it is an athlete's style, all bone and sinew, without superfluous flesh or ornament.

It would seem that from the date of Machiavelli's discourse to Leo on the government of Florence the Medici had taken him into consideration and he was employed on one or two missions of little importance. But his public career was virtually closed. A translation of the *Andria* and three original comedies from his pen are extant, the precise dates of which are uncertain, though the greatest of them, *Mandragola,* was first printed at Rome in 1524. It is the ripest and most powerful play in the Italian language.

The plot is improbable and unpleasing. But the wit, humour, vivacity and satire of the piece bring before us the old life of Florence in a succession of brilliant scenes. If Machiavelli had any moral object when he composed the *Mandragola,* it was to paint in glaring colours the corruption of Italian society. It shows how a bold adventurer, aided by the profligacy of a parasite, the avarice and hypocrisy of a confessor, and a mother's complaisant familiarity with vice, achieves the triumph of making a gulled husband bring his own unwilling but too yielding wife to shame. The whole comedy is a study of stupidity and baseness acted on by roguery. The force of healthy instincts is underestimated.

He composed a second comedy, *Clizia,* which is even homelier and closer to the life of Florence than its predecessor. It contains incomparable studies of the Florentine housewife and her husband, a grave business-like citizen, who falls into the senile folly of a base intrigue. There remains a short piece without title, the *Commedia in prosa,* which, if it be Machiavelli's, as internal evidence of style sufficiently argues, might be accepted as a study for both the *Clizia* and the *Mandragola.*

The little novel of *Belfagor* is a good-humoured satire upon marriage, the devil being forced to admit that hell itself is preferable to his wife's company. The story has a mediaeval origin, and it was almost simultaneously treated in Italian by Machiavelli, Straparola and Giovanni Brevio.

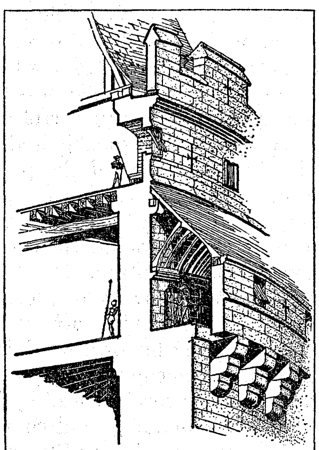
Last Years.—In the spring of 1526 Machiavelli was employed by Clement VII. to inspect the fortifications of Florence. In the summer of the same year he received orders to attend Francesco Guicciardini, the pope's commissary of war in Lombardy. Guicciardini sent him in August to Cremona, to transact business with the Venetian *Provveditori.* Later on in the autumn we find him once more with Guicciardini at Bologna. Thus the two great Italian historians of the 16th century, who had been friends for several years, were brought into intimacy.

After another visit to Guicciardini in the spring of 1527, Machiavelli was sent by him to Civita Vecchia. But what seemed like a new diplomatic opportunity ended. He died in Florence on June 20, 1527, receiving the last offices of the Church.

In person Machiavelli was of middle height, black-haired, with rather a small head, very bright eyes and slightly aquiline nose. His thin, close lips often broke into a smile of sarcasm. His activity was almost feverish. When unemployed in work or study he was not averse to the society of boon companions, gave himself readily to transient amours, and corresponded in a tone of cynical bad taste. At the same time he lived on terms of intimacy with worthy men. Varchi says that "in his conversation he was pleasant, obliging to his intimates, the friend of virtuous persons." The contradictions of which such a character was capable are seen in his correspondence with Vettori. It would be unfair to charge what is repulsive in their letters wholly on the habits of the times, for the published correspondence of similar men at the same epoch offers little that is so disagreeable.

Bibliography.—Among the many editions of Machiavelli's works the one in 8 vols., dated Italia, 1813, may be mentioned (new ed., 1833). Also "Le più belle pagine di Niccolò Machiavelli" in *Le più belle pagine degli scrittori italiani*, ser. vol. 24 (ed. G. Prezzolini, Milan 1925). The best biography is the standard work of P. Villari, *Niccolò Machiavelli e i suoi tempi* 3 vol. (Florence 1877–82. 3rd ed., 1913–14. Eng. trans. by L. Villari, 2 vol. 1878); in vol. 2 there is an exhaustive criticism of the various authors who have written on Machiavelli. *See* also: F. Nitti, *Machiavelli nella vita e nelle dottrine* (Naples 1876); O. Tommasini, *La vita e gli scritti di Niccolò Machiavelli* (Turin 1883); *Il Principe* (with notes by L. A. Burd 1891); Lord Morley, *Machiavelli* (Romanes lecture, Oxford 1897); L. A. Burd, "Florence: Machiavelli" in Camb. Mod. Hist. vol. I., *The Renaissance* (with bibl. 1902); V. Turri, *Machiavelli* (1902); J. G. Fichte, *Machiavelli* (1918); F. Ercole, *La Politica di Machiavelli* (1926); J. Schubert, *Machiavelli und die politischen Probleme unserer Zeit* (1927); M. Praz, *Machiavelli and the Elizabethans* (1928). (J. A. S.)

MACHICOLATION, an opening between a wall and a parapet, formed by corbelling out the latter, so defenders might hurl missiles down upon assailants.



Machicolation (Château of Pierrefonds, 1390)

MACHINE, any apparatus for the application or modification of force to a specific purpose. The term "simple machine" is applied to the six so-called mechanical powers—the lever, wedge, wheel and axle, pulley, screw and inclined plane.

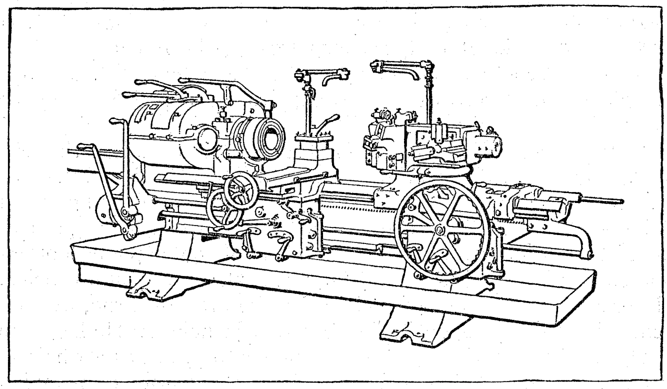
MACHINE BELTING: *see* Belting For Power Transmission.

MACHINE GUN: *see* Gun, Machine.

MACHINE KNIVES are a large group of cutting tools which operate by a linear or a circular action. Among the smallest are the cutters in woodworking machines to produce mouldings, and the largest are shear knives for paper, fabrics and steel plates. The edges are keen and honed up finely, and the knife must be well supported in the machine to cut truly and preserve the edge in good condition. Knives in revolving heads and drums for moulding and planing wood require careful balance in order to eliminate vibration and produce good surfaces. A balancing scale is employed to test the uniformity of weight of each of a set of blades. When a knife has linear cutting action it is often set at an angle or "shear," so as to operate gradually instead of all along the edge at once. Paper, leather, tobacco, veneer and metal are among the substances cut with a linear or slicing movement. Some of the wood planing machines combine high-speed rotary knives and fixed knives in the outfit, the wood being fed through and receiving an extra finish from the fixed knives.

MACHINE PHOTOGRAVURE: *see* Photogravure (Machine).

MACHINE-TOOLS. These lie at the basis of all modern industrial production, for they are not only necessary for the manufacture of every class of engine and kind of mechanism but every manufactured product, whether fabrics or textiles, metal goods, soap, foodstuffs, building materials, scientific instruments, etc., must be made either on a machine-tool, or on a machine which is constructed with their help. Little can be done by purely



By courtesy of Warner and Swasey Company

Fig. 1.—A turret lathe for bar work up to 4½ inches in diameter

casting or forging processes; there is nearly always need to finish certain surfaces truly and smoothly to size in order to produce accurate fitting, or to enable the parts of a mechanism to work.

Machine-tools correct the inaccuracies in cast, forged, or rolled metal articles due to warping and other causes.

The term machine-tool strictly includes wood-working machinery, and there are many resemblances between some of these and metal-working machines. As a rule, however, the latter hold the pieces of work with powerful clamps, vices, chucks and fixtures, while wood can be presented to the cutters with far less trouble, direct by hand, or against guides, or with feeding rollers.

The necessity for firmly holding or driving a casting, forging, or a piece of bar or plate while the machine-tool is cutting it affects the design in many ways, and there are comparatively few machines which can dispense with mechanical holding devices. These are chiefly simple grinding or polishing machines (the operator pressing the articles against the wheels by hand) and punching and shearing machines (the plate resting on a bed and being steadied and moved about as required to make the cuts). Most other machines either take the object between point centres (lathes and grinding-machines) or grip it against jaws or flat surfaces.

In wood-working machinery the tools are very keen for soft woods, rather less so for hard woods, but thin edges such as these are quite unsuited for use against metal. Metal-working machine-tools therefore use tools and cutters with more obtuse angles, and the speed of cutting has to be set so that these will not be destroyed rapidly. For example, brass and similar alloys can be cut at high speed without injury to the tools, but the same rate on iron and steel would abrade and burn the tools. The use of a lubricating and cooling medium such as oil, soapy water or an emulsion greatly relieves the tools and enables a higher speed to be attained than by dry working; and there are special steels which will perform very severe duties without failure, even on hard materials such as chilled rolls and railway wheel tyres, which latter develop very hard spots by running on the rails; stellite will cut at an astonishing rate compared with the performance of a steel tool. This question of capacity affects the running of a machine-tool for definite periods on similar work, for if a tool edge requires frequent regrinding the machine cannot run automatically for many hours or days without attention. Consequently the tool must be made of a suitable steel and so designed that it will resist wear for the required length of service, and the speed of the machine must be regulated to suit the class of metal being machined.

A large group of machine-tools, the grinding-machines, do not use metal tools, but operate with high-speed wheels of emery, corundum, carborundum and other abrasives. The kind or condition of metal makes no difference to these wheels—they grind off the hardest steel without difficulty—but there are many limitations to their use; thick cuts possible with steel tools cannot be taken off castings or forgings with these, and surfaces of certain shapes cannot be readily dealt with. But the grinding wheel often acts as a finishing agent after forms have been roughed out on some other sort of machine-tool; highly accurate results, sometimes to within one ten-thousandth part of an inch and finer still in making gauges, can be attained by their use. After pieces have been hardened also the grinding-machine is the only means of further correction, and all sorts of tools and cutters which have been hardened or tempered need their use for final truing up and subsequent sharpening at intervals. The demands of the motor industry for immense quantities of relatively small hardened parts have led to the design of new types of machines which either handle these rapidly in succession, or grind a large number at one pass of a wheel all to similar thickness.

Early Machine-tools.—The lathe is the parent of all machine-tools, and some of its elements are curiously traceable in many kinds of machines, including fresh types not known a quarter of a century ago.

Machines derived from the lathe model include the boring, drilling, milling, sawing and grinding machines; the planing machine was a new departure rendered necessary by the introduction of flat surfaces in steam-engines and machines. These at first were made slowly and laboriously with hammer and chisel and file, but on the *planer* they were readily and accurately surfaced by passing under a tool. Then for smaller articles the *shaper* was invented, the object remaining fixed on a table while the tool was reciprocated by a ram above; the *slotting-machine* is practically a vertical type of shaper, the tool going up and down and cutting along edges according to how the table feeds the work; the *broaching-machine,* a recent type, effects its cut in one instead of many strokes (as in the preceding machines), the broach being a long tool furnished with teeth increasing in cutting depth, so that a hole or slot is cut a trifle deeper by each tooth in the traverse of the broach through the hole. This method is quick and highly accurate, besides being suited for shapes that are awkward to plane, shape, slot or mill.

Drilling and Boring Machines.—All drilling and boring was at first—and much of it still is—effected in the lathe; but the upright drilling-machine, in which the object to be treated can be held in a more convenient position while the drill descends on it, was soon developed. Horizontal boring machines, too, were built with slight differences from the lathe; these gradually extending to alterations which radically changed the appearance, though the revolving spindle remained, and the essential differences are greater adjustability to suit different sizes of work and improved means for holding the latter. The speed range of the spindle of a drilling or a boring machine is often more extensive than that of a lathe, the light sensitive drills for small holes running up to 12,000 revolutions or more per minute, with means for going at slower speeds for larger drills or extra hard metal; such a speed is necessary to secure the full advantage of the high-speed steel drills. A great enhancement of output is obtained in automobile factories, engine works, valve and fitting factories and others by using multi-spindle machines. Instead of putting one drill through the metal at a pass of the spindle, the latter is duplicated, or multiplied into often scores of spindles, each holding a drill, so that all the holes wanted in the face of the work are drilled simultaneously.

Milling-machines.—Milling was originally also performed in the lathe, the rotating cutter being driven by the spindle while the piece of metal was fed under it by the slide-rest; and from that principle dozens of different kinds of milling-machines utilizing cutters of various shapes that can finish flat surfaces, curves, slots and every conceivable shape required in metal construction from the tiniest to the most massive, have been evolved. Wood is also milled on machines of a somewhat different type, and forms in either wood or metal which would be slow and tedious to produce on certain other machine-tools and difficult by hand methods alone, can be milled in a brief time with great accuracy. As in most instances the milling-cutter imparts its shape or part shape upon the metal, the intricate outlines are as easy to cut as the plain flat ones; hence a cutter or set of cutters mounted together will mill flats, bevels, curves and slots along a casting or forging all in perfect relationship and turn out hundreds or thousands of pieces alike. As in drilling, two or more spindles may be fitted on a machine, and the work be milled on each flank, or at top and sides, or underneath. Cylinder blocks, crank-cases and various parts of engines and machines are bolted on a long table to feed past such cutters, so that when the table has completed its feed from 6 to 20 units have received treatment. The quantity will be greatly increased if a double row is laid down the table, the cutters milling on one side only of each piece. Mass production in the motor-car and other factories has extended so much that even the halting of a machine for the purpose of removing milled units and putting on others to be done has been partly abolished.

Sawing Machines.—Like the milling-machines these have a rotary drive to a many-toothed tool, but in the sawing-machines the latter is comparatively narrow and the feed only has to cause a penetration partly or completely through the object. The cutting serves to make slots as well as severance, while in wood-working certain kinds of saws perform quite a range of cutting of various outlines. Reciprocating saws are an adaptation of the hand saw, accurately guided, and with control of the object. Files are also worked in machines so increasing accuracy and output.

Grinding-machines.—All grinding was formerly done in the lathe, and its chief purpose was to correct the bearing portions of spindles which had been hardened and had warped slightly in the process. There is still a large amount of grinding of small hardened components in the fine instrument-makers' lathes, but in general engineering practice the grinding-machines are distinct designs, more suited for running the wheels at the requisite great speeds without vibration, and with special provisions for pre-

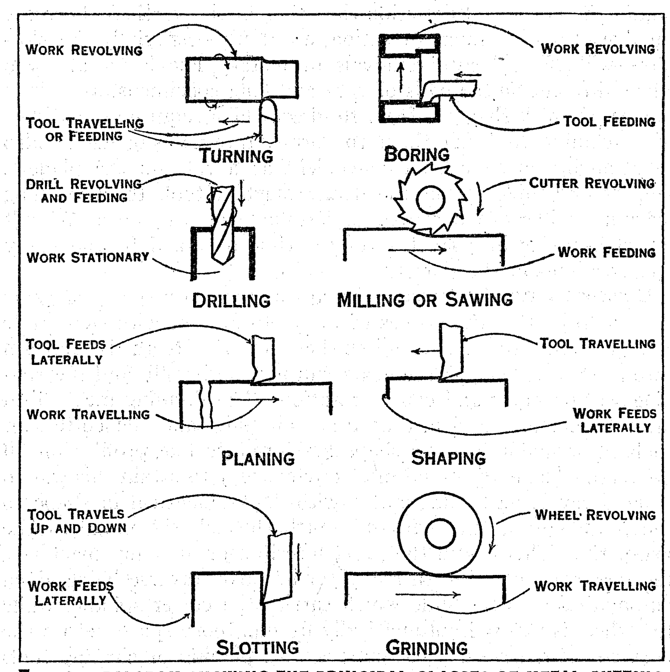


FIG. 2.—DIAGRAM SHOWING THE PRINCIPAL CLASSES OF METAL-CUTTING DONE BY MACHINE-TOOLS

venting damage to bearings and slides from the grit and from the water used in cooling the work. For a good while only finishing was attempted, the major portion of the work being done on the lathe, a trifle only being left for the wheel to remove; mechanical improvements have altered this, and now the grinder can deal with rough castings, forgings and rolled bars and will take off all the metal necessary to reach the finished size. Parts of stoves, doors, dampers and other boiler details, forgings for cars and engines, and many items for agricultural and domestic machinery are now cast or forged very nearly to the final dimension, and grinding is a quick and economical method of completing the work.

Practically all running parts of good-class machinery, such as shafts, spindles, bushes, washers, ball and roller bearings, gears, nuts, pins and pivots and such-like are finished to a close degree of accuracy by grinding, and mass production is favoured thereby.

Planing, Shaping and Slotting Machines.—Before the possibilities of milling were apparent all heavy and much light cutting was effected on one or other of the reciprocating machines using a tool with a single edge as distinct from a rotary many-toothed cutter. The objections to these machines are that no work is performed on the return stroke as the tool only cuts on the forward stroke, and difficult contours, which are easy to mill with formed cutters, are not so conveniently planed or slotted, nor is the finish usually so good. At one time the milling-machines competed with the reciprocating machines in the speed at which metal could be removed, but the designers of the latter soon remedied this. Stronger construction, higher rates of cutting, and a much faster rate of return on the non-cutting stroke were introduced, and electric driving helped in increasing the speeds for big machines. Further, by arranging switches along the table edge of the large planers the speed could be accelerated suddenly at any spot, and decelerated to the proper cutting rate again the advantage being that the table can rapidly jump any gaps between pieces of work bolted on the table, or openings in the surfaces of work. Economy in planing is best secured by employing a very long table filled with pieces of work all to pass under the tools, instead of a short table carrying only a few articles, or by using a machine that carries several tools, one or two operating along the top of the work, and one at each side.

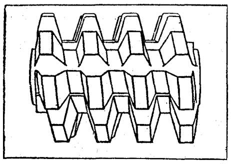


FIG. 3.—A HOB WHICH CUTS TEETH AS THE GEAR REVOLVES

Shapers and slotters are utilized for relatively short cuts, the one in the horizontal direction the other in the vertical; both are capable of a wide range of action, and both—especially the slotters—will effect heavy removals of metal. The latter are well adapted to cut on the ends of rods and long specimens, as well as to slog off thick shavings from forgings which require a good deal of machining to bring them to form. Internal slotting is also easy, an operation not so convenient as a rule on the planers, shapers and millers; but the newer machine-tool, the broaching machine, will at one stroke undertake even the most difficult internal cutting in a fraction of the time occupied by the many reciprocations of the slotter.

Gear-cutting Machines.—In cutting the tooth spaces of gears it is essential that the curves of the teeth are cut with exactitude and that the spacing or pitch between the teeth is uniform throughout. Otherwise the gears will not mesh well, and the running will be noisy and cause vibration. The dividing mechanism must be perfect to ensure accurate pitching, and the cutters or tools must maintain their shape and produce like profiles on all the teeth. The earliest and most obvious way to attain this was to make a revolving milling-cutter with flanks identical in shape to the tooth curves, and with it plough through the metal of the wheel rim. This is still the procedure in a great many machines, the feed and quick return ready for another traverse being given automatically to the slide which carries the cutter spindle, while the wheel is indexed automatically by one tooth space before the next cut commences. Gear-cutters with planing or shaping tools instead of milling-cutters are employed for two reasons. One is that bevel gears can only be cut with correctly shaped teeth by a tool which travels in a path corresponding to the taper of the teeth, from the big to the small end; a cutter with fixed curves obviously cannot produce such a tapered shape. The other reason is that a planing type of machine with its simple flat-edged tools does away with the necessity for a large stock of cutters to suit each size of tooth, and the shape of the tooth is correctly formed or generated by mechanism incorporated in the construction of the machine. For the best workmanship, such as is necessary in automobile and other high-grade gears, the teeth are finished by grinding so as to ensure perfect contact and noiseless running.

Portable Machine-tools.—Machine-tools are ordinarily fixed to a floor, and the work is brought to them; but very big castings or forgings, machinery that has to be repaired, altered or put together *in situ*, etc., often cannot satisfactorily be treated in this way, and in such cases it is usually quicker, easier and cheaper to employ a portable machine that can be bolted to the work, or supported closely to it in position for the cutting. Parts of large engine beds and frames and of electrical machinery and turbines are conveniently drilled, bored, tapped, milled, planed, shaped, slotted or ground by appropriate machines driven with flexible shafts or electric motors. Workshops dealing with such large objects have *floor-plates*, huge cast-iron beds with tee-slots into which bolts may be set about anywhere over the surface. The casting to be machined is bolted on the plate, and the portable machines are appropriately bolted alongside, several being used simultaneously on the various faces. Repair operations in mills and factories and on board ship often demand the services of a portable machine-tool which is attached to a framing, or clamped upon a shaft or wheel, to drill holes or ream them, or to mill off surfaces or cut keyways; such work could be done with hand tools, but as time is usually a vital factor in repairs and breakdown cases, a hand or power-driven portable machine-tool is preferable. Many tools are not really attached, but are held and controlled by the hands, as explained under PNEUMATIC TOOLS, but there is usually some sort of support by the tool, otherwise the operator would not be able to guide the cutting action.

Plate and Sheet-metal Working Tools.—Although a certain amount of cutting is done in the machine-shop on plates as well as castings and forgings, the great bulk of such machining is relegated to special departments. The thicker iron and steel sheets and plates for boilers, bridges, buildings, ships, cranes and other constructions are sheared, planed, drilled, punched, reamed and tapped in machines of specialized type, giving capacity for the fast working necessary in view of the enormous mass of detail involved. Multiple working is adopted as far as possible, *i.e.*, a number of holes are punched or drilled simultaneously, some sheets requiring scores or even hundreds to be put through.

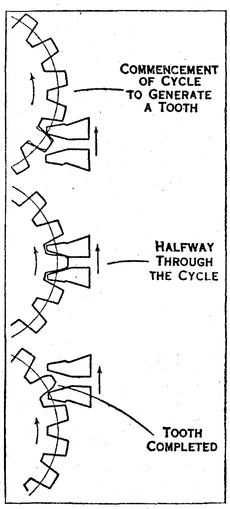
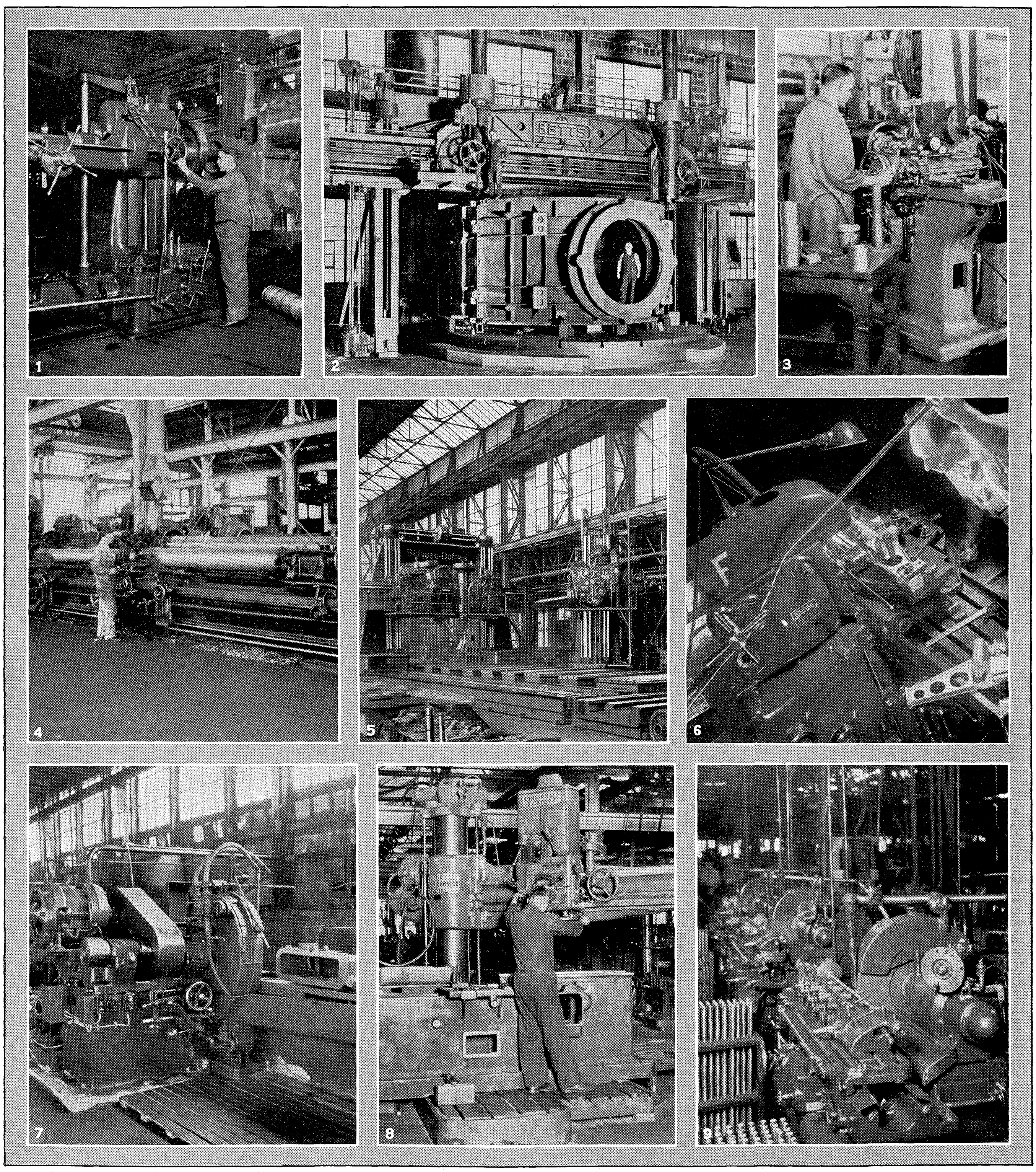


FIG. 4.—GENERATION OF BOTH FLANKS OF A BEVEL-GEAR TOOTH BY DUPLEX TOOLS

Sheet-metal working on the lighter side is done in shearing and punching machines of much lighter construction than those of the planing- and boiler-shop, and there is a whole range of presses using punches and dies for blanking or finishing all sorts of metal articles. Some machines perform more or less elaborate operations, including bending, folding, assembling and riveting, and are formative in the main.

The wood-working machine-tools are characterized by high speeds, keenness, and the rapidity with which the wood is fed for cutting. A simple kind of vice or clamp may be employed, corrugated rollers, or just a guide plate or fence to keep the position right. As with metal-working machines, the tools for making holes and the various knives, bits and cutters are used in multiple whenever practicable. A problem which is more insistent than with some of the metal cutting operations is the disposal of the masses of shavings which accumulate in a few moments; pneumatic suction pipes effect their removal.

Methods of Measurement.—It is in practice always essential to machine off a definite amount of metal to bring the piece of work to a dimension determined on the shop drawings and in many instances a second cut is necessary for accurate finishing, the machine taking a heavy cut nearly to the indicated size and then a light one to make a smooth and accurate surface. If the attempt is made to take off the whole of the cut at one traverse, accuracy is not so likely to result, for the tools, cutters and the machine parts tend to spring under the stress, and slight deviations occur in the movements resulting in vibration and minor

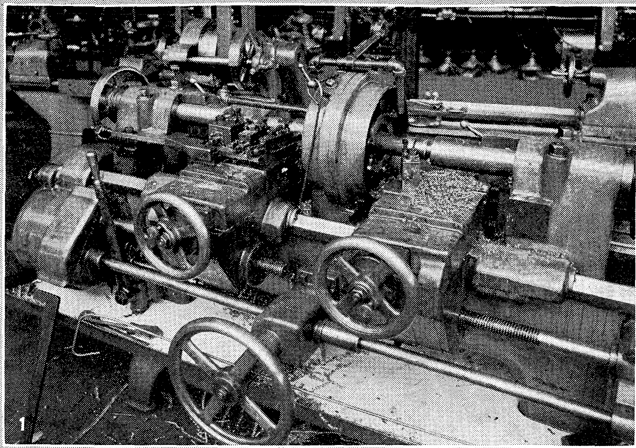


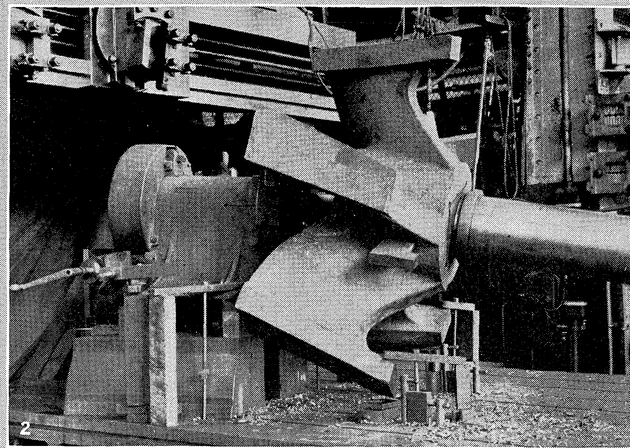
BY COURTESY OF (1) THE LUCAS MACHINE TOOL CO., (2) THE CONSOLIDATED MACHINE TOOL CORPORATION OF AMERICA, (3) THE HEALD MACHINE CO., (4) THE AMERICAN TOOL WORKS CO., (5) "MACHINERY," (6) THE CINCINNATI MILLING MACHINE CO., (7) THE DIAMOND MACHINE CO., (8) THE CINCINNATI BICKFORD TOOL CO., (9) THE LANDIS TOOL COMPANY

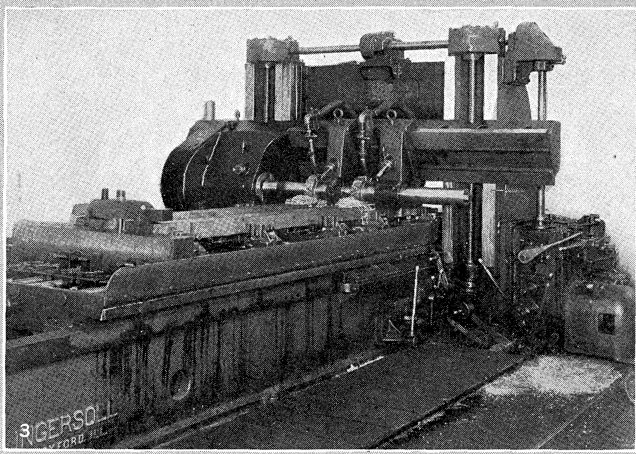
MODERN TYPES OF MACHINE-TOOLS IN OPERATION

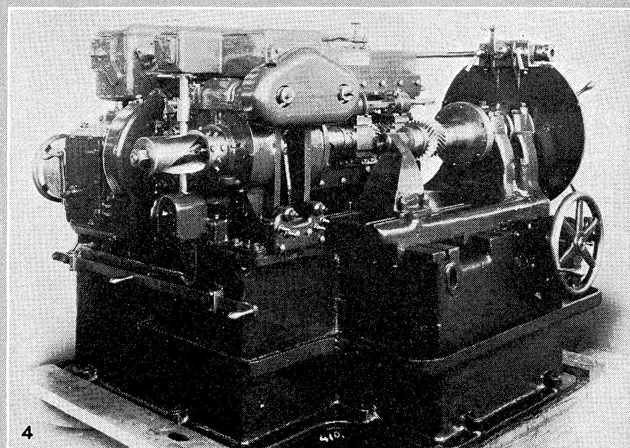
1. Precision horizontal boring machine. Head carrying the spindle moves on upright column; work can be moved on bed (right) in either direction
2. Large boring mill. This machine was designed for finishing large hydraulic and electrical equipment parts. The work in place in the mill is a turbine casting weighing 197,900 pounds. Mill has swing of 32ft. 3in., table diameter is 24 feet. Operators' platforms on either side at top
3. Automatic grinding machine, which measures opening in piece to be worked and "works" or grinds the piece accurately to the size desired
4. A simple motor-driven lathe turning out 14-in. propeller shaft for an ocean vessel. Shafts must be turned true and balanced perfectly
5. Large combination drilling, boring and milling machine—milling element (left), drilling element (centre), boring element (right)
6. Horizontal milling machine, milling aluminium aeroplane struts. Various cutter speeds and feeds may be selected by operator at front or rear working position
7. A diamond-face grinder surfacing the mating pieces of machine parts. One piece (right) is being held to bed of machine by magnetic clutch
8. Large radial drill. Centre post holds drilling element (right) which reaches to any part of duplex base. Operator regulates drill pressure
9. Cylindrical grinder mounted on rocker-end shafts. Machine shown has automatic hydraulic feed, regulating speed and depth of cut

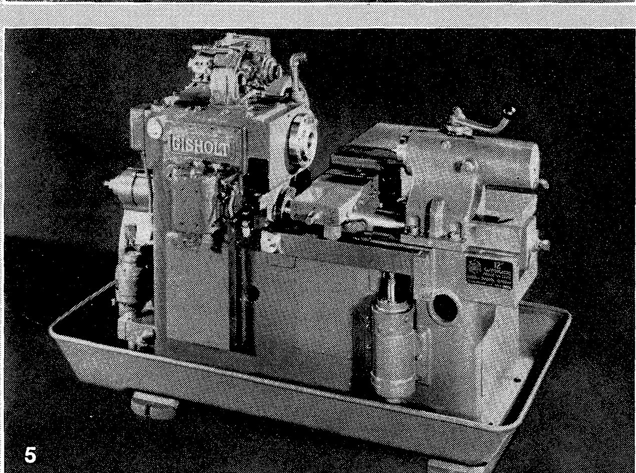
MACHINE–TOOLS

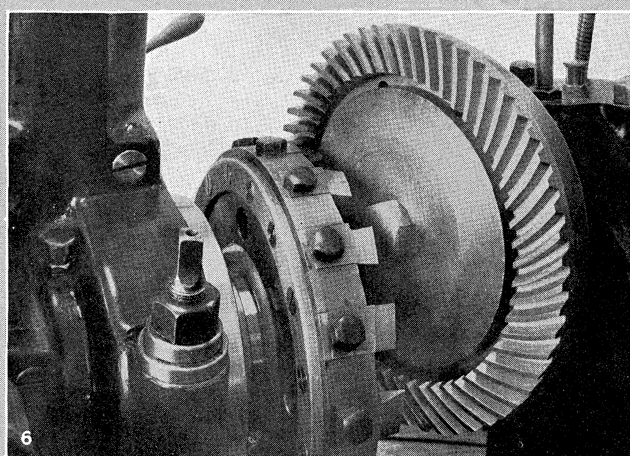












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SIMPLE AND AUTOMATIC LATHES, PLANING AND MILLING MACHINES

1. Centre driven lathe for turning both ends of automobile axle tube at once. Tube is driven from the centre of lathe, held by chuck shown at top centre of picture. Three cutting tools at left, one at right
2. Planing machine at work on section of a large turbine. Shaft (right) holds piece in place while planer (upper left) machines surfaces
3. Large milling machine channeling two main side rods for locomotive at 5½″ per minute feed. Circular milling heads or cutters are seen near centre of main shaft, rods in horizontal position on the bed
4. Automatic gear planer cutting tooth sides of a herringbone pinion having a continuous tooth and no clearance in centre. Machine also uses a cutter resembling a gear. Pinion seen on shaft at right
5. Hydraulic automatic lathe with 22-in. maximum length between centres and 16¾-in. maximum swing
6. Gear cutter (centre) of large lathe at work on ring or drive gear (right) for the differential of an automobile. Tools which perform cutting operation are fastened by bolts to rim of cutter wheel

irregularities on the surfaces. But a finishing tool with only very light duty to perform is not subject to these faults, and it can be kept sharp and in the best condition of edge to give a fine finish. Some lathes and other machines rough and finish with the same tool, others with tools of rather different shapes, while a few (such as milling-machines) pass the articles under distinct roughing and finishing cutters in the course of the one feed traverse. Or roughing is given to the lathe or planer or miller, and finishing to the grinding-machine. There is in some high-class products an interval between the two operations, such as for motor-car cylinders and parts of scientific machines, when the rough skin of the casting has been taken off the whole thing may alter its form to a small degree owing to the release of surface tension. By leaving the pieces time to "season" after roughing there is avoidance of warping taking place after the fine finishing process.

It is necessary to allow a predetermined amount for roughing, and in repeat orders all the sizes are marked on the drawings, so that the tool-maker and setter and the operator know just what to do. Sometimes there is no necessity for measuring while the cuts are in progress, in other instances frequent checking has to be made. The familiar hinged leg calipers have been mostly displaced in up-to-date factories in favour of more precise instruments.

Methods of adjusting edged tools vary; they may either be set tentatively and then tested and re-tested against the actual work, or they may be set by means of a thickness block or gauge which brings the cutter to exact position. Careful measurement or gauging of components turned out in large quantities is requisite at frequent intervals, so as to be sure that none of the numerous tools (as in an automatic screw machine) have altered, slipped, or become blunted. The tendency is always towards reduction of hand measurements in favour of automatic indication of sizes; of grinding-machines especially is this true, a magnifying arm or an electric indicator showing when the work reaches a specified size.

(F. H.)

UNITED STATES

Beginning with the demand of the builders of steam engines for machines that would bore cylinders more nearly round than the early, crude machines, machine tools have been developed in the United States to a remarkable degree. The demands of builders of automobiles has made possible the spending of great sums for specially developed machines. Where tolerances of a few thousandths of an inch were formerly permitted, the practice in 1928 holds the accuracy well within a thousandth or even two or three ten-thousandths of an inch.

The lathe was in 1928, for example, largely used in roughing work to be finished by grinding; milling had supplanted planing in many cases, and was in turn, being supplanted by grinding in some fields. The vertical milling machine was at the same time doing much work formerly done on the slotter, and, for finishing such internal surfaces as automobile cylinder bores, the honing process has almost entirely supplanted the internal grinder. Many of the newer designs of machines had their beginning before 1918, but in most cases the final development that has given them such a permanent place in modern metal working industries, came within the decade 1918–28. Hydraulic feed was built into machines at least 30 years ago, but its successful introduction into machine tool use is quite recent, as an accepted method of securing a positive and easily regulated feed. The drilling machine, one of the oldest of machine tools, has undergone many changes. This main development has been in high speed sensitive machines, in heavy duty vertical machines, and in the radial type, in which much of the mechanism has been transferred from the base of the column to the head, and all of the controls are now under the operator's hands, without moving from his working position. The "way-drilling" machine, in which spindles are arranged to drill holes in three, four or five sides at once, and at any angle, has been developed to handle much intricate work at a rapid rate.

In all machine tools the use of the cone pulleys and shifting belts as a means of securing different speeds has practically disappeared, except in the sensitive drilling machine. Change gear boxes have become common in most classes of work. The two main developments in sensitive drilling machines have been the replacement of plain bearings by ball-bearings, and the careful balancing of the spindles, including the chuck, or drill holding device. This balancing makes for smoother and steadier running at the higher speeds and also greatly lengthens the life of the machine by reducing the load imposed on the bearings. Heavy-duty machines were developed largely to meet the demand for rapid drilling or boring of large holes such as formed a large part of big gun ammunition and for automobile cylinders. Heavy thrust bearings are usually ball—and both ball- and roller-bearings have come to be a part of the design in these machines. Nor are they confined to single spindle machines but are found with four, six or eight in the case of automobile shops. This is also one of the fields to be invaded by hydraulic feed. In no field however has the advance been more marked than in radial drilling machines. Not only have sizes and weights increased but there are great refinements in design that make it of particular interest. Among the new features is the centralizing of all control on the head. This includes the locking of the arm on the column, the raising and lowering of the arm and the changing of spindle speeds and feeds, all without manual labour. Roller-bearing spindles and ball- and roller-bearings in the gear shafts, hardened gears of alloy steels, and special oiling systems cover the main features of the newer machines. Multiple spindle and standard drilling machines have both been improved, the bearings of the former being limited by the closeness of spindles. There is also a growing tendency to use multiple spindle drilling heads with fixed spindles on single spindle drilling machines. By this method the same machine can be used on different jobs by merely changing the drilling heads instead of by re-setting the spindles on a multi-spindle machine.

Engine Lathe.—The engine lathe, formerly one of the most important machines, finds its greatest usefulness in 1928 in rough turning work. Even for this work the turret lathe, with its modern simplified tooling, has still further reduced the field for the engine lathe. The result of this tooling has been to have the turret lathe selected for work where as few as six duplicate pieces are to be made. This is one of the most drastic changes that has taken place in machine methods. Both engine and turret lathe work is commonly finished by grinding. In the meantime however the engine lathe has been developed into a heavy-duty, geared head machine, with all changes of speeds controlled by suitable levers that are easily accessible.

The first development away from the engine lathe was to replace the tail-stock, or back centre, with a turret for holding several tools which could be presented to work held in a chuck, one after the other. This only affected chucking work and not work held between centres. The multiple tooling permitted several operations to be performed in quick succession, at one setting of the work. These have been developed in many forms and in the semi-automatic or full automatic form; they now produce intricate pieces with great accuracy and speed. Hand-operated turret lathes have standardized the tools used so that they can now be used on a large variety of work and only require a minimum of time to set them up for a particular job. Semi-automatic machines, in which the tools are fed to the work automatically after the piece has been put in place, are in common use. The automatic feeds are secured by cams, gears and screws, or, in some cases, by hydraulic pressure. Semi-automatic machines of the lathe family are used in nearly all metal manufacturing. Another and later development retains the tail stock and is used for "centre work," the tool carriage being provided with multiple tools and the feeding movements, both longitudinally and as it affects diameter, automatically controlled.

Turret Lathes and Station Machines.—Modifications of turret lathes have also been made in which several work spindles are indexed from one position to another so as to present different tools to the work in the proper succession. An excellent example of the station type machine is the Bullard Mult-au-matic, which is in reality a multi-spindle, multi-tooled vertical lathe, or a number of lathes. This machine has six vertical work spindles, each carrying a table, or horizontal face plate as in the vertical boring mill. Above and in vertical alinement with these spindles are five tool slides each carrying tool heads. The sixth place is vacant so that the work can be loaded and unloaded at this point. When the empty spindle has been loaded and the indexing takes place, all six spindles move one-sixth of the circle. Each spindle stops during the indexing but resumes speed as soon as it is in the new position. Its speed varies with the operation being performed at the particular station, being slow for large diameters or broad cuts and fast where the work and tools permit.

Planers and Shapers.—Although the use of planers and shapers have not increased as with some other types of machine tools, they have been greatly improved. Planer beds have been made heavier, stiffer and longer; the planer table no longer overruns the bed, but is fully supported at all parts of even the longest stroke. Driving gears are wider and heavier, and are of steel instead of cast iron, and in some cases have helical or herringbone teeth. Shafts and shaft bearings are also much heavier and forced lubrication supplies all the driving mechanism with oil. Reversing electric motors that eliminate the use of shifting belts are now in common use. Another innovation is the application of individual motors to various functions such as raising and lowering the cross rail and side heads, and of moving the tool heads or saddles on the cross rail. A more common method however is to secure power from the main drive but to control each movement from either end of the cross rail, by individual control handles. They are so arranged that all movements can be made by power and at high speed if desired. The open side type of planer handles a wide variety of work that cannot be done on the regular type planer.

Milling Machines.—The old knee type machine has, to a great extent, given way to other designs. In a type known as the manufacturing design, a heavy bed supports a long deep table while on both sides is a massive column each with a heavy spindle driven by hardened and ground steel gearing. The spindle sleeve or quill, moves in or out and supports the cutters with a minimum of overhang. In addition, the heavy overarms can be used to provide additional bearings for the cutter arbours and so counteract the tendency to spring under a heavy cut. The planer type machine, which resembles the planer in general appearance, has the cross-rail carrying milling cutters instead of a head for single point tools. Side milling heads are also used, the total number of milling heads frequently reaching ten or more on a single machine. As each milling head represents a surface that can be machined at a single pass of the work, the capacity of such machines can easily be estimated. A particularly interesting development of the milling machine is the drum, or rotary type. This is a continuous operation machine, the drum carrying the work past a number of milling cutters.

Automatic Die Cutting Machine.—Another and special form of milling machine has been built to handle the increased use of dies for forging, stamping, etc. Until about 1921, machines for cutting dies required the use of models made of such materials as bronze, cast iron or electrotypes. These were of two distinct types: reducing machines in which the model is larger than the die required, and duplicating machines in which the model is the same size as the die. Both these types are still in use, but they have their limitations. To meet the demand for a machine on which models made of softer materials could be used, the full electric controlled machine was devised in 1921. This machine is, in its essentials, a milling machine. The movement of the cutting tool is positive, and under control of a tracer or finger which follows the surface of the model by means of an electrical mechanism. The main bed carries a column sliding thereon, and operated by a lead screw driven through suitable gearing by a pair of oppositely rotating magnetic clutches. On the column is the saddle, operated vertically by a vertical lead screw, which is driven by a similar mechanism as the main column. Mounted on this saddle is the cutter head designed to slide in a transverse direction and operated by a lead screw, again in the same manner as the other two motions. The cutter head carries the cutter spindle and driving gears, also the motor supplying power to the cutting tool. On the front part is a long bracket extending vertically for the support of the tracer. The tracer operates the three slides of the machine in such a manner as to cause the cutting tool to follow the same path over the die as the tracer point follows over the model—thereby reproducing the exact shape of the model in the cast iron or steel die block. The model is usually made of wood, plaster, cement or other convenient material. The pressure of the tracer point on the model is only a few ounces, but the cutter by means of the lead screws and power driven magnetic clutches, is forced to cut the material of the die. This machine has played an important part in the mass production of automobiles and other articles manufactured on a large scale by greatly reducing the time necessary to produce a set of tools for body-work on forging parts, etc., and also cutting materially the cost of the same. Since the machine will follow the outline of a male or female thin sheet metal template with unusual fidelity, it is also a very efficient profiler. It may also be conveniently used for jig boring operations.

Gear Cutting Machinery.—When the need for better gears than could be made by casting became apparent, both the milling machine and the planer or shaper were utilized in machining the teeth. The accuracy of the teeth depended upon the proper shaping of the teeth of the cutting tool, and the spacing on the accuracy of the indexing mechanism used. Both of these conditions still affect the accuracies of gears, more in some types of machines than in others, but with improved methods and materials, extremely accurate work is now produced by these methods. The designing of machines that could generate the teeth shape of the desired curve was first accomplished on the planer type of machine and later by the hobbing or continuous milling process. Both of these have grown to be standard methods and several types of machines are now in daily use. Machines of this kind are completely automatic after the gear blank is put in place. Two tools are used, one cutting on each side of the tooth. Both the cutting, feeding and indexing are automatic, the machine stopping when the gear is completed and ringing a bell to call the operator. Here the shape of the tooth is governed by a hardened steel form that guides the tools as they feed into the work and shape the tooth.

An entirely different type of planing gear machine is known as the gear shaper. This uses a cutter in the form of a gear. This cutter is very carefully made, the shape being finally formed after hardening, by a fine grinding wheel that generates the shape of the tooth. In this machine one of the gears is the cutter and both cutter and gear block roll slightly between each stroke of the ram.

Another type of gear cutting machine employs a similar principle. This machine in which the cutter bars are horizontal instead of vertical has two cutters at work, one on each side of the gear blank. By this method it is possible to cut the double helix or herring-bone gears, with no clearance space in the centre. Both the cutter bars and the gear blank move in unison through the proper number of degrees to give the desired angle to the helix of the teeth in the gears. The cutter bar moves from side to side, planing first one side and then the other, and leaving a perfect joint or mating point, at the centre. The proper twist is given the cutter bar by a cam on the cutter bar. Gear teeth with a single helix or straight across the gear blank, commonly known as spur gears, can be easily cut on this machine.

Still another method of cutting gears by the planer-generating process is known as the Maag system. Instead of using a cutter that is practically a hardened gear, this system uses a hardened rack which moves past the gear being cut at the same rate the gear blank is revolved. Many gears are still cut by the milling process, which includes both the formed milling cutter that is fed straight across the face of the gear (and is also used for helical gears to a limited extent), and also the hobbing, or continuous generating process. Here the milling cutter is replaced by what is called a "hob" or continuous milling cutter in the shape of a screw. By setting the cutter at the angle of the thread, and revolving the gear blank at the proper speed, the hob can be fed across the face of the gear blank and generate teeth in accordance with the form of the teeth of the hob, which conform closely to that of a rack.

Grinding Machines.—The development of centreless grinding machines and of the use of wide grinding wheels, together with the growth of the ring wheel type and automatic sizing grinders, are perhaps most noticeable improvements in the field of grinding machines since 1918. The whole machine field has been affected by the growth of grinding. Much flat work that was originally done on the planer was first taken over by the milling machine and later by the grinding machine. Such work as flat irons, mating surfaces of motor blocks, transmission cases, and the like, are usually surfaced on grinding machines of disk type, or with ring wheels. The disk machines generally use disks made of heavy paper and coated with abrasive. These formerly had plain surfaces but are now frequently embossed to give a cushioned effect and to present a series of small grinding surfaces instead of a large solid surface. The depressions serve to hold and carry away the metal particles removed by the abrasive. Various types of fixtures are used to hold the work frequently passing it between two disks and so finishing two sides at once. These disks are on both vertical and horizontal spindles, the latter utilizing the weight of the work to aid in securing the necessary pressure against the abrasive. Grinders using the ring type of wheel have been so developed that they rival the milling-machine and planer as to the amount of metal removed per hour. While much of the work done in this way is a roughing operation, some types of machines are also used for final finishing operations. This type of machine, using magnetic or other chucks, frequently holds many pieces of work at once. In some cases the work is placed in holders as the table revolves, the magnets becoming active before the work reaches the grinding wheel. After passing out from under the wheel, the magnets become inactive and the work can be removed by hand or is forced out of the chuck by what is known as a plough. The magnetic chuck has aided in the development of plane surface grinding. It provides a method of holding work that is either too thin to be held by clamping, or of such shape as readily to be sprung out of shape either by clamps or by the wheel pressure.

Still another method of grinding that has been developed in recent years involves the use of broad faced wheels, up to approximately 12 in. in width, and there is no reason to believe that this is the limit. In cylindrical work, under the name of the plunge-cut grinder, the wheel is fed straight into the work instead of being traversed along the length of the piece as by the older method. A new development in fine grinding is known as superfinishing, developed by D. A. Wallace of the Chrysler Corp. It resembles honing but must have at least three motions between the abrasive blocks and the work. It uses abrasives up to 500 fine. It removes minute high spots on bearing surfaces that might puncture the oil film and cause wear. It produces surfaces with scratches not exceeding 6-millionths of an inch deep.

Even more interesting than the plunge-cut development is the growth of the centreless grinding. Beginning with the grinding of small round pins, with more or less errors as to roundness and size, centreless grinding is now being used to secure extreme accuracy. Starting with a grinding wheel and two stationary rests, which supported the work as it revolved, one rest was abandoned in favour of a second abrasive wheel. This second wheel runs at a slower speed than the main, or grinding wheel, and is known as the feed wheel. Its main object is to insure that the work shall revolve at all times, which overcomes the occasional stoppage and the consequent flattening of the work which sometimes occurred in the older machines. One of the economical features of the centreless grinding machine is the continuous feed that can be secured by setting the feed wheel, or even a stationary rest, at a slight angle to the grinding wheel. All that is necessary is to place the work in an inclined trough leading to the opening between the wheels, and the work automatically feeds into and through the machine. In some cases two machines are placed in tandem, the first acting as a rougher while the second finishes the work. While centreless grinding is primarily for grinding straight work that can pass between the wheels continuously, the method is also used on work of different diameters or with shoulders and tapers. For this work the wheels are set parallel and the work fed between the wheels at right angles to the axis of the wheel spindles. While not as fast as the straight through feed, it is usually more rapid than work ground between centres. Centreless grinding now includes internal work with automatic sizing for both types of machines by mechanical, electrical, and pneumatic control. The latter uses an air jet that builds up back pressure and stops the feed when the correct size is reached.

Broaching.—Broaching, which is the forcing of a special cutter through an opening or beside a piece of metal in order to enlarge a hole or shape the exterior, continues to play an important part in machine work. In some cases the finishing of surfaces in this way is applied to large sizes. A broach may be likened to a special chisel, with teeth spaced at frequent intervals and of such shape as to produce the desired surface in the work. Broaching is confined to internal work in most cases, being originally used for holes that were not round. Present day practice, however, uses broaching very largely as a method of producing round holes accurately and economically. Broaches are made in both the "pull" and "push" types. The former uses a long broach and frequently finishes a hole with a single pull of the broach. Push broaches on the other hand are usually rather short and several are required to cut the hole to the desired shape or size. The number of broaches depends largely upon the length of the piece to be broached, the metal used and the accuracy required. The length is determined by the amount of metal that can be cut successfully by each tooth of the broach, as on this depends the number of teeth required. Where great accuracy is required the amount cut per tooth is very small: as the broach reaches the maximum size, it is frequently necessary to use two or more of the long pull broaches. Outside broaching, which is the finishing of the outside surfaces of machine parts by forcing a broach past them while the work is rigidly held and the broach firmly guided, is used in some cases. Gear teeth have been cut in this way and similar work is also handled. The application of outside broaching is however, comparatively limited. Broaching machines are made in both horizontal and vertical types, the former usually for the pull broach and the vertical for the shorter push broach. Broaching is now replacing milling to some extent in the machining of outside surfaces such as automobile cylinder blocks, for straddle milling, and other surfaces where the quantity warrants the first cost of machines and broaches.

Illustrations relating to machine tool practice are shown in Plates I. and II. (F. H. C.)

See Tool, and also Automatic Machines, Tool Steel, Grinding-Machines, Presses and Presswork, Lathe, Milling-Machines, Planing-Machines, Punching and Shearing Machines, Sawing Machines, Steam-Hammer, Woodworking Machinery, etc.

MACHINERY AND PRODUCTION. The influence of machinery on production and human welfare is well illustrated by comparing the highly industrialized countries, which to-day represent the greatest advance in civilization, with those vast regions of other continents which, although rich in natural resources, are harbouring hundreds of millions of population living close to the starvation line. The substitution of power driven machinery for manual labour began in the early 19th century in England and gradually spread throughout most Occidental countries. It gained momentum in the United States during the closing decades of the 19th century and the first quarter of the 20th century, but proceeded with particular rapidity during the decade following the World War. Labour scarcity caused by the war and artificially continued since the war through restrictions placed on immigration was a powerful factor in this development in the United States. The mechanization of industry has probably been carried farther in the United States than elsewhere. The comprehensive records of manufacturing activity in the census enumerations since 1849 bear testimony to the contribution that machinery has made to production, and the evidence in the first three decades of the present century is particularly clear cut and conclusive. The record since the crash of 1929 is not so unequivocal.

In the period 1899 to 1929 the more rapid growth of manufacturing output than of the workers engaged in its production, when associated with the more rapid growth of horsepower installed in manufacturing plants indicated the growing role of machinery in manufacturing processes.

If the common measure of manufacturing output, its value, is used to display the manufacturing development, it must be adjusted to price changes. The change from a reported product of $11,407,000,000 in 1899 to one of $69,901,000,000 in 1929 embodies not only a large increase in the volume of production but also the upward movement of prices in the war period.

The influence of price change is still more apparent when the production of goods valued at $61,737,000,000 in 1919 is contrasted with an output valued at $23,837,000,000 in 1914, only five years before.

In order to eliminate the confusion arising from the changing purchasing value of the dollar, indices have been computed that show the growth in volume of the physical production of manufactures. Together with other indices of change, they are shown for the successive census enumerations in the period 1899 to 1937, in the table.

Indexes of Population and Manufacturing Development
(1899=100)

Census Year	Population	Production		Wage Earners	Man-Hours	Horse-Power	Production (Quantity)	
		Value	Quantity				Per Wage Earner	Per Man Hour
Indexes								
1904	110	127	122	114	111	133	107	109
1909	121	178	159	137	132	186	116	121
1914	131	209	170	146	137	224	116	124
1919	140	541	214	191	169	294	112	127
1921	145	381	169	147	118	...	115	143
1923	149	528	263	186	161	332	141	163
1925	154	550	274	178	151	359	154	181
1927	158	546	274	177	148	390	155	184
1929	162	613	311	188	159	431	165	195
1931	166	360	206	139	101	...	148	203
1933	168	275	191	129	86	...	148	223
1935	170	403	227	157	102	...	145	222
1937	173	544	275	188	128	...	146	216
Percentage Change Specified Periods								
1899–1914	+31	+109	+70	+46	+37	+124	+16	+24
1914–1929	+24	+193	+83	+28	+17	+ 93	+42	+57
1929–1937	+ 6	− 13	−12	+ 1	−20	...	−12	+10

Characteristic features of modern manufacturing development appeared in the 15-year period ending in 1914. Price changes during the period advanced the value of the product more than would have been accounted for by the increase in quantity. Wage earners increased somewhat more than did population, but considerably less than the volume of production. In consequence, the output per worker increased. There was some diminution in the work week and total man-hours increased less than did the number of wage earners. The output per man-hour therefore increased more than the output per worker.

In these ratios the influence of machinery is shown indirectly. It is shown directly in the greater increase of the horse-power installed in manufacturing establishments than of other factors here recorded.

The World War had an influence on the returns for 1919 that, combined later with the depression of 1921, disturbed the orderly course of development observed in the previous 15-year period. The most conspicuous features of the 1919 record were the great increase in value of product, through inflated prices, and the conspicuous increase in the physical output. The latter was brought about by an abnormal increase in the number of workers, which since the work week was not increased over 1914, but rather fell slightly, resulted in a smaller increase in man-hours.

While between 1914 and 1919 there was a slight decline in the output per worker, there was a slight increase in the output per man-hour. In other words, the great influx of untrained workers that characterized the year 1919 did not entirely counteract the normal tendency for an increase of output for a given application of manual labour which results from the gradual improvement of mechanical processes and their increasingly wide utilization in manufacturing operations. The continued expansion of horse-power in the period 1914 to 1919 shows why with a labour force of less skill and experience in 1919 than in 1914, the output per man-hour was maintained.

Attention is called to the unusual labour force in 1919 because the smaller numbers reported at subsequent enumerations have been widely used as a triumphant demonstration that technological progress has resulted in decreased employment.

A more correct view of the influence of machinery on production and employment results from a comparison of the 15 years from 1914 to 1929 with the preceding 15-year period. The increase both in wage earners and the general population was less, but the manufacturing wage earners gained a little on population. Most conspicuous was the greater increase in manufacturing production, combined with a slower increase than in the preceding period in wage earners, man-hours and horse-power.

This substantial advance in the volume of manufacturing output is reflected in a marked advance in the output per worker and a still greater advance in the output per man-hour. That these results were attained with a smaller increase of horse-power installed would appear to indicate the significance of other factors not previously considered.

The two possible explanations are an improvement in the efficiency of the individual worker and an improvement in organization and management. The vogue in the '20s of what were then designated as systems of scientific management seems to point to the last named as the probable cause of an increased productivity in the manufacturing process.

The period since 1929 witnessed in the first instance a marked decline in physical production, with a subsequent recovery that brought its volume in 1937 to a point only 12% below that of 1929. In like manner the number of wage earners fell off to a point that in 1933 was lower than in 1909.

Thanks to a marked reduction in the hours of work as well as to the increase in physical output, the number of wage earners in 1937 was practically the same as in 1929. However, each of them gave less time to his work and the aggregate man-hours were one-fifth less than eight years before.

No record was kept in this period of the horse-power installed, and what happened in the field of technological invention and its application is largely a matter of conjecture.

Reports of technological achievement in particular fields were rife, but the lower level of machine tool production did not indicate any expansion.

Indeed, it was highly probable that the efficiency of industry's mechanical equipment was not being maintained. There was on the contrary much evidence of impairment. In the early days of the depression, when production was much curtailed, it seems likely that there was a selection of the existing equipment that increased the average efficiency of this factor, just as there was a selection in the working force that retained the most capable workers in their positions. In consonance with this view it may be noted the index of output per man-hour continued to increase and reached its highest point in 1933.

To attribute such a change to increasing mechanization seems to mistake certain fundamental conditions. With the recovery noted in the years 1933 and 1935, the workers increased in number. This meant, other things being equal, (1) a lowering of the average capacity of the worker, and (2) an increased use of existing equipment bringing into operation its less effective elements. Under these conditions a lower output per worker and per man-hour after 1933 is clearly explicable.

The net result of the entire period 1929 to 1937 was a lowering of the output per worker and an increase of the output per man-hour. In such changes machinery has played a part that is far less important than in previous years.

The general effect of the introduction of machinery in increasing the volume of product for a given application of human effort is unquestioned. Equally unquestioned is the correlative effect of reducing the amount of human effort necessary to produce a given volume of output.

There have been times when this latter effect has been widely held as a menace to human welfare. The fears of social distress as a result of improved technical processes have until now proved themselves illusory.

Those fears rest on an apprehension that changes will take place suddenly and throw numbers out of employment. They miss the fact that economic changes occur slowly, that there is a gradual adaptation to them.

They miss the fact that if as a result of machinery the same goods can be made with less labour, it is equally true that the same labour can produce more goods. Thus far the introduction of machinery has vastly increased the output of manufactures and has shortened the customary hours of labour.

It has not, by and large, reduced the number of persons required to do the world's work. (R. P. F.)

MACHYNLLETH, market town, urban district and focus for the Dyfi (Dovey) valley in western Montgomeryshire (*q.v.*), Wales. Pop. (est. 1938) 1,807. Area, 1.9 sq.mi. A local tradition tells of a small Roman station on or near the site (Maglona). The town has long been a salmon fishing centre and formerly had some trade by water through Derwenlas, 2 mi. below the town, up to which point the river was formerly navigable. In 1291 the prince of upper Powys obtained from the crown a charter legally establishing and protecting the Wednesday markets and the two annual fairs. The old municipality came to an end in the reign of Charles I, though urban powers were regained in 1891. Owen Glendower's "Parliament house," now a town institute, is said to be the scene of the attempt to hold a freely elected parliament in Wales, in 1402. Plas Machynlleth is a feature of the town.

MACÍAS (O NAMORADO) (fl. 1360–1390), Galician *trovador*, represented by five poems in the *Cancionero de Baena*. According to tradition, Macías was enamoured of a great lady and murdered by her jealous husband. His legend became a favourite subject with Spanish writers, inspiring—among others—Lope de Vega in *Porfiar hasta morir* and Larra in *Macías*.

See H. A. Rennert, *Macias, o Namorado; a Galician trobador* (Philadelphia, 1900).

MACINTOSH, CHARLES (1766–1843), F.R.S., 1823, Scottish chemist, was born on Dec. 29, 1766 at Glasgow. His experiments with one of the by-products of tar, naphtha, led to his invention of the waterproof fabrics which bear his name, the essence of his patent being the cementing of two thicknesses of india-rubber together by means of naphtha. He was also responsible for important improvements in the manufacture of dyes, bleaching powder and steel. He died July 5, 1843.

See George Macintosh, *Memoir of C. Macintosh* (1847).

MACIP, VICENTE JUAN (*c.* 1523–1579), often called Juan de Juanes, head of the Valencian school of painters, and known as "the Spanish Raphael," was born in the province of Valencia in 1523 or 1524. He was probably the pupil of his father, Juan Vicente Macip, a follower of Fra Bartolommeo. The greater part of his professional life was spent in the city of Valencia, where most of the extant examples of his work are to be found. Most of his work relates to religious subjects, and is characterized by dignity of conception, accuracy of drawing, truth and beauty of colour. They combine the minute finish of the Flemish with the forms of the Italian Renaissance, but they are essentially Spanish in their expression of ardent mysticism. His chief religious paintings are "The Last Supper" and five pictures from the life of St. Stephen. He also painted some portraits, the finest of which is that of Luis de Castelvi. He died at Bocairente (near Jativa) Dec. 21, 1579.

MACKAY, CHARLES (1814–1889), Scottish writer, was born at Perth on March 27, 1814. As editor of the Glasgow *Argus*, he made his reputation in 1846 with the publication of *Voices from the Crowd*. He wrote songs, including "Cheer Boys Cheer," some of which were set to music by Henry Russell and Sir Henry Bishop (published 1855). Also, he wrote *Memoirs of Extraordinary Public Delusions* (1841) and edited *A Thousand and One Gems of English Poetry* (1867). He died in London on Dec. 24, 1889. Marie Corelli (*q.v.*) was his daughter. His son, Eric Mackay (1851–99), wrote *Love Letters of a Violinist* (1886).

MACKAY, CLARENCE HUNGERFORD (1874–1938), American capitalist, was born at San Francisco, Calif., on April 17, 1874. He was president of the Mackay companies, organized in 1903, which owned all the capital stock of the Commercial Cable company and a majority of the stock of various cable, telegraph and telephone companies in the United States, Canada and Europe, including the Postal Telegraph Cable company. As a war measure President Wilson took over the wires of the two companies on Aug. 1, 1918, and placed them under the control of Postmaster-General Burleson. Mackay opposed many of the postmaster-general's policies, and was removed from control, but was reinstated after the return of the wires to the owners in 1919. In 1931 Pope Pius XI made him a Knight of Malta, the highest Catholic lay honour. He died in New York city, Nov. 13, 1938.

McKAY, DONALD (1810–1880), American ship-builder, was born in Shelburne, N.S., on Sept. 4, 1810. After a boyhood spent amid maritime surroundings, he emigrated to New York city. There he worked in ship-yards and after an apprenticeship of ten years, became a master ship-wright. He then removed to Newburyport, Mass., where he established his own yard, and in 1840 built the "Delia Walker" for John Currier, which resulted in their forming a partnership. They built three ships, among them the packet-ship "Courier," in 1842, the first ship designed by McKay. Attracting the favourable attention of Enoch Train, founder of the Train line of packet-ships, he opened a ship-yard in East Boston in 1845, at the foot of Border street, where he became one of the greatest ship-builders of his time. Though he was not the originator of the clipper hull, his "Flying Cloud," 1851, was one of the most notable of clipper ships, sailing from New York city to San Francisco via Cape Horn in 89 days. He died at Hamilton, Mass., on Sept. 20, 1880.

See A. H. Clark, *The Clipper Ship Era* (1910); R. C. McKay, *Donald McKay and The Ships He Built* (Boston, 1925); O. Thorndike Howe and F. C. Matthews, *American Clipper Ships, 1833–1858* (Salem, 1926–27).

MACKAY, HUGH (*c.* 1640–1692), Scottish general, was born in Scourie, Sutherlandshire. He entered Douglas's (Dumbarton's) regiment of the English army (now the Royal Scots) in 1660, and accompanied it to France when it was lent by Charles II. to Louis XIV. In 1669 he was in the Venetian service at Candia, and in 1672 he was back with his old regiment, taking part in the invasion of Holland. Convinced that he was fighting in an unjust cause, he resigned his commission to take a captaincy in a Scottish regiment in the Dutch service. In 1685 he returned with the Scots brigade to England to assist in the suppression of the Monmouth rebellion. He went back to Holland and when the Prince of Orange started on his expedition to England, Mackay's division led the invading corps. As major-general commanding in chief in Scotland, he was called upon to deal with the formidable insurrection headed by Graham of Claverhouse, Viscount Dundee. In the battle of Killiecrankie Mackay was severely defeated, but Dundee was killed, and the English commander subdued the Highlands in one summer. He was killed at the battle of Steinkirk. Mackay invented the ring bayonet.

See H. Mackay, *Memoirs of the War carried on in Scotland and Ireland, 1689, 1691*, Publ. by the Maitland Club (Edinburgh, 1833); J. Mackay, *Life of Lieut. General H. Mackay of Scoury* (Edinburgh, 1836); J. W. Fortescue, *History of the British Army*, vol. i. (1899, 2nd ed., 12 vols., 1910–27), also Mackay's papers (Bannatyne Club, 1883).

MACKAY, JOHN WILLIAM (1831–1902), American capitalist, was born in Dublin, Ireland, Nov. 28, 1831. His parents brought him in 1840 to New York city; in 1851 he went to California and in 1859 to Virginia city, Nevada, where he formed with James G. Fair, James C. Flood and William S. O'Brien the firm which in 1873 discovered the Great Bonanza vein, more than 1,200ft. deep, in the Comstock lode. In 1884, with James Gordon Bennett, Mackay formed the Commercial Cable company—largely to fight Jay Gould and the Western Union Telegraph company—and laid two transatlantic cables. In connection with the Commercial Cable company he formed the Postal Telegraph company. Mackay died July 20, 1902, in London. He endowed the Roman Catholic orphan asylum in Virginia city, Nevada. In June 1908 a school of mines was presented to the University of Nevada, as a memorial to him, by his widow and his son, Clarence H. Mackay.

MACKAY, a seaport on the north-eastern coast of Queensland, Australia, some 600 miles N. of Brisbane. The lowlands, which stretch inland (west) and along the coast (north and south) of Mackay, and which are shut in by rough highlands (Clarke and Leichhardt Ranges on the north; Mount Dalrymple, 4,265 ft.), afford a rich agricultural area. The climate is hot and humid (av. ann. temps, 86°–54° F; av. ann. rainfall, 69 in., with variations 32–101 in.) and sugar, besides tropical fruits (pineapples, bananas, etc.), are grown. Dairying is making headway and, in the little-developed hinterlands, cattle do well and minerals occur. There are nine mills which crush some 400,000 tons of cane annually. A system of railway lines—with privately-owned tramlines as "feeders" from the cane-fields—serve the area, while the main Great Northern Coast Line connects Mackay with Brisbane and other coast towns. The harbour is poor, but is visited by coastwise and overseas shipping. Pop. (1933) 10,665.

MACKAYE, PERCY (1875–), U.S. poet and dramatist, son of Steele Mackaye (*q.v.*) was born in New York city March 16, 1875. After graduating from Harvard in 1897 he travelled and studied abroad (1898–1900). He taught and lectured in a number of schools and colleges in the U.S. He created new forms in native drama and literature and instigated national movements for community theatres, folk-plays and poetry.

His many works include—in poetry: *Poems* (collected, 1916); *Dogtown Common* (1921); *William Vaughan Moody—Twenty Years After* (1930); *The Far Familiar* (1937); *My Lady Dear, Arise! . . . Songs and Sonnets in Remembrance of Marion Morse Mackaye* (1940)—plays: *The Canterbury Pilgrims* (1903); *Jeanne d'Arc* (1906); *Sappho and Phaon* (1907); *The Scarecrow* (1908); *Yankee Fantasies* (1912); *Washington* (1918); *This Fine-Pretty World* (1924); *The Sphinx* (1929)—operas: *The Immigrants* (1915)—masques: *Saint Louis* (1914); *Caliban* (1916); *Wakefield* (1932)—essays: *The Civic Theatre* (1912)—folk-stories: *Tall Tales of the Kentucky Mountains* (1926); *The Gobbler of God* (1928); *Kentucky Mountain Fantasies* (1928)—biography: *Epoch; the Life of Steele MacKaye, Genius of the Theatre* (1927).

MACKAYE, STEELE (1842–1894), American dramatist, actor, inventor, was born in Buffalo, N.Y., on June 6, 1842, son of Col. James Morrison MacKaye (1805–88), author of *The Birth and Death of Nations,* president of the American Telegraph company, and a "special commissioner" for President Lincoln. In youth, Steele MacKaye studied painting with Hunt, Inness and Troyon. A pupil of Delsarte and Régnier, of the Théâtre Français, he was the first American to act *Hamlet* in London (1873), collaborating there in plays with Tom Taylor and Charles Reade. At Harvard, Cornell and elsewhere, he lectured on aesthetic philosophy. In New York he founded the St. James, Madison Square and Lyceum theatres. He wrote 30 plays, including *Hazel Kirke* (performed many thousand times), *Paul Kauvar, Money Mad,* etc., acting in them in 17 different rôles. He organized the first school of expression, originating "harmonic gymnastics"; initiated overhead lighting (1874); invented the first moving "double" stage (1879) and folding theatre-chairs, patenting over 100 theatrical inventions. At the World's Fair, Chicago (1892–93), he projected the world's largest theatre, his Spectatorium (seating 12,000, with 25 moving stages) revolutionizing stage production and anticipating cinemas in his vast "spectatorio" of Columbus, *The World-Finder,* for which Dvořák composed the New World symphony. He died at Timpas, Colo., on Feb. 25, 1894.

MACKE, AUGUST (1887–1914), German painter, was born on Jan. 3, 1887, at Meschede, Westphalia. His youth was spent in Cologne and Bonn, and he studied art from 1904, at the Düsseldorf Academy and later in Berlin with Louis Korinth. He was influenced particularly in his earlier work by the older Impressionists: Cezanne, Matisse, Renoir, Picasso; and the Cubists. He also visited Paris, Holland and Italy. The period of his independent creation embraces the years 1909–14. With Kandinski, Jawlenski and Marc, he was one of the most important representatives of the "Blaue Reiter," the group of painters from which Expressionism in Germany originated. His art combines the tradition of French painting, its sense of the grace of movement and atmosphere in landscape painting, with the cosmic sentiment of German art, without losing itself in the subtle and problematical. A journey to Tunis in the spring of 1914 inspired some of his most beautiful pictures. He was killed in World War I at Perthes-les-Hurlus, Champagne, on Sept. 26, 1914.

See Walter Cohen, *August Macke* (Leipzig, 1922).

McKEESPORT, a city of Allegheny county, Pennsylvania, U.S.A., on the Monongahela river at the mouth of the Youghiogheny, 15 mi. S.E. of Pittsburgh. It has two airports north of the city, and is served by the Baltimore and Ohio, the Pittsburgh and Lake Erie and the Pennsylvania railways. Pop. 46,781 in 1920 (25% foreign-born white); 54,632 in 1930; 55,355 in 1940 by the federal census. The city is compactly built on a site of 4.8 sq.mi., rising from the rivers to hills occupied by the newer residential districts. It has 5.5 mi. of navigable river front, coal mines at its very door, natural gas from West Virginia and southwestern Pennsylvania, 8 public parks, 23 schools, 73 churches, an assessed valuation (1941) of $55,039,025 and a commission form of government. It is an important industrial unit of the greater Pittsburgh district, making iron and steel, pipe and tubing, tin plate, boilers, radiators, sheet metal and other metal products. The first white settler here was David McKee, who established a ferry in 1769. His son John, because of severe losses during the Whisky Insurrection, laid out the homestead in 200 town lots, which were sold by lottery on April 1, 1795.

Coal mining began in 1830, and not long after that the building of barges developed on a large scale. During the '50s the town was an important boat-building centre. The first iron works was established in 1851. In 1878, and again in 1919, natural gas was struck within the city limits, but the supply was soon exhausted. In each case a brief period of speculation and hectic drilling followed. McKeesport was incorporated as a borough in 1842 and chartered as a city in 1890.

McKEES ROCKS, a borough of Allegheny county, Pennsylvania, U.S.A., on the Ohio river; it is situated at the mouth of Chartiers creek, opposite Pittsburgh, and is served by the Pittsburgh and Lake Erie railroad and also by two others for freight. Pop. (1920) 16,713 (32% foreign-born white); 17,021 in 1940 by the federal census. It is a coal-mining centre, and has railroad shops and important manufactures, especially iron, steel, springs, tin and enamelled ware. The factory output in 1937 was valued at $17,458,783. Natural gas is available from wells in the vicinity. There is a prehistoric mound in the borough.

Settlement there dates from 1830, and the borough was incorporated in 1892.

McKENNA, REGINALD (1863–1943), British politician and financier, was born in London on July 6, 1863, and educated at King's college. He went up to Trinity Hall, Cambridge, as a scholar and graduated as senior optime in 1885. He also gained distinction as an oarsman, rowing in the university boat race in 1887. He was called to the bar in that year, and in 1895 was elected Liberal member for North Monmouthshire. When his party returned to power in Dec. 1905, he became financial secretary to the treasury. In 1907 he was promoted to the presidency of the Board of Education, but was no better able than his predecessor, Birrell, to draft a bill which would satisfy the Nonconformists and yet pass the House of Lords. His tenure of the office was brief, as, on Asquith's succeeding to the premiership in the spring of 1908, he was transferred to the Admiralty.

He entered on his new duties at a time when the country was profoundly stirred by the rapid increase of the German fleet, and was in doubt whether the preparations of the Admiralty were on a sufficiently extensive scale. McKenna, supported by the prime minister and Edward Grey, persuaded his other colleagues to agree to the building of four battleships of dreadnought type in 1909, and to ask for power, if necessary, to prepare for the construction of four more a year later. This contingent program was also carried.

From the Admiralty McKenna went in the autumn of 1911 to the Home Office, and, as home secretary, had charge of the Welsh Disestablishment bill. In the first Coalition ministry in 1915 he was made chancellor of the exchequer, and a still more difficult task was imposed on him—to find the money to carry on the World War. By a 4½% war loan a subscription of nearly £600,000,000 was obtained. In the autumn he introduced a supplementary war budget, providing for over £100,000,000 by new taxation. Income tax was raised 40%, and the abatement and exemption limits lowered; the rates of supertax were seriously heightened; all the old duties on sugar, tea, tobacco, cocoa, coffee, motor spirit and patent medicines were almost doubled; the import of luxuries such as motor cars, cinema films, clocks and musical instruments was restrained by an *ad valorem* duty of 33⅓%; and an excess profits tax of 50% was imposed. Other methods of financing the war which he adopted were war savings certificates, which realized over £40,000,000 in their first year; 5% exchequer bonds, replaced after a year for a short time by 6% exchequer bonds: but for current expenses he relied mainly on the sale of treasury bills. In his 1916 budget he raised taxation still further. Income tax was increased to 5s. in the £ and excess profits tax to 60%; there were further increases on sugar, cocoa and coffee; higher duties were imposed on motor vehicles; there were new taxes on amusements, railway tickets, matches and mineral waters.

McKenna went out of office with Asquith in Dec. 1916, and, in 1919, he accepted the chairmanship of the Midland Bank, Limited, a position he retained until his death Sept. 6, 1943, in London. He wrote *Post-War Banking Policy* (1928). (G. E. B.)

MACKENNAL, ALEXANDER (1835–1904), English Nonconformist divine, was born at Truro in Cornwall, on Jan. 14, 1835, the son of Patrick Mackennal, a Scot, who had settled in Cornwall. In 1848 the family removed to London, and at sixteen he went to Glasgow University. He entered the Congregational Ministry in 1856, and from 1877 to his death was pastor of the Congregational Church at Bowdon, Cheshire. In 1886 he was chairman of the Congregational Union. In 1892 Mackennal became associated with a movement for free church federation which grew out of a series of meetings held to discuss the question of home reunion. When the Lambeth articles put forward as a basis of union were discussed, it was evident that all the free churches were agreed in accepting the three articles dealing with the Bible, the Creed and the Sacraments as a basis of discussion, and were also agreed in rejecting the fourth article, which put the historic episcopate on the same level as the other three. Out of this grew the Free Church Federation, which secures a measure of co-operation between the Protestant Evangelical churches throughout England. Mackennal was a lifelong advocate of international peace, and made a remarkable declaration as to the Christian standard of national action when the Free Church Federation met at Leeds during the South African War in 1900. He died at Highgate, London, on June 23, 1904.

See D. Macfadyen, *Life and Letters of Alexander Mackennal* (1905).

MACKENSEN, A. L. F. AUGUST VON (1849–1945), German fieldmarshal, was born in Haus Leiptnitz, Saxony, on Dec. 6, 1849. Educated at Torgau and the University of Halle, he entered the Second Death's Head Hussars as a cadet in 1869. He saw service in the Franco-Prussian War, and in 1882 was promoted to the Great General Staff. He accompanied the German Emperor on his journey to Palestine. In 1908 he was given command of the XVII. Army Corps on the Vistula. At the outbreak of World War I he was placed in charge of the IX. Army on the Eastern Front, where he conducted successful operations against the Russians at Kutno, Łódź and Lowicz. In April 1915 he became leader of the German forces in western Galicia and was largely responsible for the German break-through at Gorlice. On June 20, 1915, he was made a fieldmarshal and in Aug. and Sept. of that year had further successes at Brest-Litovsk and Pinsk. In Oct. and Nov. 1916, as commander of the army sent against Serbia, he practically overran that country; and in 1916, with the composite army which invaded Rumania, he subjugated the Dobruja and by the middle of Jan. 1917 had to all intents and purposes occupied the country. At the Armistice, he was interned by the French at Neusatz, till Dec. 1919. He retired from the army in 1920 and was made a state counsellor in 1933. He died Nov. 8, 1945, at Celle, Germany.

See W. Renner, *Feldmarschall von Mackensen* (1915); M. Luyken *Generalfeldmarschall von Mackensen, Von Bukarest bis Salonika* (1920).

MACKENZIE, SIR ALEXANDER (*c.* 1764–1820), Canadian explorer, was born at Stornoway, Island of Lewis. Emigrating to North America at an early age, he was for several years engaged in the fur trade at Fort Chippewyan, at the head of Lake Athabasca. His first journey (1789) was from Fort Chippewyan along the Great Slave Lake, and down the river which now bears his name to the Arctic Ocean; and his second, made in 1792 and 1793, from Fort Chippewyan across the Rocky Mountains to the Pacific coast near Cape Menzies. He died at Mulinearn, near Pitlochry, on March 12, 1820.

See his *Voyages on the River St. Lawrence and through the Continent of North America to the Frozen and Pacific Oceans* (1801).

MACKENZIE, ALEXANDER (1822–1892), Canadian statesman, was born in Perthshire, Scotland, on Jan. 28, 1822. He emigrated to Canada in 1842, and later worked in Ontario as a stone-mason, later becoming a builder and contractor at Sarnia with his brother. In 1852 his interest in questions of reform led to his becoming the editor of the *Lambton Shield,* a local Liberal paper. In 1861 he became a member of the Canadian parliament, where he at once made his mark and was closely connected with the liberal leader, George Brown. He was elected for Lambton to the first Dominion house of commons in 1867, and soon became the leader of the liberal opposition; from 1871 to 1872 he also sat in the Ontario provincial assembly, and held the position of provincial treasurer. In 1873 on the defeat of Sir John Macdonald's ministry Mackenzie formed a new Government, taking the portfolio of public works and becoming the first liberal premier of Canada. He remained in power till 1878, when industrial depression enabled Macdonald to return to office on a protectionist programme. In 1875 Mackenzie paid a visit to Great Britain, and was received at Windsor by Queen Victoria; he declined knighthood. In 1880 he resigned the leadership of the opposition owing to failing health, but he retained a seat in parliament till his death at Toronto on April 17, 1892. While perhaps too cautious to be the ideal leader of a young and vigourous community, his grasp of detail, industry, and integrity won him the respect even of his opponents.

See W. Buckingham and the Hon. George W. Ross, *Alexander Mackenzie, His Life and Times* (Toronto, 1892); G. Stewart, *Canada under the Administration of the Earl of Dufferin* (Toronto, 1878).

MACKENZIE, SIR ALEXANDER CAMPBELL (1847–1935), British composer, son of an eminent Edinburgh violinist and conductor, was born on Aug. 22, 1847. Mackenzie studied at the Sondershausen conservatorium under Ulrich and Stein, and in 1861 entered the ducal orchestra as a violinist. At this time he made Liszt's acquaintance. On his return home he spent three years at the Royal Academy of Music. He took part in Chappell's quartette concerts, and started a set of classical concerts. He was appointed precentor of St. George's Church in 1870, and conductor of the Scottish vocal music association in 1873. The most important compositions of this period of Mackenzie's life were the Quartette in E flat for piano and strings, Op. 11, and an overture, *Cervantes,* which owed its first performance to the encouragement and help of von Bülow. On the advice of this great pianist, he settled in Florence in order to compose. The cantatas *The Bride* (Worcester, 1881) and *Jason* (Bristol, 1882) belong to this time, as well as his first opera, *Colomba* (1883), commissioned for the Carl Rosa Company. Mackenzie's second opera, *The Troubadour,* was produced by the same company in 1886; and his third dramatic work was *His Majesty,* an excellent comic opera (Savoy Theatre, 1897). In 1888 he succeeded Macfarren as principal of the Royal Academy of Music. This post he held until 1924, and the importance of his influence over the younger generation of English musicians was very great. From 1892 to 1899 Mackenzie conducted the Philharmonic Concerts, and was knighted in the year 1894. In the two "Scottish Rhapsodies" for orchestra, in the music to *The Little Minister,* and in a beautiful fantasia for pianoforte and orchestra on Scottish themes, he has seized the essential, not the accidental features of his native music.

Mackenzie's works include *The Rose of Sharon* (Norwich festival, 1884); three Scottish Rhapsodies: No. 1 (Glasgow, 1880); No. 2, "Burns" (Glasgow, 1881); No. 3, "Tam O'Shanter" (Int. Music Congress, London, 1911); the Pibroch suite for violin (Leeds, 1889), etc. *See* his *A Musician's Narrative* (1927).

MACKENZIE, EDWARD MONTAGUE COMPTON (1883–), British novelist, son of Edward Compton, was born at West Hartlepool on Jan. 17, 1883, and educated at St. Paul's school, London, and Magdalen college, Oxford. He saw a good deal of stage life before embarking on his literary career which began with *Poems* (1907) and a picturesque "period" novel, *The Passionate Elopement* (1911). *Kensington Rhymes* and the novel *Carnival* followed in 1912, and the long novel *Sinister Street* (2 vols., 1913–14) was characteristic of the quasi-autobiographical novels of childhood and youth which were then attracting some of the younger novelists. War experiences yielded *Extremes Meet* and other accounts of the secret service. His work is characterized by a coloured style, picaresque action and humorous character study, and, in some of his best work, a sympathetic portrayal of religious sensibility. This last is to be seen in the trilogy *The Altar Steps* (1922), *The Parson's Progress* (1923) and *The Heavenly Ladder* (1924). Other works are *Guy and Pauline* (1915), *Sylvia Scarlett* (1918), *Coral* (1925), *Vestal Fire* (1927), *Extraordinary Women* (1928) and *The Windsor Tapestry* (1938).

MACKENZIE, SIR GEORGE (1636–1691), of Rosehaugh, Scottish lawyer, the grandson of Kenneth, first Lord Mackenzie of Kintail. He was born at Dundee in 1636, educated at the grammar school there, at Aberdeen, at St. Andrews and Bourges. He was called to the bar in 1659. He succeeded Sir John Nisbet as king's advocate in August 1677, and in the discharge of this office became implicated in all the worst acts of the Scottish administration of Charles II., earning for himself an unenviable distinction as "the bloody Mackenzie." His refusal to concur in the measures for dispensing with the penal laws against Catholics led to his removal from office in 1686, but he was reinstated in February 1688. At the Revolution, being a member of convention, he was one of the minority of five in the division on the forfeiture of the crown. King William was urged to declare him incapacitated for holding any public office, but refused. When the death of Dundee (July 1689) had finally destroyed the hopes of his party in Scotland, Mackenzie went to Oxford, where he did literary work. He died at Westminster on May 8, 1691.

While still a young man Sir George Mackenzie appears to have aspired to eminence in the domain of pure literature, his earliest publication having been *Aretina, or a Serious Romance* (anon., 1661); it was followed, also anonymously, by *Religio Stoici, a Short Discourse upon Several Divine and Moral Subjects* (1663); *A Moral Essay, preferring Solitude to Public Employment* (1665); and one or two other disquisitions of a similar nature. His most important legal works are entitled *A Discourse upon the Laws and Customs of Scotland in Matters Criminal* (1674); *Observations upon the Laws and Customs of Nations as to Precedency, with the Science of Heraldry* (1680); *Institutions of the Law of Scotland* (1684); and *Observations upon the Acts of Parliament* (1686); of these the last-named is the most important, the *Institutions* being completely overshadowed by the similar work of his great contemporary Stair. In his *Jus Regium: or the Just and Solid Foundations of Monarchy in general, and more especially of the Monarchy of Scotland, maintained* (1684), Mackenzie appears as an uncompromising advocate of the highest doctrines of prerogative. His *Vindication of the Government of Scotland during the reign of Charles II.* (1691) is valuable as a piece of contemporary history. The collected *Works* were published at Edinburgh (2 vols. fol.) in 1716–22; and *Memoirs of the Affairs of Scotland from the Restoration of King Charles II.*, from previously unpublished mss., in 1821.

See A. Lang, *Sir George Mackenzie of Rosehaugh* (1909).

MACKENZIE, HENRY (1745–1831), Scottish novelist and miscellaneous writer, the "Man of Feeling," born at Edinburgh, was educated at the high school and the university of his native town, and was then articled to George Inglis of Redhall, who was attorney for the crown in the management of exchequer business. In 1765 he was sent to London to prosecute his legal studies, and on his return to Edinburgh became partner with Inglis, whom he afterwards succeeded as attorney for the crown. His first and most famous work, *The Man of Feeling*, was published anonymously in 1771, and met with instant success. The "Man of Feeling" is a weak creature, dominated by a futile benevolence, who goes up to London and falls into the hands of people who exploit his innocence. One Eccles of Bath claimed the authorship of this book, bringing in support of his pretensions a ms. with many ingenious erasures. Mackenzie's name was then officially announced, but Eccles appears to have induced some people to believe in him. The first of his dramatic pieces, *The Prince of Tunis*, was produced in Edinburgh in 1773 with a certain measure of success. The others were failures. At Edinburgh Mackenzie belonged to a literary club, at the meetings of which papers in the manner of the *Spectator* were read. Mackenzie conducted two critical journals: *The Mirror* (1779–80) and *The Lounger* (1785–87). His critical work was good. He was the first critic to recognize the genius of Burns; he hailed the early works of Scott; and he was a faithful friend to many men of letters. His nickname, the "man of feeling," by no means represents the man of critical acumen and practical commonsense. *Waverley* was dedicated to him. No one now reads *The Man of Feeling*, but his commonplace book *Anecdotes and Egotisms of Henry Mackenzie* (edit. H. W. Thompson, 1928) is an interesting record.

Mackenzie was an ardent Tory, and wrote many tracts opposing the doctrines of the French Revolution. Most of these remained anonymous, but he acknowledged his *Review of the Principal Proceedings of the Parliament of 1784*, a defence of the policy of William Pitt, written at the desire of Henry Dundas. He was rewarded (1804) by the office of comptroller of the taxes for Scotland. In 1776 Mackenzie married Penuel, daughter of Sir Ludovick Grant of Grant. He was, in his later years, a notable figure in the social life of Edinburgh. He died on Jan. 14, 1831.

In 1807 *The Works of Henry Mackenzie* were published surreptitiously, and he then himself superintended the publication of his *Works* (8 vols. 1808).

See the *Prefatory Memoir*, by Sir Walter Scott, to an edition of his novels in Ballantyne's *Novelist's Library* (vol. v., 1823).

McKENZIE, SIR JOHN (1838–1901), New Zealand statesman, was born at Ard-Ross, Scotland, in 1838, the son of a crofter. He emigrated to Otago, New Zealand, in 1860. Beginning as a shepherd, he rose to be farm manager at Puketapu near Palmerston South. In 1865 he was clerk to the local road board and school committee; in 1871 he entered the provincial council of Otago; and on Dec. 11, 1881 was elected member of the House of Representatives, in which he sat till 1900. In 1891 he held the portfolio of lands, immigration and agriculture. He died on Aug. 6, 1901.

MACKENZIE, SIR MORELL (1837–1892), British physician, son of Stephen Mackenzie, surgeon (d. 1851), was born at Leytonstone, Essex, on July 7, 1837. He studied at the London hospital, at Paris, Vienna and Pesth, where he learnt the use of the newly-invented laryngoscope under J. N. Czermak. In 1862 he took his degree and became a specialist in diseases of the throat. In 1863 he helped to found the Throat hospital in King street, Golden square, and became a leading authority.

In May 1887 he was summoned to attend the German Crown Prince Frederick, whose illness was difficult to diagnose. The summoning of the English specialist was attributed to the Empress Frederick, but she was not responsible, still less, as stated in Germany, Queen Victoria (*see* Correspondence in *The Times*, Jan.-Feb. 1928). The German physicians who had attended the prince since the beginning of March (Karl Gerhardt, and subsequently Tobold, E. von Bergmann, and others) had diagnosed his disease on May 18 as cancer of the throat; but Morell Mackenzie insisted (basing his opinion on a microscopical examination by R. Virchow of a portion of the tissue) that the disease was not demonstrably cancerous, that an operation for the extirpation of the larynx (planned for the 21st May) was unjustifiable, and that the growth might well be a benign one and therefore curable by other treatment. Morell Mackenzie's opinion was followed; he was knighted in September 1887 for his services, and decorated with the Grand Cross of the Hohenzollern Order. In November, however, it was ultimately admitted that the disease really was cancer; though Mackenzie, with very questionable judgment, more than hinted that it had become malignant since his first examination, in consequence of the irritating effect of the treatment by the German doctors. The crown prince (*see* FREDERICK III.) became emperor on March 9, 1888, and died on June 15. A violent quarrel raged between Sir Morell Mackenzie and the German medical world. The German doctors published an account of the illness, to which Mackenzie replied by a work entitled *The Fatal Illness of Frederick the Noble* (1888), the publication of which caused him to be censured by the Royal College of Surgeons. Morell Mackenzie died on Feb. 3, 1892, leaving several books on laryngoscopy and diseases of the throat.

MACKENZIE, WILLIAM LYON (1795–1861), Canadian politician, was born near Dundee, Scotland, on March 12, 1795. In April 1820 he emigrated with his mother to Canada. There he became a general merchant, first at York, then at Dundas, and later at Queenston. The discontented condition of Upper Canada drew him into politics, and on May 18, 1824 he published at Queenston the first number of the *Colonial Advocate,* in which the ruling oligarchy was attacked with great asperity, and which roused great anger among the social and political set at York (Toronto), which was headed by John Beverley Robinson. In Nov. 1824 Mackenzie removed to Toronto, but he had little capital; his paper appeared irregularly, and was on the point of suspending publication when his office was attacked and his type thrown into the bay by a number of the supporters of his opponents. In an action against the chief rioters he was awarded £625 and costs, which enabled him to set up a much larger plant, and the *Colonial Advocate* ran till Nov. 4, 1834.

In 1828 he was elected member of parliament for York, but was expelled on the technical ground that he had published in his newspaper the proceedings of the house without authorization. Five times he was expelled and five times re-elected by his constituents, till at last the Government refused to issue a writ, and for three years York was without one of its representatives. In May 1832 he visited England, where he was well received by the colonial office. Largely as the result of his representations, many important reforms were ordered by Lord Goderich, afterwards earl of Ripon, the colonial secretary. While in England, he published *Sketches of Canada and the United States,* a statement of Canadian grievances. On his return in March 1834 he was elected mayor of Toronto. In Oct. 1834 he was elected member of parliament for York, and took his seat in Jan. 1835, the Reformers being now in the majority. A committee on grievances was appointed, and as chairman Mackenzie presented the admirable *Seventh Report on Grievances,* advocating responsible government.

In the general election of June 1836 the Tory party won a complete victory, Mackenzie and almost all the prominent Reformers being defeated at the polls. This totally unexpected defeat greatly embittered him. On July 4, 1836, he began the publication of the *Constitution,* which openly advocated a republican form of government. Later in the year he was appointed "agent and corresponding secretary" of the extreme wing of the Reform party. He was also in correspondence with Papineau and the other leaders of the Reformers in Lower Canada, who were already planning a rising. Early in Dec. 1837 Mackenzie gathered a mob of his followers at Gallows Hill, Toronto, with the intention of seizing the lieutenant-governor and setting up a provisional Government. The total failure of the revolt forced Mackenzie to fly to the United States with a price on his head. In the town of Buffalo he collected a disorderly rabble, who seized and fortified Navy island, in the river between the two countries, and for some weeks troubled the Canadian frontier. After the failure of this attempt he was put to the most pitiful shifts to make a living. In June 1839 he was tried in the United States for a breach of the neutrality laws, and sentenced to 18 months' imprisonment, of which he served over eleven. While in gaol at Rochester he published the *Carolina Almanac,* the tone of which may be judged from its references to "Victoria Guelph, the bloody queen of England," and to the cabinet as "Victoria Melbourne's bloody divan." He returned to Canada under the Amnesty Act 1849.

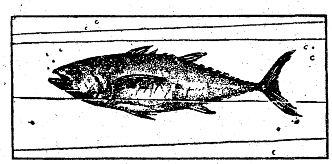
In 1851 he was elected to parliament for Haldimand, defeating George Brown. He at once allied himself with the Radicals (the "Clear Grits"), and became one of Brown's lieutenants. He was still miserably poor, but refused all offers to accept a government position. In 1858 he resigned his seat in the house, owing to incipient softening of the brain, of which he died on Aug. 29, 1861.

Turbulent, ungovernable, vain, often the dupe of schemers, Mackenzie united with much that was laughable not a little that was heroic. He could neither be bribed, bullied, nor cajoled. In 1832 he refused from Lord Goderich a position of great influence in Canada and an income of £1,500. He was a born agitator, and the evils against which he struggled were real and grave.

The *Life and Times* by his son-in-law, Charles Lindsey (Toronto, 2 vols., 1862), is moderate and fair, though tending to smooth over his anti-British gasconade while in the United States. An abridgment of this work was edited by G. G. S. Lindsey for the "Makers of Canada" series (1909). In *The Story of the Upper Canadian Rebellion* by J. C. Dent (2 vols., Toronto, 1885), a bitter attack is made on him, which drew a savage reply from another son-in-law, John King, K.C., called *The Other Side of the Story.* The best short account of his career is given by J. C. Dent in *The Canadian Portrait Gallery,* vol. ii. (Toronto, 1881). (W. L. G.)

MACKENZIE, a river of the Northwest Territories, Canada, discharging the waters of the Great Slave Lake into the Arctic Ocean. It was discovered and first navigated by Sir Alexander Mackenzie in 1789. It has an average width of 1 m., an average fall of 6 in. to the mile; an approximate discharge, at a medium stage, of 500,000 cu. ft. per second; and a total length, including its great tributary, the Peace, of 2,514 mi. The latter rises as the Finlay in British Columbia, joins the Parsnip, and is then called the Peace. It next unites with the discharge from Lake Athabasca and, as the Slave river, it proceeds to the Great Slave Lake. The Mackenzie enters the Arctic Ocean near 135° W. and 68° 50′ N., after flowing for 70 to 80 m. through a flat delta, not yet fully surveyed. With its continuation, Slave river, it is navigable from the Arctic ocean to Fort Smith, a distance of over 1,200 m., and between the latter and the head of Lesser Slave Lake, a further distance of 625 m., there is only one obstruction to navigation, the Grand Rapids near Fort McMurray on the Athabasca river. The Peace is navigable from its junction with Slave river for about 220 m. to Vermilion Falls. The Mackenzie is navigable from about the 10th of June to the 20th of October, and Great Slave Lake from about the 1st of July to the end of October.

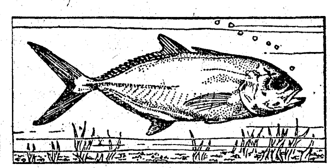
MACKEREL (*Scomber scombrus*), the typical fish of the family Scombridae, which are swift carnivorous pelagic fishes found in tropical and temperate seas, of fusiform shape, generally bluish above and silvery below, with small, thin scales, pointed head and rather large mouth, spinous dorsal fin of slender spines that are depressible in a groove, soft dorsal and anal, followed by a series of detached rays, or finlets, and with slender caudal peduncle and widely forked caudal fin. The flesh is oily, generally red. These are energetic fishes in which the temperature is generally several degrees higher than that of the water.



BY COURTESY OF THE NEW YORK ZOOLOGICAL SOCIETY

THE GREAT ALBACORE MACKEREL

The albacores, bonitoes and tunnies are large oceanic fishes. *Scombromorus* and *Acanthocybium* are important tropical genera, longer and more compressed than other Scombridae, and with strong trenchant teeth. The mackerel genus, *Scomber,* is distinguished by feeble teeth and by the maxillary being sheathed by the praeorbital; it includes about 10 species from tropical and temperate seas. *Scomber scombrus* is a valuable food-fish found in the Mediterranean and on both sides of the north Atlantic; it reaches a length of about 18 inches. It swims in large schools, which approach the coasts in the spring; after spawning in the summer they return to the ocean. The principal British fishery is in the western part of the Channel. The air-bladder is absent in *S. scombrus,* but a small one is present in *S. colias,* termed Spanish mackerel in England and chub mackerel in America; this is a smaller and less valuable fish than the common mackerel and more southerly in its distribution, but reaches Britain occasionally.



BY COURTESY OF THE NEW YORK ZOOLOGICAL SOCIETY

YELLOW MACKEREL OR CREVALLY (CARANX CRYSOS)

McKIM, CHARLES FOLLEN (1847–1909), American architect, was born in Chester county, Pennsylvania, on Aug. 24, 1847. His father, James Miller McKim (1810–74), a Presbyterian minister, was a prominent abolitionist and one of the founders (1865) of the New York *Nation.* The son studied at Harvard (1866–67) and at Paris in the École des Beaux Arts (1867–70).

In 1872 he became an architect in New York city, entering the office of H. H. Richardson. In 1877 he formed a partnership with William Rutherford Mead (b. 1846), the firm becoming in 1879 McKim, Mead & White, when Stanford White (q.v.) (1853–1906) became a partner. McKim was one of the founders of the American Academy in Rome; received a gold medal at the Paris exposition of 1900; in 1903, for his services in the promotion of architecture, received the King's Medal of the Royal Institute of British Architects; and in 1907 became a National Academician. He died at St. James, Long Island, N. Y., Sept. 14 1909. McKim's name is especially associated with the University Club in New York and the Boston Public Library.

See Charles Moore, *Life and Times of Charles Follen McKim* (1929).

MACKINAC ISLAND, a city of Mackinac county, Michigan, U.S.A., on Mackinac island in the northwest extremity of Lake Huron. It is connected by steamers with St. Ignace (6 mi. W.) and Mackinaw City (7 mi. S.W.), on both sides of the Straits of Mackinac, and is served by the principal steamship lines on the Great Lakes. Pop. (1940) 508. The island (3 mi. by 2 mi.) is a beautiful summer resort, rich in Indian lore and historic interest. White limestone cliffs line the shores and the interior is covered with forests. No automobiles are allowed. The city is an old fishing and trading village, with large modern hotels, club-houses and summer homes. Fort Mackinac and its surroundings are included in a State park. The island was occupied at various times by the Chippewas, the Hurons, and the Ottawas. The French established a post in 1670 (abandoned 1701) at Point St. Ignace, on the north side of the strait, and in 1712 built a fort on the south side, surrendered to the British in 1761 and held by them until 1796. In July, 1812, a British force surprised the American garrison, which did not yet know that war had been declared. In August, 1814, Colonel George Croghan (1791–1849) made an unsuccessful attempt to retake the island. It was restored to the United States in July, 1815, and the fort was maintained by the Federal government until 1895, when it was ceded to the State. From 1820–40 the village was a chief post of the American Fur Company.

McKINLEY, WILLIAM (1843–1901), twenty-fifth president of the United States, was born in Niles, Trumbull county, O., on Jan. 29, 1843. His ancestors on the paternal side were Scotch-Irish who lived at Dervock, Co. Antrim, and spelled the family name "McKinlay." His great-great-grandfather settled in York county, Pa., about 1743, and from Chester county, Pa., his great-grandfather, David McKinley, who served as a private during the War of Independence, moved to Ohio in 1814. David's son James had gone in 1809 to Columbiana county, O. His son William McKinley (b. 1807), like his father an iron manufacturer, was married in 1829 to Nancy Campbell Allison, and to them were born nine children, of whom William, the president, was the seventh. In 1852 the family removed to Poland, Mahoning county, where the younger William was placed at school. At 17 he entered the junior class of Allegheny college, at Meadville, Pa.; but he studied beyond his strength, and returned to Poland, where for a time he taught in a neighbouring country school. When the Civil War broke out in 1861 he enlisted as a private. He saw service in West Virginia, at South Mountain, and at Antietam, and was promoted second lieutenant in 1862, and first lieutenant early in Feb. 1864. For his services at Winchester in 1864 he was promoted captain. He was on the staff of Gen. George Crook at the battles of Opequan, Fisher's hill and Cedar creek in the Shenandoah valley, and in 1865 he was breveted major of volunteers for gallant and meritorious services. He also served on the staff of Gen. Rutherford B. Hayes.

After the war McKinley returned to Poland, and bent all his energy upon the study of law. He completed his preparation at the Albany (N.Y.) law school,was admitted to the bar at Warren, O., in March 1867, and began practice in Canton, O., which place became his permanent home. He identified himself immediately with the Republican Party, and took part in the campaign work on behalf of Grant's presidential candidature in 1868. In 1875 he first became known as an able campaign speaker by his speeches on behalf of Rutherford B. Hayes, the Republican candidate for governor of Ohio. In 1876 McKinley was elected to the national House of Representatives. Conditions both in Ohio and in Congress had placed him, and were to keep him for twenty years, in an attitude of aggressive and uncompromising partisanship. His Congressional district was naturally Democratic, and its boundaries were changed by Democratic legislatures for the purpose of causing his defeat. But he overcame what had threatened to be adverse majorities at all elections from 1876 to 1890, with the single exception of 1882. McKinley reflected the strong sentiment of his manufacturing constituency in behalf of a high protective tariff, and he soon became known in Congress (where he particularly attracted the attention of James G. Blaine) as one of the most diligent students of industrial policy and questions affecting national taxation. In 1878 he took part in the debates over the Wood tariff bill, and in the same year he voted for the Bland-Allison silver bill. In Dec. 1880 he was appointed a member of the ways and means committee, succeeding James A. Garfield, who had been elected president in the preceding month, and to whose friendship, as to that of Rutherford B. Hayes, McKinley owed much in his earlier years in Congress. He was prominent in the debate which resulted in the defeat of the Democratic Morrison tariff bill in 1884, and in the defeat of the Mills bill for the revision of the tariff in 1887–1888. In 1889 he became chairman of the ways and means committee and Republican leader in the House of Representatives, after having been defeated by Thomas B. Reed for speaker of the House. On April 16, 1890, he introduced the tariff measure known commonly as the McKinley bill, which passed the House in May, passed the Senate in September, and was approved by the president on Oct. 1, 1890. The McKinley bill reduced revenues by its high and in many cases almost prohibitive duties; it attempted to protect many "infant" industries such as the manufacture of tin-plate; under its provision for reciprocal trade agreements (a favourite project of James G. Blaine) reciprocity treaties were made with Germany, France, Italy and Belgium. Abroad there was bitter opposition to it and reprisals were threatened by several European States. In the United States the McKinley tariff bill was one of the main causes of the Democratic victory in the Congressional elections of 1890, in which McKinley himself was defeated. In 1891 he was elected governor of Ohio, and in 1893 was re-elected, so gaining experience in executive as distinguished from legislative work.

McKinley had been prominent in national politics even before the passage of the tariff measure bearing his name. In 1888 in the national Republican convention in Chicago he was chairman of the platform committee and was leader of the delegation from Ohio, which had been instructed for John Sherman; after James G. Blaine withdrew his name there was a movement to nominate McKinley, but he passionately refused to be a candidate, considering that his acquiescence would be a breach of faith toward Sherman. In 1892 McKinley was the permanent president of the national Republican convention which met in Minneapolis and which renominated Benjamin Harrison on the first ballot, on which James G. Blaine received $182\frac{5}{6}$ votes, and McKinley, 182 votes. In 1896 he seemed for many reasons the most "available" candidate of his party for the presidency: he had no personal enemies in the party; he had carried the crucial state of Ohio by a large majority in 1893; his attitude on the coinage question had never been so pronounced as to make him unpopular either with the radical silver wing or with the conservative "gold-standard" members of the party. The campaign for his nomination was conducted with great adroitness by his friend, Marcus A. Hanna, and in the national Republican convention held in St. Louis in June he was nominated for the presidency on the first ballot. The convention adopted a tariff plank drafted by McKinley, and, of far greater immediate importance, a plank, which declared that the Republican Party was "opposed to the free coinage of silver, except by international agreement with the leading commercial nations of the world, which we pledge ourselves to promote, and until such agreement can be obtained the existing gold standard must be preserved." This "gold standard" plank drove out of the Republican Party the Silver Republicans of the West, headed by Senator Henry M. Teller of Colorado.

The national Democratic convention declared for the immediate opening of the mints to the free and unlimited coinage of silver at the ratio with gold of 16 to 1; and it nominated for the presidency William Jennings Bryan of Nebraska. There was a secession from the Democratic Party of conservatives who called themselves the National Democratic Party, who were commonly called Gold Democrats, and who nominated John M. Palmer (1817–1900) of Illinois for president. In this re-alignment of parties McKinley, who had expected to make the campaign on the issue of a high protective tariff, was diverted to the defence of the gold standard as the main issue. The campaign was enthusiastic: the Republican candidate was called the "advance agent of prosperity"; "Bill McKinley and the McKinley Bill" became a campaign cry; the panic of 1893 was charged to the repeal of the McKinley tariff measure; and "business men" throughout the states were enlisted in the cause of "sound money" to support McKinley, who was elected in November by a popular vote of 7,106,779 to 6,502,925 for Bryan, and by an electoral vote of 271 to 176. (*See* UNITED STATES: *History*.) Following his inauguration the president summoned Congress to assemble in an extra session. His message urged revision of the tariff and revenue, and the Dingley tariff bill was accordingly passed through both houses, and was approved by the president on July 24.

The ensuing regular session of Congress was occupied chiefly with the situation in Cuba. President McKinley showed himself singularly patient and self-controlled in the midst of the popular clamour for intervention by the United States in behalf of the Cubans; but finally, on March 23, 1898, he presented an ultimatum to the Spanish government, and on April 25, on his recommendation, Congress declared war upon Spain. During the war itself he devoted himself with great energy to the mastery of military details; but there was bitter criticism of the war department resulting in the resignation of the secretary of war, Russell A. Alger (*q.v.*). The peace treaty, signed at Paris, Dec. 10, was ratified by the United States Senate on Feb. 6, 1899; and in accordance with its terms Porto Rico, the Philippine archipelago, and Guam were transferred by Spain to the United States, and Cuba came under American jurisdiction pending the establishment there of an independent government. Two days before the ratification of the peace treaty, a conflict took place between armed Filipinos under the leadership of Emilio Aguinaldo and the American forces that were in possession of Manila. The warfare waged by these Filipinos against the United States, while having for the most part a desultory and guerrilla character, was of a very protracted and troublesome nature. Sovereignty over the Filipinos having been accepted by virtue of the ratification of the Paris treaty, President McKinley was not at liberty to do otherwise than assert the authority of the United States and use every endeavour to suppress the insurrection. But there was bitter protest against this "imperialism," both within the party by such men as George F. Hoar, Eugene Hale, Thomas B. Reed and Carl Schurz, and from the leaders of the Democratic Party. In the foreign relations of the United States, as directed by President McKinley, the most significant change was the cordial understanding established with the British Government. Other important foreign events during McKinley's administration were: the annexation of the Hawaiian islands (*see* HAWAII) in August 1898, and the formation of the Territory of Hawaii in April 1900; the cessation in 1899 of the tripartite (German, British and French) government of the Samoan islands, and the annexation by the United States of those of the islands east of 171°, including the harbour of Pago-Pago; the participation of American troops in the march of the allies on Pekin in August 1900, and the part played by McKinley's secretary of state, John Hay, in securing a guarantee of the integrity of the Chinese empire. In 1900 McKinley was unanimously renominated by the national Republican convention which met in Philadelphia in June, and which nominated Theodore Roosevelt, governor of New York, for the vice-presidency. The Republican convention demanded the maintenance of the gold standard, and pointed to the exceptional prosperity of the country resulting from the fulfilment of some of the most important of the pledges given by the Republican Party four years earlier. However, the tendency towards the concentration of capital in great industrial corporations had been active to an extent previously undreamt of, with incidental consequences that had aroused much apprehension; and the Democrats accused President McKinley and the Republican Party of having fostered the "trusts." But the campaign against McKinley and the Republican Party was not only "anti-trust" but "anti-imperialistic." William Jennings Bryan, renominated by the Democratic Party on a free silver platform, declared that imperialism was the "paramount issue" and made a second vigorous campaign. As the result of the polling in November, 292 Republican presidential electors and 155 Democratic electors were chosen. The Republican popular vote was 7,207,923, and the Democratic 6,358,133.

In the term of Congress immediately following the presidential election arrangements were perfected for the termination of the American military occupation of Cuba and the inauguration of a Cuban republic. In the Philippines advanced steps had been taken in the substitution of civil government for military occupation, and a governor-general, Judge William H. Taft, had been appointed and sent to Manila. Prosperity at home was great, and foreign relations were free from complications. After an arduous term, the president had reached a period that promised to give him comparative repose and freedom from care. In these circumstances, President McKinley, accompanied by the greater part of his cabinet, set forth in the early summer on a tour to visit the Pacific coast. The route chosen was through the Southern states, where many stops were made, and where the president delivered brief addresses. The heartiness of the welcome accorded him seemed to mark the disappearance of the sectional feeling that had survived the Civil War. After his return he visited the city of Buffalo, New York, in order to attend the Pan-American exposition and deliver a public address. This address (Sept. 5, 1901) was a public utterance designed by McKinley to affect American opinion and public policy, and apparently to show that he had modified his views upon the tariff. It declared that henceforth the progress of the nations must be through harmony and co-operation and it maintained that the time had come for wide-reaching modifications in the tariff policy of the United States through commercial reciprocity arrangements with various nations. On the following day, Sept. 6, 1901, a great reception was held for President McKinley in one of the public buildings of the exposition. Advantage of this opportunity was taken by a young man of Polish parentage, by name Leon Czolgosz, to shoot at the president with a revolver at close range. One of the two bullets fired penetrated the abdomen. After the world had been assured that the patient was doing well and would recover, he collapsed and died on the 14th. The assassin, who professed to hold the views of that branch of anarchists who believe in the assassination of rulers, was promptly seized, convicted and executed. McKinley's funeral took place at Canton, O., on Sept. 19, the occasion being remarkable for the public manifestations of mourning.

Though he had not the personal magnetism of James G. Blaine, whom he succeeded as a leader of the Republican Party, McKinley had great personal suavity and dignity, and was thoroughly well liked by his party colleagues. As a politician he was always more the people's representative than their leader, and that he "kept his ear to the ground" was the source of much of his power and at the same time was his greatest weakness. His apparently inconsistent record on the coinage question becomes consistent if considered in the same way, as the expression of the gradually changing views of his constituency. He was an able but far from brilliant campaign speaker. His greatest administrative gift was a fine intuition in choosing men to serve him. His *Speeches and Addresses* were printed in 2 vols. (1893 and 1901).

See Jane Elliott Snow, *The Life of William McKinley* (1908); Charles Sumner Alcott, *The Life of William McKinley* (1916); Nicholas Murray Butler, *William McKinley and Twenty Years After* (1920); Herman Henry Kohlsaat, *From McKinley to Harding* (1923); Joseph Green Butler, *Life of William McKinley* and *History of National McKinley Birthplace Memorial* (1924); and Alfred L. Dennis, *Adventures in American Diplomacy*, 1896–1906 (1928).

McKINLEY, MOUNT, a peak of the Alaska range in south-central Alaska in lat. 63° 63′ 56·8″ N. and long. 151° 00′ 41″ W. It is the culminating point of North America (20,300 ft. above sea-level) and rises higher above the surrounding country than any other mountain in the world. Its crest gives rise to numerous glaciers of gigantic size, and it is claimed that the entire surface, above 19,000 ft., is a field of snow and ice. Under favourable conditions, its summit affords a panorama of an area over 200 m. in diameter. The mountain was named in 1896 by W. A. Dickey in honour of William McKinley and its apex was first attained on June 7, 1913 by Hudson Stuck, H. P. Karstens, Robert Tatum and a half-breed boy named Walter Harper, in an expedition of three months' duration. The previous year Browne, Parker and LeVoy were driven back by a fierce blizzard when just short of the summit. The North peak, some 20,000 ft. in elevation, was ascended in 1910 by Pete Anderson and Billy Taylor, Alaskan prospectors of the Lloyd expedition. The Mt. McKinley national park was created on Feb. 26, 1917, with an area as changed on Mar. 19, 1932, of 3,030 sq.mi.

See A. H. Brooks, *The Mt. McKinley Region, Alaska* (1911), which is professional paper No. 70 of the U.S. Geological Survey; Hudson Stuck, *The Ascent of Denali* (1914); and E. S. Balch, *Mount McKinley and Mountain Climber's Proofs* (1914).

McKINNEY, a city of northeastern Texas, U.S.A., on Federal highway 75, 32 mi. N. by E. of Dallas; the county seat of Collin county. It is served by the Texas Electric railway and the Southern Pacific lines. The population was 7,307 in 1930 (8% Negroes) and was 8,555 in 1940 by the federal census. It has a large trade in purebred livestock, cotton, grain, onions, alfalfa hay and other agricultural products; also cotton textiles, dairy products and cotton-seed products. Since 1915 the city has had government by commission. It owes its name to Collin McKinney, a land surveyor and pioneer settler, one of the 56 signers of the Texas Declaration of Independence. McKinney was founded in 1844, became the county seat in 1848, and was chartered as a city in 1874.

MACKINTOSH, SIR JAMES (1765–1832), Scottish publicist, was born at Aldourie on Oct. 24, 1765, and was educated at Aberdeen and at Edinburgh, where he took his degree in medicine in 1787. In 1788 he removed to London, and becoming interested in politics, in 1791 published his *Vindiciae Gallicae,* a reply to Burke's *Reflections on the French Revolution.* It was the only worthy answer to Burke that appeared, and won him a European reputation and many friends, including Burke himself. Its success finally led him to take up the legal profession. He was called to the bar in 1795. In 1797 his wife died, and next year he married Catherine Allen, sister-in-law of Josiah and John Wedgwood, through whom he introduced Coleridge to the *Morning Post.*

His greatest legal successes were his lectures (1799) at Lincoln's Inn on the law of nature and nations, and his defence (1803) of Jean Gabriel Peltier, a French refugee, tried at the instance of the French government for a libel against the first consul. In 1803 he was knighted, and received the post of recorder at Bombay, but he returned to England in 1812. He entered parliament in the Whig interest as member for Nairn, and he sat for that county, and afterwards for Knaresborough, till his death. He opposed the reactionary measures of the Tory government, supported and afterwards succeeded Romilly in his efforts for reforming the criminal code, and took a leading part both in Catholic emancipation and in the Reform Bill. From 1818 to 1824 he was professor of law and general politics in the East India Company's College at Haileybury. His *Dissertation on the Progress of Ethical Philosophy,* prefixed to the 7th edition of the *Encyclopædia Britannica,* and published in 1831, was severely attacked in 1835 by James Mill in his *Fragment on Mackintosh.* About the same time he wrote for the *Cabinet Cyclopaedia* a "History of England from the Earliest Times to the Final Establishment of the Reformation." His more elaborate *History of the Revolution* was published after his death. Already a privy councillor, Mackintosh was appointed commissioner for the affairs of India under the Whig administration of 1830. He died on May 30, 1832.

The *History of the Revolution in England,* breaking off where William of Orange is about to intervene, is chiefly interesting because of Macaulay's essay on it and its author.

A *Life,* by his son R. J. Mackintosh, was published in 1836.

MACKLIN, CHARLES (1697?–1797), Irish actor and playwright, whose real name was McLaughlin, had an adventurous youth before coming to Bristol, where he made his first appearance as Richmond in *Richard III.* At the end of 1753 Macklin bade farewell to the stage to open a tavern, near the theatre, where he personally supervised the serving of dinner. The tavern failed and Macklin returned to the stage, and played for a number of years in London and Dublin. His quick temper got him into constant trouble. In a foolish quarrel over a wig in 1735 he killed a fellow actor in the green-room at Drury Lane, and he was constantly at law over his various contracts and quarrels. The bitterest of these arose on account of his appearing as Macbeth at Covent Garden in 1772, when the audience demanded William Smith in the part. A few nights later the audience refused to hear Macklin as Shylock, and Macklin was discharged in order to avoid a riot. The courts awarded the actor £600 and costs, but Macklin magnanimously elected instead that the defendants should take £100 in tickets at three benefits—for himself, his daughter and the management. He died on July 11, 1797, and his last years were provided for by a subscription edition of two of his best plays, *The Man of the World* and *Love in a Maze.* His wife, dying about 1758, was an excellent actress.

See Edward A. Parry, *Charles Macklin* (1891).

MACK VON LEIBERICH, KARL, Freiherr (1752–1828), Austrian soldier, was born at Nenslingen, Bavaria, on Aug. 25, 1752. In 1770 he joined an Austrian cavalry regiment, becoming an officer seven years later. During the brief war of the Bavarian Succession he served on the staff of Count Kinsky, and subsequently under the commander-in-chief Field Marshal Count Lacy. He was promoted first lieutenant in 1778, and captain on the quartermaster-general's staff in 1783. In 1785 Mack married Katherine Gabrieul, and was ennobled under the name of Mack von Leiberich. In the Turkish war he was employed on the headquarters staff, becoming in 1788 major and personal aide-de-camp to the emperor, and in 1789 lieutenant-colonel. He distinguished himself greatly in the storming of Belgrade. Shortly after this, disagreements between Mack and Loudon, led to the former's demanding a court-martial and leaving the front. He was, however, given a colonelcy (1789) and the order of Maria Theresa, and in 1790 Loudon and Mack, having become reconciled, were again on the field together. During these campaigns Mack received a severe injury to his head, from which he never fully recovered. In 1793 he was made quartermaster-general (chief of staff) to Prince Josias of Saxe-Coburg, commanding in the Netherlands. He enhanced his reputation by the ensuing campaign, receiving a wound at Famars. In 1797 he was promoted lieutenant field marshal, and in 1798 accepted command of the Neapolitan army. Forced to take refuge from his own men, he escaped to the French camp, and was sent to Paris, whence he escaped in disguise two years later. He was not employed for some years, but in 1804 was made quartermaster-general of the army, with instructions to prepare for a war with France. He attempted hastily to reform the army, and in 1805 became the real commander (under titular commander-in-chief Archduke Ferdinand) of the army which opposed Napoleon in Bavaria, but his position was ill-defined and his authority treated with slight respect by his colleagues. (*See* Napoleonic Campaigns.)

See Schweigerd, *Oesterreichs Helden* (Vienna, 1854); Würzbach, *Biogr. Lexikon d. Kaiserthums Oesterr.* (Vienna, 1867); Ritter von Rittersberg, *Biogr. d. ausgezeichneten Feldherren d. oest. Armee* (Prague, 1828); Raumer's *Hist. Taschenbuch* (1873) defends Mack.

McLANE, LOUIS (1786–1857), American lawyer, business executive, political leader and diplomat, was descended from Scottish grandparents of the Isle of Man who had moved to Philadelphia in 1731. His immediate family had settled in the three lower counties of Delaware, where Allan McLane, his father, had entered business with Robert Morris in 1773. He began the practice of law in 1807, served in Congress, 1817–27, and in the Senate, 1827–29. He first inclined toward Federalism, but by

1823 he had formed with Martin Van Buren a group of William H. Crawford Democrats and later supported Andrew Jackson when Crawford's ill-health forced him out of politics. As an able representative of the Middle Atlantic States free-trader exporting and carrying-trade interests, he was well qualified to negotiate for the opening of the British West Indian trade, which was the main business of the London post under the new Jackson Administration. His appointment was the signal for a great protectionist outcry against the "Wilmington conspiracy" to bargain away the advantages of the tariff of 1828. The Government allowed him to follow his own course in the negotiations, with the result that within ten months after he had presented his credentials, an agreement was reached which ended an irritation of nearly 50 years. The cabinet, as the British were privately informed, favoured a reduction of the American tariff; but this was not secured until the southern free-traders organized the nullification movement and brought about the adoption of the Compromise tariff of 1833, which McLane, who had returned in the meantime to the United States as secretary of the treasury, had influenced by formulating the administration tariff proposals. Then came a turning-point in his career. He refused to join Van Buren in approving Jackson's proposal to remove deposits from the bank without the authority of Congress and was transferred to the Department of State. He resigned the next year, 1834, breaking with Van Buren. From 1834–37 he was president of the Morris Canal and Banking Company (New York), and from 1837–47 president of the Baltimore and Ohio Railroad. In 1845, when the Democrats returned to office without Van Buren and when Anglo-American relations were strained over the Oregon question, McLane accepted from President Polk an appointment to return to England "upon condition that if he could induce the British Government to reconsider the rejection of the offer of '49 he, the President, would consult the Senate as to the propriety of accepting this compromise." Whatever may have been McLane's real influence upon Lord Aberdeen, he had the satisfaction of seeing another great difference between the two countries "amicably" settled, and this time in conjunction with the triumph of free trade—the repeal of the British Corn Laws and the substitution of the low Walker tariff of 1846 for the high Whig tariff of 1842.

Bibliography.—There is no biography of Louis McLane, but *see* R. M. McLane's *Reminiscences, 1827–97;* Fitzpatrick (ed.), *Autobiography of Martin Van Buren;* Bassett (ed.), *The Andrew Jackson Papers;* Quaife (ed.), *Polk's Diary; The Aberdeen Papers* (ms.); *The Peel Papers* (ms.); *The C. R. Vaughan Papers* (ms.); and Benns, *The American Struggle for the British West India Carrying Trade.*

MACLAREN, CHARLES (1782–1866), Scottish editor, was born at Ormiston, Haddingtonshire, on Oct. 7, 1782, the son of a farmer and cattle-dealer. He was almost entirely self-educated, and became a clerk in Edinburgh. In 1817 he established the *Scotsman* newspaper in Edinburgh and at first acted as its editor. Offered a post as clerk in the custom house, he resigned his editorial position, resuming it again from 1820 to 1845. He was editor of the 6th edition of the *Encyclopædia Britannica* in 1820. From 1864–66 he was president of the Geological Society of Edinburgh, where he died on Sept. 10, 1866.

MACLAURIN, COLIN (1698–1746), Scottish mathematician, was the son of a clergyman, and born at Kilmodan, Argyllshire. He was educated at the University of Glasgow.

At nineteen he was elected professor of mathematics in Marischal college, Aberdeen, two years later he was admitted F.R.S. and made the acquaintance of Sir Isaac Newton. In 1719 he published his *Geometria organica, sive descriptio linearum curvarum universalis.* In it Maclaurin developed several theorems due to Newton, and introduced the method of generating conics which bears his name, and showed that many curves of the third and fourth degrees can be described by the intersection of two movable angles. In 1721 he wrote a supplement to the *Geometria organica,* which he afterwards published, with extensions, in the *Philosophical Transactions* for 1735. This paper is principally based on the following general theorem, which is a remarkable extension of Pascal's hexagram: "If a polygon move so that each of its sides passes through a fixed point, and if all its summits except one describe curves of the degrees m, n, p, etc., respectively, then the free summit moves on a curve of the degree $2mnp$ . . . which reduces to mnp . . . when the fixed points all lie on a right line." In 1722 Maclaurin travelled as tutor and companion to the eldest son of Lord Polwarth, and after a short stay in Paris resided for some time in Lorraine, where he wrote an essay on the percussion of bodies, which obtained the prize of the French Academy of Sciences for the year 1724. In 1725 he was made professor of mathematics in the university of Edinburgh on the recommendation of Newton.

In 1740 Maclaurin divided with Leonhard Euler and Daniel Bernoulli the prize offered by the French Academy of Sciences for an essay on tides. His *Treatise on Fluxions* (1742), written in reply to George Berkeley contains his essay on the tides. In this he showed that figures of equilibrium for a homogeneous rotating fluid mass are the ellipsoids of revolution, now known as Maclaurin's ellipsoids. Maclaurin was the first to introduce into mechanics, in this discussion, the important conception of *level surfaces.* He also gave in his *Fluxions,* for the first time, the correct theory for distinguishing between maxima and minima in general, and pointed out the importance of the distinction in the theory of the multiple points of curves. As a result of Maclaurin's suggestion, the newly formed (1731) Medical Society of Edinburgh was enlarged into the Philosophical Society (1739), and later (in 1783) into the Royal Society of Edinburgh. Of Newton's British successors, Maclaurin alone ranked equal with continental mathematicians of his day.

In 1745, when the rebels were marching on Edinburgh, Maclaurin took a prominent part in preparing trenches and barricades for its defence. As soon as the rebel army got possession of Edinburgh Maclaurin fled to England, to avoid making submission to the Pretender. He died on June 14, 1746, at Edinburgh.

After Maclaurin's death his *Account of Newton's philosophical discoveries* was published by Patrick Murdoch, and also his *Algebra* in 1748. As an appendix to the latter appeared his *De linearum geometricarum proprietatibus generalibus tractatus,* an elegant treatise.

MACLAURIN'S THEOREM: *see* Taylor's Theorem.

MACLEAN, SIR DONALD (1864–1932), British politician, the eldest son of John Maclean of Kilmoluag, Tiree, Scotland, was admitted a solicitor in 1887. After three unsuccessful contests, he entered the House of Commons in 1906 as Liberal member for Bath. He failed to hold his seat at the general election of Jan. 1910, but in December of that year he was elected for Peebles and Selkirk, which he represented until 1918. He was member for Peebles and South Midlothian from 1918 to 1922, when he lost his seat. In the absence of Asquith from the House of Commons, he became chairman of the Parliamentary Liberal party (1919–22). He was deputy chairman, House of Commons, 1911–18, and chairman of the London Appeal Tribunal, 1916–18. During the World War he was chairman of the Enemy Debt treasury commission and of the House of Commons military appeal tribunal. He was sworn of the privy council in 1916, and created K.B.E. in 1917. He died June 15, 1932.

McLEAN, JOHN (1785–1861), American jurist, was born in Morris county, N.J., on March 11, 1785. His father, a farmer, removed to Virginia in 1789, later to Kentucky and finally to Ohio. The boy's schooling was irregular, but he went to Cincinnati to study law in the office of Arthur St. Clair, and in 1807 was admitted to the bar. In 1812 he was elected U.S. representative from the district which included Cincinnati, and in 1814 was re-elected. In 1816 he was appointed a judge in the supreme court of Ohio, which position he resigned in 1822 to become commissioner of the General Land Office under President Monroe. Monroe in 1823 appointed him postmaster-general, in which office he continued throughout the administrations of John Quincy Adams. His conduct of this office was notable for its efficiency and economy, and for the strict non-partisan treatment of postmasters and other employees. President Jackson continued McLean in office, but McLean refused to accept the president's views on patronage, and resigned. Jackson thereupon appointed him an associate justice of the Supreme Court, which position he held from 1830 until his death in 1861. His career on the bench was long and distinguished, his most famous decision, perhaps, being the dissenting opinion in the Dred Scott case. In 1848 he was considered as a presidential candidate at the Free Soil convention in Buffalo, and in 1856 he was the chief opponent of J. C. Frémont at the first Republican convention, receiving 196 votes. He received a number of votes in the Chicago convention which nominated Lincoln. His death occurred at Cincinnati on April 4, 1861.

MACLEOD (mąk-lowd′), **HENRY DUNNING** (1821–1902), Scottish economist, was born in Edinburgh, and educated at Eton, Edinburgh University, and Trinity College, Cambridge, graduating in 1843. He travelled in Europe, and in 1849 was called to the English bar. He was employed in Scotland on the work of poor-law reform, and devoted himself to the study of economics. Between 1868 and 1870 he was employed by the government in codifying the law of bills of exchange. He died on July 16, 1902. He was the first British economist to elucidate the real nature of credit, the rôle of the banks in the creation of credit, and the effect of the discount rate on the volume of bank loans.

His most important works are: *Theory and Practice of Banking* (1858); *Elements of Political Economy* (1858); *Dictionary of Political Economy* (1863), 1st vol. and *Principles of Economist Philosophy* (1873).

MACLEOD, JOHN JAMES RICKARD (1876–1935), British physiologist, was born on Sept 6, 1876, near Dunkeld, Scotland, and was educated at Aberdeen grammar school, Marischal college, Aberdeen, and Leipzig university. From 1899 to 1902 he was demonstrator in physiology and then lecturer in biochemistry at the London Hospital, holding also from 1901–03 the Mackinnon research scholarship of the Royal Society; and from 1903 to 1918 he was professor of physiology at the Western reserve university, Cleveland (Ohio), subsequently becoming professor of physiology, director of the physiological laboratory and associate dean of the Faculty of Medicine in the University of Toronto in Canada. His most important work was on the nature of the control of the metabolism of carbo-hydrates in the animal body, and, together with Dr. Banting, with whom he shared the Nobel prize for medicine in 1923, he achieved fame as one of the discoverers of insulin (*q.v.*). He was elected F. R. S. in 1923, and received the Cameron prize of Edinburgh university. He was president of the Royal Canadian Institute in 1925. (*See* PHYSIOLOGY).

His publications include *Practical Physiology* (1903); *Recent Advances in Physiology,* edited by Leonard Hill (1905); *Diabetes, its Physiological Pathology* (1913); *Fundamentals of Physiology* (1916); *Physiology and Biochemistry in Modern Medicine* (5th ed. 1926), and numerous papers on insulin, etc., published in *The Journal of Physiology* and *The American Journal of Physiology.*

MACLEOD, NORMAN (1812–1872), Scottish divine, son of Rev. Norman Macleod (1783–1862), and grandson of Rev. Norman Macleod, minister of Morven, Argyllshire, was born at Campbeltown on June 3, 1812. In 1827 he became a student at Glasgow university, and in 1831 went to Edinburgh to study divinity under Dr. Thomas Chalmers. On March 18, 1838, he became parish minister at Loudoun, Ayrshire. At this time the troubles in the Scottish Church were already gathering to a head. (*See* FREE CHURCH OF SCOTLAND.) Macleod took a middle course in the non-intrusion controversy, holding that the fitness of those who were presented to parishes should be judged by the presbyteries—the principle of Lord Aberdeen's Bill. On the secession of 1843 he became pastor of Dalkeith. He was one of the founders of the Evangelical Alliance, and from 1849 edited the *Christian Instructor* (Edinburgh). In 1851 he was called to the Barony church, Glasgow, where he remained until his death (June 16, 1872). Macleod instituted temperance refreshment rooms, a congregational penny savings bank, and held services specially for the poor. In 1860 he was appointed editor of the new monthly magazine *Good Words,* to which he was a large contributor. By far his best work was the spontaneous and delightful *Reminiscences of a Highland Parish* (1867). Macleod was moderator of the church assembly in 1869. In recognition of his wide sympathy and high ideals, Queen Victoria gave two memorial windows to Crathie Church.

See *Memoir of Norman Macleod,* by his brother, Donald Macleod (1876).

MACLISE, DANIEL (1806–1870), Irish painter, was born at Cork, the son of a Highland soldier. For two years he worked in a bank before going to study in the Cork school of art. In 1825 he happened to see Sir Walter Scott, who was travelling in Ireland, in a bookseller's shop, and he made a surreptitious sketch of the great man, which he afterwards lithographed. The sketch was exceedingly popular, and the artist received many commissions for portraits. He refused to accept help for the purpose of study but, by economy, saved enough to enable him to leave for London. There he made a lucky hit by a sketch of the younger Kean, which, like his portrait of Scott, was lithographed and published. He entered the Academy schools in 1828, and carried off the highest honours. In 1829 he exhibited for the first time in the Royal Academy. Later he painted chiefly subject and historical pictures, with occasional portraits. In 1835 the "Chivalric Vow of the Ladies and the Peacock" procured his election as associate of the Academy, of which he became full member in 1840.

He designed the illustrations for several of Dickens's Christmas books, and between 1830 and 1836 contributed to *Fraser's Magazine,* under the pseudonym of Alfred Croquis, a remarkable series of portraits of the literary and other celebrities of the time, afterwards published as the *Maclise Portrait Gallery* (1871). In 1858 Maclise commenced work on the "Meeting of Wellington and Blücher," on the walls of Westminster Palace. It was begun in fresco, a process which proved unmanageable. Maclise then studied in Berlin the new method of "water-glass" painting, and carried out the subject and its companion, the "Death of Nelson," in that medium. He died on April 25, 1870.

A memoir of Maclise, by his friend W. J. O'Driscoll, was published in 1871.

MACLURE, WILLIAM (1763–1840), American geologist, was born at Ayr in Scotland in 1763. Maclure has become known as the father of American geology, because of his publication of a geological map of America in 1809 which, with the exception of Guettard's mineralogical *Map of Louisiana and Canada,* was the earliest attempt at a geological map of America, and antedates William Smith's geological map of England by six years. The map, together with a memoir entitled *Observations on the Geology of the United States Explanatory of a Geological Map* was the result of his voluntary and unaided labours.

Maclure was a liberal patron of science for many years, and from 1817 was president of the Philadelphia Academy of Natural Science to which institution he subsequently donated his valuable private library and about $20,000 in money. He died at San Angel, Mexico, in 1840.

A complete bibl. is in the *Bulletin of the Geol. Soc. of America,* vol. 10 (1898). *See* S. G. Morton, "Memoir of William Maclure," *Amer. Journ. of Sci.,* vol. xlvii. (1844), p. 1; George P. Merrill, *First Hundred Years of American Geology,* pp. 31–37 (1924); and the *Bulletin of the Geol. Soc. of Amer.,* vol. x., p. 83 (1899).

M'MAHON, SIR ARTHUR HENRY (1862–), K.C. I.E. (1906), G.C.M.G. (1916), British soldier and administrator, was born on Nov. 28, 1862, the son of General C. A. M'Mahon, F.R.S. He was educated at Haileybury and entered Sandhurst. In 1883 he joined the army, and later, having joined the Indian political department, was in 1901 appointed revenue and judicial commissioner in Baluchistan. After holding several administrative posts, he was from 1911 to 1914 foreign secretary to the Government of India. In 1913–14 he was British Plenipotentiary for the treaty regarding Tibet, between England, China and Tibet. In 1914 he became first high commissioner for Egypt under the British protectorate. In 1919 he was British commissioner on the Middle East International Commission (Peace Conference).

MacMAHON, MARIE EDMÉ PATRICE MAURICE DE, duke of Magenta (1808–1893), French marshal and president of the French republic, was born on July 13, 1808, at the château of Sully, near Autun. He was descended from an Irish family which went into exile with James II. Educated at the military school of St. Cyr, in 1827 he entered the army, and served in the first French campaign in Algeria. He gained distinction in the expedition to Antwerp in 1832. In 1833 he returned to Algeria. He led daring cavalry raids across plains infested with Bedouin, and distinguished himself at the siege of Constantine in 1837. He was almost constantly in Algeria until 1854. MacMahon commanded a division in the Crimean War, and in September 1855 he conducted the assault upon the Malakoff works, which led to the fall of Sevastopol. Declining the highest command in France, he was once more sent out, at his own request, to Algeria, where he completely defeated the Kabyles. After his return to France he voted as a senator against the unconstitutional law for general safety, brought forward in consequence of Orsini's abortive attempt on the emperor's life. MacMahon distinguished himself in the Italian campaign of 1859. Partly by good luck and partly by pushing forward without orders at a critical moment at the battle of Magenta, he secured victory. For this MacMahon received his marshal's baton and was created duke of Magenta. In 1861 he represented France at the coronation of William I. of Prussia, and in 1864 he was nominated governor-general of Algeria. MacMahon's administration was unsuccessful and when the ill-fated Ollivier cabinet was formed, the emperor abandoned his Algerian schemes and MacMahon was recalled.

In 1870 MacMahon was appointed to the command of the Alsace army detachment (*see* FRANCO-GERMAN WAR). On Aug. 6, MacMahon fought the battle of Wörth (*q.v.*). He was compelled to fall back upon Saverne, and thence to Toul. The emperor then gave him supreme command of the new levies which he was mustering at Châlons, and he was directed to effect a junction with Bazaine. This operation he undertook against his will. He had an army of 120,000 men, with 324 guns; but large numbers of the troops were disorganized and demoralized. Early on Sept. 1, the decisive battle of Sedan began. MacMahon was dangerously wounded in the thigh, whereupon General Ducrot, and soon afterwards General de Wimpffen, took command. MacMahon shared the captivity of his comrades, and was interned at Wiesbaden.

In March 1871 MacMahon was appointed by Thiers commander-in-chief of the army of Versailles; in that capacity he suppressed the Communist insurrection, and successfully conducted the second siege of Paris. On the resignation of Thiers on May 24, 1873, MacMahon was elected president of the Republic by an almost unanimous vote. On Nov. 5, 1873, General Changarnier presented a motion in the Assembly to confirm MacMahon's powers for a period of ten years, and to provide for a commission of thirty to draw up a form of constitutional law. The president consented, but in a message to the Assembly he declared in favour of a confirmation of his own powers for seven years, and expressed his determination to use all his influence in the maintenance of Conservative principles. After prolonged debates the Septennate was adopted on Nov. 19 by 378 votes to 310. There was no *coup d'état* in favour of "Henri V.," as had been expected, and the president resolved to abide by "existing institutions." One of his earliest acts was to receive the finding of the court-martial upon his old comrade in arms, Marshal Bazaine, whose death sentence he commuted to one of twenty years' imprisonment in a fortress.

The president was popular in the rural districts of France, but in Paris and other large cities the Republican party were alienated by press prosecutions and the attempted suppression of Republican ideas. Matters were at a comparative deadlock in the National Assembly, until the accession of some Orleanists to the Moderate Republican party in 1875 made it possible to pass various constitutional laws. In May 1877 the constitutional crisis became acute. A peremptory letter of censure from MacMahon to Jules Simon caused the resignation of the ministry. The duc de Broglie formed a cabinet, but Gambetta carried a resolution in the Chamber of Deputies in favour of parliamentary government. The president declined to yield, and being supported by the Senate, he dissolved the Chamber, by decree, on June 25. The prosecution of Gambetta followed for a speech at Lille, in which he had said, "the marshal must, if the elections be against him, *se soumettre ou se démettre*." In a manifesto respecting the elections, the president declared: "I cannot obey the injunctions of the demagogy; I can neither become the instrument of Radicalism nor abandon the post in which the constitution has placed me."

But the elections in October resulted in the return of 335 Republicans and only 198 anti-Republicans, the latter including 30 MacMahonists, 89 Bonapartists, 41 Legitimists, and 38 Orleanists. As a last resort the president called to power an extra-parliamentary cabinet under General Rochebouet, but the Republican majority refused to vote supplies, and after a brief interval MacMahon had to accept a new Republican ministry under Dufaure. The prolonged crisis terminated on Dec. 14, 1877, and no further constitutional difficulties arose in 1878. But as the senatorial elections, held early in 1879, gave the Republicans an effective working majority in the Upper Chamber, they now called for the removal of the most conspicuous anti-Republicans among the generals and officials. MacMahon resigned the presidency on Jan. 30, 1879, and Jules Grévy was elected as his successor.

MacMahon now retired into private life. He died at Paris on Oct. 17, 1893. A fine, tall, soldierly man, of a thoroughly Irish type, in private life MacMahon was universally esteemed as generous and honourable; as a soldier he was brave and able, without decided military genius; as a politician he was patriotic and well-intentioned, but with no real statecraft.

See Grandin, *Le Maréchal MacMahon* (2 vols., 1893); G. Hanotaux, *La France contemporaine* (vol. 2, 1905).

MACMANUS, TERENCE BELLEW (1823–1860), Irish rebel, was born at Tempo, Fermanagh. He joined the '82 Club in 1844, took part in the W. S. O'Brien outbreak of 1848, and was arrested in Cork and sentenced to death. The sentence was transmuted to transportation to Tasmania. MacManus escaped to America. He died in San Francisco in 1860. His body was brought back to Ireland and the interment at Glasnevin was the occasion of a great Fenian demonstration.

McMASTER, JOHN BACH (1852–1932), American historian, was born in Brooklyn, N.Y., on June 29, 1852. He graduated from the College of the City of New York in 1872, worked as civil engineer in 1873–77, was instructor in civil engineering at Princeton university in 1877–83, and from 1883 until 1920 was professor of American history in the University of Pennsylvania. His earliest writings were on engineering subjects; but he is best known for his *History of the People of the United States, from the Revolution to the Civil War* (1883–1913), a work which was a pioneer in the task of interpreting the American nation to itself and in the use of social rather than purely political materials. It was supplemented by *A History of the People of the United States during Lincoln's Administration* (1927). Among McMaster's other books are *With the Fathers* (1896); *A Brief History of the United States* (1907, rev. enl. ed. 1918 and 1924); and *The Life and Times of Stephen Girard, Mariner and Merchant* (1918). McMaster died May 22, 1932.

MACMILLAN, the name of a family of English publishers. The founders of the firm were two Scotsmen, Daniel Macmillan (1813–57) and his younger brother Alexander (1818–96). Daniel was a native of the Isle of Arran, and Alexander was born in Irvine on Oct. 3, 1818. Daniel was for some time assistant to the bookseller Johnson at Cambridge, but entered the employ of Messrs. Seeley in London in 1837; in 1843 he began business in Aldersgate street, and in the same year the two brothers purchased the business of Newby in Cambridge. They began to publish educational works in 1844. In 1845 they became the proprietors of the more important business of Stevenson, in Cambridge, the firm being styled Macmillan, Barclay and Macmillan. In 1850 Barclay retired and the firm resumed the name of Macmillan and Co. Daniel Macmillan died at Cambridge on June 27, 1857. In that year an impetus was given to the business by the publication of Kingsley's *Two Years Ago.* A branch office was opened in 1858 in Henrietta street, London, and in 1897 the buildings in St. Martin's street were opened. Alexander Macmillan died in Jan. 1896. In little over half a century he had built up one of the most important publishing houses in the world. Macmillan published the works of Kingsley, Huxley, Maurice, Tennyson, Lightfoot, Westcott, J. R. Green, Lord Roberts, Lewis Carroll, and of many other well-known authors. In 1898 they took over the house of R. Bentley and Son, and in 1893 the firm was converted into a limited liability company, its chairman being Frederick Macmillan (b. 1851), who was knighted in 1909. The American firm of the Macmillan Company, of which he was also a director, is a separate business.

See Thomas Hughes, *Memoir of Daniel Macmillan* (1882); *A Bibliographical Catalogue of Macmillan and Co's Publications from 1843 to 1889* (1891), with portraits of the brothers Daniel and Alexander after Lowes Dickinson and Hubert Herkomer; also articles in *Le Livre* (Sept. 1886), *Publishers' Circular* (Jan. 14, 1893), the *Bookman* (May 1901), etc.

MACMONNIES, FREDERICK WILLIAM (1863–1937), American sculptor and painter, was born at Brooklyn (N.Y.), on Sept. 20, 1863. At the age of 16 he was received as an apprentice in the studio of Augustus St. Gaudens, the sculptor, where he remained for five years. In 1884 he went to Paris and thence to Munich, where he painted for some months. Returning to Paris the next year he became the most prominent pupil of Falguière. His "Diana" brought him a mention at the Salon of 1889. Three life-sized figures of angels for the church of St. Paul, New York, were followed by his "Nathan Hale," in the City Hall park, New York, and a portrait of James S. T. Stranahan, for Brooklyn. This last brought him a "second medal" in the Salon of 1891, the first time an American sculptor had been so honoured. In 1893 he was chosen to design and carry out the Columbian fountain for the Chicago World's Fair, which placed him instantly in the front rank of his profession. His largest work is a decoration for the memorial arch to soldiers and sailors, at Prospect park, Brooklyn, where he has also a large "Horse Tamer," a work of much distinction. A "Winged Victory" at the U.S. military academy at West Point (N.Y.), is of importance; "Bacchante," an extraordinary combination of realism and imagination, rejected by the Boston public library, is now at the Metropolitan Museum of Art, New York. His group, "Civic Virtue" for the City Hall fountain, New York, caused much discussion (1919). He was also well known as a portrait-painter.

MACNAGHTEN, SIR WILLIAM HAY, BART. (1793–1841), Anglo-Indian diplomatist, was the second son of Sir Francis Macnaghten, Bart., judge of the supreme courts of Madras and Calcutta. He went out to Madras in 1809, and was transferred to the Bengal Civil Service in 1816. In 1830 he became secretary to Lord William Bentinck; and in 1837 the trusted adviser of the governor-general, Lord Auckland, with whose policy of supporting Shah Shuja against Dost Mohammed, the reigning amir of Kabul, Macnaghten was closely identified. As political agent at Kabul he came into conflict with the military authorities and subsequently with his subordinate Sir Alexander Burnes. Macnaghten attempted to placate the Afghan chiefs with heavy subsidies, but when the drain on the Indian exchequer became too great, and the allowances were reduced, this policy led to an outbreak. Burnes was murdered on Nov. 2, 1841; and owing to the incapacity of the aged General Elphinstone the British army in Kabul degenerated into a leaderless mob. Macnaghten tried to save the situation by negotiating with the Afghan chiefs and, independently of them, with Dost Mohammed's son, Akbar Khan, by whom he was assassinated on Dec. 23, 1841. Retreating through the Kurd Kabul, the British suffered massacre.

MacNALLY, LEONARD (1752–1820), Irish informer, was born in Dublin, the son of a merchant. In 1776 he was called to the Irish, and in 1783 to the English bar. He supported himself for some time in London by writing plays and editing the *Public Ledger*. Returning to Dublin, he entered upon a systematic course of informing against the members of the revolutionary party, for whom his house had become the resort. He also betrayed to the Government prosecutors political clients whom he defended eloquently in the courts. He made a fine defence for Robert Emmet and cheered him in his last hours, although before appearing in court he had sold, for £200, the contents of his brief to the lawyers for the Crown. After living as a Protestant all his life, on his deathbed he received absolution from a Catholic priest. He died on Feb. 13, 1820.

MacNEIL, HERMON ATKINS (1866–), American sculptor, was born at Chelsea (Mass.). He was an instructor in industrial art at Cornell university in 1886–89, and was then a pupil of Henri M. Chapu and Falguière in Paris. Returning to America, he aided Philip Martiny in the preparation of sketch models for the Columbian exposition. In 1896 he won the Rinehart scholarship, passing four years (1896–1900) in Rome. In 1906 he became a National Academician. His first important work was "The Moqui Runner," which was followed by "A Primitive Chant," and "The Sun Vow," all figures of the North American Indian. A "Fountain of Liberty," for the St. Louis exposition, and other Indian themes came later; his "Agnese" and his "Beatrice," two fine busts of women, also deserve mention. His principal work is the sculpture for a large memorial arch at Columbus (O.), in honour of President McKinley. He executed the frieze for the Missouri State capitol, and the war memorial for Flushing, Long Island. In 1909 he won the commission for a soldiers' and sailors' monument in Albany, N.Y., and in 1923 the Saltus gold medal. His wife, Carol Brooks MacNeil (1871–1944), was also a sculptor of distinction.

McNEILE, HUGH (1795–1879), Anglican divine, was born at Ballycastle, Co. Antrim, on July 15, 1795, and graduated at Trinity college, Dublin, in 1810. He came under the influence of Edward Irving but was soon alienated by the latter's increasing extravagance. In 1834 he became incumbent of St. Jude's, Liverpool, where for 30 years he had great political as well as ecclesiastical influence, maintaining that "God, when he made the minister did not unmake the citizen." In 1835 McNeile entered on a long contest with the Liverpool corporation, which proposed to secularize its elementary schools by the introduction of the Irish national system. McNeile led a fierce agitation against the threatened withdrawal of the Bible as the basis of denominational religious teaching; before the new system could be introduced every child was provided for in new Church of England schools established by public subscriptions. McNeile was a zealous opponent of the Tractarian movement, and a conspicuous leader of the evangelical party. In 1840 he published *Lectures on the Church of England*, and in 1846 (the year after Newman's secession to Rome), *The Church and the Churches*, maintaining the evangelical doctrine of the "invisible Church" in opposition to the teaching of Newman and Pusey. In 1860 he was appointed a canon of Chester, and in 1868 dean of Ripon.

See J. A. Picton, *Memorials of Liverpool*, vol. i. (1873); Sir Edward Russell, "The Religious Life of Liverpool," in the *Sunday Magazine* (June 1905); Charles Bullock, *Hugh McNeile and Reformation Truth* (1882).

MACNEILL, JOHN GORDON SWIFT (1849–1926), Irish historian, and an authority on parliamentary procedure, was born in Dublin on March 11, 1849, and educated at Trinity college, Dublin, and Christ Church, Oxford. In 1875 he was called to the Irish Bar. He became professor of constitutional and criminal law at King's Inn, Dublin, and from 1909 was professor in the National university of Ireland. In 1887 he entered politics as the Nationalist representative of South Donegal, until the party was defeated by Sinn Fein in 1918. He was an accepted authority on parliamentary procedure and history. His books include *The Irish Parliament; What it was and what it did* (1885); *English interference with Irish industries* (1886); *How the Union was carried* (1887); *Titled Corruption* (1894); *Constitutional and Parliamentary History of Ireland* (1917); *Studies in the Constitution of the Irish Free State* (1925). In 1925 he published reminiscences, and quotes a remark of Lord Fisher which is indicative of his political career: "Mr. MacNeill you are a damned good fighter! I wish to God I had you with me in the Navy!" MacNeill died in Dublin on Aug. 24, 1926.

MACOMB, a city of western Illinois, U.S.A., 190 m. S.W. of Chicago; the county seat of McDonough county. It is on federal highway 67 and state highway 10 and is served by the Burlington Route. Pop. (1930) 8,509 (96% native white); 8,764 (1940). It is the seat of the Western Illinois State Teachers college (established 1899). Clay, oil and coal are found in the vicinity, and the city manufactures beverages, cheese, tooth powder, poultry equipment, electric clocks and mixers, stokers, thermos jugs, bomb fins, pottery, electric insulators and other articles. Macomb became the county seat in 1830, and a city in 1856.

MACOMER, a village of Sardinia, province of Nuoro, 95 mi. N.N.W. of Cagliari by rail. Pop. (1936), 4,950 (town), 5,588 (commune). It is 1,890 ft. above sea-level on the southern ascent to the central plateau (Campeda); and it is the junction of narrow-gauge lines branching from the main line eastwards to Nuoro and westwards to Bosa. The old parish church of S. Pantaleone has three Roman mile-stones in front of it, belonging to the Roman high-road from Carales to Turris Libisonis. The *nuraghe* of S. Barbara is fine. The Allies bombed Macomer in World War II.

MACON, NATHANIEL (1758–1837), American political leader, was born at Macon Manor, North Carolina, Dec. 17, 1758. He studied at the College of New Jersey (now Princeton university) from 1774 to 1776, when the institution was closed on account of the outbreak of the Revolutionary War. In 1777–80 he studied law at Bute Court-house, North Carolina, and in 1781–85 served in the North Carolina senate. In 1791–1815 he was a member of the national House of Representatives, and in 1815–28 of the United States Senate. Macon's point of view was always local rather than national. He was essentially a North Carolinian first, and an American afterwards; and throughout his career he was an aggressive advocate of State sovereignty and an adherent of the doctrines of the "Old Republicans." In Congress he denounced Hamilton's financial policy, opposed the Jay Treaty (1795) and the Alien and Sedition acts, and advocated a continuance of the French alliance of 1778. His party came into power in 1801, and he was Speaker of the house in 1801–07. At first he was in accord with Jefferson's administration; he approved the Louisiana Purchase, and as early as 1803 advocated the purchase of Florida. For a number of years, however, he was politically allied with John Randolph in a group of about 10 independents, called the "Quids," who strongly criticized Jefferson and opposed the presidential candidature of Madison. By 1809, however, Macon was again in accord with his party, and during the next two years he was one of the most influential of its leaders. In Dec. 1809 he introduced resolutions recommending the complete exclusion of foreign war vessels from United States ports and the suppression of illegal trade carried on by foreign merchants under the American flag. The substance of these resolutions was embodied in a bill which became law on May 1, 1810. This measure provided for the repeal of the Non-Intercourse Act of 1809, authorized the president, "in case either Great Britain or France shall before the 3rd day of March next so revoke or modify her edicts as that they shall cease to violate the neutral commerce of the United States," to revive non-intercourse against the other, and prohibited British and French vessels of war from entering American waters. In 1812 Macon voted for the declaration of war against Great Britain. He opposed the Bank Act of 1816, the "internal improvements" policy of Calhoun (in the early part of his career) and Clay, and the Missouri Compromise. In 1824 Macon received the electoral vote of Virginia for the vice-presidency, and in 1826–28 was president pro tempore of the Senate. He died at Buck Springs, N.C., on June 29, 1837.

See William E. Dodd, *The Life of Nathaniel Macon* (Raleigh, N.C., 1903); E. M. Wilson, *The Congressional Career of Nathaniel Macon* (Chapel Hill, N.C., 1900).

MÂCON, a town of east-central France, capital of the department of Saône-et-Loire, 45 m. N. of Lyons on the Paris-Lyon railway. Pop. (1936) 18,178. Mâcon (*Matisco*) was an important town of the Aedui, but under the Romans it was supplanted by Autun and Lyons. It suffered at the hands of the Germans, Burgundians, Vandals, Huns, Hungarians and even of the Carolingian kings. In the feudal period it was an important countship sold in 1228 to the king of France, but at times in the possession of the dukes of Burgundy until the ownership of the French Crown was established in the time of Louis XI. In the 16th century Mâcon became a stronghold of the Huguenots, but afterwards fell to the League, and only yielded to Henry IV. in 1594. The bishopric, created by King Childebert, was suppressed in 1790.

Mâcon is situated on the Saône facing the plain of the Bresse; a bridge of 12 arches connects it with the suburb of St. Laurent on the opposite bank. The modern Romanesque church of St. Pierre is a large three-naved basilica. Of the old cathedral of St. Vincent (12th and 13th centuries), destroyed at the Revolution, nothing remains but the Romanesque narthex, now used as a chapel, the façade and its two flanking towers. The hôtel de ville contains a library, a theatre and picture-gallery. Macon is the seat of a prefecture, and has tribunals of first instance and of commerce, and a chamber of commerce. Copper-founding is an important industry, also printing; manufactures include casks, mats, esparto articles, powders, rope and utensils for the wine-trade. The town has a large trade in wine of the district, known as Mâcon. The railways from Paris to Marseilles and from Mont Cenis to Geneva, with a branch from Moulins here are joined.

MACON, a city of central Georgia, U.S.A., the county seat of Bibb county; on federal highways 41, 80 and 129. It has a municipal airport and is served by the Central of Georgia; the Georgia; the Macon, Dublin and Savannah; Georgia, Southern and Florida; and the Southern railways. Population in 1930 was 53,829 (42·7% were Negroes); and it was 57,865 by the federal census of 1940. Macon is a city of wide streets, many trees, stately old mansions and attractive new residence districts on the hills, several beautiful public buildings (including the municipal auditorium, opened in 1925), 500 ac. of parks and playgrounds, and a municipal stadium seating 12,000 spectators. It is the seat of Wesleyan college (1836), the first college in the world chartered to confer academic degrees on women, which occupies a large $3,000,000 plant on a campus of 170 ac., 5 mi. N. of the city; Mercer university (Baptist), established as Mercer institute in 1833, at Penfield; the Georgia Academy for the Blind (1852); and several other institutions. The Ocmulgee National monument near the city is of great archaeological interest. Macon is the centre of the peach industry of Georgia, is a large cotton market, and handles increasing amounts of pecans, peanuts and cattle each year. Other principal products are brick and tile, lumber and textiles.

Immense beds of kaolin are nearby.

Macon has a large wholesale trade and a variety of manufacturing industries. Some of the largest greenhouses in the south are at Macon.

Bank debits for 1940 totalled $207,300,972. The assessed valuation for 1940 was $38,000,000. Macon (named after Nathaniel Macon, *q.v.*) was surveyed in 1823 by order of the Georgia legislature to be the judicial seat of Bibb county, and was chartered in 1824. It quickly became an important river port and trading centre, shipping 69,000 bales of cotton by water in 1834. In 1850 the population was 5,720; in 1860, 8,247. During the Civil War it was the seat of a Confederate commissariat and Treasury depository, and was not occupied by Federal troops until April 20, 1865.

Macon was the birthplace of Sidney Lanier.

MACPHERSON, SIR DAVID LEWIS (1818–1896), Canadian financier and politician, was born at Castle Leathers, near Inverness, Scotland, on Sept. 12, 1818. In 1835 he emigrated to Canada, settling in Montreal, where he built up a large fortune by "forwarding" merchandise. In 1853 he removed to Toronto, and obtained the contract for building a line of railway from Toronto to Sarnia, a project from which sprang the Grand Trunk railway. In 1864 he was elected to the Canadian parliament as member of the Legislative Council for Saugeen, and on the formation of the Dominion, in 1867, was nominated to the senate. He published a number of pamphlets on economic subjects, of which the best-known is *Banking and Currency* (1869). In 1880 he was appointed Speaker of the senate, and from Oct. 1883 till 1885 was minister of the interior in the Conservative cabinet. In 1884 he was knighted. He died on Aug. 6, 1896.

MACPHERSON, JAMES (1736–1796), Scottish "translator" of the Ossianic poems, was born at Ruthven, Inverness, on Oct. 27, 1736. He studied at King's college, Aberdeen (1753), at Marischal college and in Edinburgh. He is said to have written over 4,000 lines of verse while a student, but though some of this was published, notably *The Highlander* (1758), he afterwards tried to suppress it. On leaving college he taught in the school of his native place. At Moffat he met John Home, the author of *Douglas,* who encouraged him to publish translations from the Gaelic, as *Fragments of Ancient Poetry collected in the Highlands of Scotland* (Edinburgh, 1760). Dr. Hugh Blair, who was a firm believer in the authenticity of the poems, got up a subscription to allow Macpherson to pursue his Gaelic researches. In the autumn he set out to visit western Inverness, the islands of Skye, North and South Uist and Benbecula. He obtained mss. which he translated with the assistance of Captain Morrison and the Rev. A. Gallie. Later in the year he made an expedition to Mull, when he obtained other mss. In 1761 he announced the discovery of an epic on the subject of Fingal, and in December he published *Fingal, an Ancient Epic Poem in Six Books, together with Several Other Poems composed by Ossian, the Son of Fingal, translated from the Gaelic Language,* written in the musical measured prose of which he had made use in his earlier volume. *Temora* followed in 1763, and a collected edition, *The Works of Ossian,* in 1765.

The genuineness of these so-called translations from the works of a 3rd-century bard was immediately challenged in England, and Samuel Johnson, after some local investigation, asserted (*Journey to the Western Islands of Scotland,* 1775) that Macpherson had only found fragments of ancient poems and stories, which he had woven into a romance of his own composition. Macpherson never produced his originals, which he refused to publish on the ground of the expense. In 1764 he was made secretary to General Johnstone at Pensacola, West Florida, and when he returned, two years later, to England, after a quarrel with Johnstone, he was allowed to retain his salary as a pension. He wrote several historical works, the most important of which was *Original Papers, containing the Secret History of Great Britain from the Restoration to the Accession of the House of Hanover; to which are prefixed Extracts from the Life of James II., as written by himself* (1775). He enjoyed a salary for defending Lord North's government, and held the lucrative post of London agent to Mohammed Ali, nabob of Arcot. He entered parliament in 1780, and at his estate, Belville, Inverness, he died, Feb. 17, 1796.

After Macpherson's death, Malcolm Laing, in an appendix to his *History of Scotland* (1800), propounded the view that the so-called Ossianic poems were altogether modern in origin, and that Macpherson's authorities were practically non-existent. For a discussion of this question *see* SCOTTISH LITERATURE: *In Gaelic.* Apart from the doubtful morality of Macpherson's transactions he was a great writer. He did not transcribe actual Celtic poems, but he appreciated natural beauty and his art, with its tenderness, did more than any single work to bring about the romantic movement in European, and especially in German, literature. It was translated into many European languages, and Herder and Goethe (in his earlier period) were among its admirers. Cesarotti's Italian translation was one of Napoleon's favourite books.

BIBLIOGRAPHY.—For Macpherson's life, see *The Life and Letters of James Macpherson* . . . (1894, new ed., 1906), by T. Bailey Saunders who has laboured to redeem his character from the suspicions generally current with English readers. The antiquity of the Ossianic poems was defended in the introduction by Archibald Clerk to his edition of the *Poems of Ossian* (1870). Materials for arriving at a decision by comparison with undoubtedly genuine fragments of the Ossianic legend are available in *The Book of the Dean of Lismore,* Gaelic verses, collected by J. McGregor, dean of Lismore, in the early 16th century (ed. T. McLauchlan, 1862); the *Leabhar na Feinne* (1871) of F. J. Campbell, who also discusses the subject in *Popular Tales of the Western Highlands,* iv. (1893). *See* also L. C. Stern, "Die ossianische Heldenlieder" in *Zeitschrift für vergleichende Litteratur-geschichte* (1895; Eng. trans. by J. L. Robertson in *Trans. Gael. Soc. of Inverness,* xxii., 1897–1898); Sir J. Sinclair, *A Dissertation on the Authenticity of the Poems of Ossian* (1806); *Transactions of the Ossianic Society* (Dublin, 1854–61); *Cours de littérature celtique,* by Arbois de Jubainville, editor of the *Revue celtique* (1883, etc.); A. Nutt, *Ossian and the Ossianic Literature* (1899), with a valuable bibliographical appendix; J. S. Smart, *James Macpherson: an Episode in Literature* (1905), *Fragments of Ancient Poetry* was reprinted in 1917.

McPHERSON, JAMES BIRDSEYE (1828–1864), American soldier, was born at Sandusky, O., on Nov. 14, 1828. He entered West Point at the age of 21, and graduated (1853) at the head of his class, which included Sheridan, Schofield and Hood. He was employed at the military academy as instructor of practical military engineering (1853). A year later he was sent to engineer duty at New York, and in 1857 he was sent as superintending engineer to San Francisco, becoming first lieutenant in 1858. He was promoted captain during the first year of the Civil War, and towards the close of 1861 became lieutenant-colonel and aide-de-camp to Gen. Halleck, who in the spring of 1862 sent him to Gen. Grant as chief engineer. He remained with Grant during the Shiloh campaign, and acted as engineer adviser to Halleck during the siege operations against Corinth in the summer of 1862. In October he distinguished himself in command of an infantry brigade at the battle of Corinth, and on the 8th of this month was made major-general of volunteers and commander of a division. In the second advance on Vicksburg (1863) McPherson commanded the XVII. corps, fought at Port Gibson, Raymond and Jackson, and after the fall of Vicksburg was strongly recommended by Grant for the rank of brigadier-general in the regular army, to which he was promoted on Aug. 1, 1863. He commanded at Vicksburg until the following spring. He was about to go on leave of absence when he received his nomination to the command of the Army of the Tennessee, Grant's and Sherman's old army, which was to take part under Sherman's supreme command in the campaign against Atlanta (1864). This nomination was made by Sherman and entirely approved by Grant. McPherson commanded his army at the actions of Resaca, Dallas, Kenesaw Mountain and the battles about Atlanta. On July 22, when the Confederates under his old classmate Hood made a sudden and violent attack on the lines held by the Army of the Tennessee, McPherson rode up, in the woods, to the enemy's firing line and was killed. Grant is reported to have said "The country has lost one of its best soldiers and I have lost my best friend."

See Amos A. Fries, "Major General James Birdseye McPherson," *U.S. Engin. Dept.,* vol. vii, p. 378–82 (1915).

MACPHERSON, SIR WILLIAM GRANT (1858–1927), British doctor, soldier, and writer, was born on Jan. 27, 1858, at Kilmuir, Ross-shire, and was one of the original pupils at Fettes college in 1870. Completing his education at Edinburgh, Tübingen and Leipzig, he accompanied Sir C. Euan Smith's mission to Fez in 1892, and Sir A. Nicolson's mission to Morocco in 1896. In 1902 he served in South Africa, and after further experience in Cuba, Panama, the Russo-Japanese War and Malta he was appointed to the staff college at Quetta. During the World War, he was director of medical services to the I. Army serving in Macedonia. He was created K.C.M.G. in 1918. He contributed greatly to the efficiency of the British medical services during the World War, and afterwards edited the *Official Medical History of the War.* He died on Oct. 15, 1927, in London.

McPHERSON, a city in the central part of Kansas, U.S.A., on Federal highways 50N and 81, and served by the Missouri Pacific, the Rock Island, the Santa Fe and the Union Pacific railways. It is the county seat of McPherson county; an important shipping point for corn, wheat and other agricultural products; and the seat of McPherson college (Church of the Brethren; 1887). The population was 7,194 in 1940.

MACQUARIE, a British island in the South Pacific Ocean, in 54° 49′ S. and 159° 49′ E. It has an area of 170 sq.m., and is covered with a grassy vegetation, with some trees or shrubs in the sheltered places which afford food to a parrot of the genus *Cyanorhamphus,* allied to those of the Auckland Islands. Although it has no settled population, Macquarie is constantly visited by seal hunters.

MACRAUCHENIA, a long-necked, long-limbed, three-toed South American ungulate, typifying the Litopterna (*q.v.*).

MACREADY, WILLIAM CHARLES (1793–1873), English actor, was born in London on March 3, 1793, and educated at Rugby. On June 7, 1810 he appeared as Romeo at Birmingham. On Sept. 16, 1816, Macready made his first London appearance at Covent Garden as Orestes in *The Distressed Mother,* a translation of Racine's *Andromaque* by Ambrose Philips. Macready's choice of characters was at first confined chiefly to the romantic drama. In 1818 he won a permanent success in Isaac Pocock's (1782–1835) adaptation of Scott's *Rob Roy.* He showed his capacity in high tragedy by his impersonation of Richard III. at Covent Garden (Oct. 25, 1819).

Transferring his services to Drury Lane, he gradually rose in public favour, his most conspicuous success being in the title-rôle of Sheridan Knowles's *William Tell* (May 11, 1825). In 1826 he completed a successful engagement in America, and in 1828 in Paris. On Dec. 15, 1830, he appeared at Drury Lane as Werner, a powerful impersonation. In 1833 he played in *Antony and Cleopatra,* in Byron's *Sardanapalus,* and in *King Lear.*

After entering on the management of Covent Garden in 1837 he introduced Robert Browning's *Strafford,* and in the following year Bulwer's *Lady of Lyons* and *Richelieu,* the principal characters in which were among his most effective parts. On June 10, 1838, he gave a memorable performance of *Henry V.,* for which Stanfield prepared sketches; the mounting was superintended by Bulwer, Dickens, Forster, Maclise, W. J. Fox and other friends. The first production of Bulwer's *Money* took place under the artistic direction of Count d'Orsay Dec. 8, 1840, Macready playing the part of Alfred Evelyn. Both in his management of Covent Garden, which he resigned in 1839, and of Drury Lane, which he held from 1841 to 1843, he found little support for his efforts to elevate the stage. In 1843–44 he visited the United States; his last visit to that country, in 1849, was marred by a riot at the Astor opera house, New York, arising from the jealousy of the actor Edwin Forrest, and resulting in the death of 17 persons, who were shot by the military called out to quell the disturbance. Macready took leave of the stage in a farewell performance of *Macbeth* at Drury Lane on Feb. 26, 1851. The remainder of his life was spent in happy retirement, and he died at Cheltenham on April 27, 1873. He had married, in 1823, Catherine Frances Atkins (d. 1852). Of a numerous family of children only one son and one daughter survived. In 1860 he married Cecile Louise Frederica Spencer (1827–1908), by whom he had a son.

Macready's performances always displayed fine artistic perceptions developed to a high degree of perfection by very comprehensive culture, and even his least successful personations had the interest resulting from thorough intellectual study. He belonged to the school of Kean rather than of Kemble; but, if his tastes were better disciplined and in some respects more refined than those of Kean, his natural temperament did not permit him to give proper effect to the great tragic parts of Shakespeare, *King Lear* perhaps excepted, which afforded scope for his pathos and tenderness, the qualities in which he specially excelled. With the exception of a voice of good compass and capable of very varied expression, Macready had no especial physical gifts for acting, but the defects of his face and figure cannot be said to have materially affected his success.

Bibliography.—*Macready's Reminiscences, and selections from his diaries and letters* 2 vol. (ed. Sir F. Pollock, 1875; new ed., 1876); *The Diaries of William Charles Macready* 2 vol. (ed. W. Toynbee, 1912); *see* also W. Archer, *William Charles Macready* (1890); Sir T. Martin, *Monographs: Garrick, Macready,* etc. (1906).

MACROBIUS, AMBROSIUS THEODOSIUS, Roman grammarian and philosopher, flourished during the reigns of Honorius and Arcadius (395–423). He himself states that he was not a Roman, but there is no certain evidence about his descent. He is generally supposed to have been praetorian praefect in Spain (399), proconsul of Africa (410), and lord chamberlain (442). But the tenure of high office at that date was limited to Christians, and there is no evidence in the writings of Macrobius that he was a Christian. The identification is thus doubtful.

The most important of his works is the *Saturnalia,* containing an account of the discussions held at the house of Vettius Praetextatus (*c.* 325–385) during the Saturnalia. It was written by the author for the benefit of his son Eustathius, and contains a great variety of curious historical, mythological, critical and grammatical disquisitions. There is but little attempt to give any dramatic character to the dialogue; in each book some one of the personages takes the leading part, and the remarks of the others serve only as occasions for calling forth fresh displays of erudition. The first book contains a history and discussion of the Roman calendar, and an attempt to derive all forms of worship from that of the sun. Most of the second book, which begins with a collection of *bons mots,* is lost. The next four books are devoted to Virgil, and the seventh book consists largely of the discussion of various physiological questions. The work has little original merit and its value lies in the quotations from earlier writers; the main authorities are Gellius, Seneca the philosopher, Plutarch (*Quaestiones conviviales*), Athenaeus and the commentaries of Servius (excluded by some) and others on Virgil. We have also two books of a commentary on the *Somnium Scipionis* narrated by Cicero in his *De republica.* The moral elevation of the fragment of Cicero thus preserved to us gave the work a popularity in the middle ages to which its own merits have little claim. Of a third work, *De differentiis et societatibus graeci latinique verbi,* we only possess an abstract.

See editions by L. von Jan (1848–52, with bibliography of previous editions and commentary) and F. Eyssenhardt (1893, Teubner text); on the sources of the *Saturnalia see* H. Linke (1880) and G. Wissowa (1880). The grammatical treatise will be found in Jan's edition and H. Keil's *Grammatici latini,* v.; *see* also G. F. Schömann, *Commentatio macrobiana* (1871) and T. Whittaker, *Macrobius* (Cambridge, 1923).

MACROOM, a town of co. Cork, Eire, on the River Sullane, $24\frac{1}{2}$ mi. W. of Cork. Pop. (1936) 2,382. Macroom possesses a modernized castle, founded either by King John or by Norman invaders. Trade is in corn, leather-work and dairy produce. The town is a centre for salmon and trout fishing.

MACTARIS, 22 m. S.E. of Le Sers, which is 103 m. S.W. of Tunis by rail, an ancient town of North Africa, in which the influence of Punic civilization lasted until A.D. 200, when it became a Roman colony. It has a fine arch of triumph of Trajan (A.D. 116), another triumphal arch; a temple of Apollo and Diana; an aqueduct, of which 12 arches are still standing, and (perhaps) the thermae which it supplied, and the remains of two mausolea.

MacVEAGH, WAYNE (1833–1917), American lawyer and diplomat, was born near Phoenixville, Chester county (Pa.) on April 19, 1833. He graduated at Yale in 1853, was admitted to the bar in 1856, and was district attorney of Chester county in 1859–64. He held commands in militia forces raised to meet threatened Confederate invasions of Pennsylvania (1862–63). He became a leader in the Republican party, and was a prominent opponent of his father-in-law, Simon Cameron, in the fight within the party in 1871. MacVeagh was minister to Turkey in 1870–71; was a member of the State constitutional convention of 1872–73; was chairman of the "MacVeagh Commission," sent in 1877 by President Hayes to Louisiana, which secured the settlement of the contest between the two existing state governments and thus made possible the withdrawal of Federal troops from the state; and was attorney-general of the United States in 1881 under President Garfield, but resigned immediately after Garfield's death. In 1892 he supported Grover Cleveland, the Democratic nominee for the presidency, and from 1893 to 1897 was ambassador to Italy. He returned to the Republican party in 1896. In 1903 he was chief counsel of the United States before The Hague tribunal in the case of Germany, Great Britain and Italy against Venezuela. He died at Washington, Jan. 11, 1917.

MACWHIRTER, JOHN (1839–1911), British landscape painter, was born near Edinburgh on March 27, 1839. He was elected member of the Royal Scottish Academy in 1867, A.R.A. in 1879 and R.A. in 1893. His "June on the Austrian Tyrol" was bought in 1892 out of the Chantrey bequest. He died in London on Jan. 28, 1911.

MADÁCH, IMRE (1823–1864), Hungarian dramatist, was born at Alsó-Sztregova. He took part in the great revolution of 1848–49 and was imprisoned; on his return to his small estate in the county of Nógrád, he found that his family life had meanwhile been wrecked. This increased his natural tendency to melancholy, and he withdrew from public life till 1861, devoting his time mainly to the composition of his chief work, *Az ember tragoediája* ("The Tragedy of Man"), which begins with the Garden of Eden and ends with an ice-bound earth. In this drama of the life and the downfall of the human race, Adam and Eve and Lucifer maintain the continuity of the piece. John Arany, then at the height of his fame as a poet, at once recognized the great merits of that peculiar drama, and Madách enjoyed a short spell of fame before his untimely death of heart-disease in 1864. The diction of the drama is elevated and pure, and although not meant for the stage, it has proved effective when performed.

See M. Polagyi, *Madách und seine Werke* (1900); G. Bocnovich, *Madách, seine Leben und Werke* (1914). *See* also articles by Charles Szász (1862), Augustus Greguss (1872), B. Alexander (1871), M. Palágyi (1890), and others.

MADAGASCAR, an island in the Indian ocean, after Greenland, New Guinea, and Borneo, the largest island in the world, about 400 km. distant, on an average, from the south-east coast of Africa, from which it is separated by the Mozambique channel. Since 1896 Madagascar has been a French colony. It is 995 m. in length from north to south, and about 250 m. in average breadth, although, near the centre, it is nearly 360 m. across; its area is 228,589 square miles. It lies mainly between 44° and 50° E. Its northernmost point, Cape Ambro, in 12° S., inclines 16° to the E. from the longitude of Cape St. Mary, the southernmost point, in 25° 35′ S., so that the main axis of the island runs from north-north-east to south-south-west. There is a central plateau, roughly quadrilateral in shape, from 3,000 to 5,000 ft. in altitude, around which are extensive plains at a much less elevation above the sea, and most developed on the western and north-east sides. But this lower region is broken up by masses of hills, with several elevated plateaux, especially in the south-west and south.

Geology.—Madagascar was probably joined to Africa, possibly until Triassic times, thus forming part of the Gondwana continent, but the splitting off is very ancient, and bordering islands, such as the Seychelles, etc., allow of the conclusion that the island belonged to a continent called by the geologists Lemuria, from the lemurs which still inhabit the island, and stretching as far as India. The sinking which brought about the disappearance of this continent gave rise to violent volcanic eruptions, which explain the abundance of basalts in the Amber mountains and in the Ankàratra mountains, 2,000 sq.m. of which are lava covered. These ancient volcanoes are found along a line, following a line of fracture, in the east centre of the island, but they are present also in the western side. Itàsy is a more recent Tertiary volcano. Thermal springs, "Ranu-mafana" (warm water), such as those of Antsirabé are numerous, and slight earthquakes are frequent.

The subsoil of the island is formed of crystalline schists and of gneiss and associated rocks, metamorphic and other; granites, porphyries, etc. Iron is very abundant and is used for native industry, as is gold, which is found throughout the zone of crystalline rocks, especially in the eastern part of the island. Other metals exist in small quantities, such as graphites and numerous precious stones, etc.

Two-thirds of the surface soil of the island is made up of laterites, which cover the high plateaux; compact and dry, they are not very fertile. The western part of the island is formed of stratified sedimentary rocks. The plateaux of Antankara are formed of limestones, sandstones and clays of Jurassic to Tertiary origin. The Jurassic limestones form, in places, karst areas.

The lake alluvium of the depressions and the alluvium of the coastal plains are very fertile, and an arborescent vegetation grows on all the Tertiary sedimentary outcrops.

Palaeontology.—Bones of 12 species of struthious birds have been found in a sub-fossil state. They belonged to two genera, *Aepyornis* and *Mullerornis,* which varied in size from that of a bustard to birds much exceeding an ostrich, and rivalling the recently extinct moa of New Zealand, the largest species being about 10 ft. in height. One species of these great wingless birds laid an egg which is the largest known, being 12½ in. by 9½ inches. Associated with these remains there have been found those of many other birds, some of these being much larger than any now inhabiting Madagascar. In the same beds remains of two or three species of hippopotamus have been found, about two-thirds the size of the living South African species; also the bones and carapace, etc., of gigantic tortoises, and the bones of crocodile, now extinct on the coast and rivers, but still living in the two chief lakes; also the remains of a river-hog, of a species of swine and of a slender-legged form of zebu-ox. Near the south-west coast the skull of a large lemuroid animal was discovered in 1893, much longer than that of any living lemur, the animal being probably three times the size of any previously known Madagascar lemuroid. Later still, the bones of two other lemuroids have been discovered, one of them indicating an animal much larger than a man. Many of these birds and animals were probably contemporaneous with the earliest human inhabitants of Madagascar. The remains of two species of Edentata have been found, as well as those of several species of small Rodents, also of a Carnivore (*Cryptoprocta*), a larger variety of the species still living in the island.

In deposits of the Jurassic the bones of some enormous terrestrial lizards have been brought to light, belonging to Sauropodous dinosaurs of the genera *Bothriospondylus* and *Titanosaurus,* and to a Theropod of the genus *Megalosaurus.* In the beds of the Lower Oolite portions of the skull of a reptile resembling the gavial of the Ganges had been previously discovered, from which a new genus called *Steneosaurus* has been founded. Since the French occupation (1895) considerable additions have been made to our knowledge of the fossil fauna of Madagascar, from researches made both on the west and south-west coasts (at Bèlo and Ambòlisatrana), and in the interior (at Antsìrabè), especially in the rich deposits near Tsàrazàza (Ampàsambazimba), to the north-west of Lake Itàsy. From these various localities the sub-fossil remains of 13 or 14 extinct species of lemuroid animals have been obtained, and have been classified under five new genera: viz., *Megaladapis* (3 sp.), *Palaeopropithecus* (3 sp.), *Archaeolemur* (2 sp.), *Bradylemur* (1 sp.) and *Hadropithecus* (1 sp.), together with three new species of lemur. Of these, the *Archaeolemurs* seem to have combined the characteristics of lemuroid animals with those of the monkeys, while *Hadropithecus* is pronounced to be the nearest known link with them. About 280 species of Madagascar invertebrate fossils are known, including Molluscs, Foraminifera, Echinoderms, etc.

Physical Features.—Madagascar has few indentations, considering its great extent of shore-line. The east coast is almost a straight line, with dunes, lagoons and alluvial plains; Tamatave, the chief port on this side of the island, being only protected by coral reefs. The only indentations are the Bays of Antongil, of Port Louquez, and, at almost the extreme northern point of the island, Diégo-Suarez bay, one of the finest harbours in the world. The north-western side of Madagascar, on which the mountains often reach the sea, is broken up by a number of inlets, some of them land-locked and of considerable size. South of Cape St. Andrew, the north-west angle of the island, the low, flat coastline is unbroken until the estuary of the river Onilàhy, or St. Augustine bay, is reached. The south coast, though higher, has neither bays nor capes.

The largest coastal islands are Ste. Marie, near the eastern coast, a narrow island about 35 m. long, and Nossi-bé (*q.v.*), opposite Ampasindàva bay on the north-west coast. Except the Minnow group, north of Nossi-bé, the rest are merely rocky islets, chiefly of coral.

On the east the plains vary from 10 to 50 m. in breadth, but on the west they exceed, in some localities, 100 miles. From these coast-plains the ground rises by successive ranges of hills to the high interior plateau. This elevated region, the edge of which is formed on all sides by cliffs several hundreds of metres in height, is broken in all directions by mountains, from which the crystalline rocks show most frequently as huge bosses, and in certain regions present very varied and picturesque outlines. The highest mountain mass, east-centrally situated, is the ancient extinct volcano, Ankàratra, three of the highest points varying in elevation from 7,284 to 8,635 ft. above the sea, and from 4,000 to 5,000 ft. above the general level of the surrounding country. The loftiest of these is named Tsi-àfa-jàvona, *i.e.,* "That which the mists cannot climb." The highest point in the island is Ambòro, about 9,490 ft., in the northern province of Antankara. The other massifs are, on the north the Tsaratànana, on the south-east that of Iratsy and Horembé, rugged and bare, on the south the Vohimainty, dominated by the volcano Antandroy, etc. One of the finest of the Madagascar mountains is an isolated volcanic mass near the northern point of the island called Ambòhitra. The east slope of Madagascar is the edge of a fault, and slopes steeply to the Indian ocean, heights of more than 1,500 metres fringing depths of 4,000 to 5,000 metres. The western side, on the other hand, slopes gradually towards the Mozambique channel, the depth of which is more than 3,000 metres. The plateau is dissected by transverse valleys, which have served as migration routes. Between the mountain heights stretch fertile plains of lake alluvium, such as the Imèrina and the Plain of Bétsiléo, the rice-fields of which have given rise to towns like Antanànarìvo. Longitudinal valleys like those of the Ankay and of Lake Alàotra are equally fertile.

There are no arid districts, except in the extreme south-west and towards the southern point of the island. The general surface of the interior highland consists of bare rolling moor-like country, with a great amount of red, clay-like soil, while the valleys have a rich humus of bluish-black alluvium.

The chief rivers flow to the west and north-west sides of the island. The eastern streams are all less in size, except the Mangòro, in valley of Ankay, which flows parallel with the coast. They become navigable at best only when they have left the plateau, from which they often fall in cataracts, as in the case of the Ikòpa; and all are more or less closed at their outlets by sand-bars. The well-watered eastern slope is rich in short torrents, with many waterfalls. The most important are the Mangòro and the Mànanàra, formed by three large rivers from the plateau. On the more gradual western slope the rivers, although broken by rapids at their descent from the plateau, are longer and more important, but they often end in deltas. The largest river is the Bètsibòka, which receives on its left the Ikòpa, on which stands Antanànarìvo. The Bètsibòka is navigable for 70 km., and in the rainy season steamers go up the Ikòpa as far as Mevatanana. To the north, the Sofia has a fertile, well-populated valley, to the south the Tsiribihina, the Onitahy and the Mangòky are considerable streams.

On the eastern coast, the mouths of the rivers form lagoons, bordered by a series of spits, and often of considerable extent. By cutting about 30 m. of canal to connect them, a continuous waterway could be formed for 270 m. along the coast. This has already been done for about 55 m. between Ivòndrona and Andòvorànto, a service of small steamers forming part of the communication between the coast and the capital. Besides these lagoons there are some very extensive lakes in a recent geological epoch. Of the largest of these, the Alàotra lake, in the Antsihànaka plain, is the relic; it is about 25 m. long. Next comes Kinkòny, near Maròambitsy bay (north-west coast), about 16 m. long, and then Itàsy, in western Imèrina, about half as large. There is also a salt lake, Tsimànampetsòtsa (south-west coast), about as large as Alàotra, and numerous crater lakes, and lakes behind a lava-dam.

Climate.—Madagascar has, on the whole, a tropical climate, but climatic differences result from differences of altitude and slope, the contrasts being in a longitudinal sense, between the west and east coasts. There are two clearly-marked seasons, one warm and rainy, from November to April, the other dry and cool, from April to November. The influence of the south-east trade winds is felt over the whole island, but, whilst it brings rain in a fairly constant manner to the east coast (3 metres to 3 metres 50, and 164 rainy days), on the west the wet and the dry seasons are very distinct, the type of climate being governed by the alternation between the trade-wind and the monsoon. (Average rainfall at Majunga 1 metre 50 from October to April). Cyclones are fairly frequent on the east coast from January to March. Temperature for the whole island varies between $55\frac{1}{2}°$ F and 95°. (Tamatave, February 80°, July 68°; Majunga 70° and $89\frac{1}{2}°$.) The south and south-west coasts have a sub-desertic climate, with an annual rainfall of 350 millimetres. The east coast is particularly unhealthy, because of its marshes. The west coast has great variations of temperature, but the centre is suitable to Europeans, because of its mild and healthy climate.

Fauna.—The plateau is too bare to have much animal life, but the forests and coastal plains are well stocked. Many species have a limited range, and there are no large mammalia, but the island is headquarters of *Lemuroidea*, no fewer than 39 species of which are found in its forests and wooded plains. Some of these creatures are highly specialized, while the curious aye-aye (*Daubentonia madagascariensis*), has a genus and family by itself. Other peculiar animals are 23 species of the *Centetidae*, a family of the Insectivora almost confined to Madagascar. There are several small civets (*Viverridae*); the largest, also forming a genus and family by itself, is *Cryptoprocta ferox*, 3 ft. long, but like an enormous weasel. The mammals show Asiatic rather than African affinities. The island contains 25 species of bats, mostly of African, but some of Indian, affinities. African humped cattle were introduced several hundred years ago, and now exist in large herds all over the country. The fat-tailed sheep, goats and swine have also been naturalized, as well as all kinds of domestic poultry.

The avi-fauna, although wanting the largest birds as well as the most brilliantly-coloured, comprises 260 species, half of which are endemic; many belong to peculiar genera, and some are so isolated that new families have had to be formed for their reception.

The island contains two or three small species of boa; crocodiles abound in the rivers and lakes; and numerous species of lizard, chameleon and tree-frog inhabit the woods. Madagascar may be considered as one of the headquarters of the *Chamaeleontidae*, with 25 of the 50 known species, some with spines and horns. There are several peculiar tortoises, but the gigantic species are now found alive only on the little island of Aldabra, to the north. The insect life comprises many brilliantly-coloured beetles, butterflies (about 800 species of which are known), moths, locusts, spiders and flies, and also noxious spiders, with scorpions and centipedes. The river fishes belong chiefly to the family *Chromididae;* many of them are of brilliant and bizarre appearance, with strongly contrasted colours in bands and spots.

As a whole, the Madagascar fauna is marked by a strong individuality, which would appear to be the result of long isolation from the other zoological "regions." The fauna of Madagascar corroborates, according to its palaeontological evidence, the hypotheses put forward by the geologists.

Flora.—A belt of forest follows the coast-line, and is denser on the east than on the west, where it is often reduced to scattered clumps of trees on savannah-like plains; while in the south-west, where the rainfall is very scanty, the vegetation is largely of fleshy-leaved and spiny plants—aloes and cacti (the latter introduced), with several species of Euphorbia, as well as lianas, one of which (*Intisy*) yields india-rubber. The abundant epiphytes, the tree-mosses, the filmy ferns and the viviparous character of many of the ferns, show clearly how abundant the rainfall is in the east. Forest occupies only 13·5% of the total surface, or about 8 million hectares. This contains many hard-wooded and valuable timber trees, including species of *Weinmannia* (*Lalòna*), *Elaeocarpus* (*Voànana*), *Dalbergia* (*Vòambòana*), *Nuxia* (*Vàlanìrana*), *Podocarpus*, a pine, the sole species in the island (*Hètatra*), *Tambourissa* (*Ambòra*), *Neobaronia* (*Hàrahàra*), *Ocotea* (*Varòngy*) and probably ebony, *Diospyros* sp., etc. The following trees are characteristic of Madagascar vegetation, some of them being endemic, and others very prominent features in the landscape; the traveller's tree (*Urania speciosa*), with its enormous fan at the top of a tall trunk, and affording a supply of pure cool water, every part of the tree being of some service in building; the Raphia (*rofia*) palm (*Sagus ruffia*); the tall fir-like *Casuarina equisetifolia* or beefwood tree, very prominent on the eastern coast, as well as several species of screw-pine (*Pandanus*); the Madagascar spice (*Ravintsara madagascariensis*), a large forest tree, with fragrant fruit, leaves and bark; a beautiful-leaved species of *Calophyllum*; and the Tangèna (*Tanghinia venenifiua*), formerly employed as a poison ordeal. On the lagoons and lower reaches of the rivers the Viha (*Typhonodorum lindleyanum*), an arum endemic to Madagascar, grows in great profusion to a height of 12 or 13 ft., and has a white spathe more than a foot in length; and on the western coast dense thickets of mangrove line the creeks and rivers. In the interior rivers is found the curious and beautiful lace-leaf plant (*Ouvirandra fenestralis*), with an edible tuberous root. On the western side of the island, the baobab, the tamarind, the ròtra (*Eugenia* sp.), the rofia palm, and several species of fan-palm (*Hyphaene*) and of

Ficus are prominent; and the mango (introduced) grows to a large tree. In the generally bare interior highlands, large trees, species of *Ficus,* often mark the position of the old towns; and some of these, as Ambòhimànga, Vòhilèna, etc., are surrounded by remnants of the original forests, which formerly covered large portions of the interior. The most prominent tree in the central province is now the Cape-lilac (*Melia azederach*), introduced about 1825; and, since the French conquest, several species of eucalyptus have been planted in vast numbers by the road sides. In the eastern forests, palms, bamboos, lianas and tree-ferns, as well as species of *Dracaena,* are found.

There are many fine flowering trees, such as *Poinciana regia,* presenting a mass of scarlet flowers; *Colvillia racemosa,* with yellow flowers; *Astrapaea Wallichii,* striking attention from its abundant flowers; and species of *Cryptostegia,* a purple-flowered creeper, and *Strongylodon,* another creeper with cream-coloured blossoms. On the east coast two orchids, species of *Angraecum,* with large white waxy flowers, attract the attention of every traveller during June and July by their abundance and beauty. Some 320 species of fern have been collected, and there are large numbers of spiny and prickly plants, as well as numerous grasses, reeds and rushes, many of them of great service in the native manufactures of mats, hats, baskets, etc.

To sum up, one may group these different species into four types of plant associations: (1) The *prairie,* the most widespread, covering most of the central plateau; (2) the *savoka,* formed where the forest is replaced by rice-cultivation and a kind of brushwood, on soil which may serve to grow tropical plants, coffee, cocoa, etc.; (3) the *forest,* discussed above; (4) the *scrub-vegetation* of the scouts, analogous to the South African bush. The number of endemic genera now known is 148. Of the 3,178 species of plants whose localities have been determined, 35% are peculiar to the eastern region, 27·5% to the central, and 22% to the western. One natural order, Chlaenaceae, is strictly confined to Madagascar. A small proportion of the species are Asian, but not African; and the flora of the mountains corresponds closely with that of the great ranges of the tropical zone of Africa. The general plan of the flora follows thoroughly the same lines as that of the tropical regions of the Old World.

Among the food-giving plants are rice—the staff of life, to the majority of the Malagasy—in many varieties, maize, millet, manioc, yams, sweet potatoes, arrowroot, which is largely used by the western tribes—as well as numerous vegetables, many of them of foreign introduction. The majority of the fruits have been introduced.

Inhabitants.—The population (1936) was 3,797,796, including 25,255 French and 14,343 foreigners. The average density is 16.6 persons per square mile; the centre and the east are the most populous regions. The natives, collectively known as Malagasy, are divided into a considerable number of tribes, each having its distinct customs. The majority of the inhabitants are probably derived, the lighter portion of them from the Malayo-Polynesian stock, and the darker races from the Melanesian, who reached the island with the aid of the equatorial winds and currents. The population shares a number of characters with the peoples of the Indian and Pacific archipelagoes, physical appearance, mental habits, customs, and, above all, language. Their traditions also point in the same direction. There is an Arab element, introduced especially in the 9th century, on both the north-west and south-east coasts; and it appears that most of the families of the ruling classes in those parts of the island are descended from Arabs, who married native women. Numerous Africans were brought into Madagascar as slaves; they are the Makao of the west and the Masombiky of the interior. The Hòva became the dominant tribe from the beginning of the 19th century; they appear to be the latest immigrants, and are the lightest in colour; they are of Mongoloid type and also the most civilized of all the tribes of the island.

Unity of language is the true link uniting all the Malagasy, in spite of marked differences of dialect. Van der Tuuk, Marre de Marin and W. E. Cousins have shown conclusively the close relationships between the language of the Malagasy and those of the Malayo-Polynesian regions; similar connections exist, especially in grammatical construction, between the Malagasy and the Melanesian languages. English missionaries were the first to establish a grammar for the Malagasy language, there being no written symbols. Malagasy, nevertheless, is very full in many of its verbal and other forms, while it also exhibits some curious deficiencies. It is an agglutinative language, very soft and musical, full of vowels and liquids, and free from all harsh gutturals. Native oratory abounds in figures, metaphors and parables; and a great many folk-tales, songs, legends and proverbs give ample evidence of mental ability and imaginative powers.

Native society in Imèrina among the Hòva was formerly divided into three great classes: the Andriana, or nobles; the Hòva, freemen or commoners; and the Andevo, or slaves; but these last became free by a proclamation issued in 1896. The Andriana are, strictly speaking, royal clans, being descendants of Malayan chiefs. They form a very select caste, possessing many privileges, such as special terms of salutation, the use of the smaller scarlet umbrella (the larger one was the mark of royal rank), the right to build a particular kind of tomb, etc. The Hòva, or commoners, form the mass of the population of Imèrina. This is a special and restricted sense of the word Hòva, which, in its widest sense, is a tribal name, including all ranks of people in Imèrina. They are composed of a large number of tribes, who usually intermarry strictly among themselves, as indeed do families, so that property and land may be kept together. The third great division was the slave population, which since 1896 has become merged in the mass of the people. The Mozambiques, or African slaves, who had been brought from the African coast by Arab dhows, were in 1877 formally set free by an agreement with the British Government. The Hòva have stronger social institutions than the other Malagasy tribes, organized States more strongly administered by hereditary chiefs, who impose their authority upon the whole country. The Hòva are temperate, hard-working, vigorously disciplined, with a profound love for their country.

Royalty and chieftainship in Madagascar had many peculiar customs. It had a semi-sacred character; the chief was, in heathen tribes, while living, the high priest for his people, and after death, was worshipped as a god; in its modern development among the Hòva sovereigns it gathered round it much state and ceremony. There were curious examples of the taboo, particularly seen in everything having to do with the burial of a monarch, and the foregoing description of native society is applicable, with local modifications, to most of the Malagasy tribes. But on the island becoming a French colony in 1896, royalty was formally abolished.

The chief employment of the Malagasy is agriculture. In the cultivation of rice they show very great ingenuity, the *kètsa* grounds, where the rice is sown before transplanting, being formed either on the margins of the streams or in the hollows of the hills, in a series of terraces, to which water is often conducted from a considerable distance. In this agricultural engineering no people surpass the Bétsiléo. No plough is used, all work being done by a long-handled spade; and oxen are only employed to tread out the soft mud preparatory to transplanting. The manioc root is also largely consumed, together with several other roots and vegetables; but little animal foods (save fish and freshwater *Crustacea*) is taken by the mass of the people, except at festival times. Large herds of fine humped cattle are found almost all over the island.

The central and eastern peoples have considerable manual dexterity. The women spin and weave, and manufacture a variety of strong and durable cloths of silk, cotton and hemp, and of ròfia palm, aloe and banana fibre, of elegant patterns, and often with much taste in colour. They also make, from straw and papyrus peel, strong and beautiful mats and baskets, some of much fineness and delicacy, and also hats resembling those of Panama. The people of the south and south-east make large use of soft rush matting for covering, and they also prepare a rough cloth of bark. Their non-employment of skins for clothing is a marked distinction between the Malagasy and the South African races, and their use of vegetable fibres an equally strong link between them and the Polynesian peoples. Although the clothing may, in general, vary a great deal, it is usually very scanty, generally. The men wear a loin-cloth or *salàka,* and the women a *kitàmby* or apron folded round the body, from waist to heel, to which a jacket or dress is usually added; both sexes use over these the *làmba,* a large square of cloth folded round the body something like the Roman toga, and which is the characteristic native dress. The Malagasy are skilful in metal-working; they manufacture silver chains of great fineness, and filigree ornaments both of gold and silver. Their iron-work is of excellent quality, and in copper and brass they can produce copies of anything made by Europeans. They display considerable inventive power, and they are exceedingly quick to adopt new ideas from Europeans.

There is a considerable variety in the houses of the different Malagasy tribes. In the interior, the houses generally well kept, are made of dried clay and covered with a roof of branches and thatch. In the houses of the forest dwellers the walls are of bamboo and the houses built on piles; among the coastal tribes the bamboo structure predominates, and in the south this often forms a simple hut into which one has to enter by crawling. Among the Hòva and Bétsiléo the old villages were always built, for security, on the summits of lofty hills, around which were dug several deep fosses, one within the other.

Until lately, polygamy has been common among all the Malagasy tribes. The position of women is much higher in Madagascar than in most heathen countries; and, the fact that from 1828 to 1897 there were (with a few months' exception) only female sovereigns, helped to give women considerable influence in native society. The men and women are on equal footing in sex conventions. The old laws among the Hòva were very barbarous in their punishments, and death in various cruel forms was inflicted for very trifling offences. Drunkenness is very prevalent in many parts of the island; and it can hardly be said of many of the Malagasy that they are very industrious. But they are courageous and loyal to their chiefs and tribe, and for short periods are capable of much strenuous exertion. They are affectionate and firm in their friendships, kind to their children and their aged and infirm relatives, very respectful to old age, most courteous and polite and very hospitable to strangers.

The Malagasy have never had any organized religious system or forms of worship; there are no temples, images or stated seasons of devotion, nor is there a priesthood, properly so-called. Yet they have never been without some distinct recognition of a supreme being, whom they call *Andriamànitra* "The Fragrant One," and *Zànahàry,* "The Creator." Animism, with the double cult of ancestor worship and worship of the spirits of nature, prevails. Among the Hòva, there is also a firm belief in sorcery, in divination, and in trial by ordeal. The chief of these was the celebrated tangèna poison ordeal, by which, until its prohibition by an article in the Anglo-Malagasy treaty of 1865, thousands of persons perished every year. Sacrifices of fowls and sheep are made, at many places, at sacred stones and altars, both in thanksgiving at times of harvest, etc., and as propitiatory offerings. In some of the southern districts it is said that human sacrifices were occasionally offered. The chief festival among the Hòva, and almost confined to them, was that of the New Year, at which time a kind of sacrificial killing of oxen took place, and a ceremonial bathing, from which the festival took its name of Fàndròana (the Bath). This festival is now merged in the French national fête of July 14. Another great festival was at circumcision times. This rite was observed by royal command at intervals of a few years. Since 1868 circumcision has been observed by each family at any time convenient to itself. It is practised by all Malagasy. Funerals were also times of much feasting, and, at the death of people of rank and wealth, numbers of bullocks were and still are killed.

Economic Conditions.—The natives of Madagascar formerly grew only foodstuffs (rice, etc.), but introduced plants include, in the eastern coastal regions, vanilla, cocoa, coffee, spices, the cocoa-tree, rubber, etc., and in the west, sugar cane, cotton, Kapok; the central regions grow the mulberry, fruit trees, vines, tobacco, etc. Cattle-rearing also is important, 7,294,000 cattle, 450,000 pigs, 220,000 sheep and 57,000 goats being reared; this has given rise to development of the dairy industry. Europeans have also undertaken the rearing of ostriches. Development of the natural resources of the island, if somewhat slow, was real. Cultivation is mainly by Malagasy; the number of French settlers on the island is small. In 1924 the white colonists were cultivating 150,000 hectares; natives 1,110,000 hectares. Industries undertaken or developed by Europeans are silk and cotton-weaving and raffia-fibre preparation. Sugar, rice and other factories have been established. Gold mining has been carried on since 1897, but experts, sent from the Transvaal, came to the conclusion that it was not one of the rich goldfields of the world. The mines afford, nevertheless, lucrative employment for some thousands of persons, and the export of gold was 3,365,114 fr. in 1924. Although, as the result of a protective tariff, three-fourths of the trade is with France, about one-seventh is with Great Britain, and much British capital is invested in the island. A feature of the commerce is that exports exceed imports both in quantity and value. The chief imports are cotton goods, wines, machinery, metals, cement, petrol, and flour; nine tenths from France and its dependencies. The figures show the external trade at 646,605,197 fr. in 1924. Imports amounted to 259,033,753 fr. and exports to 387,571,444 francs. The chief exports are raw hides, salt and preserved meat, rice, dried vegetables, tapioca, coffee, etc., as well as graphite and precious stones.

The trade (in francs) of Madagascar has been as follows in five years:—

	1922	1923	1924	1925	1926
Imports	173,831,641	209,818,297	259,033,753	491,854,433	592,611,944
Exports	132,472,491	191,840,781	387,571,444	443,922,818	535,856,989

The chief articles of import and export in 1925 and 1926 were the following:—

Imports	1925	1926	Exports	1925	1926
	Metric tons	Metric tons		Metric tons	Metric tons
Cottons	6,370	4,553	Graphite	14,979	11,453
Wines (gals.)	104,192	76,890	Manioc	42,557	40,746
Machinery	2,568	1,785	Tanning bark	7,674	6,113
Metals	7,518	6,599	Rice	42,327	22,291
Cement	11,930	7,782	Hides	9,620	8,065
Petrol	3,363	4,700	Rafia fibre	6,276	7,622
Flour	2,288	2,259	Mica	267	296

Means of communication were greatly improved by harbour works and the building of roads and railways. By 1925 there were 1,500 m. of first-class roads and 540 m. of railway. The chief railway (240 m. long), joining the port of Tamatave with Antananarivo, was opened in 1918. From this railway a branch line goes northward, and from Antananarivo a railway (107 m. long), opened in 1923, runs south to Antsirabé. There is a road but no railway to Majunga, the chief port on the west coast. A railway is to be built from Fianàrantsòa to the east coast, and motor services run from Antanànarivo and Diégo-Suarez. The equipment of the ports is still primitive. Tonnage entered and cleared (1925) was 4,293,292. Canals have been made and irrigation works carried out.

Revenue is derived mainly from customs and a poll tax; expenditure was largely on the civil service. In 1924 the budget was balanced at 100,000,000 fr.; in effect, taxation and receipts had not increased. It was then realized that if economic progress was not to be checked, a revision of taxation was essential.

Provinces and Towns.—The island may be divided into districts or provinces, which, in the main, indicate tribal divisions, among which may be distinguished, taking them in three main divisions, from north to south: (1) *Eastern:* Antankàrana, occupying the northern peninsula; the country of the Bétsimisàraka, who inhabit a long extent of the coast plains, about 500 m. in length; parallel with this for about a third of it, and between the two lines of forest, is the Bézànozàno country. South again are the districts of the Taimbahòaka, the Taimòro, the Taifàsy and the Taisàka; and at the south-eastern corner are the Tanòsy. (2) *Central:* the districts of Tsimihèty and the Sihànaka; Imèrina, the Hòva province; the Bétsiléo; the Tanàla or foresters; the Bàra; and the emigrant Tanòsy. (3) *Western:* the people from almost the northern to the southern extremities of the island are known as Sàkalàva, but consist of a number of distinct tribes. South of these last are the Màhafàly, with the Tandròy at the extreme south. There are numerous subdivisions of most of the tribes.

The capital, Antanànarìvo (pop. [1937] 124,611), in the highlands of Imèrina, and Tamatàve (pop. 21,456) on the east coast and the chief seaport, are separately described. Majunga (properly Mojangà, pop. 34,683) on the north-west coast, just north of 16° S., and Diégo-Suarez (15,012), are important ports for foreign trade, the latter being also a fortified naval and military station. Other ports and towns are Màhanòro, Mànanjàry (south-east coast, pop. 11,974), Tuléar (south-west coast, pop. 12,004) and Fianàrantsòa (pop. 15,219), the chief towns of the Bétsiléo. There are very few places besides these with as many as 2,000 people.

Government.—The colony is not represented in the French Chambers, nor has it self-government. At the head of the administration is a governor-general, who is assisted by three councils and by the financial delegations, composed of 24 Europeans and 24 natives, who are consulted in the matter of the budget and of public works (Decree of May 7, 1924). In several towns there are *chambres consultatives,* composed of local merchants and planters. The French Government associates itself closely with the natives in the administration of their country. The island is divided into *circles,* placed under military officers, and *provinces,* presided over by a civilian. As far as possible, in local affairs, each of the native races is granted autonomy, the dominion of the Hòva over the other tribes being abolished. Each province has its native governor and minor officials, the governor being generally selected by popular vote. Each village has an organization (the *Fòkon òlona*) resembling that of a commune; at its head is a chief or *mpiadìdy,* who serves for three years.

For Europeans, and in suits between Europeans and natives, the French judicial code is applicable; suits between natives are tried by native tribunals (established 1898) presided over by a European, assisted by two native assessors. These tribunals judge according to native law and usages, except when such customs (*e.g.,* polygamy and slavery) have been expressly abolished. Arbitration councils are available everywhere for the settlement of disputes between native workmen and their employers. Besides teaching establishments based on the French system, there is a well-developed system in three stages for natives; nearly 900 schools are attended by 100,000 pupils.

Bibliography.—The standard work on the island is the *Histoire physique, naturelle et politique de Madagascar* (1875, etc.), in many vols., by Alfred Grandidier (1836–1921), founded on his exploration of Madagascar in 1865–70 and subsequent researches. Besides this great work, Grandidier edited a *Collection des ouvrages anciens concernant Madagascar* (1903, etc.), of which vol. ix. was published in 1920. *See* also James Sibree, *A Naturalist in Madagascar* (1915) and *Fifty Years in Madagascar* (1924); Dandouau, *Géographie de Madagascar* (1922); Julien, *Madagascar et ses dépendances* (1926); Gautier, *Madagascar-Essai de géographie physique;* Perier de la Bathie, *La vegetation malgache;* G. Grandidier, Le Myre de Vilers, Duchesne, Galliéni, *Quarante années de l'histoire de Madagascar, 1880–1920* (1923); Jean Lefranc, "La Prosperité et les Besoins de Madagascar," in *Renseignements Coloniaux* (Dec. 1925); *Guide-Annuaire de Madagascar et Depêndances.* (J. Sib.; M. M. B.)

Native Traditions.—The Malagasy people have contributed not a little to the solution of various ethnographical problems of Oceania. They have preserved from very remote times the forms of important rituals and semi-historical legends in the minds of the priests who have continued through unbroken lines to expound the *mana* mysteries and to impose the tabus. It is, of course, natural that the pure stream of Oceanic tradition should have become somewhat tainted from its close association with the conflicting traditions of the South African mainland and there are traces of Hottentot stories in some Malagasy folklore.

There is one way, however, in which the Malagasy class have been enabled to keep a more rigid record of their traditions, than their Oceanic brothers. They have, or at least certain of them have, for some time used the Arabic script in a peculiarly modified form. In this script but in pure Malagasy speech form, they have preserved their history, many legends and a certain number of ritual songs. This far-flung area of Arabic influence has felt, too, the shaping hand of Arabian civilization, for the written traditions, preserved in Arabic script in the Antaimoro language, are more polished and more neatly turned than those which have come down by purely oral record. A strange paradox, therefore, exists; the purest versions of the common Oceanic records are found side by side with legends bearing a decided African tinge and intermingled with folklore from Bushman and Hottentot sources.

Theories of Migration.—The realization that the Malagasy people are part of the far-flung family of Oceanic speech and tradition (now commonly divided into Polynesian, Melanesian, Indonesian and Micronesian), immediately gave rise to much speculation as to the path by which this division of the family reached its present habitat. Many theories hurriedly enunciated were soon discredited, and evidence drawn from a full consideration of the physical characteristics, language form, ritual practices and migration-stories was used as the basis for research. Even now the field of speculation is not entirely closed. There are still workers in Oceanic studies who are not satisfied with the present state of the theories concerning the true place of the Hòva, Bekimitsara, Sakalave, and the thirty other dialects of Madagascar speech in the Oceanic linguistic family. The full story of the relationships existing between these varied dialects and the languages of the Malay peninsula is to be found in the contributed papers to the *Antananarios Journal* and in the publications of M. Ferrand, for several years Governor-General of the island. *The Journal of the Polynesian Society* (Wellington, N.Z. quarterly) publishes papers concerning the history and languages of the Oceanic peoples. (X.)

HISTORY

From the earliest accounts given of the people of Madagascar by European travellers, as well as from what may be inferred from their present condition, they seem for many centuries to have been divided into a number of tribes, often separated from one another by a wide extent of uninhabited country. Each of these was under its own chief, and was often at war with its neighbours. No one tribe seems to have gained any great ascendancy over the rest until about the middle of the 17th century, when a small but warlike people called Sàkalàva, in the south-west of Madagascar, conquered the western half of the island, as well as some northern and central tribes, and eventually founded two kingdoms which retained their supremacy until the close of the 18th century. About that time the Hòva in the central province of Imèrina began to assert their own position under two warlike and energetic chieftains, Andrianimpòina and his son Radàma; they threw off the Sàkalàva authority, and after several wars obtained a nominal allegiance from them; they also conquered the surrounding tribes, and so made themselves virtual kings of Madagascar. From that time until 1895 Hòva authority was retained over a large part of the central and eastern provinces, but it was only nominal over much of the western side of the island, while in the south-west the people were independent.

Arab Influence.—The connection of the Arabs with the island dates from a remote epoch; and in very early times settlements were formed both on the north-west and south-east coasts. In the south-east the Arabs have become merged in the general mass of the people. It is different, however, in the north-west and west of the island. Here are several large Arab colonies, occupying the ports of Anòrontsànga, Mòjangà, Màrovoày and Mòrondàva, and retaining their distinct nationality. There is also in these districts a Hindu element in the population, for intercourse has also been maintained for some centuries between India and northern Madagascar. In the early days the Arabs had a very powerful influence upon the Malagasy. This is seen in the number of words derived from the Arabic in the native language. Among these are the names of the months and the days of the week, those used in astrology and divination, some forms of salutation, words for dress and bedding, money, musical instruments, books and writings, together with a number of miscellaneous terms.

Early European Intercourse.—Marco Polo has a chapter upon "Madeigascar," but his accounts of it are confused with those of the mainland of Africa. The first European voyager to see the island was a Portuguese named Diogo Diaz, captain of one of the ships of a fleet bound for India. Separated from his companions by a storm near the Cape, he sighted the eastern coast of the island on Aug. 10, 1500. That day being the feast of St. Lawrence, Madagascar was named the "Isle of St. Lawrence," and retained that name on all maps and charts for 100 years. The Portuguese gave names to most of the capes, but made no persistent attempts at colonization. Portuguese missionaries between 1600 and 1619 made strenuous efforts to teach their faith to the tribes on the south-east coast, but there is no record of any converts to reward the zeal and self-denial of the priests. After the Portuguese the Dutch endeavoured, with little success, to form colonies; and in the time of Charles I. proposals were made to form an English "plantation," and for a short time there was a settlement on the south-west coast. In the latter part of the 17th and during most of the 18th century, the French attempted to establish military positions on the east coast. For some time they held the extreme south-east point of the island at Fort Dauphin; but more than once their stations were destroyed and the French were massacred. In 1811 Tamatàve had been occupied by British troops, and the Treaty of Paris of 1814 recognized as British the "French settlements in Madagascar," but, as a matter of fact, France had then no settlements on the mainland, possessing only the island of Ste. Marie on the east coast. The then governor of Mauritius, Sir Robert Farquhar, obtained a cession of Diégo-Suarez bay. But the British claims were not prosecuted by the home Government, and a little later the policy was adopted by Great Britain of supporting the Hòva authority.

Hòva Rule.—The political history of Madagascar as a whole may be said to date from the reign of Radàma I. (1810–1828). He was a man much in advance of his age—shrewd, enterprising and undeterred by difficulty—a kind of Peter the Great of his time. He saw that it was necessary for his people to be educated and civilized if the country was to progress; and making a treaty with the governor of Mauritius to abolish the export of slaves, he received every year in compensation a subsidy of arms, ammunition and uniforms, as well as English training for his troops. He was thus enabled to establish his authority over a large portion of the island. For some years a British agent, Hastie, resided at Radàma's court, and exercised a powerful influence over the king, doing much for the material advance of the country. At the same period (1820) Christian teaching was begun in the capital by the London Missionary Society, and by its missionaries, the language was reduced to a systematic written form, and the art of printing introduced; books were prepared, the Scriptures were translated, numerous schools were formed, and several Christian congregations were gathered together. Useful arts were imported, valuable products were discovered and superstitions were broken.

The bright prospects thus opening up were clouded by the death of Radàma at the age of 36 and the seizure of the royal authority by one of his wives, the princess Rànavàlona. She looked with much suspicion upon the ideas then gaining power among many of her people, and determined to strike a decisive blow at the new teaching. In 1835 the profession of the Christian religion was declared illegal; all worship was to cease, and all religious books were ordered to be given up. By the middle of 1836 all the English missionaries were obliged to leave the island, and for 25 years the most strenuous efforts were made by the queen and her Government to suppress opposition. Of the Christian Malagasy, about 200 suffered death, while many hundreds were punished by fine, degradation, imprisonment and slavery. During the queen's rule there were frequent rebellions, distant provinces were desolated by barbarous wars; for some years all Europeans were excluded, and foreign commerce almost ceased. This last circumstance was partly owing to an ill-managed attack upon Tamatàve in 1846 by a combined British and French force, made to redress the wrongs inflicted upon the foreign traders of that port.

This reign of terror was brought to a close in 1861 by the death of the queen and the accession of her son, Radàma II. The island was reopened to European trade, and missionary efforts were recommenced. A concession he was induced to sign, giving great powers to a French company, as well as the vices and insane follies into which he was led by worthless foreign and native favourites, soon brought both the reign and the life of Radàma II. to an end. He was put to death in his palace (1863) and his wife was placed on the throne. The new sovereign refused to ratify the agreement with the French company, illegally obtained, choosing rather to pay a million francs as compensation. During the five years' reign of Queen Rasohèrina, quiet and steady advances were made in civilization and education, and treaties were concluded with the British, French and United States Governments. Besides the London Missionary Society various other Christian agencies were now at work, including the Jesuits and the Anglicans, the Society of Friends and the Norwegian Lutherans.

At the death of Rasohèrina in 1868, she was succeeded by her cousin, Rànavàlona II. One of the first acts of the new queen was the public recognition of Christianity; and soon afterwards she and her husband, the prime minister, were baptized. This was followed in the succeeding year by the burning of the royal idols and immediately afterwards by the destruction of the idols throughout the central provinces, the people generally putting themselves under Christian instruction.

The Hòva Government, though absolute under such monarchs as Radàma I., bore traces of popular control. New laws were announced at assemblies of the people, whose consent to them was given through the headmen of the different divisions of native society; this custom was no doubt a survival from a time when the popular assent was not a merely formal act. Rànavàlona II., her predecessor and her successor, were successively married to the prime minister, Ràinilaiàrivòny, a man of great ability and sagacity, who, by his position as husband and chief adviser of the sovereign, became virtual ruler of the country. Chiefly owing to his influence, many measures tending to improve the administration were introduced. The Hòva army was estimated at from 30,000 to 40,000 men, several English non-commissioned officers, and later others of higher rank, being engaged to train them in European methods. Revenue was derived from customs duties, first-fruits, fines and confiscation of offenders' property, and a money offering, called *hàsina,* presented on a great variety of occasions both to the sovereign in person and to her representatives; and these were supplemented by "benevolences" (in the mediaeval sense of the word) levied upon the people for occasional State necessities. The Government also claimed the unpaid services of all classes of the community for every kind of public work.

The Hòva Government aspired to have Madagascar recognized as an independent civilized State, and consuls appointed by the British, French and United States Governments were accredited to the Malagasy sovereign. The treaty with Great Britain, concluded in 1865, gave the consuls of that nation jurisdiction over the British subjects in the island. At this period, on the initiative of the 4th earl of Clarendon, then foreign secretary, an understanding was come to between the British and French Governments by which it was agreed that each Power should respect the independence of Madagascar; and the future of the country appeared to be bound up in the general consolidation of the central Hòva authority over the whole island.

Relations with the French.—While Hòva rule would have satisfied British interests in the island, it was otherwise with the French. The tradition of their former settlements in and influence over the island was strong; in 1840 they had taken under their protection the Sàkalàva ruler of the small island of Nossi-bé, off the north-west coast, and in virtue of that act claimed a vague protectorate over the adjacent shores of the mainland. But a treaty, concluded in 1868, while establishing French consular jurisdiction in Madagascar, recognized Rànavàlona II. as queen of Madagascar, and under the Second Empire attempts to establish French political influence were discouraged; a change came under the Third Republic. In 1878 the French consul, Laborde, died, and a dispute arose as to the disposal of his property. The French Government supported the claims of Laborde's heirs, and revived their claim to a protectorate over the Sàkalàva of the north-west coast. A policy of colonial expansion generally, and in Africa in particular, was manifest at this time in France, as in other European countries, and the French claims on the Hòva were pressed with vigour. To settle, if possible, the causes of dispute, two Hòva officers of high rank were sent to France in 1882, but as they were not authorized to cede any territory, their visit accomplished very little. In May 1883 an ultimatum was sent to the Malagasy queen, requiring immediate compliance with the demands of France; and as these were refused by the Hòva Government, Tamatàve was bombarded by a French squadron and then occupied by the marines. After the war had continued in a desultory fashion for many months terms of peace were drawn up. By a treaty signed on Dec. 17, 1885, it was agreed that the foreign relations of Madagascar should be directed by France; that a resident should live at the capital, and that the Bay of Diégo-Suarez, together with surrounding territory, should be ceded to France. The word "protectorate" was carefully excluded from the treaty, although the French intended that this should be its practical issue. It was at the same time agreed that there should be no foreign interference with the internal government of the country, and that the queen should retain her position, with all its honours and dignity. Queen Rànavàlona II. had died at the beginning of the war, on July 13, 1883, and had been succeeded by her niece, Princess Razàfindrahèty, under the title of Rànavàlona III., who maintained the same policy as her predecessor. In 1890 the British Government, in return for concessions in Zanzibar, consented to recognize a French protectorate over Madagascar, but the Malagasy prime minister, Ràinilaiàrivòny, was not disposed to give any advantage to France, and continued to arm and train, with the help of British officers, a large body of native troops. This state of tension and irritation could not last, and at length, towards the close of 1894, the French Government sent an ultimatum to the Malagasy sovereign, demanding such powers as would have made French authority supreme in the island. These demands were refused and war followed. The chief ports were occupied by French troops, and an expeditionary force under Gen. Duchesne was landed on the north-west coast at Mòjangà—commonly, but incorrectly, written Majunga—with the object of breaking the Hòva authority. Owing to the necessity of making a road for the passage of artillery and military stores, many months were spent on the march, and there was considerable loss of life by fever and other disease among the invading troops. But no effectual resistance was made by the Malagasy, and at length, on Sept. 30, 1895, the French forces reached the heights north and east of Antanànarìvo. They bombarded the city, which surrendered in the afternoon, and on the evening of the same day the French entered the capital. The French protectorate now became effective in the central provinces, but the queen was allowed to retain her position. Early in 1896, however, a serious rebellion broke out in several parts of Imèrina. This movement was not only anti-French and anti-foreign, but also anti-Christian. The French troops gradually broke up the power of the rebellion in the central provinces, but as there appeared to be considerable unrest in many other parts of the island, Gen. Gallieni, an officer with a reputation for vigour and ability in the Sudan and Tongking campaigns, was sent out to relieve the then resident-general.

Under French Rule.—Gen. Gallieni had a difficult task. Among the first steps he took were to put the country under martial law, to abolish royalty and all semblance of Hòva government, and to declare Madagascar to be henceforth a colony of France. Queen Rànavàlona III. was exiled to Réunion, and subsequently to Algeria, where she died in 1917. Meanwhile, by 1890, the authority of France was established throughout the island. Gen. Gallieni, whose firm and vigorous administration, and desire to treat the Malagasy justly and kindly, made him liked, retired in 1905, and was succeeded as governor-general by Victor Augagneur, the late mayor of Lyons. The Malagasy, though regretting the loss of independence, conformed fairly readily to the new order under French rule. Justice was administered, on the whole, with fairness and impartiality; but the taxation was heavy, the staff of officials was excessive, and various monopolies interfered with the habits of the people and tended to produce discontent. But the most serious cause for dislike of the Government was the interference by the governor-general, in 1907, with their religious customs, by the suppression of hundreds of their congregational schools, and the closing of numbers of their churches. In July 1910 Augagneur was replaced as governor-general by N. Picquié, who had served with acceptance as deputy governor-general of French Indo-China, and who had a reputation for tact and impartiality. Under him the anti-clerical policy of his predecessor was modified. It may be noted that when Madagascar became a French possession the French Protestant Churches had begun (in 1896) to take part in the evangelizing of their new colony, and about half the area, for long occupied by the London Missionary Society, was transferred to the Paris Society. It is also to be noted that the bulk of the Malagasy Christians are Protestants, probably three-fourths or four-fifths of those (over 500,000) professing Christianity. The anti-clerical policy of the French Government crippled to a large extent, and for many years, the educational work of the missions, both Protestant and Roman Catholic. Certain of the schools, medical and technical, hospitals and other establishments of the missionaries, were taken over by the Government.

From the time of the appointment of Picquié as governor-general, French policy was directed not only to material development and to attracting French settlers to the island, but also to the training of the natives to ways and outlook essentially French. While the Hòva were not neglected, special attention was paid to the Sàkalàva, the Betsimisàraka and other tribes. In accordance with the usual French colonial system the tribes were all placed under direct control of French officials, but large numbers of natives were employed in the French administration, and the few Malagasy who became thoroughly assimilated were given French citizenship (there were about 150 native French citizens in 1924).

Notwithstanding these measures the growth of a sense of Malagasy nationality could be discerned. Dislike of French rule continued strong for many years after the conquest of the island in 1896. This discontent culminated during the World War in the formation of an anti-French secret society, whose members included a large proportion of the native officials. The existence of the society which, it was alleged, plotted the simultaneous "removal" of the Europeans by means of poison, was discovered early in 1916. The society was rigorously suppressed, and hundreds of Malagasy were condemned to hard labour in the Comoro islands. Gradually, conditions on the island improved. Gradually, too, a better class of European official was sent out. The number of French functionaries was, however, still large, and was a drain on the scanty colonial revenue.

Malagasy troops were employed in considerable numbers in France during the World War and subsequently in Morocco and in Syria. They formed, however, inferior fighting material, and the influence of the returned soldiers on their countrymen was not good. Other disturbing factors were the spread of alcoholism and of malaria and pulmonary disease among the people, leading to a marked decrease in the number of Hòva and other races.

A brighter prospect was, however, shown in the marked attention paid by the French to education, and largely by this means the party among the natives attached to the French connection was built up. Education was made compulsory between the ages of 8 and 14, and the primary schools were supplemented by excellent regional schools—where lads were trained to become officials—and at Tananarivo and other towns there were means for higher education, including medical and agricultural schools. Support of the administration is promoted also by decorations, including the Dragon of Annam, the Star of Anjouan and the Étoile Noire, with *Honneurs* (12 classes), and medals like the *mérite agricole, mérite indigène* and *la médaille du travail.*

Marcel Olivier, who became governor-general in Feb. 1924, adopted a policy of decentralization of the administration—greater local autonomy and the employment of more natives and in more responsible posts. While there was no form of popular representation an Economic and Financial Delegation was created in May 1924 as an advisory body. It consisted of 24 Europeans and an equal number of Malagasy, and it did good work. By laying before the delegation his annual programme, Olivier engaged the interest of the Malagasy in practical reforms.

BIBLIOGRAPHY.—As regards the scientific aspects of the country, almost everything of value in previous books and papers is included in the magnificent work (Paris, 1875–1917) in many vols., by Alfred Grandidier (1836–1921), entitled *Histoire naturelle, physique et politique de Madagascar,* and founded on his exploration of Madagascar in 1865–70 and subsequent researches. Several of the volumes consist of coloured lithograph plates illustrating the natural history of the country, as well as atlases of maps from the earliest period. Grandidier also edited a *Collection des ouvrages anciens concernant Madagascar* (9 vols., 1903–20). *See* also J. Sibree, *A Madagascar Bibliography* (Antanànarivo, 1885); G. Grandidier, *Bibliographie de Madagascar* (2 vols., 1905 and 1907); J. S. Gallieni, *Neuf ans à Madagascar* (1908); J. Sibree, *Fifty Years in Madagascar* (1924). Also consult the works cited under Madagascar in the *Annuaire Général* (Paris, yearly) and the *Journal* of the African Society (quarterly).

(J. SIB.; F. R. C.)

MADAN, MARTIN (1726–1790), English writer, was educated at Westminster school, and at Christ Church, Oxford. In 1748 he was called to the bar, and lived a very gay life, until he was influenced by a sermon by John Wesley. He took holy orders, and was appointed chaplain to the Lock hospital, London. He acted from time to time as an itinerant preacher for the Countess of Huntingdon's Connection. In 1780 Madan raised a storm of opposition by the publication of his *Thelyphthora, or A Treatise on Female Ruin,* in which he advocated polygamy as the remedy for the evils of prostitution. The book called forth many angry replies. Retiring to Epsom, Madan produced *A New and Literal Translation of Juvenal and Persius* (1789).

MADAUROS, an ancient city of Numidia (near the modern Mdaourouch, 55 m. N. of Tebessa by rail), which became a Roman colony at the end of the 1st century after Christ. It was the birthplace of Apuleius, and its schools were celebrated. Among its ruins are some large thermae, a fine Roman mausoleum, a large Christian basilica of the Byzantine period, with a nave and two aisles, and a Byzantine fortress built about A.D. 535.

See Joly, *Mdaourouch.*

MADDALONI, a town of Campania, Italy, in the province of Naples, about $3\frac{1}{2}$ m. S.E. of Caserta, with stations on the railways from Caserta to Benevento and from Caserta to Avellino, 200 ft. above sea-level. Pop. (1936) 19,558 (town); 23,336 (commune). It is prettily situated at the base of one of the Tifata hills, the towers of its mediaeval castle and the church of San Michele crowning the heights above. The fine old palace of the Caraffa family, once dukes of Maddaloni, the old college now named after Giordano Bruno, and the institute for the sons of soldiers are the chief points of interest. About $2\frac{1}{2}$ m. east of Valle di Maddaloni, the Ponti della Valle, an aqueduct built by the orders of Charles III. of Naples and his son to convey the water of the Tiburno to Caserta (19 m.), is carried across the valley between Monte Longano and Monte Gargano by a threefold series of noble arches rising to a height of 210 ft. The work was designed by Lodovico Vanvitelli, and constructed, 1753–59.

MADDEN, SIR FREDERIC (1801–1873), English palaeographer, of Irish extraction, was born at Portsmouth on Feb. 16, 1801. In 1826 he entered the British Museum, and in 1828 he became assistant keeper of manuscripts. In 1833 he was knighted, and in 1837 became keeper of manuscripts, retiring in 1866. He edited for the Roxburghe club *Havelok the Dane* (1828), discovered by himself among the Laudian mss. in the Bodleian, *William and the Werwolf* (1832) and the old English versions of the *Gesta Romanorum* (1838). The edition (1850) in parallel columns, of what are known as the "Wycliffite" versions of the Bible, from the original mss., upon which he and Forshall had been engaged for 20 years, was published by the University of Oxford. In 1866–69 he edited the *Historia Minor* of Matthew Paris for the Rolls Series. In 1833 he wrote the text of Henry Shaw's *Illuminated Ornaments of the Middle Ages;* and in 1850 edited the English translation of Silvestre's *Paléographie universelle.* He died on March 8, 1873, bequeathing his journals and other private papers to the Bodleian library.

MADDER or DYERS' MADDER, the root of *Rubia tinctorum* and perhaps also of *R. peregrina,* both European, *R. cordifolia,* a native of the hilly districts of India and of north-east Asia and Java, supplying the Indian madder or *manjit. Rubia* is a genus of about 15 species of the tribe *Galieae* of the family Rubiaceae, and much resembles the familiar lady's bedstraw (*Galium verum*) and the cleavers (*G. aparine*) of hedges and woodlands, having similarly whorled leaves, but the parts of the flowers are in fives and not fours, while the fruit is somewhat fleshy. The only British species is *R. peregrina,* which is found in Wales, the south and west of England, and in east and south Ireland. The use of madder appears to have been known from the earliest times, as cloth dyed with it has been found on the Egyptian mummies. It was used for dyeing the cloaks of the Libyan women in the days of Herodotus (Herod. iv. 189). *R. tinctorum,* a native of western Europe, etc., has been extensively cultivated in south Europe, France, where it is called *garance,* and Holland, and to a small extent in the United States. Large quantities have been imported into England from Smyrna, Trieste, Leghorn, etc. The cultivation, however, has greatly decreased since alizarin, the red colouring principle of madder, was made artificially. Madder was employed medicinally by the ancients and in the middle ages. Its most remarkable physiological effect is that of colouring red the bones of animals fed upon it, as also the claws and beaks of birds. This appears to be due to the chemical affinity of phosphate of lime for the colouring matter. This property has been of much use in enabling physiologists to ascertain the manner in which bones develop, and the functions of the various types of cells found in growing bone.

MADEC, RENÉ-MARIE (1736–1784)—called Medoc in Anglo-Indian writings—French adventurer in India, was born at Quimper in Brittany on Feb. 7, 1736, of poor parents. He went out to India and served under Dupleix and Lally, but being taken prisoner by the British he enlisted in the Bengal army. Deserting with some of his companions shortly before the battle of Buxar (1764), he became military instructor to various native princes, organizing successively the forces of Shuja-ud-Dowlah, nawab of Oudh, and of the Jats and Rohillas. He took service under the emperor Shah Alam in 1772, and when that prince was defeated at Delhi by the Mahrattas, Madec rejoined his own countrymen in Pondicherry, where he took an active part in the defence of the town (1778). After the capitulation of Pondicherry he returned to France with a considerable fortune, and died there in 1784. At one time he worked for a French alliance with the Mogul emperor against the British, but the project came to nothing.

See Émile Barbé, *Le Nabob René Madec* (1894).

MADEIRA or FUNCHAL, a group of islands in the North Atlantic ocean, which belong to Portugal, and consist of two inhabited islands named Madeira and Porto Santo and two groups of uninhabited rocks named the Desertas and Selvagens. Pop. (1930) 211,601; (1940) 250,124; area, 314 sq.mi. Funchal, the capital of the archipelago, is on the south coast of Madeira island, in 32° 37′ 45″ N. and 16° 54′ W. It is about 360 mi. from the coast of Africa, 535 from Lisbon, 1,215 from Plymouth, 240 from Teneriffe, and 480 from Santa Maria, the nearest of the Azores.

Madeira (pop. in 1940, 247,423), the largest island of the group, has a length of 30 mi., an extreme breadth of 12 mi., and a coast-line of 80 or 90 mi. Pico Ruivo, the highest summit, stands in the centre of the island, and has a height of 6,056 ft., while some of the adjacent summits are very little lower. The depth of the ravines, the rugged peaks, often snow-covered, the bold precipices of the coast and the proximity of the sea afford many scenes of picturesque beauty or striking grandeur. The greater part of the interior is uninhabited, though cultivated, for the towns, villages and scattered huts are usually built either at the mouths of ravines or upon the lower slopes that extend from the mountains to the coast. The ridges between the ravines usually terminate in lofty headlands, one of which, called Cabo Girão, has the height of 1,920 ft., and much of the seaboard is bound by precipices of dark basalt. The north coast, having been more exposed to the erosion of the sea, is more precipitous than the south, and presents everywhere a wilder aspect. On the south there is left very little of the indigenous forest which once clothed the whole island. A long, narrow and comparatively low rocky promontory forms the eastern extremity of the island; and here is a tract of calcareous sand, known as the Fossil Bed, containing land shells and numerous bodies resembling the roots of trees, probably produced by infiltration.

Porto Santo is about 25 mi. N.E. of Madeira. Pop. in 1940 2,709. It has a length of $6\frac{1}{3}$ mi. and a width of 3 mi. The capital is Porto Santo, called locally the *villa* or town. At each end of the island are hills, of which Pico do Facho, the highest, reaches the altitude of 1,663 ft. Little but barley is grown, the limited requirements of the inhabitants being supplied from Funchal.

The Desertas lie about 11 m. S.E. of Madeira, and consist of three islands, Ilheo Chão, Bugio and Deserta Grande, together with Sail Rock off the north end of Ilheo Chão. They present lofty precipices to the sea on all sides. Rabbits and goats abound on them. The archil weed grows on the rocks, and is gathered for exportation. The largest islet (Deserta Grande) is $6\frac{1}{2}$ m. long, and attains the height of 1,610 feet.

The Selvagens or *Salvages* are a group of three islands, 156 m. from Madeira, and between Madeira and the Canary islands. The largest island is the Great Piton, 3 m. long, and 1 m. broad.

Geology.—All the islands of the group are of volcanic origin. They are the summits of very lofty mountains which have their bases in an abyssal ocean. The greater part of what is now visible in Madeira is of subaerial formation, consisting of basaltic and trachytic lavas, beds of tuff and other ejectamenta, the result of a long and complicated series of eruptions from innumerable vents.

There are no data for determining when volcanic action began in this locality, but looking at the enormous depth of the surrounding sea it is clear that a vast period of time must have elapsed to allow of a great mountain reaching the surface and then rising several thousand feet, as well as to excavate the deep and wide ravines that everywhere intersect the island. At the present day there are no live craters or smoking crevices, as at the Canaries and Cape Verdes, nor any hot springs, as at the Azores.

The rarity of crateriform cavities in Madeira is remarkable. There exists, however, to the east of Funchal, on a tract 2,000 ft. high, the Lagoa, a small but perfect crater, 500 ft. in diameter, and with a depth of 150 ft.; and there is another, which is a double one, in the district known as Fanal, in the north-west of Madeira, nearly 5,000 ft. above the sea. The basalt, of which much of the outer part of the island is composed, is of a dark colour and a tough texture, with small disseminated crystals of olivine and augite and often forms a rude columnar structure. The basalt yields good building-stone, some of which is quarried.

Climate.—Observations taken at Funchal Observatory (80 ft. above sea-level) in the last twenty years of the 19th century showed that the mean annual temperature is about 65° F. The mean minimum for the coldest part of the year (Oct. to May inclusive) does not fall below 55°, and the average daily variation of temperature in the same period does not exceed 10°. The mean humidity of the air is about 75 (saturation=100). The prevalent winds are from the north or from a few points east or west of north, but these winds are much mitigated on the south coast by the central range of mountains. A hot and dry wind, the *leste* of the natives, occasionally blows from the east-south-east, the direction of the Sahara, and causes the hill region to be hotter than below; but even on the coast the thermometer under its influence sometimes indicates 93°. As the thermometer has never been known to fall as low as 46° at Funchal, frost and snow are there wholly unknown; but snow falls on the mountains once or twice during the winter, but seldom below the altitude of 2,000 ft. Madeira has a high reputation as a health resort for persons suffering from chest diseases and is well-known as a winter resort.

Fauna.—No species of land mammal is indigenous to the Madeiras. The rabbit, black rat, brown rat and mouse have been introduced. The first comers encountered seals, and this amphibious mammal (*Monachus albiventer*) still lingers at the Desertas. Amongst the many species of birds which breed in these islands only one is endemic, that is a wren (*Regulus madeirensis*), but five other species are known elsewhere only at the Canaries. These are the green canary (*Fringilla butyracea*, the parent of the domesticated yellow variety), a chaffinch (*Fringilla tintillon*), a swift (*Cypselus unicolor*), a wood pigeon (*Columba trocaz*) and a petrel (*Thalassidroma Bulwerii*). There is also a local variety of the blackcap, distinguishable from the common kind by the extension in the male of the cap to the shoulder.

The only land reptile is a small lizard (*Lacerta dugesii*), which is destructive to the grape crop. The loggerhead turtle (*Caouana caretta*, Gray) is frequently captured and cooked but the soup is inferior to that made from the green turtle of the West Indies.

Many kinds of fish, such as the mackerel, horse mackerel, groper, mullet, braise, etc., are caught in abundance, and afford a cheap article of diet. Several species of tunny are taken plentifully in spring and summer, one of them sometimes attaining the weight of 300 lb. The only fresh-water fish is the common eel, which is found in one or two of the streams.

A large majority of the land shells are considered to be peculiar. Many of the species are variable in form or colour, and some have an extraordinary number of varieties. About 43 species are found both living and fossil in superficial deposits of calcareous sand in Madeira or Porto Santo. These deposits were assigned by Lyell to the Newer Pliocene period. Some species have not been hitherto discovered alive.

By the persevering researches of T. V. Wollaston the astonishing number of 695 species of beetles at the Madeiras was brought to light as early as 1870. The proportion of endemic kinds is large, and it is remarkable that 200 are either wingless or their wings are so poorly developed that they cannot fly, while 23 of the endemic genera have all their species in this condition. Upward of 100 moths have been collected, the majority being of a European stamp, but probably a fourth are peculiar to the Madeiran group. Among *Neuroptera* a certain number are peculiar.

The bristle-footed worms of the coast have been studied by Professor P. Langerhans, a large number being new to science. There is a white stony coral allied to the red coral of the Mediterranean which would be valuable as an article of trade if it could be obtained in sufficient quantity. Specimens of a rare and handsome red *Paragorgia* are in the British Museum and Liverpool Museum.

Flora.—The vegetation is strongly impressed with a south-European character. Many of the plants in the lower region undoubtedly were introduced and naturalized after the Portuguese colonization. A large number of the remainder are found at the Canaries and the Azores, or in one of these groups, but nowhere else. Lastly, there are about a hundred plants which are peculiarly Madeiran, either as distinct species or as strongly marked varieties. Among the large number of ferns three are endemic species and six others belong to the peculiar flora of the North Atlantic islands. A connection between the flora of Madeira and that of the West Indies and tropical America has been inferred from the presence of six ferns found nowhere in Europe or North Africa, but existing on the islands of the east coast of America or on the Isthmus of Panama. A further relationship to that continent is to be traced by the presence in Madeira of the beautiful ericaceous tree *Clethra arborea*, belonging to a genus which is otherwise wholly American, and of a *Persea*, a tree laurel, also an American genus. The dragon tree (*Dracaena Draco*) is almost extinct. Amongst the trees most worthy of note are four of the laurel order belonging to separate genera, an *Ardisia, Pittosporum, Sideroxylon, Notelaea, Rhamnus* and *Myrica*,—a strange mixture of genera to be found on a small Atlantic island. Two heaths of arborescent growth and a whortleberry cover large tracts on the mountains. In some parts there is a belt of the Spanish chestnut about the height of 1,500 ft. There is no indigenous pine tree as in the Canaries; but large tracts on the hills have been planted with *Pinus pinaster*, from which the fuel of the inhabitants is mainly derived. Several of the native trees and shrubs now grow only in situations which are nearly inaccessible, and some of the indigenous plants are of the greatest rarity. But some plants of foreign origin have spread in a remarkable manner. Among these is the common cactus or prickly pear (*Opuntia Tuna*), which in many spots on the coast is sufficiently abundant to give a character to the landscape. The coast being rocky and the sea unquiet, the species of *Algae* are few and poor.

Agriculture.—A large portion of the land was formerly entailed in the families of the landlords (*morgados*), but entails have been abolished by the legislature, and the land is now absolutely free. An incredible amount of labour has been expended upon the soil, partly in the erection of walls intended to prevent its being washed away by the rains, and to build up the plots of ground in the form of terraces. Watercourses have been constructed for purposes of irrigation, without which at regular intervals the island would not produce a hundredth part of its present yield. These watercourses originate high up in the ravines, are built of masonry or driven through the rock, and wind about for miles until they reach the cultivated land. Some of them are brought by tunnels from the north side of the island through the central crest of hill. Each occupier takes his turn at the running stream for so many hours, day or night, at a time notified to him.

The system of cultivation is primitive. Few of the occupiers own the land they cultivate; but they almost invariably own the walls, cottages and trees, the land alone belonging to the landlord. The tenant practically enjoys fixity of tenure, for the landlord is seldom in a position to pay the price at which the tenant's share is valued. The métayer system regulates almost universally the relations between landlord and tenant, the tenant paying a certain portion of the produce, usually one half or one third. There are few meadows and pastures, the cattle being stall-fed when not feeding on the mountains. Draught labour is performed by oxen.

The two staple products are wine and sugar. The vine was introduced from Cyprus or Crete soon after the discovery of the island by the Portuguese (1420), but it was not actively cultivated until the early part of the 16th century. The wine usually termed Madeira is made from a mixture of black and white grapes, which are also made separately into wines called Tinta and Verdelho, after the names of the grapes. Other wines, known as Bual, Sercial and Malmsey, are made from varieties of grapes bearing the same names. (*See* MADEIRA WINE.) The sugar cane is said to have been brought from Sicily about 1452. A considerable quantity of spirit, consumed on the island, is made by the distillation of the juice or of the molasses left after extracting the sugar.

The common potato, sweet potato and gourds of various kinds are extensively grown, as well as the *Colocasia esculenta,* the *kalo* of the Pacific islanders, the root of which yields an insipid food. Most of the common table vegetables of Europe are plentiful. Besides apples, pears and peaches, all of poor quality, oranges, lemons, guavas, mangoes, loquats, custard-apples, figs, bananas and pineapples are produced. The last two are articles of export.

Population and Administration.—The inhabitants are of Portuguese descent, with probably some intermixture of Moorish and negro blood. Both men and women in the outlying country districts wear the *carapuça,* a small cap made of blue cloth in shape something like a funnel, with the pipe standing upwards. The men have trousers of linen, drawn tight, and terminating at the knees; a coarse shirt covered by a short jacket completes their attire. The population increased 20% in the years 1900–20. Many of the able-bodied males emigrate to Brazil or the United States. The density of population (796.5 per sq.mi. in 1940) is great for an agricultural district containing no large town.

Funchal (pop. 1940, 54,856), headquarters of Madeiran commerce and shipping, is described in a separate article. The other chief towns are Camara de Lobos (4,968), Machico (10,820), Santa Cruz (609), Ponta do Sol (204), Calheta (2,735), São Vicente (6,110), Santa Anna (4,468), and Porto Santo (784), from the census of 1940. Each of these is the capital of a commune (*concelho*), to which it gives its name. Madeira is connected by regular lines of steamships with Great Britain, Germany, Portugal, Cape Colony, Brazil and the United States.

The archipelago is officially styled the district of Funchal; it returns members to the Portuguese Cortes, and is regarded as an integral part of the kingdom. The district is subdivided into the eight communes already enumerated. Funchal is a Roman Catholic bishopric in the archiepiscopal province of Lisbon.

History.—It has been conjectured, but on insufficient evidence, that the Phoenicians discovered Madeira at a very early period. Pliny mentions certain Purple or Mauretanian Islands, the position of which with reference to the Fortunate Islands or Canaries might seem to indicate the Madeiras. There is a romantic story to the effect that two lovers, Robert Machim, à Machin, or Macham, and Anna d'Arfet, fleeing from England to France (*c.* 1370) were driven out of their course by a violent storm and cast on the coast of Madeira at the place subsequently named Machico, in memory of one of them. João Gonçalvez Zarco first sighted Porto Santo in 1418, having been driven thither by a storm while he was exploring the coast of West Africa. Madeira itself was discovered in 1420. It is probable that the whole archipelago had been explored at an earlier date by Genoese adventurers; for an Italian map dated 1351 (the Laurentian portolano) shows the Madeiras quite clearly, and there is some reason to believe that they were known to the Genoese before 1339. When Zarco visited Madeira in 1420 the islands were uninhabited, but Prince Henry the Navigator at once began their colonization, aided by the knights of the Order of Christ. Sanctioned by the pope and by two charters which the king of Portugal granted in 1430 and 1433, the work proceeded apace; much land was deforested and brought into cultivation, and the Madeiran sugar trade soon became important. Slavery was abolished in Madeira in 1775, by order of Pombal. In 1801 British troops, commanded by General Beresford, occupied the island for a few months, and it was again under the British flag from 1807 to 1814. It shared in the civil disturbances at the accession of Dom Miguel, but after 1833 was peaceful.

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MADEIRA WINE. The Portuguese introduced viticulture into the island of Madeira in the early part of the fifteenth century, but all the wine which was made in the island from that early date until the latter part of the seventeenth century was merely for local consumption, none being exported; sugar was then the staple commodity grown at Madeira for export. Sugar canes were uprooted and replaced by vines, and the export of wine became the chief source of revenue of Madeira, owing to an ordinance of 15 Car. II. cap. 7 (1663), by which it was enacted that "wines of the growth of Madeiras, the Western Islands or Azores, may be carried from thence to any of the lands, islands, plantations, colonies, territories or places to his Majesty belonging, in Asia, Africa or America, in English built ships." As, at the same time, all exports from France, Spain, Italy and Portugal to any English colonies were strictly prohibited, Madeira and the Azores were thus given the monopoly of the supply of the wine required by all English ships and colonists overseas.

The bulk of the wine shipped from Madeira to the West Indies, North America and India was just plain beverage red wine, vintaged in September, racked in January and shipped for immediate consumption in the following spring and during the ensuing twelve months, or, at most, eighteen months. A smaller quantity of beverage white wine was also made, from the *Verdelho* grape, which was sharp and refreshing as a summer drink, being usually consumed in the summer following the vintage, before having reached the immature age of twelve months. A small quantity of a very dark red wine, known as *tinto* or *tent,* was also made from a black grape called the *Negra Molle,* and was chiefly used for blending with red wines lacking in colour.

In some vineyards, where the soil was particularly suitable, finer species of vines were grown, mostly of the *Vidonia* and *Malvazia* varieties; the grapes they yielded were gathered later than the commoner grapes and they were pressed with greater care. A wine was made from such grapes which was better and richer than any other Madeira wine, but not a fortified wine. It was only when, during the wars of Queen Anne's reign, ships failed to call at Madeira for wine that surplus stocks of wines were distilled into brandy, which later was used to fortify some of the best wines. Gradually, by careful selection, blending, and ageing, the best wines of Madeira reached a degree of excellence in the early nineteenth century, which placed them in the first rank of dessert wines. (*See* WINE.)

See A. J. D. Biddle, *The Madeira Islands* (1900); André L. Simon: *Wine and Spirits* (1919) and *The Blood of the Grape* (1920). (A. L. S.)

MADELEY, market town, Wenlock municipal borough, Wrekin parliamentary division, Shropshire, England, 159 m. N.W. from London on the L.M.S. and G.W. railways. Pop. (1931) 7,532. There are ironworks, ironstone and coal are mined, and potter's clay is raised. The church of St. Michael (1796) replaced a Norman building. The parish includes a portion of Coalbrookdale (*q.v.*), and the towns of Ironbridge and Coalport. IRONBRIDGE, a town picturesquely situated on the Severn, adjoins Madeley on the south-west. It is so called because of a one-span iron bridge (1779) across the river. Probably the first such bridge erected, it attracted great attention at the time. Here are brick and tile works and lime-kilns. There is a station (Ironbridge and Broseley) on the G.W. railway. COALPORT lies also on the Severn, with a station on the G.W. railway. It has large china works, founded at the close of the 18th century.

MADERO, FRANCISCO INDALECIO (1873–1913), Mexican revolutionary leader and president, was born on Oct. 4, 1873, at San Pedro, in the State of Coahuila, Mexico. He was educated at the University of California and spent the years 1889–95 in France. During the first years after his return he devoted himself to the administration of the extensive family estate and mine holdings in northern Mexico, but after 1900 he became more and more active in politics. He organized the Club Democrático Benito Juárez, with branches throughout the country, in an effort to interest and appeal to the independent voter. With the help of these he introduced State conventions culminating in a national convention after the pattern of the United States. In 1905, in the gubernatorial campaign in Coahuila, he came out openly against the Díaz Government, but the Díaz *régime* had the election too well in hand for a successful assault. He was now the acknowledged leader of the independent voters of Mexico, and immediately began preparing for the next presidential election, to be held in 1910. In 1908 he published *La succesión presidencial en 1910,* a clear, reasoned statement of the problems of Mexico, and criticizing the Díaz *régime* for its unconstitutional methods of ruling. The book was immediately suppressed, but gave Madero standing as the chief opponent of Díaz in the coming election. However, after making a number of speeches, he was imprisoned on a charge of libel against the Government until the re-election of Díaz. He then crossed the border and from San Antonio, Texas, on Oct. 5, 1910, issued his call for revolution and announced the plan of San Luis Potosí, a definite political platform with "effective suffrage" and "no re-election" as its main planks. Recrossing into Chihuahua he joined rebel armies already in the field and entered actively into the campaign. Other States joined one by one and, with the capture of Juárez, after seven months of fighting, the Díaz Government sued for peace. Madero showed notable generosity to the vanquished, and his liberal proclamations won him the esteem and support of the populace. After the six months rule of a provisional president, a constitutional election was held and he was elected by a large majority. On Nov. 6, 1911, the new Government was inaugurated. Madero made a sincere effort to rule according to the Constitution, but met practical difficulties almost at once. His ideals, especially concerning the division of land and the suffrage, were too visionary to be carried into execution at once as he had promised. He retained the old Díaz Congress, which began an obstructionist policy, and he lacked the confidence of the army officers, most of whom were also Díaz's men. His interference and indecision with regard to the gubernatorial elections in a number of States brought sharp criticism. An unpopular vice-president had been forced upon the people, alienating a powerful group upon which he had counted for support. He had to contend with revolutions under Zapata in the south and under Orozco and Félix Díaz (nephew of the former president) in the north. Finally on Feb. 9, 1913, a revolution broke out in Mexico City. Desertion of the chief general, Huerta, with the army, caused Madero's overthrow and led to the establishment of the Huerta Government. On Feb. 22, while being taken to prison, Madero met his death, it is generally believed by assassination at the hands of the Huerta guards.

See H. I. Priestley, *The Mexican Nation* (1923); P. S. Krecher, "The Personal Side of Madero," *Outlook,* vol. ciii. (1913); E. Emerson, "Madero of Mexico," *Outlook,* vol. xcix. (1911); H. Thompson, "The Maderos of Mexico," *Munsey's Magazine,* vol. xlviii. (1913); R. Martínez, *Madero: su vida y su obra* (1914); S. Márquez, *Los ultimos Dias del Presidente Madero* (1917); R. Estrada; *La revolución y Francisco I. Madero* (1912).

MĀDHAVA ĀCHĀRYA (*fl. c.* 1380), Hindu statesman and philosopher, lived at the court of Vijayanagar (the modern Humpi in the district of Bellary), the vigorous Southern Hindu kingdom that so long withstood Mohammedan influence and aggression. His younger brother Sāyaṇa (d. 1387) was associated with him in the administration and was a famous commentator on the *Rigveda.* Sāyaṇa's commentaries were influenced by and dedicated to Mādhava, who is best known as the author of the *Sarvadarsana Samgraha* (*Compendium of Speculations*). With remarkable mental detachment he was an adherent of 16 distinct systems. Mādhava also wrote a commentary on the *Mīmāmsā Sūtras.* He died as abbot of the monastery of Sringeri.

MADHVAS. *Mādhva,* another distinguished Vedanta teacher and founder of a Vaishnava sect, born in Kanara in A.D. 1197, aimed at a reconciliation of the Saiva and Vaishnava forms of worship. The *Madhvas* or *Madhvacharis* favour Krishna and his consort as their special objects of adoration, whilst images of Siva, Parvati, and their son Ganesa are admitted and worshipped in some of their temples, the most important of which is at Udipi in South Kanara, with eight monasteries connected with it. This shrine contains an image of Krishna, which is said to have been rescued from the wreck of a ship which brought it from Dvaraka, where it was supposed to have been set up of old by no other than Krishna's friend Arjuna, one of the five Pandava princes. Followers of the Madhva creed are but rarely met with in Upper India. Their sectarial mark is like the U of the Sri-Vaishnavas, except that their central line is black instead of red or yellow. Madhva—who after his initiation assumed the name Anandatirtha—composed numerous Sanskrit works, including commentaries on the Brahma sutras (*i.e.,* the Vedanta aphorisms), the Gita, the Rigveda, and many Upanishads. His philosophical theory was a dualistic one, postulating distinctness of nature for the divine and the human soul, and hence independent existence, instead of absorption, after life on earth.

MADI, a Negro race of the Nile valley, occupying both banks of the Bahr-el-Jebel immediately north of Albert Nyanza. Tradition makes them immigrants from the north-west. The women choose their own husbands, are never ill-treated, and take part in tribal deliberations. The Madi build interesting sepulchral monuments. See *Petermann's Mittheilungen* for May 1883.

MADISON, JAMES (1751–1836), 4th president of the United States, was born at Port Conway, in King George county, Virginia, on March 16, 1751. His first ancestor in America may possibly have been Captain Isaac Maddyson, a colonist of 1623 mentioned by John Smith as an excellent Indian fighter. His father, also named James Madison, was the owner of large estates in Orange county, Virginia. In 1769 the son entered the College of New Jersey (now Princeton university). He graduated in 1771, but remained for another year at Princeton studying, apparently for the ministry, under the direction of John Witherspoon (1722–94). In 1772 he returned to Virginia, where he pursued his reading and studies, especially theology and Hebrew, and acted as a tutor to the younger children of the family. In 1775 he became chairman of the committee of public safety for Orange county, and in the spring of 1776 he was chosen a delegate to the new Virginia convention, where he was on the committee which drafted the constitution for the State, and proposed an amendment (not adopted) which declared that "all men are equally entitled to the full and free exercise" of religion. In 1777, largely, it seems, because he refused to treat the electors with rum and punch, after the custom of the time, he was not re-elected, but in November of the same year he was chosen a member of the Privy

Council or Council of State, in which capacity he took a prominent part from Jan. 14, 1778, until the end of 1779, when he was elected a delegate to the Continental Congress.

He was in Congress during the final stages of the Revolutionary War, and in 1780 drafted instructions to Jay, then representing the United States at Madrid, that in negotiations with Spain he should insist upon the free navigation of the Mississippi and upon the principle that the United States succeeded to British rights affirmed by the Treaty of Paris of 1763. When the confederation was almost in a state of collapse because of the failure of the States to respond to requisitions of Congress for supplies for the Federal treasury, Madison was among the first to advocate the granting of additional powers to Congress, and urged that Congress should forbid the States to issue more paper money. In 1781 he favoured an amendment of the Articles of Confederation giving Congress power to enforce its requisitions, and in 1783, in spite of the open opposition of the Virginia legislature, which considered the Virginian delegates wholly subject to its instructions, he advocated that the States should grant to Congress for 25 years authority to levy an import duty, and suggested a scheme to provide for the interest on the debt not raised by the import duty—apportioning it among the States on the basis of population, counting three-fifths of the slaves, a ratio suggested by Madison. To accompany this plan he drew up an able address to the States. In the same year he was a member of the committee which reported on the Virginia proposal as to the terms of cession to the Confederation of the unoccupied Western territory, held by several of the States; the report was a skilful compromise made by Madison, which secured the approval of the rather exigent Virginia legislature.

In Nov. 1783 Madison's term in Congress expired, and he returned to Virginia and took up the study of the law. In the following year he was elected to the house of delegates. As a member of its committee on religion, he opposed the giving of special privileges to the Episcopal (or any other) Church, and contended against a general assessment for the support of the churches of the State. His petition of remonstrance against the proposed assessment, drawn up at the suggestion of George Nicholas (*c.* 1755–99), was widely circulated and procured its defeat. On Dec. 26, 1785, Jefferson's bill for establishing religious freedom in Virginia, which had been introduced by Madison, was passed. In the Virginia house of delegates, as in the Continental Congress, he opposed the further issue of paper money; and he tried to induce the legislature to repeal the law confiscating British debts, but he did not lose sight of the interests of the Confederacy. The boundary between Virginia and Maryland, according to the Baltimore grant, was the south shore of the Potomac, a line to which Virginia had agreed on condition of free navigation of the river and the Chesapeake bay. Virginia now feared that too much had been given up, and desired joint regulation of the navigation and commerce of the river by Maryland and Virginia. On Madison's proposal commissioners from the two States met at Alexandria (*q.v.*) and at Mount Vernon in March 1785. The Maryland legislature approved the Mount Vernon agreement and proposed to invite Pennsylvania and Delaware to join in the arrangement. Madison, seeing an opportunity for more general concert in regard to commerce and trade (and possibly for the increase of the power of Congress), proposed that all the States should be invited to send commissioners to consider commercial questions, and a resolution to that effect was adopted (on Jan. 21, 1786) by the Virginia legislature. This led to the Annapolis convention of 1786, and that in turn led to the Philadelphia convention of 1787. In April 1787 Madison had written a paper, *The Vices of the Political System of the United States,* and from his study of confederacies, ancient and modern, later summed up in numbers 17, 18 and 19 of *The Federalist,* he had concluded that no confederacy could long endure if it acted upon States only and not directly upon individuals. As the time for the convention of 1787 approached he drew up an outline of a new system of government, the basis of the "Virginia plan" presented in the convention by Edmund Jennings Randolph. Madison's scheme, as expressed in a letter to Washington dated April 16, 1787, was that individual sovereignty of States was irreconcilable with aggregate sovereignty, but that the "consolidation of the whole into one simple republic would be as inexpedient as it is unattainable." He considered as a practical middle ground changing the basis of representation in Congress from States to population; giving the national Government "positive and complete authority in all cases which require uniformity"; giving it a negative on all State laws, a power which might best be vested in the Senate, a comparatively permanent body; electing the lower house, and the more numerous, for a short term; providing for a national executive, for extending the national supremacy over the judiciary and the militia, for a council to revise all laws, and for an express statement of the right of coercion; and finally, obtaining the ratification of a new constitutional instrument from the people, and not merely from the legislatures. The "Virginia plan" was the basis of the convention's deliberations which resulted in the constitution favourably voted on by the convention on Sept. 17, 1787. Madison, always an opponent of slavery, disapproved of the compromise (in Art. I. sec. 9 and Art. V.) postponing to 1808 (or later) the prohibition of the importation of slaves. He took a leading part in the debates of the convention, of which he kept careful notes, afterwards published by order of Congress (3 vols., Washington, 1843).

Many minute and wise provisions are due to Madison, and he spoke before the convention more frequently than any delegate except James Wilson and Gouverneur Morris. In spite of the opposition to the Constitution of the Virginia leaders George Mason and E. J. Randolph, Madison induced the State's delegation to stand by the Constitution in the convention. To meet the objections brought against it throughout the country, he joined Alexander Hamilton (*q.v.*) and John Jay in writing *The Federalist,* a series of 85 papers, out of which 20 certainly, and nine others probably, were written by him. In the Virginia convention for ratifying the Constitution (June 1788), when eight States had ratified and it seemed that Virginia's vote would be needed to make the necessary nine (New Hampshire's favourable vote was cast only shortly before that of Virginia), and it appeared that New York would vote against the constitution if Virginia did not ratify it, Madison was called upon to defend that instrument again, and he appeared at his best against its opponents, Patrick Henry, George Mason, James Monroe, Benjamin Harrison, William Grayson and John Tyler. He answered their objections in detail, calmly and with an intellectual power and earnestness that carried the convention. The result was a victory against an originally adverse public opinion and against the eloquence of the opponents of the constitution, for Madison and for his lieutenants, Edmund Pendleton, John Marshall, George Nicholas, Harry Innes and Henry Lee. At the same time Madison's labours in behalf of the constitution alienated from him valuable political support in Virginia. He was defeated by Richard Henry Lee and William Grayson for the United States Senate, but in his own district he was chosen a representative to Congress, defeating James Monroe.

Madison took his seat in the House of Representatives in April 1789, and assumed a leading part in the legislation necessary to the organization of the new Government. He drafted a tariff bill giving certain notable advantages to nations with which the United States had commercial treaties, hoping to force Great Britain into a similar treaty; but his policy of discrimination against England was rejected by Congress. It was his belief that such a system of retaliation would remove the possibility of war arising from commercial quarrels. He introduced resolutions calling for the establishment of three executive departments, foreign affairs, treasury and war, the head of each removable by the president. Most important of all, he proposed nine amendments to the constitution, which were the basis of the Bill of Rights embodied in the first ten amendments. Although a staunch friend of the Constitution, Madison believed that the instrument should be interpreted conservatively. The tide of "strict construction" was setting in strongly in his State, and he was borne along with the flood. It is very probable that Jefferson's influence over Madison, which was greater than Hamilton's, contributed to this result. Madison now opposed Hamilton's measures for the funding of the debt, the assumption of State debts, and the establishment of a national bank, and on other questions he sided more and more with the Opposition, gradually assuming its leadership in the House of Representatives and labouring to confine the powers of the National Government within the narrowest possible limits. Madison objected to the carrying out of the recommendations in Hamilton's famous report on manufactures (Dec. 5, 1791), which favoured a protective tariff. In 1793–96 he strongly criticized the administration for maintaining a neutral position between Great Britain and France, writing for the public press five papers (signed "Helvidius"), attacking the "monarchical prerogative of the executive" as exercised in the proclamation of neutrality in 1793 and denying the president's right to recognize foreign States. He found in Washington's attitude—as in Hamilton's failure to pay an instalment of the moneys due to France—an "Anglified complexion," in direct opposition to the popular sympathy with France and French Republicanism. In 1794 he tried again his commercial weapons, introducing in the House of Representatives resolutions based on Jefferson's report on commerce, advising retaliation against Great Britain and discrimination in commercial and navigation laws in favour of France; and he declared that the friends of Jay's treaty were "a British party systematically aiming at an exclusive connection with the British Government."

In 1797 Madison retired from Congress, but not to a life of inactivity. In 1798 he joined Jefferson in opposing the Alien and Sedition laws, and Madison himself wrote the resolutions of the Virginia legislature declaring that it viewed "the powers of the Federal Government as resulting from the compact to which the States are parties, as limited by the plain sense and intention of the instrument constituting that compact; as no further valid than they are authorized by the grants enumerated in that compact; and that, in case of a deliberate, palpable and dangerous exercise of other powers, not granted by the said compact, the States, who are parties thereto, have the right and are in duty bound to interpose for arresting the progress of the evil, and for maintaining within their respective limits, the authorities, rights and liberties appertaining to them." The Virginia resolutions and the Kentucky resolutions (the latter having been drafted by Jefferson) were met by dissenting resolutions from the New England States, from New York, and from Delaware. In answer to these, Madison, who had become a member of the Virginia legislature in the autumn of 1799, wrote for the committee to which they were referred a report elaborating and sustaining in every point the phraseology of the Virginia resolutions.

Madison became secretary of State upon Jefferson's accession to the presidency in 1801, and it is said that no secretary of State was ever confronted with larger problems or worked more closely with his president to solve them. For the very reason of their close relationship it is difficult to separate their parts in the diplomacy of 1801–09. The great achievement was the purchase of Louisiana, and following it the success with the Barbary pirates. Their failures were their inability to acquire Florida and the hopelessness of the relationship with England and France. During the eight years that he held the portfolio of State, he had continually to defend the neutral rights of the United States against the encroachments of European belligerents; in 1806 he published *An Examination of the British Doctrine which subjects to Capture a Neutral Trade not open in Time of Peace,* a careful argument against the rule of war of 1756 extended by Great Britain in 1793 and 1803.

Jefferson's wish was that Madison should succeed him in the presidency and to this the party acceded. However, a hostile group practically forced the new president to take Robert Smith as his secretary of State. So for two years his foreign policy suffered because the two could not temperamentally co-operate. Jefferson's peace policy—or, more correctly, Madison's peace policy—of commercial restrictions to coerce Great Britain and France he continued to follow until 1812, when he was forced to change these futile commercial weapons for a policy of war, which was very popular with the extreme French wing of his party. After being tricked by France and seemingly unable to gain any concessions from Great Britain he embarked upon war. The country was unprepared for war, and Madison and his cabinet proved unable efficiently to cope with the difficulties. Re-elected in 1812 in spite of formidable opposition, he grew increasingly unpopular as disaster followed the armies; the New England Federalists wished his resignation and even talked secession. In general, Congress was more blamable than either the president or his official family, or the army officers. With the declaration of peace the president again gained a momentary popularity much like that he had won in 1809 by his willingness to fight France.

Retiring from the presidency in 1817, Madison returned to his home, Montpelier, Orange county, Va., which he was to leave in no official capacity save in 1829, when he was a delegate to the State Constitutional Convention and served on several of its committees. Montpelier, like Jefferson's Monticello and Monroe's Oak-Hill, was an expensive bit of "gentleman farming," which with his generous hospitality nearly ruined its owner financially. Madison took an interest in education, in emancipation, and in agricultural questions, to the last. He died at Montpelier on June 28, 1836. Madison married, in 1794, Dorothy Payne Todd (1772–1849), a widow of great social charm. Her plump beauty was often remarked—notably by Washington Irving—in contrast to her husband's delicate and feeble figure and wizened face—for even in his prime he was, as Henry Adams says, "a small man, quiet, somewhat precise in manner, pleasant, fond of conversation, with a certain mixture of ease and dignity in his address."

Henry Clay, contrasting him with Jefferson, said that Jefferson had more genius, Madison more judgment and common sense; that Jefferson was a visionary and a theorist; Madison cool, dispassionate, practical and safe. The broadest and most accurate scholar among the "founders and fathers," he was particularly an expert in constitutional history and theory. In the great causes for which Madison fought in his earlier years—religious freedom and separation of Church and State, the free navigation of the Mississippi, and the adoption of the constitution—he met with success. His greatest and truest fame is as the "father of the Constitution."

Bibliography.—Madison's personality is perplexingly vague; the biographies of him are little more than histories of the period, and the best history of the later period in which he was before the public, Henry Adams's *History of the United States from 1801 to 1817* (1889–90), gives the clearest sketch and best criticism of him. The lives of Madison are: J. Q. Adams's (Boston, 1850); W. C. Rives's (Boston, 1859–69, 3 vols.), covering the period previous to 1797; S. H. Gay's (Boston, 1884) in the "American Statesmen Series"; and Gaillard Hunt's (1902). Madison's *Writings* (1900–06) were edited by Hunt, who also edited *The Journal of the Debates in the Convention which framed the Constitution of the United States, as Recorded by James Madison* (1908). *See* also Mrs. Madison's *Memoirs and Letters* (Boston, 1887) and M. W. Goodwin, *Dolly Madison* (1897). The most authoritative account of Madison's diplomatic activities is contained in vol. iii. of the *American Secretaries of State* (1927).

MADISON, a village of western Illinois, U.S.A., 2 mi. N. of East St. Louis; served by the Illinois Central, the Nickel Plate and the Litchfield, Madison railways. Pop. was 4,996 in 1920 (29% foreign-born white); and 7,782 in 1940 by federal census. It has car works, a creosoting plant, a steel mill and a village-owned and operated bridge connecting St. Louis, Mo. with Madison county, Ill. Madison was founded and incorporated in 1890.

MADISON, a city of southeastern Indiana, U.S.A., on the Ohio river, 90 mi. below Cincinnati, at an altitude of 450 ft.; the county seat of Jefferson county. It is served by the Pennsylvania railroad. The population was 6,530 in 1930 (93% native white) and was 6,923 by federal census in 1940. It is a shipping point of tobacco, grain and fruit; and has a variety of manufacturing industries. In North Madison is a state hospital for the insane. Madison was chartered as a city in 1836.

MADISON, a borough of Morris county, New Jersey, U.S.A., on the Lackawanna railroad, 23 mi. W. of New York city. Pop. (1930), 7,481; and was 7,944 in 1940. It is a residential suburb among the hills, and the seat of Drew university (Methodist), founded in 1866 as Drew Theological seminary, on an endowment by Daniel Drew (1788–1829) and expanded into a university in 1928 through a gift of $1,500,000 from Leonard D. and

Arthur J. Baldwin, of New York city. The cultivation of roses and cut flowers is the principal industry.

MADISON, a city of South Dakota, U.S.A., in the eastern part of the state, 50 mi. N.W. of Sioux Falls; county seat of Lake county. It is on federal highway 81 and state highway 34; is served by the Chicago, Milwaukee, St. Paul and Pacific railroad. Pop. (1940) 5,018. Madison is the trading centre of a farming and stock-raising region which specializes in pure-bred stock. It is the seat of the Eastern State Teachers college (1881).

MADISON, the capital city of Wisconsin, U.S.A., the seat of the state university, and the county seat of Dane county; in the "four-lake region" midway between Lake Michigan and the Mississippi river, in the southern part of the state. It is on federal highways 12, 14, 18, 51 and 151; and is served by the Chicago and North Western, the Chicago, Milwaukee, St. Paul and Pacific, and the Illinois Central railways, and by motor bus lines in all directions. Pop. (1920) 38,378 (87% native white), 67,447 in 1940 by federal census, to which the university adds 12,000, and visitors an average of 2,000 daily. The city is built on the isthmus between Lake Mendota on the northwest (15·2 sq.mi. in area, with a circumference of 25 mi.) and Lake Monona (5·5 sq.mi.) on the southeast. Farther south lie the other lakes (Waubesa and Kegonsa). On a hill at the narrowest part of the isthmus, in a wooded park of 14 ac. stands the State House, a beautiful building (constructed 1904–14). A mile west, along Lake Mendota, are the grounds of the University of Wisconsin (*q.v.*) covering 1,000 acres. Many of the city's parks (540 ac.) are on the shores of one or another of the three lakes, and facilities for all kinds of water sports abound. Madison is the seat of the only U.S. Forest products laboratory in the country. Its seven libraries (state, university and city) contain 1,750,000 volumes. Its six hospitals had in 1940 over 1,200 beds, and the city is an important medical centre. Though primarily an educational and political centre, Madison has a large jobbing and wholesale business, a large retail trade, and diversified manufacturing industries with an output in 1940 valued at $45,000,000. Bank resources in 1940 amounted to $45,000,000. The assessed valuation of property for 1940 was $132,000,000.

A trading post was established on Lake Mendota as early as 1820, but white settlement on the site of Madison did not begin until it had been selected by the territorial legislature (on Dec. 3, 1836, after a protracted and acrimonious debate) to be the seat of government, and had been named after James Madison, who had recently died. Earlier in the year a survey had been made, and a city laid out on paper, by Stevens T. Mason, governor of Michigan, and James Duane Doty, then United States district judge, who had visited the region in 1829 and recorded a tract including most of the land within the city limits. It was Doty's influence that largely determined the choice of the legislature. Building began early in 1837. The village was incorporated in 1846, with a population of 626, and chartered as a city in 1856.

MADISONVILLE, a city of western Kentucky, U.S.A., the county seat of Hopkins county; 40 mi. S. of Evansville (Indiana), on federal highway 41. It is served by the Illinois Central and the Louisville and Nashville railways. Pop. (1920) 5,030 (30% Negroes); 6,908 in 1930; 8,209 in 1940 by federal census. It is the market and trading centre of a coal-mining, lumbering and agricultural region, where dark tobacco is a leading crop.

MADIUN (Dutch, *Madioen*), a residency of the province of East Java, Netherlands Indies. It is bounded N. by Japara-Rembang and Bojonegara, E. by Kediri, W. by Surakarta and S. by the Indian ocean; area, 2,512 sq.mi.; pop. 1,968,547 (3,314 Europeans and Eurasians). It consists of very fertile plains in the north and centre. To the east and west are high volcano groups, including Mt. Liman (8,335 ft.) and Mt. Lawu (10,777 ft.). There are limestone ranges in the south, forming a difficult coast without a harbour. The principal river is the Madiun, which flows from the centre of the residency northwards to join the Solo, and there is a small river in the south, the Pajitan. Madiun, the capital (pop. 41,872, 1,681 Europeans and Eurasians), has large railway workshops and fine irrigation works; it is on the banks of the Madiun river. Other towns are Ponorogo, pop. 21,680, Ngawi, Mejajon, Batong, Magetan and Pajitan. Rice, maize, sugar-cane, cassava, coffee, coca, chinchona, coco-nuts, ground-nuts and the usual native fruits and vegetables are grown, and the principal crops are rice and sugar cane; teak is obtained from the forests. The main railway line from Batavia to Surabaya runs from west to east, touching Madiun. The central districts have good roads, and there is a good road in the south of Pajitan to Ponorogo and Madiun. The people are almost entirely Javanese. Madiun became a Dutch residency after the rebellion of 1825–30; it was occupied by Japan in 1942.

MADOZ, PASCUAL (1806–1870), Spanish statistician, born at Pamplona, May 7, 1806. He joined the Progressists during the first Carlist war (1833–40); was elected deputy to the Cortes of 1836; took part for Espartero, and then against him; was imprisoned in 1843; went into exile, returned, was governor of Barcelona in 1854, and minister of finance in 1855; had a large share in secularizing the Church lands; and after the revolution of 1868 was governor of Madrid. He died at Genoa in 1870.

MADRAS. A presidency of British India—officially styled Fort St. George—occupying, with its dependencies, the entire south of the Indian peninsula. The north boundary is extremely irregular. On the extreme north-east is the Bengal province of Orissa; then the wild highlands of the Central Provinces; next Hyderabad; and, on the north-west, the Bombay districts of Dharwar and North Kanara. Mysore and Coorg lie within the bounds of Madras, and it includes the Laccadive islands, off the Malabar coast, in the Indian ocean. Its area, excluding native states, is 126,166 sq.mi., and its population in 1941 was 49,341,810. The capital is Madras (*q.v.*).

Structural Geography.—The Madras presidency may be considered broadly in three sections: (1) the high interior tableland, (2) the long and broad east coast, (3) the shorter and narrower west coast. The central plateau has a general elevation of 1,000 to 3,000ft. and includes the whole of Mysore and extends over about half a dozen districts of Madras. It is composed essentially of very ancient granitic and gneissic rocks, which shelve sharply down to the coastal lands on either side, forming the eastern and western Ghats (*q.v.*) respectively. In Bellary and Anantapur districts, as well as in Mysore and Hyderabad, several long and narrow strips of a later formation, known as the Dharwar system, are folded or faulted into the gneissic floor. They run from north-north-west to south-south-east and consist of conglomerates, lavas and schists. These beds contain gold, the Kolar goldfield in Mysore being important. The gneissic and Dharwar rocks are overlaid unconformably by the sandstones, limestones, shales, etc., of the Cuddapah and Kurnool series. In the latter series most of the diamonds of southern India are found. Anaimundi mountain (8,837ft.) in Travancore is the highest in southern India. The Nilgiri hills, which join the Ghats, culminate in Dodabetta (8,760ft.). There are also many outlying spurs and tangled masses of hills, of which the Shevaroys, Anamalais and Palnis are the most important.

In the areas let down by faults there are strips of Gondwana beds, and their softer rocks have helped the growth of river valleys. Such a strip is associated with the Godavari valley. The Godavari, Kistna and Cauvery rivers, each with a large tributary system, rise in the western Ghats, cross the peninsula and reach the bay of Bengal over alluvial deltas which extend over long stretches on the east coast. Marine cretaceous deposits are found in three detached areas, near Trichinopoly, Viruddhachalam and Pondicherry. On the west coast are a series of backwaters or lagoons, fringing the sea-board of Kanara, Malabar and Travancore. The largest is the backwater of Cochin, which extends 120m. from north to south. Some of the coastal sandstones may be of late Tertiary age, but fossils of that period are only in a few patches on the west coast, as at Quilon in Travancore.

Climate.—The climate varies in accordance with the height of the mountain chain on the western coast. Where this chain is lofty, as between Malabar and Coimbatore, the rainclouds are checked and give a rainfall of 150 in. on the side of the sea, and only 20 in. on the landward side. Where the range is lower, the rainclouds pass over the hills and carry their moisture to the interior districts. The Nilgiri hills enjoy the climate of the temperate zone, with a moderate rainfall. The Malabar coast has a rainfall of 150in., and the clouds on the western Ghats sometimes obscure the sun for months at a time. Along the eastern coasts and central table-lands the rainfall is low and the heat excessive. At Madras the average rainfall, 50 in., is above the mean.

Minerals.—The mineral wealth is undeveloped. Excellent iron has been smelted by native smiths from time immemorial; but European methods have proved unsuccessful. Coal exists, but is not worked. The manganese of Vizagapatam and mica of Nellore are the only minerals extensively produced. Gold and silver are obtained at Anantapur, magnesite at Salem, barytes at Kurnool, and bauxite on the Malabar coast and at Vizagapatam.

Forests.—Forests cover a total area of nearly 1,300,000 acres. In recent years experimental afforestation has received much attention. In 1927 there were 19,028 sq.m. under State control including teak, ebony, rosewood, sandalwood and redwood.

Fauna.—The wild animals include the elephant, bison, sambur and ibex of the western Ghats and the Nilgiris. Bison are found also in the hill tracts of the northern Circars. In Travancore State the black leopard is not uncommon. The elephant is protected by law from indiscriminate destruction. The cattle are small, but in Nellore and along the Mysore frontier a superior breed is carefully kept up by the wealthier farmers. The best buffaloes are imported from the Bombay district of Dharwar.

Population.—Of the population in 1931, 883 in every thousand were Hindus, 70 Mohammedans, 38 Christians and 9 Animists. The death rate in 1926 was about 23 and the birth rate about 36 per thousand. The most numerous of the hill tribes are the Kondhs and Savaras, two cognate races who inhabit the mountainous tracts of the eastern Ghats. On the Nilgiris the best known aboriginal tribe is the Todas (*q.v.*). The chief Mohammedan tribes are Labbai, Moplah, Sheikh, Sayad, Pathan and Dudecula. The Labbais are the descendants of Hindu converts, and are traders by hereditary occupation, although many now employ themselves as sailors and fishermen. The Moplahs are the descendants of Arab sailors, but have now practically no foreign blood. They are a hard-working, frugal people, but extremely fanatical, and under the influence of religious excitement have often disturbed the public peace. The Christian population is comparatively large and is every year increasing. Broadly speaking, the entire population of Madras belongs to the five linguistic offshoots of the great Dravidian stock, dominant throughout southern India. At an early period, before the dawn of history, these races appear to have accepted some form of the Brahmanical or Buddhist faiths. Many storms of conquest have since swept over the land, and colonies of Mogul and Mahratta origin are to be found here and there. But the evidence of language proves that the ethnical character of the population has remained stable under all these influences, and that the Madras Hindu, Mohammedan, Jain and Christian are of the same stock. Of the five Dravidian languages in British territory Telugu is spoken by 377 persons in every thousand; Tamil by 410; Kanarese by 35 and Malayalam by 75 persons in every thousand. Oriya, spoken by 37 in every thousand, Khond and Savara are employed in Ganjam, Vizagapatam and the Madras Agency. Tulu and Kamkani are used on the west coast.

Agriculture.—Over the greater part of the area of Madras artificial irrigation is impossible, and cultivation is dependent upon the local rainfall, which rarely exceeds 40in. a year, and is irregular. On the Malabar coast alone can the south-west monsoon be trusted to produce steady rain. Other districts, such as Bellary, are also dependent upon this monsoon.

The system of irrigation has been most successful in the case of the three great eastern rivers, the Godavari, Kistna and Cauvery. Each of these is intercepted by an *anicut* or dam at the head of its delta, from which canals diverge on each side for navigation and irrigation. The project of leading the Periyar river through a tunnel on to the plain of Madura has been successful and a scheme for utilization of the Cauvery was in progress in 1927. Seven million acres were irrigated in 1927, three million of them by small works.

The principal food staples are rice, *cholam, cambu, ragi* and *varagu* (four kinds of millet). The most common oil-seed is ground-nut. Sugar is derived from cane and the sap of palms. The fruit trees are coco-nut, areca-nut, jack, tamarind and mango. Other crops are indigo, coffee, rubber, tobacco and tea. Cotton is grown mostly in the ceded districts, in the Guntur highlands and in the southern districts (Tinnevelly, etc.). The larger portion of the coffee-growing area lies within Mysore, Coorg and Travancore States, but the Wynaad and the Nilgiri hills are within Madras. The tea plant was also introduced into the Nilgiri hills about 1840, and is still unimportant, though increasing. Deccan hemp is grown in the northern Circars.

The greater part of the soil in Madras is held by the cultivators direct from the Government under the tenure known as *ryotwari*. Besides these lands, in the hands of the Government, there are also proprietary or *samindari* estates in all parts of the country. Of the total population 71% are engaged in agriculture.

Manufactures.—Madras possesses few staple manufactures, and industry is not in an advanced condition, owing partly to lack of coal. Projects for the supply of hydro-electric power to various places were under consideration in 1927. The chief industries of the presidency are cotton-ginning, coffee-curing, oil-pressing, rice-curing, rope-making, sugar refining, tanning, tile and brick-making, salt and soap manufacture and railway works. Up to the close of the 18th century cotton goods constituted the main article of export. There are now a number of cotton mills, and native looms still hold their own in the local market.

Commerce and Trade.—The continuous seaboard of the Madras presidency, without any natural harbours of the first rank, has tended to create a widely-diffused trade. Madras city conducts nearly one-half of the total sea-borne commerce; next comes Malabar, with Calicut; then Godavari, with its cluster of ports along the fringe of the delta; Tinnevelly, with the harbour at Tuticorin, Tanjore, South Kanara, Ganjam and Vizagapatam. Madras is broadly marked by the larger proportion assigned to coasting trade. The chief staples of the export trade are cotton, and cotton piece goods, ground-nuts, hides and skins, tea and coffee, coir manufactures, rice and oil.

The presidency is well supplied with railways, which naturally have their centre in Madras city, the chief seaport. The broad gauge line of the Madras and Southern Mahratta railway connects with Bombay and Bangalore, and also crosses the peninsula to Calicut and Mangalore on the western coast. The South Indian (narrow-gauge) serves the extreme south, and has several branches. The narrow-gauge line of the Madras and Southern Mahratta railway traverses the Deccan districts; and the East Coast line (broad-gauge), through the northern Circars, has brought Madras into direct communication with Calcutta.

Administration.—In 1937 by the provisions of the Government of India act of 1935, Madras received "provincial autonomy" under a popularly elected ministry formed by the Congress party with C. Rajagopalachariar as premier. The ministry resigned after the outbreak of war in 1939. The number of districts is 24, each under the charge of a collector, with sub-collectors and assistants.

Local administration includes at the bottom union *panchayats* or village committees, whose chief duty is to attend to sanitation. Above them come *taluk* or subdivisional boards. At the head of all are district boards, a portion of whose members are elected by the *taluk* boards. There is a High Court of Justice at Madras, with a chief judge and 11 puisne judges, 25 sessions judges for criminal law and 24 district judges for civil justice.

The chief educational institutions are the Madras university, the Presidency college, Madras Christian college and Pachayyappa's college at Madras; the Government arts colleges at Combaconum and Rajahmundry; the medical college and engineering college at Madras; the college of agriculture at Coimbatore, St. Joseph's college, Trichinopoly; the teachers' college at Saidapet; the school of arts at Madras; and the military orphanage at Ootacamund, in memory of Sir Henry Lawrence. In 1921 the total number of pupils at all institutions was 1,799,850; 98 per thousand over five years of age could read and write.

HISTORY

Until the British conquest the whole of southern India had never acknowledged a single ruler. The Tamil country in the extreme south is traditionally divided between the three kingdoms of Pandya, Chola and Chera. The west coast supplied the nucleus of a monarchy which afterwards extended over the highlands of Mysore, and took its name from the Carnatic. On the north-east the kings of Kalinga at one time ruled over the entire line of seaboard from the Kistna to the Ganges (*see* INDIA). The Mohammedan invader first established himself in the south in the beginning of the 14th century. Ala-ud-din, the second monarch of the Khilji dynasty at Delhi, and his general Malik Kafur conquered the Deccan, and overthrew the kingdoms of Karnataka and Telingana, which were then the most powerful in southern India. But after the withdrawal of the Mussulman armies the native monarchy of Vijayanagar (*q.v.*), arose out of the ruins. In 1565, it was overwhelmed by a combination of the four Mohammedan principalities of the Deccan. At the close of the reign of Aurangzeb, although that emperor nominally extended his sovereignty as far as Cape Comorin, in reality South India had again fallen under a number of rulers who owned no regular allegiance. The nizam of the Deccan, himself an independent sovereign, represented the distant court of Delhi. The most powerful of his feudatories was the nawab of the Carnatic, with his capital at Arcot.

Vasco da Gama cast anchor off Calicut on May 20, 1498, and for a century the Portuguese retained the commerce of India. The Dutch, superseding the Portuguese at the beginning of the 17th century, were quickly followed by the English, who established themselves at Calicut and Cranganore in 1616. The Portuguese eventually retired to Goa, and the Dutch to the Spice Islands. The first English settlement on the east coast was in 1611, at Masulipatam, even then celebrated for its fabrics. Farther south a fort, the nucleus of Madras city, was erected in 1640. Pondicherry was purchased by the French in 1762. The war of the Austrian succession in Europe lit the first flame of hostility on the Coromandel coast. In 1746 Madras was forced to surrender to La Bourdonnais, and Fort St. David remained the only English possession in southern India. By the peace of Aix-la-Chapelle Madras was restored to the English, and English influence was generally able to secure the favour of the rulers of the Carnatic and Tanjore, while the French succeeded in placing their own nominee on the throne at Hyderabad. Clive, whose defence of Arcot in 1751 forms the turning point in Indian history, defeated Dupleix, and in 1760 the crowning victory of Wandewash was won by Colonel (afterwards Sir Eyre) Coote, over Lally. A year later, despite help from Mysore, Pondicherry was captured.

Since the beginning of the 19th century Madras has known no regular war, but occasional disturbances have called for measures of repression. In 1836 the *zamindári* of Gumsur in this remote tract was attached by government for the rebellious conduct of its chief. In 1879 the country round Rampa on the northern frontier was the scene of riots necessitating calling out the troops, but more serious were the "Anti-Shanar riots" of 1899. The Maravans of Tinnevelly and parts of Madura, resenting the pretensions of the Shanans, a toddy-drawing caste, to a higher social and religious status, organized attacks on Shanan villages. In 1763 the tract encircling Madras city, then known as the Jagir now Chingleput district, was ceded to the British by the nawab of Arcot. In 1765 the Northern Circars, out of which the French had recently been driven, were granted to the Company by the Mogul emperor, but at the price of an annual tribute of £90,000 to the nizam of Hyderabad. Full rights of dominion were not acquired till 1823, when the tribute was commuted for a lump payment. In 1792 Tippoo was compelled to cede the Baramahal (now part of Salem district), Malabar and Dindigul subdivision of Madura. In 1799, on the reconstruction of Mysore state after Tippoo's death, Coimbatore and Kanara were appropriated as the British share; and in the same year the Mahratta rajah of Tanjore resigned the administration of his territory, though his descendant retained titular rank till 1855. In 1800 Bellary and Cuddapah were made over by the nizam of Hyderabad to defray the expense of an increased subsidiary force.

In the following year the dominions of the nawab of the Carnatic, extending along the east coast almost continuously from Nellore to Tinnevilly, were resigned into the hands of the British by a puppet who had been put upon the throne for the purpose.

The last titular nawab of the Carnatic died in 1855; but his representative still bears the title of prince of Arcot, and is recognized as the first native nobleman in Madras. In 1839 the nawab of Kurnool was deposed for misgovernment and suspicion of treason, and his territories were annexed.

See INDIA, *History* and HYDER ALI.

See *Madras Manual of Administration,* 3 vols. (Madras, 1885 and 1893); S. Ayyangar, *Forty Years' Progress in Madras* (Madras, 1893); J. P. Rees, *Madras* (Society of Arts, 1901); *Madras Provincial Gazetteer* (2 vols., Calcutta, 1908).

MADRAS, the capital of Madras presidency, and the chief seaport on the eastern coast of India and third city of India, is situated in 13° 4′ N. and 80° 17′ E. The city, with its suburbs, extends nine miles along the sea and nearly four miles inland, intersected by the little river Cooum. Area, 27 sq.mi.; pop. (1941), 777,481, of whom about five-sixths are Hindus.

In the decade from 1911 to 1921 the deaths were over 11% more numerous than the births, owing to the high infantile death rate.

Although at first sight the city presents a disappointing appearance, and has no handsome streets, it has several fine buildings and many spots of historical interest. It is spread over a very wide area, and many parts of it are almost rural in character. Roughly speaking, the city consists of the following divisions: (1) George Town (formerly Black Town, but renamed after the visit of the Prince of Wales in 1906), an ill-built, densely-populated block, about a mile square, is the business part of the town, containing the banks, custom house and high court. The mercantile offices lie along the beach and on the sea-face are the pier and the new harbour. Immediately south of George Town there is (2) an open space which contains Fort St. George, the Marina, a promenade by the seashore, Government house, and several public buildings on the sea-face. (3) West and south of this lung of the city are crowded quarters which bend to the sea again at the old town of Saint Thomé. (4) To the west of George Town are the quarters of Veperi and Pudupet, chiefly inhabited by Eurasians, and the European suburbs of Egmore, Nangambakam and Perambur. (5) South-west and south lie the European quarters of Tanampet and aristocratic Adyar. Notable buildings are the cathedral, general hospital, Government house, Pachayappa's hall, high court and Chepauk palace (now the revenue board). The city has drainage works and a filtered water supply.

Madras possesses no special industries. There are several large cotton mills, engineering, dyeing and cement works, iron foundries and cigar factories. Large sums of money have from time to time been spent upon the harbour, which is entirely artificial. It is screened by breakwaters enclosing 200 ac. of calm water, dredged to a depth of 30 ft., and is thoroughly equipped. A deep water quay was in process of construction in 1926. The sea bottom is unusually flat, reaching a depth of ten fathoms only at about 2 miles from the shore. Madras conducts about 46% of the seashore trade of the presidency. The chief exports are hides and skins, oil seeds, cotton, chrome and magnesite, and the imports timber, coal and oil, grain and machinery. Madras is the centre on which all the great military roads converge, and the terminal station of two lines of railway, the Madras & Southern Mahratta line and the Madras & Tanjore section of the South Indian railway. The municipal corporation, which is the oldest in India, consists of 50 councillors of whom 41 are elected under an annually elected president. The Madras university was constituted in 1857 as an examining body. The chief educational institutions in Madras city are the Presidency college; missionary and native colleges; the medical, engineering, law and veterinary colleges; the teachers' college in Saidapet and the school of arts.

The foundation of Madras dates from 1640, when Francis

Day, chief of the East India Company's settlement at Armagon, obtained a grant of the present site of the city from a native ruler. A fort was constructed, and a gradually increasing population settled around its walls. In 1653 Madras, which had previously been subordinate to the settlement of Bantam in Java, was made an independent presidency. In 1702 Daud Khan, Aurangzeb's general, blockaded the town for a few weeks, and in 1741 the Mahrattas unsuccessfully attacked the place. In 1746 La Bourdonnais bombarded and captured Madras. The settlement was restored to the English two years later by the Treaty of Aix-la-Chapelle, but the government of the presidency did not return to Madras till 1762. In 1758 the French under Lally occupied the Black Town and invested the fort. After two months an English fleet relieved the garrison. Saint Thomé, now part of Madras, founded and fortified by the Portuguese in 1504, was held by the French from 1672 to 1674.

MADRAZO Y KUNT, DON FEDERICO DE (1815–1894), Spanish painter, was born in Rome on the 12th of February 1815. He was the son of the painter Madrazo y Agudo (1781–1859), and received his first instruction from his father, afterwards attending the classes at the Academy of San Fernando. His "Continence of Scipio," secured him admission to the Academy as a member "for merit." While decorating the palace of Vista Alegre he took up portraiture. In 1852 he went to Paris, where he studied under Winterhalter and painted portraits of Baron Taylor and of Ingres. In 1837 he carried out special work for the Gallery at Versailles. Then the artist made a lengthy stay in Rome, where he painted many subjects, sacred and profane. His sojourn in Italy was not without influence upon his subsequent work. He received the Legion of Honour in 1846. He was made a corresponding member of the Paris Academy of Fine Arts on the 10th of December 1853, and in 1873, on the death of Schnorr, the painter, he was chosen foreign member. After his father's death he succeeded him as director of the Prado Gallery and president of the Academy of San Fernando. He originated in Spain the production of art reviews and journals, such as *El Artista, El Renacimiento* and *El Semanario pintoresco*. He died at Madrid on the 11th of June 1894.

His brother, Don Louis De Madrazo, was also known as a painter, chiefly by his "Burial of Saint Cecilia" (1855). Don Federico's best-known pupil was his son, Don Raimundo De Madrazo (1841–1920).

His principal works are "Godfrey de Bouillon proclaimed King of Jerusalem," commissioned for Versailles (1837); "Maria Christina in the Dress of a Nun by the Bedside of Ferdinand III" (1843), "Queen Isabella," "The Duchess of Medina-Coeli," and "The Countess de Vilchès" (1845–47), besides a number of portraits of the Spanish aristocracy, some of which were sent to the exhibition of 1855.

MADRE DE DIOS, a department in eastern Peru, created in 1912, estimated to contain 58,842 sq.mi. It is situated in the *montaña* district east of the cordillera and is bounded north and east by Brazil and Bolivia, and south, west and north by the departments of Puno and Cusco. It occupies part of the headwaters basin of the Madre de Dios river, which flows via the Madeira river into the Amazon. Its population in 1940 was 25,212. Its capital, Puerto Maldonado, is situated on the Tambopata river at its junction with the Madre de Dios. The district, largely unexplored, possesses immense forest resources, including rubber, and gold and silver are known to exist. A railway has been projected from the Cusco line, and if carried to completion, development of the department may be rapid.

MADRID, a province of central Spain, formed in 1833 of districts previously included in New Castile, and bounded on the W. and N. by Ávila and Segovia, E. by Guadalajara, S.E. by Cuenca and S. by Toledo. Population (1940) 1,579,793, of whom 1,088,647 inhabited the city of Madrid; area, 3,090 sq.mi. Madrid belongs to the basin of the Tagus, being separated from that of the Douro by the Sierra de Guadarrama on the northwest and north, and by the Sierra de Gredos on the south-west. Like the rest of Castile, Madrid is chiefly of Tertiary formation; the soil is mostly clayey, but in part sandy. The south-eastern districts are the best watered, and produce in abundance fruit, vegetables, wheat, olives, esparto grass and excellent wine. To the north, there is timber for fuel and building. The royal domains of the Escorial, Aranjuez and El Pardo, and the preserves of the nobility, are wooded and supplied with game. The Sierra de Guadarrama has quarries of granite, lime and gypsum, and is known to contain iron, copper and argentiferous lead. Other industries are chiefly confined to the capital. All the great railways converge in this province, and it contains 221 mi. of line. Besides Madrid, the towns of Aranjuez (21,771), Alcalá de Henares (18,013) and the Escorial are described in separate articles. Other towns with more than 10,000 inhabitants are Puente de Vallecas (55,707), Chamartín (64,480) and Carabanchel Bajo (17,327), Vistalegre-Ventas (18,547), Pueblo-Nuevo-Ventas (17,698).

MADRID, the capital of Spain and of the province of Madrid, on the left bank of the river Manzanares, a right-hand tributary of the Jarama, which flows south into the Tagus. Pop. (1877), 397,816; (1900), 539,835; (1940) 1,088,647. The earliest authentic historical mention of the town (Majrít, Majoritum) occurs in the Arab chronicle, and does not take us farther back than to the first half of the 10th century. The place was finally taken from the Moors by Alphonso VI (1083), and was made a hunting seat by Henry IV, but first rose into importance when Charles V, benefiting by its keen air, made it his occasional residence. Philip II created it his capital and "only court" (*única corte*) in 1560. It is only classed as a town (*villa*), having never received the title of city (*ciudad*). Madrid is the see of an archbishop, the focus of the principal Spanish railways, the headquarters of an army corps, the seat of a university and was formerly the chief residence of the king, the court, and the captain-general of New Castile. It is surpassed in ecclesiastical importance by Toledo and in commerce by Barcelona.

Madrid is built on an elevated and undulating plateau of sand and clay, which is bounded on the north by the Sierra Guadarrama and merges on all other sides into the barren and treeless tableland of New Castile. The highest point in Madrid is 2,372 ft. above sea level. The city is close to the geographical centre of the peninsula, nearly equidistant from the Bay of Biscay, the Mediterranean and the Atlantic. Owing to its high altitude and open situation it is liable to sudden and frequent variations of climate, and the daily range of temperature sometimes exceeds 50°, the total range being from 10° to 110°.

The Inner City.—The form of Madrid proper (exclusive of the modern suburbs) is almost that of a square with the corners rounded off; from east to west it measures rather less than from north to south. Of the 16 city gates only three, the Puerta de Alcalá on the east, the Puerta de Toledo on the south and the Portillo de San Vicente on the west, actually exist. The Manzanares is spanned by six bridges, the Puente de Toledo and Puente de Segovia being the chief.

The Puerta del Sol is the centre of Madrid, the largest of its many plazas, and the place of most traffic. It derived its name from the former east gate of the city, which stood here until 1570, and had on its front a representation of the sun. On its south side stands the Palacio de la Gobernacion, or ministry of the interior, a heavy square building dating from 1768.

The Calle de Alcalá contains the Real Academia de Bellas Artes, founded in 1752 as an academy of art and music; its collection of paintings by Spanish masters includes some of the best-known works of Murillo. The Bank of Spain (1884–91) stands where the Calle de Alcalá meets the Prado; in the oval Plaza de Madrid, at the same point, is a fine 18th-century fountain with a marble group representing the goddess Cybele drawn in a chariot by two lions. The Plaza de las Cortes is so called from the Congreso de los Diputados, or house of commons, on its north side. The Plaza Mayor, built in 1619, a rectangle of about 430 ft. by 330 ft., was formerly the scene of tournaments, bull fights and *autos de fé,* which used to be viewed by the royal family from the balcony of one of the houses called the Panaderia (belonging to the guild of bakers). The house occupied by Cervantes from 1606 until his death in 1616 stands at the point where it meets the Calle de León; in this street is the Real Academia de la Historia, with a valuable library and collections of mss. and plate. In the centre of the Plaza del Oriente is a fine bronze equestrian statue of Philip IV (1621–65); it was designed by Velazquez and cast by Tacca.

Modern Development of the City.—The north and east of the city—the new suburbs—developed past the Retiro park as far as the Bull-ring, and covered all the vast space included between the Retiro, the Bull-ring and the long Paseo de la Castellana. Madrid made very rapid progress during the 20th century. The underground railway (inaugurated in 1924) facilitated the growth of garden cities, as at Carabanchel; a new broad Ronda was built from Atocha to the park of Moncloa; the Manzanares was canalized and land reclaimed along its banks; the Gran Via was completed; the Calle de Alcalá was adorned by the construction of fine banks, a new ministry, and the magnificent general post office at the end of the street; the Paseo de la Castellana was prolonged to beyond Chamartín de la Rosa; and many new parks and fine buildings were constructed prior to the civil war of 1936–39. A large new bull-ring and stadium were opened.

Principal Buildings.—As compared with other capitals Madrid has very few buildings of much architectural interest. The Basilica de Nuestra Señora de Atocha was originally founded in 1523. The collegiate church of San Isidro el Real, in the Calle de Toledo, dates from 1651; it is dedicated to St. Isidore the Labourer (d. 1170), the patron saint of Madrid, whose remains were entombed here. The church of San Francisco el Grande, which contains many interesting monuments, is also known as the National Pantheon. Of secular buildings most important is the former royal palace (Palacio Real), on the west side of the town, on rising ground overhanging the Manzanares. The present edifice was begun under Philip V in 1737 by Sacchetti of Turin, and was finished in 1764. It is in the Tuscan style, and is 470 ft. square and 100 ft. in height, the material being white Colmenar granite. It contains a valuable library and a celebrated collection of tapestries. To the north of the palace are the former royal stables and coach houses, remarkable for their extent; to the south is the armoury (Museo de la Real Armería), containing what is possibly the best collection of the kind in existence. After the Palacio Real may be mentioned the royal picture gallery (Real Museo de Pinturas), adjoining the Salon del Prado; it was built about 1785 as a museum of natural history and academy of sciences. It contains the collections of Charles V, Philip II and Philip IV, and the pictures number upwards of 2,000. They include Titian, Raphael, Tintoretto, El Greco, Ribera, Velazquez, Goya, Vandyck, Rubens and Teniers. An improved grouping of the pictures added greatly to its charm. The Biblioteca Nacional, in the Paseo de Recoletos, was founded in 1866, and completed in 1892. Eastward from the Prado are the Buen Retiro gardens, with ponds and pavilions, and a menagerie. The gardens were formerly the grounds surrounding a royal hunting seat, on the site of which a palace was built for Philip IV in 1633; it was destroyed during the French occupation.

Education, Religion and Charity.—Madrid university developed gradually out of the college of Doña Maria de Aragon, established in 1590 by Alphonso Orozco. Schools of mathematics and natural science were added in the 16th and 17th centuries, and in 1786 the medical and surgical college of San Carlos was opened. In 1836–37 the University of Alcalá de Henares (*q.v.*) was transferred to the capital and the older foundations incorporated with it. The University of Madrid thenceforth became the headquarters of education in central Spain. It has an observatory, and a library containing more than 2,000,000 printed books and mss. It gives instruction, chiefly in law and medicine, but also in literature, philosophy, mathematics and physics. Associated with the university is the preparatory school of San Isidro, founded by Philip IV (1621–65), and reorganized by Charles III in 1770. The modern Residencia de Estudiantes does excellent work. A great new university project, located in one of the suburbs, was started in 1927; uncompleted in 1936, it was the scene of much fighting in the civil war and was practically destroyed.

There are some 100 official primary schools and a large number of private ones, among which the schools conducted by the Jesuits and the Scolapian fathers claim special mention. Madrid also has schools of agriculture, architecture, civil and mining engineering, the fine arts, veterinary science and music. The school of military engineering is at Guadalajara. Besides these special schools there are a self-supporting institute for preparing girls for the higher degrees and for certificates as primary teachers, and an institute for secondary education, conducted chiefly by ecclesiastics. Among the educational institutions may be reckoned the botanical garden, dating from 1781, the libraries of the palace, the university, and San Isidro, and the museum of natural science, exceedingly rich in the mineralogical department. The principal learned society is the royal Spanish academy, founded in 1713 for the cultivation and improvement of the Spanish tongue.

Industries.—The industries of the capital developed extraordinarily after 1890. Among the most important factories are those which make articles of leather. Next come the manufactures of fans, umbrellas, sunshades, chemicals, varnishes, buttons, wax candles, beds, cardboard, porcelain, coarse pottery, matches, baskets, sweets and preserves, gloves, guitars, biscuits, furniture, carpets, corks, cards, carriages, jewellery, drinks of all kinds, plate and plated goods. There are also tanneries, saw and flour mills, glass and porcelain works, soap works, brickfields, paper mills, zinc, bronze, copper and iron foundries.

The Siege of Madrid, 1936–39.—As the capital of Spain, Madrid was the grand prize in the 1936 rebellion, and as soon as the nationalists had united their northern and southern armies in the Badajoz area, a concerted drive was started on Madrid. Four columns were converging on the city by November, and a remark by Gen. Emilio Mola, that he had a "fifth column" of sympathizers inside the city itself, gave a new phrase to world idiom. The fall of Madrid seemed imminent, and the loyalist government was moved to Valencia Nov. 9, 1936. After initial success in the suburbs, the nationalist attack was halted by the tremendous resistance of the untrained Madrid populace. For the remainder of the winter there was a deadlock, with German and Italian forces coming to the aid of the nationalists, and with the loyalists receiving help principally from Russia. In April 1937, a "popular front" defense council, representing the various socialist factions in the city, took over civil government of Madrid, although Gen. José Miaja still remained in military command. The city suffered heavily from bombardments by artillery and from air raids, notably in June 1937, and in November and December of the same year. In 1938 the forces remained deadlocked; bombardment continued, and by July rationing of food was necessary within the city. The opening of a nationalist drive late in Dec. 1938, calculated to cut off Madrid from the east coast, started the final phase of the attack. The loyalist government was driven back to Madrid from Valencia in Feb. 1939. After many riots in the city by factional groups, the capital surrendered to Gen. Francisco Franco March 29, 1939.

See J. Amador de los Rios, *Historia de la villa y corte de Madrid* (1861–64); Valverde y Álvarez, *La Capital de España* (Madrid, 1883); E. Sepúlveda, *La Vida en Madrid en 1886* (1887); H. Peñasco, *Las Calles de Madrid* (1889); F. X. de Palacio y Garcia, count of las Almenas, *La Municipalidad de Madrid* (1896); E. Sepúlveda, *El Madrid de los recuerdos: colección de articulos* (1897); P. Hauser, *Madrid bajo el punto de vista medico-social* (1902); L. Williams, *Toledo and Madrid, their Records and Romances* (1903). E. Tormo, *Las Iglesias del antiguo Madrid* (1927).

MADRIGAL. As a definite musical art-form, the madrigal was known by the middle of the 15th century (*see* ARCADELT). It developed on the same lines as the Motet (*q.v.*) some early examples even combining an ecclesiastical canto fermo in the tenor with secular counterpoint in the other parts. Thus Josquin's *Deploration de Jehan Okenheim* (*see* MUSIC) might be called a madrigal if the term were used for compositions to French texts at all. But by the middle of the 16th century the Italian madrigal had become the highest form of secular music, and the name was appropriated to Italian compositions regardless of the form of the words. Only Yonge's *Musica Transalpina* saved the title for English composers, and this by providing singable English texts for Italian compositions. When Lasso sets Marot's madrigals he calls his compositions "chansons." On the other hand, when Palestrina composes Petrarca's sonnets to the Virgin in memory of

*In modern scores this highly characteristic effect was first correctly transcribed in Dr. Fellowes's complete collection of the English Madrigal School.

Laura, the result appears as a volume of *Madrigali spirituali.* The fame of these made elegiac madrigals, spiritual or secular, as common as livelier kinds.

The term means a polyphony not inferior to that of the motet, and thus distinguishes madrigals from *ballets, villanellas, frottolas* and other fantastic trifles. Masses were often founded on the themes of madrigals, with little more scandal than when they used the themes of motets (*see* MASS; MOTET). Some of Palestrina's masses remained in high favour even though they were avowedly founded on madrigals with almost risqué texts.

In the 17th century the new dramatic style of Monteverdi (*q.v.*) and the eclectic experiments of Schütz put the breaking-strain upon the madrigal. It had already been overworked in the attempt to make music-drama by a choir behind the stage with pantomime in front. Vecchi, a great polyphonist, laughed this to death in his *Amfiparnasso* (*see* OPERA).

Later uses of the term seldom have a definite meaning, though there was a remarkable vitality in the mid-19th century efforts of De Pearsall, in pure madrigal style; while the *Madrigale spirituale* in Stanford's oratorio *Eden* has the beauty of pure scholarship.

(D. F. T.)

MADROÑO (*Arbutus menziesii*), a handsome North American tree of the heath family (*Ericaceae*), called also madrone and laurelwood, native to the coast region from British Columbia to southern California. It is a widely branched tree, growing to a height of 125 ft., with a trunk diameter exceeding 4 ft.; polished crimson to dark brown bark; large, lustrous, dark-green leaves, nearly white beneath; small, heath-like, white flowers in dense clusters, and bright orange-red, berry-like fruit.

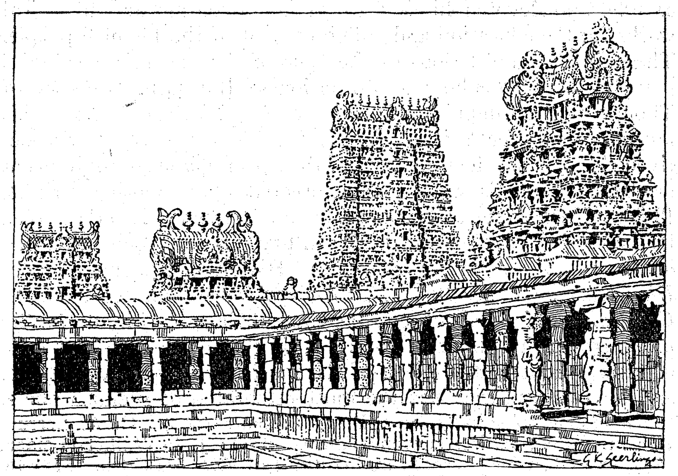
MADURA, an island and residency of the Neth. Indies (Dutch *Madoera*), lying off the north-east coast of Java, from which it is separated by a shallow strait less than $1\frac{1}{2}$ miles. It is over 100 miles long and 24 miles wide and has an area of 5,473 sq.km. Pop. 1,962,462 (1051 Europeans and Eurasians). It has an undulating surface, but no mountains, 700 ft. being the greatest elevation in the west and 1,565 ft. that of the east. In the north the hills run down nearly to the sea: in the north-west and south there are extensive alluvial plains, whilst the south coast is fringed with islets, shoals and mud-banks. The geological formation reveals the relation of Madura to northern Java, since it consists largely of the same limestone rocks, of Tertiary formation, with low alluvial tracts: there are hot springs. Off the eastern coast are several islands—Sapudi, and the Kangean group, Kangean Island being 25 miles long and from 3 to 15 wide, with hills reaching 1,500 ft.

The climate, flora and fauna of Madura resemble those of East Java. Vegetation is luxuriant, but the soil is not as fertile as the average soil in Java, and one indication of this is that rice has to be imported to meet the needs of the population. Maize and cassava are the main crops, but rice, coco-nuts, coffee, coca, kapok and most of the usual Malayan fruits and vegetables are grown, and kapok, copra and coconut oil figure largely in exports, also teak, from the extensive forests in the northwest. The island is well adapted for cattle-breeding, which is engaged in extensively, and the wide expanse of coast, well sheltered on the southern side, gives opportunity for a great deal of fishing: the Kangean Islands and Sapudi yield timber, trepang and tortoise-shell. The principal industry is that of salt winning, which is a government monopoly.

The salt is obtained from saline springs and from sea water, and the largest pans are situated at Kalianget. Manufacture is according to European method and gives employment to many. The 1939 yield was 141,208 metric tons (1938: 74,411). Petroleum has been found and is worked on a small scale. The Madurese (Mohammedans), who are keen traders, fishermen and sailors, but not very good craftsmen, are shorter, but more sturdily built than the Javanese; they are also more independent, and quick-tempered, but thrifty and hard-working, and their moral standard is high: they have their own peculiar amusements of bull-racing and bull-fighting; the races, usually held in the month of September, attract huge crowds. The capital and seat of the Resident is Pamekasan, in the central southern part of the island, not far from the coast, pop. 13,403 (269 Europeans and Eurasians), which has modern buildings, including a hotel. Other towns are Sumenep, population 17,824, near which are the tombs of the princes of Sumenep; Bangkalan, population 24,000, with the old palace of the Sultan of Bangkalan, or Madura, and an interesting mosque; Sampang, pop. 12,673; Kamal; and Kalianget. A tram line crosses the island from west to east, from Kamal to Kalianget, connection being maintained with Java by means of a ferry service between Surabaya and Kamal: the line extends to Bangkalan, in the north, and passes through Pamekasan and Sumenep. There are roads along the north and south coasts, and across the centre of the island. There is telegraphic communication with Java, and Pamekasan and Sumenep possess telephone services. Dutch influence was established in Madura late in the 17th century, and the power of the ambitious prince of Madura was circumscribed by the division of the island into three regencies, Madura (or Bangkalan), Pamekasan, and Sumenep, each having its own prince, or sultan. After much native misrule, the regencies were, in 1885, united under a residency attached to Java. Japan took Madura in 1942.

See P. J. Veth, *Java, geografisch, ethnologisch, historisch,* 4 vols. Haarlem, 1896–1907. (E. E. L.)

MADURA, a city and district of British India, in the Madras presidency. The city is situated on the right bank of the river Vaigai, and has a station on the South Indian railway 345 m. S.E. of Madras. Pop. (1941), 239,144. There is a government industrial school. Muslin weaving is a special industry,



FROM BENOIT "ARCHITECTURE DE L'ORIENT MEDIEVAL ET MODERNE" (LIBRAIRIE RENOUARD)

THE COURTYARD OF THE LOTUS LAKE, IN THE GREAT TEMPLE AT MADURA

This temple, said to have been built in the 16th century, is noted for its elaborately carved *gopuras*, four of which are seen in the above view

and brass work and wood carving are carried on. The city was the capital of the old Pandyan dynasty, which ruled over this part of India from the 5th century B.C. to the end of the 11th century A.D. Its great temple forms a parallelogram and is surrounded by nine elaborately carved and coloured *gopuras,* of which the largest is 152 ft. high. The temple, which contains a "hall of a thousand pillars" and some of the finest carving in southern India, is said to have been built in the reign of Viswanath, first ruler of the Nayak dynasty. The splendid palace of Tirumala Nayak, which covers a large area, has been restored, and is used for public offices. Also, there are Vasanta, a hall 33 ft. long, and the Tamakam, a pleasure-palace.

The last of the old Pandyan kings is said to have exterminated the Jains and conquered the neighbouring kingdom of Chola; but he was in his turn overthrown by an invader from the north. In 1324 a Moslem army under Malik Kafur occupied Madura, which subsequently became a province of the Hindu empire of Vijayanagar. In the middle of the 16th century the governor Viswanath established the Nayak dynasty, which lasted for a century. The greatest of the line was Tirumala Nayak (reigned 1623–59), who adorned Madura with many public buildings, and extended his empire over adjoining districts. Later Mohammedans again invaded Madura and compelled him to pay them tribute. After his death the kingdom of Madura gradually fell to pieces, being invaded by both Mohammedans and Mahrattas. About 1736 the district fell into the hands of the nawab of the Carnatic, and the line of the Nayaks was extinguished. About 1764 British officers took charge of Madura in trust for the last independent nawab of the Carnatic, whose son finally ceded his rights of sovereignty to the East India company in 1801.

The District of Madura has an area of 4,883 sq.mi. Pop. (1941) 2,446,601. It consists of a section of the plain stretching from the mountains east to the sea, coinciding with the basin of the Vaigai river, and gradually sloping to the south-east. The plain is broken by the outlying spurs of the Ghats, rising 8,000 feet above sea level. They enclose a plateau of about 100 square miles. On it is situated the sanatorium of Kodaikanal, and fruit is grown and coffee-planting carried on. Other crops are millets, rice, other food-grains, oil-seeds and cotton. Tobacco is grown chiefly near Dindigul. The Periyar tunnel through the Travancore hills, conveys the rainfall across the watershed for irrigation.

MADVIG, JOHAN NICOLAI (1804–1886), Danish philologist, was born on the island of Bornholm, on Aug. 7, 1804. He was educated at Frederiksborg and at the University of Copenhagen, where in 1829 he became professor of Latin language and literature. In 1848 Madvig entered parliament and became minister of education, and later (1852), director of public instruction. From 1856 to 1863 he was president of the council and leader of the National Liberal party. His chief work was the study and teaching of Latin and Greek, and the improvement of the classical schools. He died at Copenhagen on Dec. 12, 1886.

Besides his unsurpassed edition of Cicero's *De Finibus* (1839, 3rd ed., 1876), Madvig published *Der römische Stats Forfatning og Forvaltning* (2 vols., 1881–82, Fr. trs., 1882–84); *Livseringringer* (1887); and many works on Latin grammar and Greek syntax. *See* J. E. Sandys, *History of Classical Scholarship,* iii. (2nd ed., 1908).

MAECENAS, GAIUS (Cilnius), Roman patron of letters, was probably born between 74 and 64 B.C., perhaps at Arretium. Expressions in Propertius (ii. 1, 25–30) seem to imply that he had taken some part in the campaigns of Mutina, Philippi and Perusia. He prided himself on his Etruscan lineage, and claimed descent from the princely Cilnii of Arretium. His great wealth may have been in part hereditary, but he owed his position and influence to his close connection with the emperor Augustus. He first appears in history in 40 B.C., when he was employed by Octavian in arranging his marriage with Scribonia, and afterwards in assisting to negotiate the peace of Brundusium and the reconciliation with Antony. It was in 39 B.C. that Horace was introduced to Maecenas, who had before this received Varius and Virgil into his intimacy. In the "Journey to Brundusium," (Horace, *Satires,* i. 5) in 37, Maecenas and Cocceius Nerva are described as having been sent on an important mission, and they were successful in patching up, by the Treaty of Tarentum, a reconciliation between the two claimants for supreme power. During the Sicilian war against Sextus Pompeius in 36, Maecenas was sent back to Rome, and was entrusted with supreme administrative control in the city and in Italy. He was vice-gerent of Octavian during the campaign of Actium, when, with great promptness and secrecy, he crushed the conspiracy of the younger Lepidus; and during the subsequent absences of his chief in the provinces he again held the same position. During the latter years of his life he fell somewhat out of favour with his master. Maecenas died in 8 B.C., leaving the emperor heir to his wealth.

He seems to have been of great use to Augustus in the establishment of the empire, and was credited with having influenced him towards a humane policy. The best summary of his character as a man and a statesman is that of Velleius Paterculus (ii. 88), who describes him as "of sleepless vigilance in critical emergencies, far-seeing and knowing how to act, but in his relaxation from business more luxurious and effeminate than a woman." His character as a munificent patron of literature has made his name a household word. His patronage was exercised with a political object, and he sought to use the genius of the poets of the day to glorify the new régime. The diversion of Virgil and Horace towards themes of public interest may be ascribed to him, and he endeavoured less successfully to do the same thing with Propertius. The great charm of Maecenas in his relation to the men of genius who formed his circle was his simplicity, cordiality and sincerity. He admitted none but men of worth to his intimacy, and when once admitted they were treated like equals. Much of the wisdom of Maecenas probably lives in the *Satires* and *Epistles* of Horace. It has fallen to the lot of no other patron of literature to have his name associated with works of such lasting interest as the *Georgics* of Virgil, the first three books of Horace's *Odes,* and the first book of his *Epistles.*

Maecenas himself wrote in both prose and verse. His prose works on various subjects—*Prometheus, Symposium* (a banquet at which Virgil, Horace and Messalla were present), *De cultu suo* (on his manner of life)—were ridiculed by Augustus, Seneca and Quintilian for their awkward style. Dio Cassius states that Maecenas was the inventor of a system of shorthand.

There is no good modern biography of Maecenas. The best known is that by P. S. Frandsen (1843). *See* "Horace et Mecène" by J. Girard, in *La Révue politique et littéraire* (Dec. 27, 1873); V. Gardthausen, *Augustus und seine Zeit,* i. 762 *seq.;* ii. 432 *seq.* The chief ancient authorities for his life are Horace (*Odes* with Scholia), Dio Cassius, Tacitus (*Annals*), Suetonius (*Augustus*). The fragments have been collected and edited by F. Harder (1889).

MAECIANUS, LUCIUS VOLUSIUS (2nd. cent.), Roman jurist, was the tutor in law of the emperor Marcus Aurelius. When governor of Alexandria he was slain by the soldiers, as having participated in the rebellion of Avidius Cassius (175). Maecianus was the author of works of trusts (*Fideicommissa*), on the *Judicia publica,* and of a collection of the Rhodian laws relating to maritime affairs. His treatise on numerical divisions, weights and measures (*Distributio*) is in part extant.

See Capitolinus, *Antoninus,* 3; Vulcacius Gallicanus, *Avidius Cassius,* 7; edition of the metrological work by F. Hultsch in *Metrologicorum scriptorum reliquiae,* ii. (1866); Mommsen in *Abhandlungen der sächsischen Gesellschaft der Wissenschaften,* iii. (1853).

MAELDUIN or **MAELDUNE, VOYAGE OF,** an early Irish romance. The text exists in an 11th-century redaction, by a certain Aed the Fair, the "chief sage of Ireland," but dates back to the 8th century. It belongs to the group of Irish romance, the *Navigations* (*Imrama*), resembling the classical tales of the wanderings of Jason, of Ulysses and of Aeneas. Maelduin, the foster-son of an Irish queen, learnt on reaching manhood that he was the son of a nun, and that his father, Ailill of the edge of battle, had been slain by a marauder from Leix. He set sail to seek his father's murderer, taking with him, in accordance with the instructions of a sorcerer, 17 men. His three foster-brothers swam after him, and were taken on board. This increase of the fateful number caused Maelduin's vengeance to be deferred for three years and seven months, until the last of the intruders had perished. The travellers visited many strange islands, and met with a long series of adventures, some of which are familiar from other sources. The *Voyage of St. Brendan* (*q.v.*) has very close similarities with the *Maelduin,* of which it is possibly a clerical imitation, with the important addition of the whale-island episode, which it has in common with "Sindbad the Sailor."

Imram Curaig Mailduin, is preserved, in each case imperfectly, in the *Lebor na h Uidre,* a ms. in the Royal Irish academy, Dublin; and in the *Yellow Book of Lecan,* ms. H. 216 in the Trinity college library, Dublin; fragments are in Harleian ms. 5,280 and Egerton ms. 1,782 in the British Museum. There are translations by Patrick Joyce, *Old Celtic Romances* (1879), by Whitley Stokes (a more critical version, printed together with the text) in *Revue celtique,* vols. ix. and x. (1888–89). *See* H. Zimmer, "Brendan's Meerfahrt" in *Zeitschrift für deutsch. Altertum.,* vol. xxxiii. (1889). Tennyson's *Voyage of Maeldune* includes the framework of the romance.

MAELIUS, SPURIUS (d. 439 B.C.), a wealthy Roman plebeian, who during a severe famine bought up a large amount of corn and sold it at a low price to the people. Lucius (or Gaius) Minucius, the patrician *praefectus annonae* (president of the market), thereupon accused him of courting popularity with a view to making himself king. The cry was taken up. Maelius, summoned before the aged Cincinnatus (specially appointed dictator), refused to appear, and was slain by Gaius Servilius Ahala; his house was razed to the ground, his corn distributed amongst the people, and his property confiscated. The open space called Aequimaelium, on which his house had stood, preserved the memory of his death.

See Livy, iv. 13; Cicero, *De senectute* 16, *De amicitia* 8, *De republica,* ii. 27; Florus, i. 26; Dion. Halic. xii. 1.

MAELSTROM, a term originally applied to the Moskenstrom, a strong current running between the islands of Moskenaes and Mosken in the Lofoten Islands off the west coast of Norway. Its power has been much exaggerated though it is dangerous in certain states of wind and tide. The original name occurs on Mercator's *Atlas* of 1595, and it has been used generically for large whirlpools elsewhere. It is probably from Dutch *malen,* to grind, and *stroom,* a stream.

MAENADS, the female attendants of Dionysus (Gr. Μαινάδες, frenzied women); also called Bacchae, Lenae, Thyiades, Clodones and Mimallones.

See A. Legrand in Daremberg and Saglio's *Dictionnaire des antiquités,* and A. Rapp in Roscher's *Lexikon.*

MAERLANT, JACOB VAN (*c.* 1235–*c.* 1300), Flemish poet, was born in the Franc de Burges (tradition says at Damme) between 1230 and 1240. He was sacristan of Maerlant, in the island of Ost-Voorne, and afterwards clerk to the magistrates at Damme. His early works are free translations of French romances. Maerlant's most serious work in the field of romance was his *Ystorien van Troyen* (*c.* 1264), a poem of some forty thousand lines, translated and amplified from the *Roman de Troie* of Benoît de Sainte-More. From this time Maerlant rejected romance as idle, and devoted himself to writing scientific and historical works for the education and enlightenment of the Flemish people. These include translations of the *Secreta Secretorum;* a metrical paraphrase of Josephus; a translation of the natural history of Thomas de Cantimpré; and other works. In 1284 he began his *magnum opus,* the *Spiegel historiael,* a history of the world, derived chiefly from the third part of the *Speculum majus* of Vincent de Beauvais. This work was completed by two other writers, Philipp Utenbroeke and Lodowijk van Velthem. Maerlant died in the closing years of the 13th century, his last poem, *Van den lande van oversee,* dating from 1291. His original poems include: *Die Clausule van der Bible, Der Kerken Clage,* imitated from the *Complaintes* of Rutebeuf, and the three dialogues entitled *Martijn* in which the fundamental questions of theology and ethics were discussed. Maerlant was one of the most learned men of his age, and for two centuries was the most celebrated of Flemish poets.

See monographs by J. van Beers (Ghent, 1860); C. A. Serrure (Ghent, 1861); K. Versnaeyen (Ghent, 1861); J. te Winkel (Leiden, 1877, 2nd ed., Ghent, 1892); and editions of *Torec* (Leiden, 1875) by J. te Winkel; of *Naturen Bloeme,* by Eelco Verwijs; of *Alexanders Geesten* (Groningen, 1882), by J. Franck; *Merlijn* (Leiden, 1880–82), by J. van Bloten; *Heimelicheit der Heimelicheden* (Dordrecht, 1838), by Clarisse; *Der Naturen Bloeme* (Groningen, 1878), by Verwijs; of *Rijmbijbel* (Brussels, 1858–69), by David; *Spiegel historiael* (Leiden 1857–63), by Verwijs and de Vries; selections from the *Ystorien van Troyen* (1873), by J. Verdam.

MAES, NICOLAS (1632–1693), Dutch painter born at Dordrecht, went about 1650 to Amsterdam, where he entered Rembrandt's studio. Before his return to Dordrecht in 1654 Maes painted a few Rembrandtesque genre pictures, with life-size figures and in a deep glowing scheme of colour, like the "Reverie" at the Ryks museum in Amsterdam, the "Card Players" at the National Gallery, and the "Children with a Goat Carriage," in the collection of the late J. P. Morgan, New York. In his best period, from 1655 to 1665, Maes devoted himself to domestic genre on a smaller scale, retaining to a great extent the magic of colour he had learnt from Rembrandt. His favourite subjects were women spinning, or reading the Bible, or preparing a meal. He visited Antwerp between 1660 and 1670, and his Antwerp period coincides with a complete change in style and subject. He devoted himself almost exclusively to portraiture, and abandoned the intimacy and glowing colour harmonies of his earlier work for a careless elegance which suggests the influence of Van Dyck. The change gave rise to the theory of the existence of another Maes, of Brussels. Maes is well represented at the National Gallery by five paintings: "The Cradle," "The Dutch Housewife," "The Idle Servant," "The Card Players," and a man's portrait. At Amsterdam, besides the splendid examples to be found at the Ryks museum, is the "Inquisitive Servant" of the Six collection. At Buckingham Palace is "The Idle Servant," and at Apsley House "Selling Milk" and "The Listener." Other examples are at Berlin, Brussels, Leningrad, The Hague, Frankfort, Hanover and Munich.

See Hofstede DeGroot, *Catalogue of Dutch Painters* (1916).

MAESTRO, a warm north-westerly summer wind chiefly prevalent on the western coast of the Adriatic sea and associated with the eastward movement depressions south of Italy; in winter it is a cool wind contrasting with the sirocco (*q.v.*).

MAETERLINCK, MAURICE (1862–), Belgian-French dramatist and poet, of Flemish extraction, was born at Ghent on Aug. 29, 1862. He was educated at the Collège Sainte-Barbe, and then at the university of Ghent. In 1887 he settled in Paris, where he immediately became acquainted with Villiers de l'Isle-Adam and the leaders of the symbolist school of French poetry. At the death of his father, Maeterlinck returned to Belgium, where he thenceforth mainly resided: in the winter at Ghent, in the summer on an estate at Oostacker. His career as an author began in 1889, when he published a volume of verse, *Serres chaudes,* and a play, *La Princesse Maleine,* the latter originally composed in metre, but afterwards rewritten in prose. In 1890 he published, in Brussels, two more plays, *L'Intruse* and *Les Aveugles;* followed in 1891 by *Les Sept princesses.* His strong leaning to mysticism was now explained, or defined, by a translation of the *Adornment of the Spiritual Marriage* of Ruysbroeck (*q.v.*) which Maeterlinck brought out in 1891. In 1892 appeared *Pelléas et Mélisande,* followed in 1894 by those very curious and powerful little dramas written to be performed by marionettes: *Alladine et Palomides, Intérieur* and *La Morte de Tintagiles.* In 1895 Maeterlinck brought out, under the title of *Annabella,* a translation of Ford's *'Tis Pity She's a Whore,* with a preface. Two philosophical works followed, a study on Novalis (1895) and *Le Trésor des humbles* (1896). In 1896 he returned to drama with *Aglavaine et Sélysette* and to lyric verse with *Douze chansons.* A monograph on the ethics of mysticism, entitled *La Sagesse et la destinée,* was issued, as a kind of commentary on his own dramas, in 1898; and in 1901 Maeterlinck produced a volume of prose, in which philosophy, fancy and natural history were mingled—*La Vie des abeilles.*

The nature of Maeterlinck's early writings, whether in prose or verse, was strictly homogeneous. Whether in philosophy, or drama, or lyric, Maeterlinck was exclusively occupied in revealing, or indicating, the mystery which lies only just out of sight, beneath the surface of ordinary life. In order to produce this effect of the mysterious he aimed at an extreme simplicity of diction, and a symbolism so realistic as to be almost bare. His plays are occupied with the spiritual adventures of souls, and the ordinary facts of time and space have no influence upon the movements of the characters. We know not who these orphan princesses, these blind persons, these pale Arthurian knights, these aged guardians of desolate castles, may be; we are not informed whence they come, nor whither they go; there is nothing concrete or circumstantial about them. Their life is intense and consistent, but it is wholly of a spiritual character; they are mysterious with the mystery of the movements of a soul. In spite of the shadowy action of Maeterlinck's plays, which indeed require some special conditions and contrivances for their performance, they are produced with remarkable success before audiences who cannot be suspected of mysticism, in most of the countries of Europe. His later work, published after he settled in France, presents a marked contrast. Several of his pre-War essays, collected in *The Buried Temple* (1902), *The Double Garden* (1909), *Life and Flowers* (1907), and more particularly his book on *Death* (1912), are inspired by a reaction against his early mystic and fatalistic tendencies. The same contrast applies to the spirit of such plays as *Monna Vanna* (1909) and *Mary Magdalene* (1909), in which the action is concentrated in a few important scenes, more according to the Racinian than to the Shakespearian method.

His interest in Shakespeare is nevertheless shown in his essay on King Lear, *Life and Flowers,* and in the translation of *Macbeth* (1910). *The Blue Bird* (1910), produced in 1911, still increased the popularity of the Belgian writer in English-speaking countries. It was followed by *The Betrothal* (1919), produced in London in 1921. Maeterlinck wrote a war play dealing with the German occupation of Belgium: *The Burgomaster of Stilemonde* (1920) produced in London by Sir J. Martin Harvey. *The Miracle of St. Anthony* and *Mountain Paths* appeared in 1919, and two more plays in a modern setting, *The Cloud that Lifted* and *The Power of the Dead,* in 1923. Most of the works of Maurice Maeterlinck have been translated into English. Maeterlinck was awarded the Nobel Prize for literature in 1911.

See J. Bithell, *Life and Writings of Maurice Maeterlinck* ("Great Writers," 1913); G. F. Sturgis, *The Psychology of Maeterlinck as Shown in his dramas* (1914); M. Clark, *Maurice Maeterlinck, poet and philosopher* (1915); H. Meyer-Benfey, *Das Maeterlinck-Buch* (1923).

MAFEKING, a town in the Cape Province, near the frontier of the Bechuanaland Protectorate; 25° 52′ S., 25° 41′ E.; altitude 4,194 ft. Its pop. (1936) of 4,666 makes it the trade centre for the protectorate and the western Transvaal. It is also the headquarters of the railway system between Kimberley and Bulawayo, and is the chief seat of the administration of the Bechuanaland Protectorate. The native town, a separate entity, situated about a mile away, is the chief place of the Barolong tribe, and has a population of about 3,000. The town was besieged by the Boers from Oct. 12, 1899, to May 17, 1900. (*See* SOUTH AFRICAN WAR, 1899–1902.) In memory of those who died in its defence, the English church was erected and also a memorial before the town hall.

MAFFEI, FRANCESCO SCIPIONE, MARCHESE DI (1675–1755), Italian archaeologist and man of letters, was born at Verona on June 1, 1675. He studied in Parma, at the Jesuit College, and at Rome; and in 1703–04 he took part as a volunteer in the war of succession, fighting on the Bavarian side at Donauwerth. His *Merope,* a tragedy regarded by some critics as the best Italian tragedy before Alfieri, appeared in 1713; *Teatro italiano,* a small collection of works for presentation on the stage, in 1723–25; and *Le Ceremonie,* an original comedy in 1728. From 1718 he became specially interested in the archaeology of his native town, and his investigations resulted in the valuable *Verona illustrata* (1731–1732). Maffei died at Verona on Feb. 11, 1755.

MAFIA. A word of uncertain origin, used to designate a specific form of criminality which arose on the great landed estates (*latifundia*) of Sicily as a result of bad government during a long period of the island's history, and more especially during the disorders consequent on the Napoleonic invasion of South Italy. Lawless conditions led the owners of large estates to place their lands in the charge of energetic ruffians who exercised almost despotic powers over a terrorized peasantry. The contiguity of the estates enabled these men to form an organization which gradually became very extensive and powerful, so much so that in time it turned against the land-owners themselves. The members of the organization were not very numerous, but, bound by close ties of fellowship and capable of any crime, they compelled the land-owners to employ persons of their choice, fixed the compensation they claimed for their services, and the rents and price of the lands and of the crops entrusted to their protection. Their activities sometimes extended to neighbouring towns, they made it practically impossible for lands or crops to be sold at open auction, and effectively hindered efforts likely to interfere with their interests. On the other hand, fierce quarrels of all kinds arose among them leading to terrible acts of revenge; whence the formation of bands of outlaws, at feud among themselves, and all the crimes consequent on outlawry: robbery, rapine, extortion.

A complicated code of traditions regulated the *mafia*, based on so-called *omertà* (from Sicilian *omu*, man), the obligation never, under any circumstances, to apply for justice to the legally constituted authorities, and never to assist in any way in the detection of crime committed against oneself or others. Absolute silence was required and enforced by ruthless reprisals, the right to avenge injuries being reserved to the victims or their families. Like the Camorra (*q.v.*), the Mafia was soon powerful in various social classes. In Sept. 1892, about 150 Mafiusi were arrested at Catania, but the only result was to drive some of the members abroad, with unpleasant results to other countries. In Oct. 1890 David Hennessy, chief of police in New Orleans, was murdered. Subsequent legal inquiry proved the crime to be the work of the Mafia, which had been introduced into the United States 30 years before. In May 1890 a band of Italians living in New Orleans had ambushed another gang of their fellow countrymen belonging to a society called *Stoppaghera*. The severe police measures taken brought the vengeance of the society upon Hennessy. Eleven Italians were indicted on suspicion of being implicated in his murder; but the jury was terrorized and acquitted six. On March 14, 1891, a mob led by well-known New Orleans citizens broke into the gaol where 19 Italians were imprisoned and lynched 11 of them, a fact which brought to an end a long diplomatic incident between the Italian government and the United States.

Since 1860, after the fall of the Bourbon monarchy, the Italian government had endeavoured with varying success to rid Sicily of the Mafia; but in the various Sicilian provinces the police authorities continued to tolerate it.

When the fascist regime came into power, after 1922, Sicily and Piedmont in the north were the regions of Italy most opposed to it. Many opponents of fascism have ascribed this opposition to the decision taken by the fascist regime to use its exceptional powers to capture and bring to trial the leaders of the Mafia. In a series of trials at Palermo and neighbouring Termini Imerese, in 1927, the accused, in batches of as many as 150, were brought before the courts; and their victims gave evidence against them. The leaders received life sentences and heavy punishment was meted out to their accomplices. Unfortunately, the fascist government used this occasion to get rid, at the same time, of honest Sicilians strongly opposed to it. And this fact became an advantage for the legend of the Mafia which, although composed in the recent generations of criminals, did not lack in its distant origins of a certain chivalrous element, since it appeared to many as a force fighting the Spanish misrule and feudal abuses.

See Alongi, *La Maffia* (Turin, 1887); Le Faure, *La Maffia* (1892); C. W. Heckethorn, *Secret Societies of all Ages* (1897); W. Agnew Paton, *Picturesque Sicily* (1898); A. C. Train, *Courts, Criminals and the Camorra* (1912). (O. R. A.; X.)

MAFRA, a town of Portugal, 20 mi. N.W. of Lisbon. Pop. (1940) 3,223. Mafra is remarkable for its monastery, church and palace, built by John V. in 1717–1732, in consequence of a vow to build a convent for the poorest friary of the kingdom—which proved to be a small Franciscan settlement here. The architects, Johann Friedrich Ludwig of Regensburg, and his son Johann Peter, took the Escorial for their model; but the imitation is less successful than the original, though the cost exceeded £4,000,000. The building is in the form of a parallelogram measuring upwards of 800 ft. from north to south and 700 ft. from east to west; it is said to contain 866 rooms, and to be lighted by no fewer than 5,200 windows. The church is sumptuously built of marble, and richly adorned with statues and other objects of art. In each of the twin towers there is a chime of 57 bells.

MAGADHA, an ancient kingdom of India, mentioned in the *Ramayana* and the *Mahābhārata*. It comprised that portion of Behar lying south of the Ganges, with its capital at Pataliputra or Patna. The scene of many incidents in the life of Gautama Buddha, it was a holy land, and was also the seat of the Maurya Empire, founded by Chandragupta, which extended over all India under Asoka, and, later, of the Gupta dynasty.

MAGADIS, an ancient Greek instrument believed to have been of the dulcimer type and provided with bridges so disposed as to facilitate the playing of octaves, whence the term magadizing for the making of this music, *i.e.*, in octaves. *See* HARMONY.

MAGALLANES (Spanish form of *Magellan*), a province of southern Chile extending from 49° S. to Cape Horn and including the mainland from the Argentine frontier to the Pacific coast, the islands extending along that coast, the Fuegian archipelago, and the western half of Tierra del Fuego. Area, 52,271 sq.mi. according to the most recent official definition; population (1940 census) 48,813. It is one of the most inhospitable regions of the world, being exposed to cold westerly storms for most of the year. The islands are barren, but the mainland is covered with forests, practically inaccessible to exploitation because of the inclement climate and the wet spongy soil. The coast is indented with bays and fjords and affords remarkable scenery. There is little animal life on land, but the coast is frequented by the seal and sea-otter and the sheltered waters by countless sea-fowl. The only permanent settlements are at Punta Arenas, population (1940) 29,883, the capital, on the Straits of Magellan, Palomares on Seno Otway, Mina Marta on Seno Skyring, Ultima Esperanza (Last Hope) on the east shore of Worsley sound, and a few other such isolated colonies. All are east of the Andean ranges and partially sheltered from the westerly storms. In this sheltered region there are open plains where sheep are grazed. Sheep ranges have been established also on Tierra del Fuego. There are in all some 50 great sheep farms in this territory, containing several million sheep. Many of these belong to British corporations, and are in charge of Scotch shepherds. Wool to the amount of 20,000,000 lb. is shipped annually and huge quantities of chilled or frozen mutton are sent out from the packing houses in Punta Arenas. Some nomadic tribes of Indians inhabit Tierra del Fuego and the extreme southern end of the mainland, but their numbers are small. Coal is found near Punta Arenas, and there is gold.

MAGAZINE: *see* PERIODICAL.

MAGDALA (more correctly MAKDALA), a natural stronghold in the country of the Wollo Gallas, Ethiopia, about 250 mi. W. of Jibuti on the Gulf of Aden, in 11° 22′ N., 39° 25′ E. The basaltic plateau of which it consists rises 9,110 ft. above the sea. It is about ¾ mi. in length by less than ½ mi. in breadth, and lies more than 1,000 ft. higher than the neighbouring plain of Arogié. Chosen in about 1860 by the emperor Theodore of Ethiopia as his principal stronghold in the south, Magdala owes its fame to the fact that, as the place of imprisonment of the English captives, it became the goal of the great English expedition of 1868, when it had huts for a population of about three thousand.

See Clements Markham, *History of the Abyssinian Expedition* (1869); and H. Rassam, *British Mission to Theodore* (1869).

MAGDALENIAN. The term given to the last great Palaeolithic period, which is represented at La Madeleine, in lower Vézére, France, also in England, at Cheddar and Kent's Cavern.

MAGDEBURG, a city of Germany, capital of the Prussian province of Saxony. It lies mainly on the left bank of the Elbe, 88 m. S.W. from Berlin and at the junction of main lines to Leipzig, Brunswick, Cassel and Hamburg. Pop. (1939) 334,358.

History.—Magdeburg, which was a small trading settlement at the beginning of the 9th century, owes its early prosperity chiefly to Otto the Great, who established a convent here about 937. In 968 it became the seat of an archbishop. Although burnt down in 1188, Magdeburg became a flourishing commercial town during the 13th century, and was an important member of the Hanseatic League. Its bench of jurats (*Schöppenstuhl*) became celebrated, and "Magdeburg law" (*Magdeburger Recht*), securing the administrative independence of municipalities, was widely adopted. During the middle ages the citizens were almost constantly at variance with the archbishops, and by the end of the 15th century had become nearly independent of them. The town embraced the Reformation in 1524, and was thenceforth governed by Protestant titular archbishops. It successfully resisted Wallenstein for seven months in 1629, but was stormed and sacked by Tilly in May 1631. The whole town, with the exception of the cathedral, and about 140 houses, was burned to the ground, and the greater part of its inhabitants were butchered. By the peace of Westphalia (1648) the archbishopric was converted into a secular duchy, to fall to Brandenburg on the death of the last administrator, which happened in 1680. During World War II the city, with its oil tanks, railway connections and factories, was severely damaged by British bombing attacks.

Buildings.—In the Elbe, between the old town and the Friedrichstadt, lies an island whereon stands the citadel; this is united with both banks by bridges. With the exception of the Breite Weg running from north to south, the streets of the town proper are narrow and crooked. The Friedrich Wilhelms Garten stands on the site of the convent of Berge, which was founded in 968 and suppressed in 1809. The most important building in Magdeburg is the cathedral, dedicated to SS Maurice and Catherine, a structure of the 14th century, exhibiting an interesting blending of Romanesque and Gothic architecture. The two western towers were completed about 1520. The Liebfrauenkirche, the oldest church in Magdeburg, is a Romanesque edifice of the 12th and 13th centuries, which was restored in 1890–91. The town hall (Rathaus) was built in 1691 and enlarged in 1866. The Breite Weg and the old market contain gable-ended private houses in the style of the Renaissance. In front of the town hall stands an equestrian statue of Otto the Great, erected about 1290. There are an agricultural college and an observatory.

Industries.—The first place amongst the industries is taken by the ironworks (one being a branch of the Krupp firm, the Grusonwerke), which produce armour and machinery. Of almost equal importance are the sugar refineries and chicory factories. Then come establishments for making tobacco, gloves, chocolate, artificial manure, cement, varnish, chemicals, glass and pottery. There are also distilleries and breweries, and factories for the manufacture of instruments and rubber wares. Magdeburg is the central market in Germany for sugar and chicory, but trades extensively also in cereals, fruit, vegetables, groceries, cattle, horses, wool, cloth, yarn, leather, coal and books. The completion of the Mittelland canal in 1937 made Magdeburg the centre of a 7,000-mi. network of inland waterways extending from the Rhine to East Prussia.

The Archbishopric of Magdeburg was carved out of the bishopric of Halberstadt when it was founded in 968. The doctrines of the reformers made their appearance in the diocese early in the 16th century, and soon Archbishop Sigismund, a son of the elector of Brandenburg, openly accepted Lutheranism. The distinct office of burgrave dates from Charlemagne, although its holder was not at first called by this name, and it soon became one of great importance. The burgrave was the king's representative; he was charged with the administration of the royal estates in a given district, and in general with watching the royal interests therein. In 1294 it was united with the archbishopric and the prelates, except from 1538 to 1579, retained it until the secularization of the see.

The Magdeburg Centuries (*Magdeburger Zenturien*) is the name given to the first general history of the Christian Church written from a Protestant point of view. It was compiled in Magdeburg, and was written in Latin in 1562. The cost of the undertaking was borne by some of the German Protestant princes. As the *Historia ecclesiae Christi* it was first published at Basel in seven volumes (1559–74). It deals with the Church down to 1400, and the earlier part has been translated into German (Jena, 1560–65).

MAGEE, WILLIAM (1766–1831), archbishop of Dublin, was born at Enniskillen, Co. Fermanagh, and educated at Trinity college, Dublin, where he was elected fellow in 1788. He was ordained in 1790. His *Discourses on the Scriptural Doctrines of Atonement and Sacrifice* (1801), a polemic against Unitarian theology, was answered by Lant Carpenter. Magee was appointed professor of mathematics and senior fellow of Trinity in 1800, but in 1812 he resigned, and in 1813 became dean of Cork. In 1819 he was consecrated bishop of Raphoe. In 1822 the archbishop of Dublin was translated to Armagh, and Magee succeeded him at Dublin. Though generally tolerant, he opposed the movement for Catholic Emancipation. He died on Aug. 18, 1831.

See *Works of the Most Reverend William Magee, D.D.* (1842).

MAGEE, WILLIAM CONNOR (1821–1891), British divine, was born at Cork, and educated at Trinity College, Dublin. In 1864 he became dean of Cork and chaplain to the lord lieutenant. His remarkable powers were shown in the defence of the Irish church at the time of the disestablishment proposals of 1868, when his brilliant speeches induced Disraeli to offer him the bishopric of Peterborough. He justified his appointment by his magnificent speech when the Disestablishment Bill reached the House of Lords in 1869. He took up the temperance question, and declared in the House of Lords that he would rather see "England free than England compulsorily sober," an utterance which the extreme advocates of total abstinence misquoted and attacked. He supported the movement for abolishing the recitation of the Athanasian Creed in the public services of the Church of England. Magee took a prominent part in the Ritualist controversy, opposing what he conceived to be romanizing excess in ritual, as well as the endeavour of the opposite party to "put down Ritualism," as Disraeli expressed it, by the operation of the civil law. His incisive way of putting things earned for him the title of the "Militant Bishop." He died on May 5, 1891, about four months after his appointment to the see of York.

See Canon MacDonnell, *Life and Letters* (2 vols. 1896).

MAGELLAN, FERDINAND (*c.* 1480–1521), the first to undertake a voyage around the globe, was born at Sabrosa in the Villa Real district of the Traz-os-Montes province of Portugal. He was a son of Pedro de Magalhães, and belonged to the fourth order of Portuguese nobility (*fidalgos de cota de armas*). He was brought up as a page of Queen Leonor, consort of King John II. "the Perfect."

Service in the Indies.—In 1495 he entered the service of Manuel "the Fortunate," John's successor, and in 1504 enlisted as a volunteer for the Indian voyage of the first Portuguese viceroy in the East, Francisco de Almeida. He sailed on March 25, 1505; was wounded at Cannanore on March 16, 1506; was then sent with Nuno Vaz Pereira to Sofala to build a Portuguese fortress at that place; returned to India early in 1508; and was again wounded at the battle of Diu on Feb. 3, 1509. At Cochin (Aug. 19, 1509) he joined Diogo Lopes de Sequeira on his famous voyage intended for the Spice Islands, when the Portuguese almost fell victims to Malay treachery at Malacca. Before Oct. 10, 1510 he had been rewarded for his many services with the rank of captain. He again distinguished himself at the taking of Malacca by Albuquerque (July–Aug., 1511), and was then sent on by the viceroy with Antonio d'Abreu to explore the Spice Islands (Moluccas). Leaving Malacca at the end of December 1511, this squadron sailed along the north of Java, passed between Java and Madura, left Celebes on their left, coasted by the Gunong Api volcano, touched at Bura, and so reached Amboyna and Banda. At the last-named they found such abundance of spices that they came straight back to Malacca without visiting Ternate, as had been intended.

Fitting Out the Expedition.—Magellan returned to Portugal in 1512. On July 14 of that year he was raised to the rank of *fidalgo escudeiro;* and in 1513 he accompanied a Portuguese expedition against Azamor in Morocco. The city was taken on Aug. 28–29, 1513; but Magellan was subsequently wounded, and lamed for life, in a sortie; he was also accused of trading with the Moors. The accusation was subsequently dropped, but Magellan fell into disfavour with King Manuel, who let him understand that he would have no further employment in his country's service (after May 15, 1514). Magellan formally renounced his nationality, and went to offer his services to the court of Spain. He reached Seville on Oct. 20, 1517, and thence went to Valladolid to see Charles V. With the help of Juan de Aranda, one of the three chief officials of the India House at Seville, and of other friends, especially Diogo Barbosa, a Portuguese like himself, naturalized as a Spaniard, who had acquired great influence in Seville, and whose daughter he now married, he gained the ear of Charles and of the powerful minister, Juan Rodriguez de Fonseca, bishop of Burgos, the persistent enemy of Columbus, the steady supporter of his great successor.

Magellan proposed to reach the Spice Islands of the East Indies by the west; for that purpose he hoped to discover a strait at the extreme south of South America, and is said to have declared himself ready to sail southwards to 75° to realize his project. Ruy

Faleiro the astronomer, another Portuguese exile, aided him in the working out of his plan, and he found an invaluable financial ally in Christopher de Haro, a member of a great Antwerp firm, who owed a grudge to the king of Portugal. On March 22, 1518, Magellan and Faleiro, as joint captains-general, signed an agreement with Charles V., by which one-twentieth of the clear profits were to fall to them; further, the government of any lands discovered was vested in them and their heirs, with the title of *Adelantados*. On Aug. 10, 1519, the fleet of five vessels, under Magellan's command, left Seville and dropped down the Guadalquivir to S. Lucar de Barrameda, at the mouth of the river, where they remained more than five weeks. On Sept. 20, the armada put to sea. Of the vessels which composed it, the "Trinidad" was the flagship, and the "Vittoria" the only one which accomplished the circumnavigation. Antonio Pigafetta of Vicenza, an Italian gentleman who has left the best history of the voyage, went as a volunteer in Magellan's suite. Faleiro stayed behind, having cast his horoscope and found that the venture would be fatal to him. Before starting, Magellan made his will and addressed a memorandum to Charles V., assigning geographical positions connected with the controversy he was intending to settle: viz., the proper drawing of a demarcation-line between the spheres of Spain and Portugal in the East Indies, and the inclusion of the Moluccas within the Spanish sphere.

Passing the Straits.—Steering south-west and calling at Teneriffe (Sept. 26–Oct. 3), Magellan sighted South America at Cape St. Augustine, near Pernambuco on Nov. 29; thence he followed the east coast of the New World down to the La Plata estuary, which he examined in the hope of finding a passage at this point (Jan. 11–Feb. 6, 1520). On March 31, following, he arrived at Port St. Julian (in 49° 20′ S.) where he wintered. Here he crushed a formidable mutiny (April 1–2), and made acquaintance with the natives, whom he called *Patagonians* ("Big Feet"), whose great size and lofty stature are magnified by Pigafetta to gigantic proportions. Leaving Port St. Julian on Aug. 24, 1520, he discovered on Oct. 21, the cape of the Eleven Thousand Virgins, the eastern entrance of the long-sought passage. Through this strait, 360 m. long, often narrow and very tortuous, fringed by snow-clad mountains, he guided his armada for thirty-eight days, weakened by the desertion of one vessel (the "S. Antonio"). On Nov. 21, a council of pilots and captains was held to consider the continuation of the voyage, and on Nov. 28, the fleet rounded Cabo Deseado, the "desired" western terminus of the strait of Magellan. To the south of the passage lay the forbidding land "stark with eternal cold," which from the many fires here observed Magellan named "Tierra del Fuego." The expedition now entered the "Great South Sea," first sighted by Vasco Nuñez de Balboa (*q.v.*), which, from the steady and gentle winds that drove the fleet across the immeasurable expanse, was by Magellan called "Pacific." For ninety-eight days Magellan crossed this sea from Cabo Deseado to the Ladrones. On the whole transit he discovered only two islands, sterile and uninhabited, which he called "St. Paul's" (Jan. 24, 1521) and "Shark Island" (Feb. 3). The explorers had no fresh provisions, little water (and that bad), and putrid biscuit; the ravages of scurvy became terrible. The worst fears of Magellan were realized; ox-hides, sawdust, and rats had to be eaten.

Magellan's Death.—At last, on March 6, 1521, the Ladrones (so named by Magellan from the thievish habits of the natives) came in sight, Guam being probably the first port of call. Here the fleet rested, watered, revictualled and refitted; on March 9 they started again westward; and on March 16 sighted the southern point of Samar Island in the archipelago, since 1542 called the Philippines, but named by Magellan, its first discoverer, after St. Lazarus. On April 7, the squadron arrived at Cebu, south-west of Samar, in the heart of the Philippines; here Magellan contracted a close friendship and alliance with the treacherous native sovereign, who professed Christianity the better to please and utilize his Catholic friends. Undertaking an expedition to conquer, for the Catholic faith and the king of Cebu, the neighbouring island of Mactan, Magellan was killed there in a fight with the islanders (April 27, 1521). The king of Cebu after this got into his power several leaders of the squadron, including Juan Serrano, one of the two admirals elected to replace Magellan, and then murdered them.

The survivors, burning one of the three remaining vessels, left the Philippines, and made their way to the Moluccas (Nov. 6), visiting Borneo on the way (July 9–Sept. 27, 1521). At Tidor a heavy cargo of cloves was taken in; the "Trinidad," becoming leaky, stayed behind with her crew; and the "Vittoria," under Juan Sebastian del Cano, proceeded to Europe alone (Dec. 21, 1521). To double the Cape of Good Hope the "Vittoria" reached between 40° and 41° S. (April 7–16, 1522) and suffered from contrary winds, heavy seas, scurvy and starvation. In the Cape Verde Islands (July 9–15, 1522) 13 of the crew were detained prisoners for a time by the Portuguese. Only 18 men returned with del Cano to Seville in the first vessel that had ever made the tour of the earth. Though Magellan had not quite reached the Spice Islands when he fell at Mactan, his task had then been accomplished. He had already reached and passed the longitude of the Moluccas, where he had already been; the way home from the Philippines by the Indian Ocean and the Cape of Good Hope was perfectly known to the Portuguese, himself included. Magellan's name has never received its due recognition in general history. It ranks with those of Columbus, Marco Polo, and Henry the Navigator. The circumnavigation of the globe is as great an event as the discovery of America. Magellan achieved what Columbus planned—the linking of west Europe with east Asia by direct transit over the western ocean.

Magellan's Straits, the Magellanic clouds (not first observed by him), and Magellan's Land—a name long given to Patagonia and that hypothetical southern continent of which Tierra del Fuego was considered only a portion, and now again bestowed by Chile on her territory in the extreme south—preserve the memory of the first circumnavigator. The largest of the oceans has also kept the flattering name given to it by the man who first crossed it.

Bibliography.—No record of his exploits was left by Magellan himself; and contemporary accounts are less detailed and consistent than could be wished. The best is that of Antonio Pigafetta, a volunteer in the fleet. It is printed in Ramusio, and exists in four early MS. copies, one in Italian and three in French.

Other authorities are: (1) The narrative of an unknown Portuguese in Ramusio's *Navigationi et viaggi;* (2) the *Derrotero* or Log-Book in the Seville Archives, supposed to be the work of Francisco Albo, *contramaestre* of Magellan's flagship, the "Trinidad": this consists mainly of nautical observations; (3) the narrative of the so-called Genoese pilot, written in excellent Portuguese, and printed in vol. iv. of the *Collecão de noticias* of the Lisbon Academy; (4) various *informaciones* and other papers in the Seville Archives, especially bearing on the mutiny; (5) the letter of Maximilian of Transylvania, under-secretary to Charles V., to the cardinal of Salzburg; (6) the references in Correa and Herrera, often based on good information, and adding points of interest to other records. Of these (1)–(3), (5), and an instance of (6) are translated in the Hakluyt Society's volume. Magellan's two wills (i.) executed at Belem on Dec. 17, 1504, on the eve of his departure with Almeida, (ii.) executed at Seville on Aug. 24, 1519, just before starting on his voyage round the world, are both of some value for his life.

See also Lord Stanley of Alderley, *The First Voyage round the World by Magellan, translated from . . . Pigafetta,* etc., Hakluyt Society (London, 1874); Diego de Barros Arana, *Vida e viagems de Fernão de Magalhães,* a trans. of the Spanish life by Fernando de Magalhães Villas Boas (Lisbon, 1881); F. H. H. Guillemard, *Life of Magellan* (London, 1890); *Magellan . . . the original text of the Ambrosian MS.* (of Pigafetta), with English translation, notes, bibliography, etc., by J. A. Robertson (Cleveland, U.S.A., 1906). Before the appearance of this indispensable work, the best edition of Pigafetta had been in vol. iii. part 5 of the *Raccolta di documenti e studî pubblicati nella r. commissione colombiana,* edited by Andrea daî Mosto (Rome, Ministry of Public Instruction, 1894). *See* also O. Koelliker, *Die Umsegelung der Erde durch Magellan* (1908); E. Oberhummer, *F. Maghalães, und die Bedeutung der ersten Erdumsegelung* (1921); A. S. Hildebrand, *Magellan* (1925); Plischke, *F. de Maghalães* (1926).

MAGELLANIC CLOUDS (named after Ferdinand Magellan), two cloud-like condensations of stars in the southern sky. The Large Cloud is in the constellation Dorado at R.A. 5h. 26m., dec. $-69°$; the Small Cloud in Tucana at R.A. oh. 56m., dec. $-73°$. They appear in all respects like detached portions of the Milky Way. They are very remote, being distant 30,000 parsecs from the earth and 12,000 parsecs from one another.

MAGENDIE, FRANÇOIS (1783–1855), French physiologist, was born at Bordeaux and became professor of pathology in the Collège de France. He was an admirable experimenter but weak in deduction. He succeeded in demonstrating the motor functions of the anterior and the sensory functions of the posterior spinal roots. Magendie also investigated the mechanism of deglutition and vomiting, and the cause and methods of blood-flow. He introduced into medical practice bromine, iodine compounds and such alkaloids as strychnine and morphine. Claude Bernard was one of his pupils. In addition to founding the *Journal de physiologie expérimentale* (1821–31), he produced *Précis élémentaire de physiologie* (1816), *Formulaire pour l'emploi . . . de plusieurs nouveaux médicaments* (1821), *Sur les phénomènes physiques de la vie* (1835) and *Sur les functions et les maladies du système nerveux* (1839).

MAGENTA, a town of Lombardy, Italy, province of Milan, 16 mi. W. of it by rail, 364 ft. above sea-level, in the midst of rice-fields. Pop. (1936), 10,470 (town), 13,021 (commune).

Magenta was the scene of a battle on June 4, 1859, between the Franco-Sardinians under Napoleon III. and Austrians commanded by Gyulai. Hearing from a spy that the Austrians were ready to oppose a crossing between Pavia-Piacenza, Napoleon adapted Jomini's plan—flank march from Alessandria to Novara, turning the enemy's right on Novara-Milan road. The Allies reached Novara on June 1. Gyulai retired next day over the Ticino, though Napoleon was unaware of which side of the river the enemy was standing. He therefore ordered a Guard division to occupy Trecate on June 3, sending over MacMahon with a Guard division at Turbigo. Making for Magenta, June 4, he was to draw to his sector strong hostile forces, thereby easing Napoleon's advance over Ticino. The Sardinians were to follow MacMahon, but the roads being blocked, only one division reached him at the close of battle. The I., III. and IV. Corps were left around Novara. The Allies numbered 140,000 men with 291 guns, the Austrians 112,000 with 400 guns. However, only 52,000 French and 60,000 Austrians actually participated in this day's fighting. Early on June 4, Napoleon, ascertaining that the Austrians were across the Ticino, realized that he would be unable to use the bulk of his forces, the roads being everywhere congested. Millinet's Guard division reached San Martino at 10 A.M., heavy fighting ensuing, but he was not to advance over the canal till MacMahon approached. He was supported by a division III. Corps. Both faced the Austrian I. and II. Corps. MacMahon began his march at 9 A.M., capturing Bernate at noon and approaching, later, Buffalora, was brought to a standstill. At Ponte Vecchio severe fighting occurred, troops of the III. and IV. Corps confronting III. and VII. Austrian corps. At 4 P.M. MacMahon advanced again, Buffalora being captured, while the Guards from San Martino also participated. At Ponte Vecchio fierce fighting continued, but only after Magenta fell did Gyulai give orders to evacuate it, seeing the exhausted state of his troops of the right wing. Both opponents bivouacked on the field, the Austrians retreating eastwards in the early hours of the morning.

MAGENTA, an old and well-known dyestuff and one of the first to be produced synthetically; it is also known as rosaniline or fuchsine and is described more fully under the latter heading and under DYES, SYNTHETIC and TRIPHENYLMETHANE.

MAGERSFONTEIN, ACTION OF, Dec. 11, 1899: *see* SOUTH AFRICAN WAR, 1899–1902.

MAGGIORE, LAGO, the largest lake in Lombardy, north Italy (*Lacus Verbanus* of the Romans), area about 83 sq.m., length 40 m., greatest width 5½ m., greatest depth 1,220 ft., surface 636 ft. above sea-level. The Ticino flows through, north to south, on its way to the Po; the Tosa or Toce comes in on the west from the Val d'Ossola below the Simplon Pass, the Tresa enters from L. Lugano on the east. The upper end of the lake (about 16 sq.m.) is in the Swiss canton of Ticino. Locarno, at the northern or Swiss end, is 14 m. by rail south-west of Bellinzona on the St. Gotthard line. There is a railway along the south-eastern shore, from Magadino (10½ m. south-west of Bellinzona) to Sesto Calende (36½ m.), at the southern end of the lake and 20 m. by rail from Novara. The east shore of the lake is reached at Luino by electric railway from Ponte Tresa on the lake of Lugano (8 m.), while the direct Simplon line runs along the west shore of the lake for 15½ m. from near Pallanza past Baveno and Stresa to Arona, which is 23 m. by rail from Novara. On the east shore are Luino and Laveno. On the west shore are (reckoning from north to south) Cannobio, Pallanza, Baveno, Stresa and Arona. Opposite (south-east) Baveno are the famous Borromean islands (*q.v.*), while south-west of Baveno rises the glorious view-point of the Monte Mottarone (4,892 ft.) between Lago Maggiore and the Lake of Orta, which is reached by electric railway.

MAGH, a term applied to immigrants from Burma long settled in the south-east districts of Bengal. Apparently of Taî origin, they entered Bengal from Arakan towards the end of the 18th century. Most of them have come under Bengali influence, but in the south of the Chittagong Hill Tracts, where their culture is comparatively pure, the script and dress are Burmese and the language an Arakanese dialect. Elsewhere the Bengali dress and language prevail. The religion of the Arakanese-speaking Maghs is animistic Buddhism. The race is divided into endogamous clans and there are still strong traces of a political organization under clan chiefs, the most powerful of whom are known as the Bohmong and the Mong Raoja, the former being a lineal descendant of the Mon kings of Pegu. In the hills shifting is still preferred to plough cultivation, but the villages, which contain from 10 to 50 houses, are invariably on the banks of streams. The houses are flimsy structures on bamboo piles and a relic of the communal house for men is sometimes found in the form of a roofed platform built at the end of the village street.

See Hutchinson, *Account of the Chittagong Hill Tracts* (1906).

(J. P. M.)

MAGIC. The magic art is of ancient lineage and wide distribution. Civilization even yet is not entirely devoid of all elements of magical belief and ritual. But for the savage magic is still a living reality, a serious practical means of commanding success in any critical human undertaking.

PRIMITIVE

The importance of the magic art in primitive culture has provoked an extensive theoretical discussion in which such authoritative writers as Tylor, Frazer, Westermarck, Preuss, Hubert and Mauss, Marett, Lehmann, Lowie and Malinowski, have taken a prominent part. Sir James Frazer, in particular, in his great classical treatise *The Golden Bough* has formulated a distinct and coherent theory of magic on which all subsequent studies have largely been built. These various contributions have been reviewed by H. Hubert and Marcel Mauss, and by Dr. R. R. Marett.

As a preliminary, the useful distinction drawn by Sir James Frazer between magic and religion may be noted, its essence being that magic consists in the direct control by man of the forces of nature, while religion relies upon the propitiation of these and other higher powers.

(1.) **The Sociology of Magic.**—Magic, as Frazer has so fully shown, is not merely a type of belief or a piece of man's intellectual apparatus, but an art in which theory and dogma at every step are translated into action. It is always a very practical affair. It has to bring rain to crops or game to the nets, to give stability to a house or lightness to a canoe, to inflict or ward off misfortune, disease or death, to win a loved one, to give skill in war, speed in travelling, beauty at the feast or the dance. It is distinctively a human art, in that it is practised only through man's agency and for his benefit. At the same time it involves a recognition of the supernatural, a belief in the power of magic, wielded by man, to turn aside the normal operation of the forces of the external world. Its roots lie in the diversity of human activities; it is a way of handling the forces of nature, of bending them to man's will, of safeguarding his welfare and shaping his destiny.

Magic invests its practitioners with social power. In nearly all communities the magician is the one person who can be compared with the chief in point of influence, prestige and authority. Magic thus acts as a force of social control. The important practices of the craft tend to be carried on largely by special experts, often constituting a distinct class in the community, and these, desiring to ensure the continuity of their knowledge, and prizing it as a thing of great value, transmit it only to their descendants. So magic is appropriated, forms the subject of well defined claims and privileges, and is handed down through families and clans in exclusive possession. The magic art is also of more purely economic interest, since its practitioners are usually remunerated by those who seek their services, while even the transmission of the lore is often a matter for compensation by a substantial payment. Magic on its traditional side is linked by mythology with the dim past of gods and heroes, with the origins of man, and the beginnings of the tribal culture. Legends of the miraculous deeds of ancestors bear witness to the power of the ritual, while their names are frequently cited in charm and spell.

(2.) **Elements of the Magical Art.**—As Dr. Bronislaw Malinowski clearly shows, every act of magic is characterized by things said, things done, and a person officiating. Hence the spell, the rite and the condition of the performer are fundamentals.

(i.) *The Spell.* The spell, the uttering of words according to a formula, *i.e.,* in a set order, is everywhere regarded as the outstanding part of the magical act. In fact by some peoples the word for spell, as the Maori *karakia* or the Kiriwinian *megwa,* is used also to mean magic as a whole. The virtue of the magic lies primarily in the formula, which is believed to have been handed down from immemorial antiquity. Hence the insistence upon the correct recital of it, lest variation in the text render the magic of no avail. The customary rigidity of the formula does vary in different communities. Thus among the Polynesians any slip, any omission, any alteration of wording deprived the magic of its efficiency, and in the most important sacred ritual was thought to involve the death of the practitioner from supernatural causes. But elsewhere individual changes of wording within the main frame of the formula are permissible. Nevertheless, it is always well defined by tradition, variations are minor and of a customary kind, and no major extemporization is possible. Since the spell is in fact the backbone of magic, its language is naturally correlated with the aim of the ritual. There are constant references to objects or actions, the mention of which is supposed to influence the desired end. A Maori spell to give speed and grace to a canoe, for instance, speaks of the swiftness of a bird on the wing, the lightness of a sea-gull floating on the water, and gives the names of a number of woods noted for their buoyancy. Metaphor and simile are freely used, while onomatopoeic effect is introduced, as speed-noises or the wailing of the sea. References to traditional and mythological events are frequent, ancestral names are recited, and, coupled with the cryptic and archaic language in which the spell is often couched, are apt to render it obscure to any but those trained in this type of magical lore. Thus magic maintains its bond with tradition.

(ii.) *The Rite.* Accompanying the magical formula is a set of actions, the rite, the primary function of which is to convey the spell to the object which it is desired to affect. Thus when a Maori dart-thrower wished to make a good cast he would spit upon the implement and repeat a charm beginning "Fly forward, my dart, like a meteor in the heavens." Like the spell, the rite is definitely prescribed in form and is often in distinct correspondence with the words uttered. Thus movement described in the spell is carried out or imitated by the performer, substances which produce effects analogous to those desired are handled and mentioned. The sprinkling of water on the ground, for instance, is often part of the magic of rain-making, the destruction of an image by fire accompanies a charm to bewitch an enemy with burning pains. Attractive scents are used in love magic, powdered lime is released by Melanesian sailors in danger from flying witches, to make a magic fog which will blind their pursuit. The rite is thus the vehicle of the spell and its equivalent, the translation of the word into action.

(iii.) *Condition of the Performer.* Since magic is of such importance the performer must handle it with care. In all communities he is hedged around by taboos; he must refrain from eating certain foods, from casual sexual indulgence, and from other contaminating things. If he fails to conform, then he nullifies the power of his art; breach of taboo, in fact, is the cause most frequently assigned for failure of magic. The emotional attitude of the magician is also of interest. In the rite of black magic which consists in pointing a bone or dart at a victim, the wizard twists and turns the instrument in the air and assumes a state of excitement and fury as if he actually were performing the deed of stabbing his enemy. Dr. Malinowski stresses the importance to the theory of magic of this simulation of the real act; he sees in fact in the sympathetic emotional condition of the performer, the fundamental basis of the art. Magic, for him, is a ritualized expression of an emotional state of desire, which, baulked of its object, nevertheless is constrained to find outlet in speech and gesture. In the spontaneous outburst of word and act lies the germ of spell and rite, in the illusion of subjective experience—the conviction that such actions have really had their effect—rests the foundation of the belief in magical efficiency.

(3.) **The Essence of Magical Power.**—Dr. Marett ascribes the basic idea of magic to the belief of the native in a vague mysterious power, supernatural and immaterial, animating all things. Hubert and Mauss and Prof. K. Th. Preuss have independently arrived at somewhat the same conclusion. *"Mana,"* it is said, "is the mother-idea of magic." This notion of a mystic impersonal force is held by many primitive peoples, being termed *mana* in parts of the Pacific, *hasina* by the Malagasy, and *wakan, orenda, pokunt* and *manitou* by various American Indian tribes. But examination of its content shows that it is a concept of an extremely general order. The essence of magical power, on the other hand, is very restricted; it is fixed in man, it is bound by human tradition, it is even localized at times in the body of the wizard. It is not, like *mana,* a universal force latent in all things, which man has taken and utilized for his own ends. The real virtue of magic is embodied in the spell, and to a less extent in the rite. Magic is born of the emotional tension of specific situations; it is not the concrete use of a general abstract concept. The idea of *mana* is certainly closely intertwined with the practice of magic, but they are interlacing stems which spring from a different root.

The value of Marett's contribution to the theory of magic lies in his stress on the emotional aspect of the performance, analysing the state of mind of the savage in his magical experiences. By his psychological treatment he counteracted the tendency to an over-intellectualistic study of primitive beliefs. (*See* MANA.)

(4.) **Magic and Primitive Science.**—By Edward Tylor, the great pioneer in anthropology, magic was regarded as developing from the thought-processes of primitive man by mistaken association of ideas, and becoming organized into "an elaborate and systematic pseudo-science." This position has been more explicitly formulated by Sir James Frazer. He advances the view that magic really represents the attempt of man to formulate a body of principles by which the sequence of events throughout the world may be determined. "Magic is a spurious system of natural law as well as a fallacious guide of conduct; it is a false science as well as an abortive art."

The label of "bastard science" affixed by Frazer has not remained unchallenged. Hubert and Mauss, in their study of magic, and Dr. Marett from the psychological side, point out that there are radical differences between the magical and the scientific attitude of man towards his environment. By his analysis of garden magic in Melanesia in conjunction with the actual agricultural operations, Dr. Malinowski shows that the native outlook upon the two is essentially different. Empirical knowledge of soils and plant growth, of wind and weather, is utilized to cope with the known and calculable requirements of the industry; the native is well aware that careful tillage, weeding, repairing of fences and replacement of damaged seed are essential for a good harvest. On the other hand, to secure the right amount of rain and sun, avoid insect pests, or unaccountable failure of the crop, to ward off the ill-luck which sometimes dogs his steps he has recourse to magical aid. So also in canoe-building, fishing, warfare, love-making, the birth of children and matters of health and death, primitive man recognizes both a natural and a supernatural set of conditions, facing the first with rational technique and empirical knowledge, embodied even in rudimentary theoretical laws, the second with the arts of magic. The same duality is to be found in the economic life of the Maori (Raymond Firth) and evidence is accumulating to show that this must be a phenomenon of universal occurrence. Primitive man has his real science, running side by side with his magic. The two are closely bound together in the practical activity, the body of rational knowledge being utilized to deal with the mechanical efficiency of the undertaking, while the ritual of magic deals with the incalculable elements therein, the luck and chance upon which so much of success depends.

It is permissible, then, with Sir James Frazer, to call magic a pseudo-science if the limitations of the term be borne in mind. Magic is akin to primitive science in that it exists to serve very definite, often similar ends, and is possessed of a theory, a system of principles which dictates the manner in which the ritual must be performed. Like science, it has developed a special technique which is handed down from one generation to another. But these resemblances are little more than superficial; the difference is fundamental. Science, even as represented by the rudimentary equipment of the savage, is based on experience, is open to correction by observation and experiment, is ever marked by the thirst for further knowledge and the attempt at a more exact classification and description, a more careful elucidation of the general principles governing the behaviour of the material world. Magic, on the other hand, is governed by tradition, is largely impervious to the lessons of observation, and shows no desire to make profit by experiment. The underlying mental attitude is one of implicit faith, based upon emotional rather than upon rational experience. It is clear, then, that the real roots of science are to be found, not in the magic art of primitive man, but in his rudimentary store of knowledge and his attempts at rational enquiry, stimulated by the practical needs of his technology, into the nature of his physical environment.

(5.) **The Continuity of Belief.**—It is not difficult to see the hollowness of the pretensions on which magic bases its claim to power. The sky will not really give forth thunder and rain in reply to sympathetic rites, animals do not obligingly come to the hunter through a muttered spell, nor can that *more coy game, woman,* be ensnared by the waving of a wand. Why, then, is not the fallacy of this hocus-pocus exposed, and "the whole monstrous farrago," as Tylor called it, discarded as futile? The answer usually advanced is that the false ritual of magic does not exist entirely in its own strength, but associated with it are elements of medical skill or political craft of the practitioner, which sustain its reputation when in need. Again, success is bound to come in a large proportion of cases by the mere laws of chance, aided by the shrewdness of the magician in selecting the opportune moment for the exercise of his art. This is helped by the general inability of the human mind to appreciate negative evidence when strong forces of belief are entrenched on the side of an established institution. One success counts more in retrospect than a dozen failures. More important still is what Dr. Malinowski has termed "the current mythology of magic," that is, the stories of prowess which tend to circulate round every magician of influence, exaggerated tales of wonderful cures, of game attracted, of lovers united, of enemies slain by the craft of his spells. These stories reach back into the mists of antiquity, forming a body of instances which can be drawn upon at any moment to vouch for the efficacy of the art. This halo of myth, of magical miracle, is the strength of the belief in magic, its buckler against the assaults of rational experience. The real basis for the continuity of magic, however, lies even deeper in the sphere of its cultural utility.

(6.) **The Value of Magic to Man.**—Magic is not merely a vain replica of science. Despite the fallacy of its premises and the illusory nature of its claims it possesses a real validity in human life. The magical rites performed in agriculture, for instance, are of undoubted efficacy to the native. By proceeding step by step in close contact with the actual stages of the work, of which it regulates the times and seasons, by imposing taboos, by investing the task with serious import and a supernatural sanction, the magic reinforces order and punctuality within the industry, and acts as a very valuable factor of organization, wielded as it usually is by the expert who has charge of the practical arrangements. Again, the magical ritual enters at the point where man's knowledge and foresight begin to fail, where chance, luck and the incalculable elements of nature begin, where reliance on rational technique can no longer avail. By providing him with a firm belief in his own powers, by promising him control, illusory though it may be, over these all important factors of success, it gives man that much needed psychological backing of confidence and assurance which is so essential to the accomplishment of his desire.

Bibliography.—E. B. Tylor, *Primitive Culture* (6th ed. 1920); J. G. Frazer, *The Golden Bough* (vols. i. and ii. *The Magic Art*) (3rd ed. 1911, abridged ed. 1925); K. Th. Preuss, "Der Ursprung der Religion und Kunst" in *Globus* (1904); A. Lehmann, *Aberglaube u. Zauberei* (1898); H. Hubert et M. Mauss "Esquisse d'une Théorie Générale de la Magie" in *L'Année Sociologique* vii. (1902–03); R. R. Marett, *Threshold of Religion* (1909), article "Magic" in Hasting's *Encyclopaedia;* R. H. Lowie, *Primitive Religion* (1925); B. Malinowski, *Argonauts of Western Pacific* (1922); "Magic Science and Religion" in *Science, Religion and Reality* (ed. J. A. Needham, 1925); Raymond Firth, *Work and Wealth of the Maori;* E. Westermarck, *Ritual and Belief in Morocco* (1926); H. A. Junod, *Life of South African Tribe* (1927); E. Smith and Dale, *The Ba-Ila* (1920); A. R. Radcliffe-Brown, *The Andaman Islanders* (1922); R. Thurnwald, *Forschungen auf den Salomo-Inseln und in dem Bismarck-Archipel* (1912); C. E. Seligman, *Melanesians of British New Guinea* (1910).

(R. F.)

Egyptian.—The processes of Egyptian magic, or *hike* were a spoken formula, which must be exactly as prescribed in order to be efficacious, and an act or gesture, often to be performed at a particular time and under special conditions of place and position. The choice of word and act is based on the doctrine of sympathy and homoeopathy, *i.e.,* the belief that two things which have once been connected may continue to react on each other even when separated, and that like has power to affect like. Thus a burn may be cured by the recitation of the words used by Isis over her son Horus when he was once burnt, and one may cause one's enemy pain by maltreating a wax image of him, indeed the mere knowledge of the Sun-god's name was sufficient to give Isis magical power over him. From similar conceptions arose the belief in protective amulets which assumed such vast importance both for the living and for the dead.

There was no class of professional magicians in Egypt—there is not even a general word for magician. It is not surprising, however, to find that those who exercise the art on a large scale are often priests, and more particularly lector-priests, *i.e.,* those whose business consisted especially in the study and reading of sacred books. At the same time it would seem that magic on a small scale was within the reach of everybody who was prepared to observe the conditions, and to judge from the papyri which have come down to us it must have played a very large part in every day life. It was used not only to escape death, to drive out disease, to avert the evil eye, to cure a snake bite, but also to drive rats from a barn, and to prevent the approach of a storm: there is even a spell to secure the various advantages summed up in the phrase "to be blessed every day."

MAGIC LANTERN: *see* Lantern.

MAGIC SQUARE, an arrangement of numbers in the form of a square so that every column, every row, and each of the two

8	1	6
3	5	7
4	9	2

16	3	2	13
5	10	11	8
9	6	7	12
4	15	14	1

	18	25	2	9	
17	24	1	8	15	17
23	5	7	14	16	23
4	6	13	20	22	4
10	12	19	21	3	10
11	18	25	2	9	

Figs. 1, 2 and 3.—Types of Magic Squares

diagonals, add up alike, this sum being called the *constant.* Strictly speaking the numbers used should be consecutive from 1 up to n^2, where n is the number of cells (or squares) in any side. Such an arrangement of n^2 numbers is called a square of the nth order. Thus fig. 1 complies with all the conditions and is a magic square of the 3rd order. These squares are of very great antiquity and appear to have been known from very ancient times in China and India, where, as at the present time, magic squares were worn engraved on metal or stone as amulets or talismans.

They appear to have been introduced into Europe early in the Christian era though the first known writer on the subject was Emanuel Moschopoulus, a Greek of uncertain date who lived in Constantinople, probably about 1300. His work in manuscript is in the National Library in Paris (ms. No. 2,428). Cornelius Agrippa (1486–1535) constructed squares of the orders 3, 4, 5, 6, 7, 8, 9, which were associated with the seven astrological

3	1	4	2	5
5	3	1	4	2
2	5	3	1	4
4	2	5	3	1
1	4	2	5	3

15	0	20	5	10
0	20	5	10	15
20	5	10	15	0
5	10	15	0	20
10	15	0	20	5

18	1	24	7	15
5	23	6	14	17
22	10	13	16	4
9	12	20	3	21
11	19	2	25	8

FIGS. 4, 5 AND 6.—DE LA HIRE'S METHOD OF CONSTRUCTION

"planets," Saturn, Jupiter, Mars, the Sun, Venus, Mercury and the Moon. The magic square of the 4th order shown in fig. 2 is to be seen in Albrecht Dürer's picture of "Melancholy." The date of the work (1514) is indicated in the two central cells of the bottom row, but whether this was intentional or a mere coincidence is not known (see *Notes and Queries*, Feb.–March 1918). In later times the subject has been investigated as a mathematical curiosity and has a large though scattered literature of its own. The three main lines of enquiry are construction, enumeration and classification.

Construction.—It is convenient to deal with these squares in three classes. Those of an odd order, those of a doubly-even order (that is where n is of the form $4m$) and those of a singly-even order (where n is of the form $2\ [2m+1]$). These vary in difficulty in their order. The smallest possible square of an odd order is, of course, that of the 3rd order shown in fig. 1, to which there is that one fundamental solution only. Eight different arrangements may be obtained by merely turning the page round and also turning it round in front of a mirror. These so-called reversals and reflections are not usually counted as different. A square of the odd order may immediately be written down in the manner shown in fig. 3, described first by De la Loubère. Here we start at the central cell in the top row and proceed diagonally upwards to the right. As the 2 is outside the square we bring it to the bottom of the column, thus giving it the position it occupies on the outside square. Having written the 3, the 4 falls outside the square, so we insert it at the opposite end of the row and write in the 5. As the next square is occupied by the 1 we write the 6 beneath the 5 and proceed until the 10 falls outside the square and so on. It will be noted that 16 falling outside the square at a corner is written beneath the 15 as in the case of an occupied square. This can be applied to any square of an odd order, but, like so many methods that have been adopted, it only produces one type of square, though it may be modified to form a limited number of other squares. Thus we may start with the 1 in any cell and always get a square that

NASIK

1	14	7	12
15	4	9	6
10	5	16	3
8	11	2	13

ASSOCIATED

1	14	12	7
8	11	13	2
15	4	6	9
10	5	3	16

SIMPLE

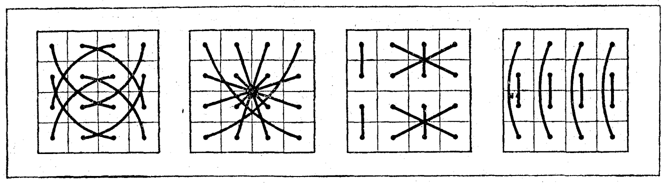
16	3	10	5
1	12	7	14
8	13	2	11
9	6	15	4

SEMI-NASIK

1	14	12	7
4	15	9	6
13	2	8	11
16	3	5	10

FIGS 7, 8, 9 AND 10.—TYPES OF MAGIC SQUARES OF THE 4TH ORDER

is magic in rows and columns, but not necessarily in the diagonals. Bachet (1612) used a somewhat similar method. Another method devised by De la Hire, may be used for the construction of squares of any order. He employed three subsidiary squares though one of these has been dispensed with by later writers. In fig. 4, the numbers 1, 2, 3, 4, 5, are arranged so that every number appears once and once only in every row and column, and in one diagonal, the other diagonal having repetitions of 3. In fig. 5, the numbers 0, 5, 10, 15, 20, are similarly treated only the repeated 10's are in the other diagonal. These squares superimposed and added produce fig. 6, which is a perfect magic square. Similar methods have been devised for the construction of magic squares and some of these will be found in the books named at the end of this article. But most of the writers on the subject develope their own favourite schemes. It is not difficult to construct squares of particular types but the ideal solution is, of course, a method completely general for squares of every order, that will include every possible arrangement of the order dealt with. Such a solution is probably not discoverable. Magic squares of singly-even orders (such as those where $n=6$, 10, 14, 18, etc.) are generally the most difficult of all to construct and their treatment is largely empirical. Large



FIGS. 11, 12, 13 AND 14.—GRAPHIC SOLUTIONS OF TYPES OF FOURTH ORDER

collections of squares of the higher orders have been compiled by Violle and others, so that examples are easily obtainable.

Classification.—This is a matter of individual taste and may be called the elegant branch of the subject. Taking the case of the 4th order the solutions can all be classified under the four types shown in figs. 7 to 10.

The Nasik square (so named by the Rev. A. H. Frost after the town in India where he lived) is the most perfect type conceivable. Here all the broken diagonals sum to the constant 34. Thus, for example, $15+14+2+3$ and $10+4+7+13$ and $15+5+2+12$. As a consequence its properties are such that if you repeat the square in all directions you may mark off a square 4×4 wherever you please and it will be magic. It should be noted that Nasik squares can be constructed for any doubly-even orders and for any odd orders not divisible by 3. But a Nasik square of a singly-even order is impossible. The number of fundamentally different Nasik squares of the 5th order is sixteen.

In the case of the associated squares every number if added to the number that is equidistant in a straight line from the centre gives 17. Thus $1+16$, $2+15$, $3+14$, etc. Dürer's square (fig. 2) is also associated The simple square is one that fulfils the simple conditions and no more. The semi-Nasik has the property that the opposite short diagonals of two cells together sum to 34. Thus $14+4+11+5=34$. $12+6+13+3=34$. And in this order there are 48 Nasiks, 384 semi-Nasik (which include 48 associated) and 448 simple, making a total of 880. The Nasik square is also sometimes called diabolique and pandiagonal and the semi-Nasik semi-diabolique.

A graphic illustration of each type is shown in figs. 11 to 14, if placed beneath the squares to which they apply. Every Nasik square takes the form of fig. 11 and every associated that of fig. 12, but the graphic forms for the simple and semi-Nasik squares are considerably varied. There are 12 such graphic forms in all of the 4th order, and these are shown in *Amusements in Mathematics*. (*See* bibliography.)

2	23	25	7	8
4	16	9	14	22
21	11	13	15	5
20	12	17	10	6
18	3	1	19	24

FIG. 15.—A BORDERED SQUARE

Another type of magic square is the bordered, an example of which is shown in fig. 15 where it will be seen that a square of the 3rd order is surrounded by a border so as to form a square of the 5th order. In fig. 16 we have an example of an extension first considered by Frénicle (*c.* 1602–75). Here the borders may be successively stripped off to produce magics of the 9th, 7th, 5th and 3rd orders, and these concentric or progressive squares for odd and even orders respectively may be constructed without any limit whatever.

Composite squares also may be formed in certain cases. If we know how to construct a square of the mth and nth orders we can directly make one of the mnth order as in fig. 17 where m and n are each 3. It will be noted that each subsidiary square is successively constructed in the same order as the smallest one and each successive square is placed in the larger square, again in the same order. A more difficult but very elegant type of square is that of two degrees, as in fig. 18. Here we have a magic square of the 8th order with the constant 260 and every square of four cells summing to 130. If for every number we substitute in its allotted place its square then it will also be entirely magic with the constant 11180. A Nasik square of this kind and order has been constructed.

16	81	79	78	77	13	12	11	2
76	28	65	62	61	26	27	18	6
75	23	36	53	51	35	30	59	7
74	24	50	40	45	38	32	58	8
9	25	33	39	41	43	49	57	73
10	60	34	44	37	42	48	22	72
14	63	52	29	31	47	46	19	68
15	64	17	20	21	56	55	54	67
80	1	3	4	5	69	70	71	66

FIG. 16.—CONCENTRIC SQUARE

71	64	69	8	1	6	53	46	51
66	68	70	3	5	7	48	50	52
67	72	65	4	9	2	49	54	47
26	19	24	44	37	42	62	55	60
21	23	25	39	41	43	57	59	61
22	27	20	40	45	38	58	63	56
35	28	33	80	73	78	17	10	15
30	32	34	75	77	79	12	14	16
31	36	29	76	81	74	13	18	11

FIG. 17.—COMPOSITE SQUARE

No square of two degrees is possible for any order smaller than the 8th.

Enumeration.—The very difficult question of enumerating the squares of the different orders has attracted the attention of many mathematicians but very little progress has been made during the last 200 years. Of the 3rd order there is only one fundamental arrangement as stated above. Of the 4th order there are 880 different fundamentals. These were all given by Frénicle in a posthumous work of 1693 and this has been frequently confirmed by later writers. It was shown in the *Queen,* Jan. 15, 1910, how the complete set might be so written out if desired (*see* also Frolow's *Carrés Magiques*).

All told there are 549,504 fourth order magic squares in rows and columns.

7	53	41	27	2	52	48	30
12	58	38	24	13	63	35	17
51	1	29	47	54	8	28	42
64	14	18	36	57	11	23	37
25	43	55	5	32	46	50	4
22	40	60	10	19	33	61	15
45	31	3	49	44	26	6	56
34	20	16	62	39	21	9	59

FIG. 18.—A SQUARE OF TWO DEGREES

No enumeration for larger squares has been completed. Particular types of squares, however, have been counted. Thus there are 28,800 Nasik and 174,240 bordered squares of order 5, and 567,705,600 bordered squares of order 6.

Actual formulas counting the so-called uniform step squares of J. Willis of any odd order n have been given by D. N. Lehmer.

The number of magic squares of order n increases very rapidly with n, as does also the difficulty of enumeration.

Extensions and Variations.—Though strictly speaking the magic square should be composed of a natural sequence of numbers from 1 to n^2 this condition is sometimes dispensed with. Any arithmetical progression will serve, as in fig. 19, where the numbers in the series used have a common difference of 2. But squares of the 3rd order may be formed with any nine numbers if we can write them thus:

$$\begin{matrix} 1 & 2 & 3 \\ 7 & 8 & 9 \\ 13 & 14 & 15 \end{matrix}$$

where the horizontal differences are all alike and the vertical differences also all alike but not necessarily the same as the horizontal. The arrangement is shown in fig. 20. This applies equally to the higher orders. Thus fig. 21 is constructed from the numbers

$$\begin{matrix} 1 & 2 & 3 & 4 \\ 6 & 7 & 8 & 9 \\ 11 & 12 & 13 & 14 \\ 16 & 17 & 18 & 19 \end{matrix}$$

and is a Nasik square.

A general solution for squares of the 4th order in which any numbers (all different but not necessarily consecutive) are used was given by Ernest Bergholt in *Nature* for March 26, 1910. Then the question of the construction of magic squares with prime numbers only, and with the smallest possible constants, has been investigated. A summary of results will be found in *The Monist* (Chicago) for Oct. 1913. The formation of squares composed of consecutive composite numbers has also been considered. These can be formed for any order without the use of tables of primes though the method will not always give the smallest possible constant. First write down any consecutive numbers, the smallest being greater than 1, say, for the 3rd order, 2, 3, 4, 5, 6, 7, 8, 9, 10. The only prime factors of these numbers are 2, 3, 5 and 7. Add

15	1	11
5	9	13
7	17	3

14	1	9
3	8	13
7	15	2

1	17	8	14
18	4	11	7
12	6	19	3
9	13	2	16

FIGS. 19, 20 AND 21.—EXTENSIONS TO OTHER SQUARES

the product of these four numbers, 210, to each of the nine numbers. The result is the nine consecutive composite numbers 212 to 220 inclusive with which we can form a magic square. Yet a square with a smaller constant may be formed, as in fig. 22, with the numbers 114 to 122 inclusive. But it would be difficult to find empirically (if possible) a lower solution for the 4th order than we get by the rule, using the numbers 510512 to 510527 inclusive.

Subtracting, multiplying and dividing magic squares have also of late been investigated, and examples of the 3rd order are given in figs. 23, 24 and 25. In fig. 23, a subtracting square, you get a constant 5 by subtracting the first figure in a line from the second and the result from the third. The operation may, of course, be

121	114	119
116	118	120
117	122	115

SUBTRACTING

2	1	4
3	5	7
6	9	8

MULTIPLYING

12	1	18
9	6	4
2	36	3

DIVIDING

3	1	2
9	6	4
18	36	12

FIGS. 22, 23, 24 AND 25.—SUBTRACTING, MULTIPLYING AND DIVIDING MAGIC SQUARES

performed in either direction but in order to avoid negative numbers it is more convenient simply to deduct the middle number from the sum of the two extreme numbers. In fig. 24, which is a multiplying square, the constant 216 is obtained by multiplying together the three numbers in any line. In the dividing square (fig. 25) the constant 6 is obtained by dividing the second number in a line by the first in either direction and the third number by the quotient. But again the process is simplified by dividing the product of the two extreme numbers by the middle number. This question has been dealt with in *Amusements in Mathematics.*

46	55	44	19	58	9	22	7
43	18	47	56	21	6	59	10
54	45	20	41	12	57	8	23
17	42	53	48	5	24	11	60
52	3	32	13	40	61	34	25
31	16	49	4	33	28	37	62
2	51	14	29	64	39	26	35
15	30	1	50	27	36	63	38

FIG. 26.—ATTEMPT AT THE KNIGHT'S-MOVE SQUARE

Other extensions of the problem such as magic polygons, magic cubes, magic circles and magic stars have also attracted the attention of mathematicians. Attempts have also been made to construct a magic knight's tour. The knight has to be played once to every square of the chessboard in a complete tour, or non-re-entrant path, numbering the squares visited in order, so that when completed the square shall be magic with the constant 260. The nearest approach to a solution is shown in fig. 26 given by C. F. Jaenisch in *Applications de l'Analyse Mathématique au Jeu des Echecs* (St. Petersburg, 1862). Unfortunately it is not a perfect magic square because the diagonals are incorrect, one adding 264 and the other 256—requiring only the transfer of 4 from one diagonal to the other. Probably a perfect solution is impossible but no rigid proof of this has been obtained. Magic squares have been devised for construction with dominoes and playing cards;

also with coins and postage stamps, where one is restricted, of course, by the limitations of issue, coins and stamps of certain convenient values not being in existence. These interesting questions are of a puzzle character and often call for considerable mathematical analysis, though, as a man said of *Paradise Lost*, they "prove nothing" and lead nowhere. They are therefore strictly speaking of no direct mathematical importance.

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MAGINN, WILLIAM (1793–1842), Irish poet and journalist, was born at Cork on July 10, 1793. The son of a schoolmaster, he graduated at Trinity college, Dublin, and after his father's death in 1813 succeeded him in the school. He first made his mark as a parodist and a writer of humorous Latin verse in *Blackwood's*. In 1821 he visited Edinburgh, where he made acquaintance with the Blackwood circle. He is credited with having originated the idea of the *Noctes ambrosianae*, of which some of the most brilliant chapters were his. His connection with Blackwood lasted, with a short interval, almost to the end of his life. His best story was "Bob Burke's Duel with Ensign Brady." In 1823 he moved to London. He was employed by John Murray on the short-lived *Representative*, and was for a short time joint-editor of the *Standard*. Maginn was the original of Captain Shandon in Thackeray's *Pendennis*.

MAGISTRATE, in general, one vested with authority to administer the law or one possessing large judicial or executive authority. In this broad sense the word is used in such phrases as "the first magistrate" of a king in a monarchy or "the chief magistrate" of the president of the United States. In countries deriving their legal systems substantially from the Roman law, it signifies more particularly the holder of a judicial office, whereas in England it is annually applied to minor or subordinate judicial officers, whether unpaid, as justices of the peace, or paid, as stipendiary magistrates. (*See* POLICE COURTS and JUSTICE OF THE PEACE. *See* also ROMAN LAW; CONSUL, etc.)

MAGLIABECHI, ANTONIO DA MARCO (1633–1714), Italian bibliophile, was born at Florence on Oct. 28, 1633. appointed librarian to Cosimo III., grand-duke of Tuscany. He followed the trade of a goldsmith until 1673, when he was appointed librarian to Cosimo III., grand-duke of Tuscany. He died on June 27, 1714, bequeathing his large private library of 30,000 vols. to the grand-duke, who gave it to the city.

MAGNA CARTA was issued by King John in June 1215, under compulsion from his barons. From the time of its issue it became a symbol to barons and people alike, and king after king, throughout the middle ages, was expected to confirm it. Its clauses were regarded with veneration long after they were out of date, and men read into them meanings which would have surprised their original drafters. Seventeenth century lawyers, ignorant of the law of the early 13th century, knowing nothing of the conditions of the time, saw in the charter a solemn grant to the people of England of rights which the Stuart kings were withholding. Trial by jury, the principle of *habeas corpus*, the right of parliament to control taxation, all these were thought to have been secured by Magna Carta. Even the great historians of the last century wrote of the charter with more enthusiasm than judgment. Modern criticism has done much to put it in its rightful perspective, but many writers have gone too far in their destructive criticism. It has often been suggested that the charter was drawn up in the interests of the barons alone, and that other clauses were inserted merely to attract support. There is an element of truth in the charge. The barons were naturally more interested in defining their own position than in securing advantages for the boroughs, or freedom of election for the Church. That the king himself, that contemporary chroniclers, that foreign observers, should describe the charter as an agreement between king and baronage was almost inevitable, for the barons supplied the motive force by which the king was brought to terms. Their relations with the king were the shifting sand on which feudal society was built, and the charter of necessity dealt at greater length with them. But an examination of the history of John's reign, of the circumstances leading to the issue of the charter, of the charter itself and the other documents which belong to the period of negotiation, show that those who drafted the charter took pains to secure through it, not only baronial demands, but administrative reforms.

The relations between king and baronage had never been precisely defined. The charter issued by Henry I. at his coronation covered only a small part of the field, and did not name the amount of the relief nor deal with the military service due from the king's tenants. The legal changes of the 12th century meant that the king's court had more power than ever before, while the baronial courts were losing business to it. On the whole the barons favoured the new methods of procedure. They were willing to submit to the firm rule of a king who should keep the understandings that governed their relations with him. So long as their reliefs were reasonable, so long as the king behaved with reason with regard to his rights of marriage, did not take excessive scutages, or insist on too much military service, they would not rebel. They might and did complain of acts of oppression, of the rigidity of the forest laws, but there had been no general antagonism between Henry II. and any class of his subjects. Richard I. prepared the way for the charter by his continual demands for money. His crusade meant a heavy drain at the moment of his accession; his ransom meant another extortion, four years afterwards; and then his war with Philip of France began. But the country was well governed by the civil service created by Henry II.

The Grievances Against John.—John inherited the fruits of his brother's policy. The possessions of his house in France were lost to Philip Augustus. Continual and increasingly heavy scutages, accompanied by fines *ne transfretet* taken from barons who did not accompany the king on his campaigns, irritated the baronial and knightly class, particularly as Normandy seemed permanently lost. The great inquest of service of 1212 increased their unrest by suggesting that the king intended to exact all that was his due, and a scutage at three marks on the knight's fee for the expedition which ended in disaster, in 1214, determined their opposition. The Church was alienated by its treatment during the Interdict, when its property was taken into lay hands and its revenues went to the royal treasury. The quarrel with the Church reacted on the general administration. The last eyre of John's reign was that of 1208; the exactions of local officers, therefore, went uncorrected, and the pleas which should have come before the judges went unheard. This collapse of the judicial administration must have done more than anything else to bring the masses of men over to the baronial side. Royal rights with regard to purveyance (*q.v.*), bridge and castle building had been stretched to the utmost by John's servants, and there existed no machinery to enforce upon royal officials payment for the food, carts, or timber which they took for the king's service. Distrusting his barons, John relied on mercenaries, and rewarded them with positions in the local government of England. They cared only for the king's interests and nothing for the welfare of their shires. Against John many men desired vengeance for personal reasons. William de Braiose was driven into exile, his wife and son starved to death because they knew that John himself had murdered his nephew, Arthur. It was unsafe for contemporary chroniclers to tell too much of the scandals of John's private life. But there seems no doubt that the baronial leader, Robert fitz Walter, wished to avenge his daughter, possibly the daughter that another rebel, Geoffrey, earl of Essex, had married. Many barons had been forced to pay far higher reliefs than had been customary. John had tried to forestall active measures against him by demanding hostages from all prominent barons. The appointment, on the eve of John's departure for his last foreign expedition, of Peter des Roches, bishop of Winchester, to the justiciarship vacated by the death of Geoffrey fitz Peter was a further grievance, for Peter was, before everything, the king's man.

The first sign of revolt had come more than a year earlier. In Sept. 1212, on his way to a Welsh expedition, John was warned both by his daughter, Joan, wife of Llewylyn of Wales, and by the king of Scots, that his barons were planning to betray him to the Welsh. He abandoned the expedition and Robert Fitz Walter and Eustace de Vesci, a prominent Northern baron, left the country. They persuaded the pope that they were suffering for righteousness' sake, and came back with other exiles when John and Innocent were reconciled in 1213. The reconciliation brought to England the new archbishop, Stephen Langton, who returned to his native land with the intention of using his position as chief adviser of the king to compel him to restore good government to the land. John was absolved after swearing on the Gospel that he would love, defend and maintain the Church, restore the good laws of his predecessors, particularly Edward the Confessor, do away with bad laws, judge all men according to the just judgments of his court, and give to every man his rights. The king then prepared to sail to Poitou, leaving the archbishop and justiciar in control of the administration to give effect to his promises. At St. Albans, early in August, they took the first steps towards the restoration of good government. Later in the month, at St. Paul's, the first suggestion that a charter should be demanded seems to have been made by the archbishop, who apparently did not know of the existence of Henry I.'s coronation charter. Langton realized at once that a formal charter was the best way of securing reforms in the administration, and John's observance of them. He took a few of the leading barons aside, read them Henry I.'s charter and suggested that it should be the basis of their programme. He must also have discussed the needs of the country with the justiciar and the other judges. In all probability the actual drafting of some of the clauses of the charter was begun by such men in private talk at this time.

John, in the meantime, had forgotten his promises in his just rage against the northern barons, who should have been awaiting him on the south coast, ready to embark to France. He found all in confusion there and, obliged to put off his expedition, turned north determined on vengeance. The archbishop pursued him, catching him up at Northampton and pointing out that the occasion demanded that the northern barons should be tried in the king's court and not punished till they had been found guilty. Though he resented the archbishop's interference, John gave way. It was this crisis combined with the new idea of a charter that probably gave occasion for a compilation known as "the unknown charter of liberties." Not mentioned by any contemporary, the document was unknown until the last century. There is no evidence that it was anything more than a basis for discussion or an attempt to draft the baronial demands. It contains none of those clauses characteristic of the later charter, which attempt administrative reforms and link Magna Carta rather with the Statutes of Edward I. than with the charters of Henry I. and Stephen.

The Crisis.—By whatever means it was secured, some compromise must have been made, for the king departed on Feb. 2, 1214, on his last expedition to Poitou, and during his absence no active steps were taken against him, although a demand for a scutage of three marks, issued from abroad, roused bitter resentment. When John returned defeated, all parties felt that the time had come to insist on definite guarantees for the future. John met the barons at Bury St. Edmunds on Nov. 4, 1214, and received a definite refusal to pay the scutage. After the king had departed they solemnly swore to withdraw their allegiance from him unless he would confirm their liberties by charter. They agreed to present their demands soon after Christmas, and in the meantime to prepare for war. John tried to win over his ecclesiastical opponents by issuing, on Nov. 21, a charter to the Church, in which he granted freedom of election. On Jan. 6 the barons put before the king at the Tower general demands that a charter should be issued on the lines of Henry I.'s charter, but incorporating administrative reforms which some at least of the barons desired. The archbishop and William Marshall, earl of Pembroke, were anxious for reform without war. Through their mediation John secured a truce till Easter. On Jan. 15, he reissued the charter to the Church, and ordered the sheriffs in every county to take oaths of allegiance to the king. Both sides appealed to the pope and the king took the cross. The pope had a double reason for protecting him; he was both a vassal and a crusader.

In Easter week the barons met at Stamford to force a charter from the king. Contemporary chroniclers emphasize the fact that the backbone of the resistance was a group of northern barons; but to label the baronial resistance as northern is inaccurate, as the contemporary chroniclers themselves imply. In Lincolnshire, Norfolk, Suffolk and Essex it was particularly strong; the great men of Essex and Hertfordshire, the earl of Essex, the earl of Oxford, Robert fitz Walter, were almost to a man against the king, and with them were joined many barons of the second rank and men of rich knightly families from the other three eastern counties. The midland counties supplied such great names as William d'Albigny and John, the constable of Chester and the west, the Fitz Alans, and Fulk fitz Warin. From the south-west came William Malet and William de Montecute. That fewer supporters for the baronial party should come from the south-west, the northern midlands, and the honour of Lancaster was natural, since these were John's own lands. That the opposition should be stronger in the south-east is again to be expected. The men of Essex were more nearly in touch with modern thought, and modern thought was much occupied with the duties of the king. But John's enemies were everywhere. John had, however, certain supporters among the greatest barons in the land. The earl of Chester, almost a sovereign prince himself, could do no other than take the king's side, though one may suspect that he approved the charter, since he issued a comprehensive charter to his own men at some phase in the struggle, a document known as the Magna Carta of Chester. The earl of Pembroke, a man grown old in the service of the royal house, the earl of Salisbury, half brother to the king, the earl of Warrenne, the earl of Arundel, and earl Ferrars were all on the royal side, but Ralf of Coggeshall tells us that even when a baron supported John his knights were generally on the other side.

The archbishop had created a situation which he could not control. The barons were eager for war. The king was determined not to give way unless he were forced, and scornfully refused to consider the schedule that the barons at Stamford sent for his seal by the hands of the archbishop and the marshal. On May 5 the barons renounced their allegiance and chose Robert fitz Walter as leader. The title he took, "Marshal of the army of God and Holy Church," emphasized the righteousness of the cause. Four days later John issued a charter to London, granting the privilege of an annually elected mayor, but it came too late to win support for him. Robert fitz Walter, lord of Baynard's Castle, on the outskirts of the city, dominated city politics. The king's offer, next day, to submit his quarrel with the barons to arbitration was in vain. When the barons entered London, easily quelling any opposition, the king realized that he must come to terms, and on June 15 met them at Runnimede, between Staines and Windsor. The barons came prepared with a document, which survives, as the *Articles of the Barons*. It was sealed on the first day of the conference and became the basis for discussion. The more elaborate charter contained amendments on both sides.

THE CONTENTS OF THE CHARTER

The charter is drawn up in the ordinary form of a contemporary grant of land or privileges. The convenience of modern commentators has necessitated the adoption of a traditional division into clauses, a division often unfortunate in that it suggests a separation where the originators of the charter were clearly following out a line of thought. In summarizing the contents it is impossible to follow the order of the clauses and at the same time give a coherent impression of the contents of the document. The intention of the men who drew up the charter was to state the law as it should be. It is the first detailed statement of feudal law, the first clear agreement between the king and his barons as to the exact demands which the king can make on them and which they can make on their men. Its emphasis on the use of the feudal council inaugurates no new policy, but simply reiterates the recognized, though not always followed, feudal practice. The statements about debt were a serious attempt to deal with one of the most pressing problems of administration and, indeed, of social intercourse, the chronic need of money, felt by all alike, and the consequent impossibility to get anyone to pay his debts. The judicial clauses were drafted with the obvious aim of restoring judicial eyres and improving the efficiency of the royal courts. The much quoted clause about the writ *Precipe* was a natural attempt to curb what was, to the barons, unfair competition with the feudal courts, competition which Glanville himself, though a royal justiciar, had hardly approved. It does not express a desire to go back upon the judicial changes of the last 50 years, but merely a feeling that the baron who had been bearing the burden of the day in the matter of judicial labour ought not to be deprived of the cases which would still be settled in his court unless he failed to do justice. A serious attempt was made in the charter to eliminate the abuses of local government, abuses which had existed in the earliest days of Norman rule, and which successive kings had fought against in vain. During his quarrel with the Church John made no effort to deal with them, and, indeed he had aggravated them by the appointments he had made to local offices. John had been interested in the development of his towns, and the charter confirmed to towns the privileges they had won. All classes of the community expected something from the charter, and the drafters did their best to satisfy the general desire. The charter therefore ranges widely over the whole field of society and administration. But it also contains clauses which reflect the bitterness of the time, clauses that must have irritated the king almost beyond endurance. Since all mercenaries were to leave the land it was but to insult the king to name a few. The determination of the barons to be rid of old grievances, particularly those connected with the forests, to right old wrongs, even those of another generation, almost destroyed the charter itself. But without the spur that the bitterness of personal hatred gave, the charter would never have been won. If the famous clause promising that no freeman shall be taken or imprisoned or disseised or outlawed or exiled . . . without the judgment of his peers or by the law of the land, was the outcome of the memory of John's attack on the northern barons in 1213, it was a guarantee of security against arbitrary rule to all men, whether barons or simple free men.

The Clauses.—The charter may be summarized as follows, the numbers in brackets being the traditional numbers of the clauses.

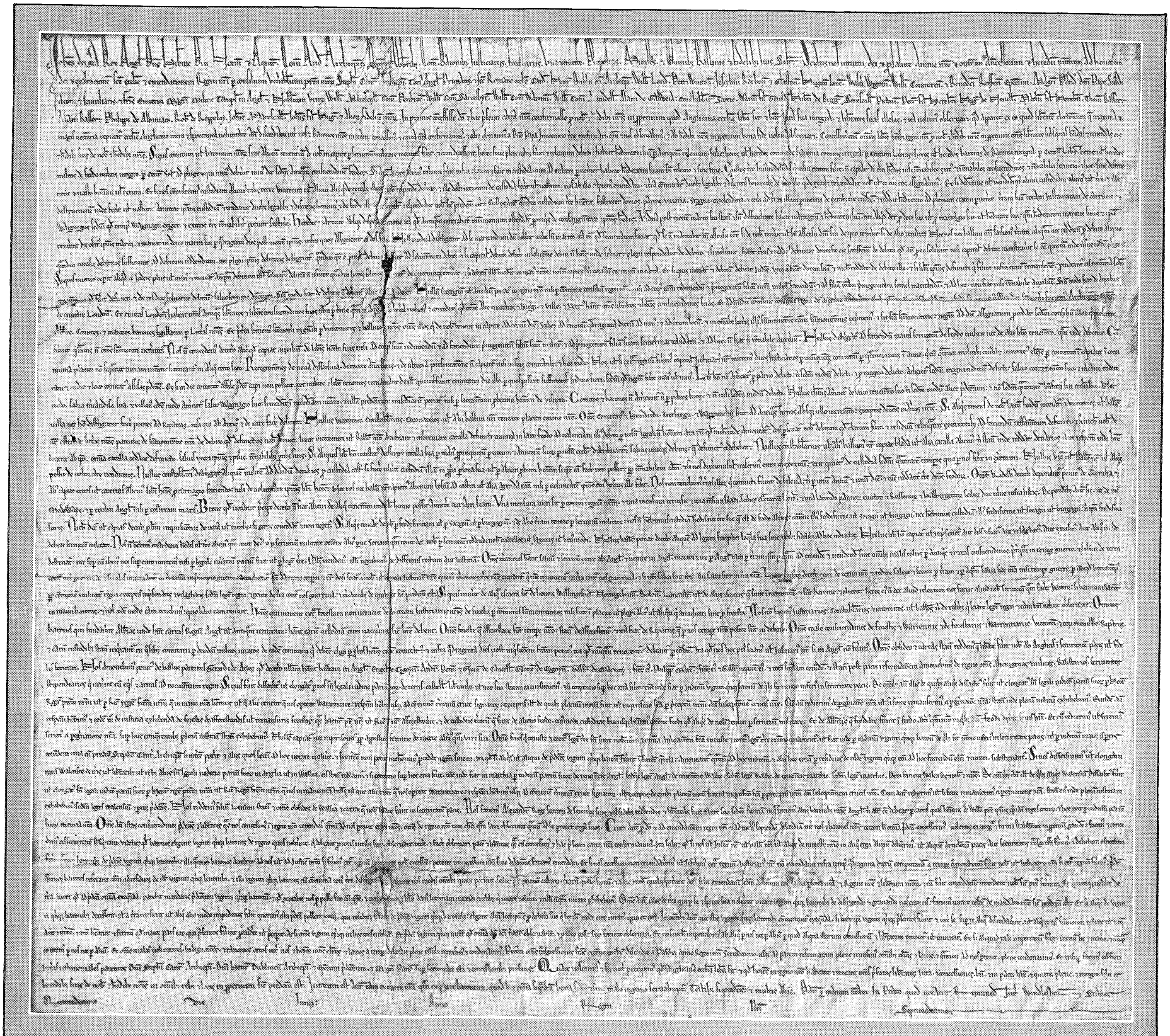
I. The clause reiterating the grant of free election to the church (1).

II. Clauses which chiefly concerned the barons. (a) *Inheritance:*—Military tenants are to have their inheritances on payment of the ancient relief, £100 for an earl or baron, 100s. for a knight. (b) *Wardship:*—Heirs who have been in wardship are to have their inheritances without relief. The heir in wardship is to be safeguarded from the rapacious guardian, who is to hand over the land well stocked (2–5). The king will not claim prerogative wardship, *i.e.*, if a man holds of the king by other than military tenure and of some other lord by military tenure, the king will not claim the wardship of his heir by reason of the land that is held of him (37). Barons who have founded abbeys are to have the custody of them when they are vacant (46). (c) *Marriage:*—Heirs are to be married without disparagement, the kinsfolk of the heir being consulted. A widow is to have her marriage portion and her inheritance at once on her husband's death, and shall give nothing for it or for her dower. The latter shall be assigned to her within forty days during which she can stay in her husband's house. No widow shall be forced to remarry provided that she gives security not to remarry without her lord's consent (6–8). (d) *Debt:*—Lands or rents are not to be seized for the payment of debt while the debtor has sufficient chattels to pay the debt. The debtor's sureties are not to be distrained so long as the debtor himself can pay. If the sureties are called on they are to hold the debtor's lands till their payment has been made up to them. No interest is to be paid on debts to the Jews while the heir of the debtor is under age. The king will only take the principal if the debt comes into his hands. When anyone dies in debt to the Jews or to other people his wife and children are to be first provided for, and the debt is to be paid out of the residue of his estate (9–11). Debts to the king are to be the first charge on the estate of crown tenants, the residue is to be left to the disposal of his executors in accordance with the will of the dead man. If no debt is owing to the crown the estate may be disposed of according to his will reserving to his wife and children their reasonable shares. If a free man dies intestate, his kin and friends under the direction of the church shall divide his chattels, after the dead man's debts have been paid (26–27). (e) *Service and rules for holding the feudal council:*—No scutage or aid is to be taken without the common council of the kingdom, that is, without the matter being brought before the feudal council of tenants in chief, except for the ransoming of the king's body, the knighting of his eldest son and the first marriage of his eldest daughter. In these cases the aid is to be a reasonable one (12). The archbishops, bishops, abbots, earls and greater barons are to be summoned to the council individually by letter stating the cause of the summons; all those who hold of the king in chief are to be summoned generally through the sheriffs or royal bailiffs. Forty days' notice is to be given and on the appointed day the business is to proceed even if all those summoned are not present (14).

III. Clauses which principally affect subtenants and freemen as well as barons:—All the customs granted to his dependents by the king all men in the kingdom shall observe towards theirs (60). The king will not allow anyone to take an aid from his free men except on the three aforesaid occasions, and the aid then is to be a reasonable one (15). No one is to be forced to do more service for a knight's fee or other free tenement than he ought to do (16). No constable shall compel a knight to give money in lieu of castle guard if the knight wishes to do it in person or through a competent deputy. Service on an expedition shall free a knight from a proportionate amount of castle guard (29). "No freeman shall be taken, or imprisoned, or disseised, or outlawed, or exiled, or in any way destroyed, nor will we go upon him, nor will we send upon him, except by the legal judgment of his peers or by the law of the land" (39). "To no one will we sell, deny, or delay right or justice" (40). All persons are to be free to come and go in time of peace, except outlaws and prisoners (42).

IV. Clauses referring to towns, trade and merchants:—The aids of the city of London are to be governed by the same rule as the baronial aids, and the city is to have its ancient liberties and free customs. All other cities, boroughs, towns and harbours, are to have their liberties and free customs (12–13). There is to be one measure of wine and ale and corn within the realm, namely the London quarter, and one breadth of cloth, and it is to be the same with weights (35). All merchants are to be free to come and go, to stay in the land and to buy and sell, except in time of war. In time of war merchants of enemy countries in England are to be treated as English merchants are treated in the enemy countries (41). All kydells are to be removed from the Thames and the Medway and throughout all England except the sea coasts (33).

V. Clauses reforming judicial and legal matters:—Common pleas are not to follow the court but to be held in some certain place (17). For the taking of inquisitions of Novel disseisin, mort d'ancestor, and darrein presentment two justices are to be sent through the realm four times a year and with four knights of each county chosen by the county are to hold the assizes on the day and in the meeting place of the shire court. If all cannot be taken on the one day, enough knights and freeholders are to remain to conduct the business (18, 19). Amercements are to be in accordance with the measure of the offence. They are not to be so heavy, in the case of grievous crimes, as to deprive any man of his means of livelihood. They are to be assessed by the honest men of the neighbourhood (20). Earls and barons are to be amerced by their peers according to the measure of their offence (21). Clerks shall only be amerced according to the measure of their offence and only the lands which they hold by lay tenure shall be answerable for the amercement (22). The lands of those convicted of felony shall only be held by the king for a year and a day and then shall return to the lord of the fee (32). The writ



PHOTOGRAPH BY S. SMITH

REPRODUCTION OF MAGNA CARTA FROM THE ORIGINAL IN LINCOLN CATHEDRAL

Transliteration of the first three-and-a-third lines: Johannes Dei gratia, rex Anglie, dominus Hybernie, dux Normannie et Aquitannie, comes Andegavie, archiepiscopis, episcopis, abbatibus, comitibus, baronibus, justiciariis forestariis, vicecomitibus, prepositis, ministris, et omnibus ballivis, et fidelibus suis, salutem. Sciatis nos, intuitu Dei, et pro salute anime nostre, et omnium antecessorum, et heredum nostrorum, ad honorem Dei, et exaltationem sancte ecclesie, et emendationem regni nostri, per consilium venerabilium patrum nostrorum Stephani Cantuariensis archiepiscopi, totius Anglie primatis et sancte Romane ecclesie cardinalis; Henrici Dublinensis archiepiscopi, Willelmi Londoniensis, Petri Wintoniensis, Joscelini Bathoniensis et Glastoniensis, Hugonis Lincolniensis, Walteri Wygornensis, Willelmi Coventrensis, et Benedicti Roffensis, episcoporum; magistri Pandulfi domini pape subdiaconi et familiaris, fratris Eymerici, magistri militie templi in Anglia, et nobilium virorum Willelmi Mariscalli comitis Penbrok, Willelmi comitis Saresberie, Willelmi comitis Warennie, Willelmi comitis Arundellie, Alani de Galweya constabularii Scottie, Warini filii Geroldi, Petri filii Hereberti, Huberti de Burgo senescalli Pictavie, Hugonis de Nevilla, Mathei filii Hereberti, Thome Basset, Alani Basset, Philippi de Albiniaco, Roberti de Roppelay, Johannis Mariscalli, Johannis filii Hugonis, et aliorum fidelium nostrorum; Imprimis concessise Deo et hac presenti carta nostra confirmasse pro nobis et heredibus nostris in perpetuum:

Translation should read: John, by the grace of God, king of England, lord of Ireland, duke of Normandy and Aquitaine, and Count of Anjou: to the archbishops, bishops, abbots, earls, barons, justices, sheriffs, reeves, ministers, and to all bailiffs, and faithful subjects, greeting. Know that we, by divine impulse, and for the salvation of Our soul, and of the souls of Our ancestors and of Our heirs, and for the honour of God, and the exaltation of Holy Church, and the amendment of Our kingdom, by advice of Our venerable fathers, Stephen, archbishop of Canterbury, primate of all England, and cardinal of the holy Roman Church: Henry, archbishop of Dublin; the bishops William of London; Peter of Winchester; Jocelin of Bath and Glastonbury; Hugh of Lincoln; Walter of Worcester; William of Coventry; Benedict of Rochester; and Master Pandulph, sub-deacon and Counsellor; Brother Eymeric, master of the Temple in England, and the noble William Marescall, earl of Pembroke; William earl of Salisbury; William earl de Warenne; William earl of Arundel; Alan of Galloway, constable of Scotland; Warin Fitzgerald, Peter Fitzherbert; Hubert de Burgh, seneschal of Poitou; Hugh de Neville; Matthew Fitzherbert; Thomas Basset; Allan Basset; Phillip d'Aubigny, Robert of Ropsley, John Marshall, John Fitzhugh, and others Our liegemen; have in the first place granted to God, and by this Our present charter, confirmed on behalf of Ourselves and Our heirs for ever:

called *Precipe* shall not in future be issued to anyone touching any tenement whereby a free man may lose his court (34). Nothing shall henceforth be given for a writ of enquiry touching life or limb, but it shall be granted freely and not denied (36). No one is to be taken or imprisoned upon the appeal of a woman for the death of any other than her husband (54).

vi. Clauses intended to check the abuses of local officers:—No town or individual shall be forced to make bridges or maintain river banks except such as ought to be so maintained by ancient custom and right (23). No sheriff, constable or bailiff is to hold the pleas of the crown (24). All counties, hundreds, wapentakes and ridings are to be at their old farm without any increment, except the king's demesne manors (25). No constable or bailiff is to take a man's corn or other chattels without immediate payment unless the owner allows a respite (29). No sheriff, bailiff or any other person shall take a freeman's horses or carts for carriage duty except with the owner's consent (30). Neither the king nor his bailiffs are to take a man's timber for castle-building or any other royal work without the consent of the owner of the wood (31). No justice, constable, sheriff or bailiff is to be appointed but such as knows the law and is willing to observe it (45). No bailiff upon his own bare word without credible witnesses is to send a man to the ordeal (38).

vii. Forest Clauses:—Men who dwell without the forest are not to come before the justices of the forests on a general summons but only when they are concerned in special cases (44). All forests made by John are to be disafforested and all evil customs of the forests abolished. Justice is to be done with regard to the forests made by Henry II. and Richard I. (47, 48).

viii. Clauses of temporary interest, to correct temporary abuses:—All hostages and charters taken from the English barons are to be returned (49). Welsh grievances are to be considered and Welsh hostages are to be returned (56–68). Scottish hostages are to be returned and justice is to be shown to Alexander, king of Scotland (59). Certain named mercenaries and their followers are to be sent away. All mercenaries are to be dismissed (50, 51). Justice is to be done in the case of wrongful dispossessions by John himself, Henry II. or Richard I. (52). In all cases the king is to have the crusader's respite. Illegal fines and amercements are to be remitted. The 25 barons who were to be responsible for the maintenance were to judge any disputed matters, together with Stephen Langton, archbishop of Canterbury.

ix. The form of security for the maintenance of the provisions of the charter:—The barons were to choose 25 of their number to be the guardians of the charter. If the king or one of his officers did anything contrary to its terms the offence was to be notified at once to 4 of the 25 who were to go to the king or the Justiciar and ask that the matter might be corrected. If it were not corrected within 40 days the 4 barons were to refer the matter to the rest of the 25, who together with the community of the whole land "shall distrain and trouble us in all possible ways by taking our castles, lands and possessions." When redress has been forced upon the king, former relations with him were to be resumed. Anyone who wished could swear to obey the 25. The king would enforce the oath on anyone who refused to take it. On the death of one of the 25 the survivors were to appoint his successor. A majority of them were to decide questions in dispute. The king promised that he would not directly or indirectly do anything by which the concessions might be revoked or diminished.

War Again.—In this last clause lies the weakness of the charter and of the whole baronial position. The legalization of temporary rebellion inevitably affected the tempers of both sides. At the same time, in the opinion of the archbishop and the moderate party, it was likely to secure not peace and good government but prolongation of the time of disorder. The baronial choice fell on some of the worst malcontents. The mayor of London was the only member of the 25 who was of less than baronial rank, no bishops were among them, and the only one of them who had any sympathy with the king's point of view was the count of Aumâle, a thoroughly untrustworthy person. The moderate men secured the appointment of a second committee of 38 men, chosen from all parties, and containing some of the wisest of the king's supporters. The work of this body was to hold the balance between the king and the 25. But despite this arrangement war broke out. The charter as it was issued can have satisfied no one. Some of the Northern barons had even withdrawn before agreement was reached; other barons evidently cared only for those clauses which secured to themselves either general promises or the redress of individual grievances. Stephen Langton, the wiser earls, and the judges saw the clauses by which they hoped to secure a well run administration wrecked by such insistence on personal questions. For the moment the king seemed willing to keep his part of the bargain. The charter was sent into every shire for publication by the sheriff, orders were sent to sheriffs and bailiffs that men should swear allegiance to the 25, and that enquiries should be set on foot as to the evil customs to be abolished. Peter des Roches ceased to be justiciar, and Hubert de Burgh was appointed. Some of the foreign mercenaries were dismissed, and some of the offending sheriffs removed. Enquiries were also set on foot as to claims of individuals against the king. This compliance did not last long. The tyranny of the 25 was not to be borne by one so impatient of control as John. He made ready for war, sending to Aquitaine and Flanders for mercenaries, and to the Pope for spiritual help.

While the king made ready for war the baronial leaders remained in London, making no other preparations than negotiations with the French king for help against John. The Northern barons who had withdrawn from the negotiations for the charter fortified their castles. All over the country the king's lands were attacked and his deer stolen. The administration was disorganized; the business of the Exchequer at a standstill. Stephen Langton and the bishops could do nothing. The Pope annulled the charter and excommunicated the baronial leaders. The archbishop refused to publish the excommunication, little as he approved of the baronial attitude, and left the country with his office in abeyance.

In October a party of barons seized Rochester castle, but John laid siege to it and it fell on St. Andrew's day. No substantial help came from France till January 1216, and Louis, son of Philip Augustus, whom the barons wished to make king, only landed in May. Meanwhile John was isolating the baronial stronghold of London by the fortification of Windsor, Hertford, Berkhampstead and Bedford castles. One company of the royal army occupied itself in reducing East Anglia and Essex. The king in person quelled resistance in the north, and appointed trustworthy men to keep the northern barons in subjection. Had it not been for French help the rebellion would have been over before the summer of 1216. The coming of Louis meant the desertion of many of John's French mercenaries. Louis' momentary success drew to his side some of the greater barons who had hitherto supported John, the earls of Warenne, Arundel and Salisbury, and the count of Aumâle. War was renewed all over the country. Alexander of Scotland raided the north. Lincoln castle was besieged by barons acting in the name of Louis. In Yorkshire the rebel barons rose again, and in Nottinghamshire the castles of Nottingham and Newark were taken by them. But the king's cause was by no means lost. In the north the men appointed by John had little difficulty in upholding his authority. Even in the south Louis made little headway. Although he took Winchester, he could not take the castles of Windsor or Dover. Meanwhile, resentment against French domination began to be felt among the barons. John reorganized his forces in the south-west, drew off the besiegers of Windsor castle and passed into the eastern counties, where he intended to crush resistance as he had done in the north in the previous winter. At Kings Lynn he was seized with dysentery. He crossed the Wash and managed to struggle to Newark, where he died on Oct. 19, 1216. With his death the need for further opposition to royal authority was gone, for the moderate party took control of affairs in the name of the young Henry.

The Reissues of the Charter.—The Charter was at once reissued with certain significant changes. All clauses of a purely temporary nature were omitted, those dealing with mercenaries and the redress of grievances. With them went the promise that only justices, constables, sheriffs and bailiffs who know the law and are willing to observe it shall be appointed (45). Clauses which might affect the royal power to raise money were omitted, those relating to the Jews, the feudal aids, and the farms of the shires. The clause laying down the way in which the barons should be consulted in the feudal council was omitted. These omissions were all matters of policy. It was not the time to haggle over personal grievances, nor could Henry's advisers rightly bind the young king in matters of general policy. The mercenaries were needed to fight Louis. Money was needed from whatever source. The necessity of the moment, too, added a provision that payment for goods for royal castles might be postponed for three weeks. Other changes, slight though they were, showed that those who reissued the charter had sufficient time and interest to consider the advantage of authoritative statements on difficult legal points. The position of the heir in his lord's wardship and the position of a widow with regard to her dower are more precisely defined. The form of security for the maintenance of the charter was omitted, but a clause was inserted promising full consideration of everything that needed correction.

In the reissue of the following year, 1217, the clauses omitted in 1216 were not replaced. The regency council might be using the charter as a political weapon to win men to their side, but they regarded it as above all an administrative measure, a guide to and a check on judges and local officers in the difficult years of reconstruction. The rights of the widow are still more carefully defined. The rules for the taking of assizes are modified. There were three fresh clauses forbidding a freeman to give or sell so much of his land as may hinder the proper performance of his services to his lord; regulating the conduct of the sheriff with regard to the holding of the shire court; and forbidding the practice of giving land to a religious house and receiving it back as its tenant. The delay of 3 weeks in the payment of goods taken for the use of a royal castle in 1216 is extended in 1217 to 40 days, but in 1217 the carts of ladies, knights and parsons are exempt from cartage duties. The provision in the 1215 issue that service with the army exempts from castle guard is limited by the statement that the exemption only applies to fiefs from which service with the army is due. If the clause which declares that the promises made by the king to his tenants shall be observed by his men to theirs is weakened by the saving clause reserving to "all archbishops, bishops, abbots, priors, templars, hospitalers, earls, barons and all other as well ecclesiastical as secular persons their liberties and free customs which they had before," it is, at any rate, made clear that all villeins, not only the king's are protected from excessive amercements. The forest clauses were omitted and issued later in a separate charter. It is to this issue that the name *Magna Carta* became attached in contrast with the charter of the forest. The edition of 1225 contained nothing new, except the statement that the charter is issued of the king's free and spontaneous will and in return for an aid. That later issues of the charter were no more than confirmations of this edition is not surprising. The administrative system was yearly becoming more complicated, the law more intricate. A carefully drawn statute was needed at the end of the century to deal with a matter for which a short clause would have sufficed in 1217.

There still exist four originals of the charter of 1215, two of them in the cathedral churches in which they were originally deposited, Lincoln and Salisbury, the other two in the British Museum. The Lincoln Charter was considered the most perfect and was reproduced in the Statutes of the Realm in 1810. The charter was commented on by Sir Edward Coke in his *Second Institute* published by order of the Long Parliament in 1642, but modern criticism was begun by Blackstone *The Great Charter and the Charter of the Forest* (1759). Richard Thomson's *Essay on the Magna Carta of King John* (1829), was a serious attempt to collect all the information on the circumstances and people connected with the charter. It also contains a useful section on the existing manuscripts, copies and printed editions of the charter. Modern authorities to be consulted are C. Bémont, *Chartes des libertés anglaises* (1892); W. S. McKechnie, *Magna Carta* (1905); Petit-Dutaillis, *Studies supplementary to Stubbs' Constitutional History* ii. (1908); R. L. Poole, *The Publication of Great Charters by the English Kings* in Eng. Hist. Review (1913); *Magna Carta Commemoration Essays* (1915); F. M. Powicke, *Stephen Langton* (1928). (D. M. S.)

MAGNA CARTA DAY ASSOCIATION, INTERNATIONAL, INC. The Association was organized in St. Paul, Minn., in 1907, to emphasize the common political heritage of the English-speaking peoples; their political harmony of thought and purpose; their championship of civil and religious liberty and common devotion to popular government. Magna Carta Day is now widely observed annually, the churches co-operating on Magna Carta Sunday, the third Sunday in every June. The association operates through the distribution of appropriate literature to educational institutions, libraries, the press, churches, State and municipal authorities, also by means of a world-wide correspondence.

MAGNA GRAECIA, the name given (first, apparently, in the 6th century B.C.) to the group of Greek cities (ἡ μεγάλη Ἑλλάς), along the coast of the "toe" of South Italy (or more strictly those only from Tarentum to Locri, along the east coast), while the people were called Italiotes (Ἰταλιῶται). The interior continued in the hands of the Bruttii, the native mountaineers, from whom the district was named in Roman times (Βρεττία also in Greek writers). The Greek colonies, at first trading stations, grew into independent cities. An early trade in copper was carried on between Greece and Temesa (Homer, *Odyssey*, i., 181), chiefly by Euboeans; and Cyme (Cumae) in Campania was founded in the 8th century B.C., when the Euboean Cyme was still a great city. After this the energy of Chalcis went onward to Sicily, and the states of the Corinthian Gulf carried out the colonization of Italy, Rhegium having been founded, it is true, by Chalcis, but after Messana (Zancle), and at the request of the inhabitants of the latter. Sybaris (721) and Crotona (703) were Achaean settlements; Locri Epizephyrii (about 710) was settled by Ozolian Locrians, so that, had it not been for the Dorian colony of Tarentum, the southern coast of Italy would have been entirely Achaean. Tarentum, whatever its origins, early became the only foreign settlement of the Spartans. Ionian Greeks fleeing from foreign invasion founded Siris about 650 B.C., and, much later, Elea (540).

The Italian colonies, planted among friendly peoples, grew much more rapidly than the Sicilian Greek states, which had to contend against Carthage. After the Achaean cities had combined to destroy the Ionic Siris, and had founded Metapontum as a counterpoise to the Dorian Tarentum, there was little strife among the Italiotes. An amphictyonic league, meeting at the temple of Hera on the Lacinian promontory, fostered a feeling of unity. The Pythagorean and Eleatic systems of philosophy had their chief seat in Magna Graecia. They sent competitors to the Olympic games (among them the famous Milo of Croton); and the physicians of Croton early in the 6th century (especially in the person of Democedes) were reputed the best in Greece. In 510 Croton, having defeated the Sybarites in a great battle, totally destroyed their city. In the war between Athens and Syracuse Magna Graecia took comparatively little part; Locri was strongly anti-Athenian, but Rhegium, though the headquarters of the Athenians in 427, remained neutral in 415. Foreign enemies pressed heavily on it. The Lucanians and Bruttians on the north captured one town after another. Dionysius of Syracuse attacked from the south; and after he defeated the Crotoniate league and destroyed Caulonia (389 B.C.), Tarentum (*q.v.*) remained the only powerful city. Repeated expeditions from Sparta and Epirus tried in vain to prop up the decaying Greek states against the Lucanians and Bruttians; and when in 282 the Romans appeared in the Tarentine Gulf the end was close at hand. The aid which Pyrrhus brought did little good to the Tarentines, and his final departure in 274 left them defenceless. Malaria increased as population diminished. Many of the cities disappeared, and hardly any were of great importance under the Roman empire; some, like Tarentum, maintained their existence into modern times. Archaeological investigations of great importance have been made. (T. A.)

MAGNASCO, ALESSANDRO (1667–1749), Italian painter belonging to the period of transition from the Baroque to the Rococo. Magnasco was born at Genoa. He studied painting under Abbiati. In landscape work he broke away from the conventions. He was most distinguished as a genre painter of Italian interiors. He is represented in the galleries of Dresden, Vienna, Berlin, Frankfurt, Florence, Milan, and Warsaw.

MAGNATE, a noble, a man in high position, by birth, wealth or other qualities. The term which is derived from Late Lat.

magnas, a great man, was specifically applied to the members of the Upper House in Hungary, the *Förendihaz* or House of Magnates. Its popular application to a wealthy man is usually satirical.

MAGNES (*c.* 460 B.C.), Athenian writer of the Old Comedy, a native of the deme of Icaria in Attica. His death is alluded to by Aristophanes (*Equites,* 518–523, which was brought out in 424 B.C.), who states that in his old age Magnes had lost the popularity which he had formerly enjoyed. The few titles of his plays that remain, such as the *Frogs,* the *Birds,* the *Gall-flies,* indicate that he anticipated Aristophanes in introducing grotesque costumes for the chorus.

See T. Kock, *Comicorum atticorum fragmenta,* i. (1880); G. H. Bode, *Geschichte der hellenischen Dichtkunst,* iii. pt. 2 (1840).

MAGNESIA, in ancient geography the name of two cities in Asia Minor and of a district in eastern Thessaly, lying between the Vale of Tempe and the Pagasaean Gulf.

(1) MAGNESIA AD MAEANDRUM, a city of Ionia, situated on a small stream flowing into the Maeander, 15 Roman miles from Miletus and rather less from Ephesus. According to tradition it was founded by colonists from the Thessalian tribe of the Magnetes, with whom were associated, according to Strabo, some Cretan settlers. It was thus not properly an Ionic city, and for this reason, apparently, was not included in the Ionian league, though superior in wealth and prosperity to most of the members except Ephesus and Miletus. It was destroyed by the Cimmerii in their irruption into Asia Minor, but was soon after rebuilt, and gradually recovered its former prosperity. It was one of the towns assigned by Artaxerxes to Themistocles for support in his exile. Magnesia continued under the kings of Pergamum to be one of the most flourishing cities in this part of Asia; it resisted Mithridates in 87 B.C., and was rewarded with civic freedom by Sulla; but it appears to have greatly declined under the Roman empire, and its name disappears from history, though on coins of the time of Gordian it still claimed to be the seventh city of Asia.

See K. Haumann, *Magnesia am Maeander* (1904).

(2) MAGNESIA AD SIPYLUM, a city of Lydia about 40 mi. northeast of Smyrna unknown before the battle of 190 B.C. In 197 B.C. the Romans, freed from all danger from Carthage, had forced the submission of Philip V of Macedon (*see* CYNOSCEPHALAE, BATTLE OF), while Antiochus, overrunning Asia Minor, had penetrated into Thrace. The Mediterranean world could not hold two such powerful rivals, and the inevitable clash was hastened by Antiochus's subsequent invasion of Greece. If by his dilatory and limited strategy he lost his opportunity, he roused the Romans, reviving from the war weariness that followed the struggle with Hannibal, to a sense of danger, and, not content with his repulse, they prepared a counter-invasion—all the more because Hannibal was now at the side of Antiochus. The expedition was placed under the consul Lucius Scipio, whose election was due to the promise of his famous brother, Publius Scipio Africanus, to accompany him as his lieutenant. The latter's combination of strategy and diplomacy ensured the expedition's secure and unchecked passage from Greece and across the Dardanelles into Asia Minor. But illness prevented him reaping the tactical fruits, and the decisive battle was fought while he was still on his sick bed. Antiochus with an army computed at 62,000 foot and over 12,000 horse had fallen back behind the Hermus river and there at Magnesia—the modern Minissa—fortified a strong camp. Though the Romans counted only two legions and proportionate allied contingents—some 30,000 in all—an attack was decided upon. "The Romans never despised an enemy so much." However, Antiochus saved them the trouble and came out to offer battle. Even so, they evidently missed the master-hand of Scipio Africanus, and were even in jeopardy for a time. For while they were driving in the enemy's centre, and their cavalry were attacking his left flank, Antiochus himself with his right wing cavalry, crossed the river—left almost unguarded—and fell upon the Romans' left flank. The troops there were dispersed and took refuge in the camp, where only the resolution of the tribune left in charge rallied them and staved off the danger until reinforcements arrived. Foiled here and seeing a heavy concentration developing against him, Antiochus fled from the battlefield, and the remnants of his demoralized army followed him to Sardis. Antiochus, with his subject states making their peace with Rome, was forced, more through Africanus's strategy than his brother's tactics, to sue for a peace which removed him to the eastern side of the Taurus range and left Asia Minor free for Roman exploitation.

MAGNESITE, a mineral consisting of magnesium carbonate, $MgCO_3$, and belonging to the calcite group of rhombohedral carbonates. It is rarely found in crystals or crystalline masses, being usually compact or earthy and intermixed with more or less hydrous magnesium silicate (meerschaum). The compact material has the appearance of unglazed porcelain, and the earthy that of chalk. In colour it is usually dead white, sometimes yellowish. The hardness of the crystallized mineral is 4; specific gravity 3·1. The name magnesite as originally applied by J. C. de Lamétherie in 1797 included several minerals containing magnesium, and at the present day it is used by French writers for meerschaum.

Magnesite is a product of alteration of magnesium silicates, and occurs as veins and patches in serpentine, talc-schist or dolomite-rock. It is extensively mined in the island of Euboea in the Grecian Archipelago, near Salem in Madras, and in California. It is principally used for the manufacture of highly refractory fire-bricks for lining steel furnaces and electric furnaces; also for making plaster, tiles and artificial stone; for the preparation of magnesium salts (Epsom salts, etc.); for whitening paper-pulp and wool; and as a paint.

MAGNESIUM, a metallic chemical element of silvery white appearance, which is familiar in the form of ribbon (symbol Mg, atomic number 12, atomic weight 24·32, isotopes 24, 25, 26). The sulphate or Epsom salts was isolated in 1695 by N. Grew, while in 1707 M. B. Valentin prepared *magnesia alba* from the mother liquors obtained in the manufacture of nitre. Magnesia was confounded with lime until 1755, when J. Black showed that the two substances were entirely different; and in 1808 Davy pointed out that it was the oxide of a metal, which, however, he was not able to isolate. Magnesium is found widely distributed in nature, chiefly in the forms of silicate, carbonate and chloride, and occurring in the minerals olivine, hornblende, talc, asbestos, meerschaum, augite, dolomite, magnesite, carnallite, kieserite and kainite. The metal was prepared (in a state approximating to purity) by A. A. B. Bussy who fused the anhydrous chloride with potassium; H. Sainte Claire Deville's process, which used to be employed commercially, was essentially the same, except that sodium was substituted for potassium and that carnallite, $KCl,MgCl_2$ was used instead of magnesium chloride, the product being further purified by redistillation. Electrolytic methods have entirely superseded the older methods; fused carnallite, $KCl,MgCl_2$, is electrolysed at 760°C. in an iron pot, which acts as the cathode, the anode being a carbon rod surrounded by a porcelain tube to carry off the chlorine.

Magnesium is malleable and ductile. Sp. gr. 1·75. Its alloys with aluminium are known as "magnalium" and are useful for light castings. Magnesium preserves its lustre in dry air, but in moist air it becomes tarnished by the formation of a film of oxide. It melts at 632·7°C. and boils at about 1,100°C. Magnesium and its salts are diamagnetic. It burns brilliantly when heated in air or oxygen, or even in carbon dioxide, emitting a white light and leaving a residue of magnesia, MgO. The light is rich in the violet and ultra-violet rays, and consequently is employed in photography. At high temperatures it acts as a reducing agent. It combines directly with nitrogen, when heated in the gas, to form the nitride Mg_3N_2 (*see* ARGON). It is rapidly dissolved by dilute acids.

Magnesium Oxide, magnesia, MgO, occurs native as the mineral periclase, and is formed when magnesium burns in air; it may also be prepared by the gentle ignition of the hydroxide or carbonate. It is a non-volatile and highly infusible white powder, which slowly absorbs moisture and carbon dioxide from air, and is readily soluble in dilute acids. On account of its refractory nature, it is employed in the manufacture of crucibles, furnace linings, etc. It is also used in making hydraulic cements. *Magnesium hydroxide* $Mg(OH)_2$ occurs native as the minerals brucite and nemalite. It is employed in the manufacture of cements.

When magnesium is heated in fluorine or chlorine or in the vapour of bromine or iodine there is a violent reaction, and the corresponding halide compounds are formed. With the exception of the fluoride, these substances are readily soluble in water and are deliquescent. The fluoride is found native as sellaïte, and the bromide and iodide occur in sea water and in many mineral springs. The most important of the halide salts is the *chloride* which, in the hydrated form, has the formula $MgCl_2,6H_2O$. The hydrated salt loses water on heating, and partially decomposes into hydrochloric acid and magnesium oxychlorides. To obtain the anhydrous salt, the double magnesium ammonium chloride, $MgCl_2,NH_4Cl,6H_2O$, is prepared by adding ammonium chloride to a solution of magnesium chloride. Magnesium oxychloride when heated to redness in a current of air evolves a mixture of hydrochloric acid and chlorine and leaves a residue of magnesia, a reaction which is employed in the Weldon-Pechiney and Mond processes for the manufacture of chlorine.

Magnesium Carbonate, $MgCO_3$.—The normal salt is found native as the mineral magnesite, and in combination with calcium carbonate as dolomite, whilst hydromagnesite is a basic carbonate. It is not possible to prepare the normal carbonate by precipitating magnesium salts with sodium carbonate.

Other Magnesium Salts.—By adding sodium phosphate to magnesium sulphate and allowing the mixture to stand, hexagonal needles of $MgHPO_4,7H_2O$ are deposited. The *normal phosphate,* $Mg_3P_2O_8$, is found in some guanos, and as the mineral wagnerite. It is a white amorphous powder, readily soluble in acids. *Magnesium ammonium phosphate,* $MgNH_4PO_4,6H_2O$, is found as the mineral struvite and in some guanos; it occurs also in urinary calculi and is formed in the putrefaction of urine. *Magnesium nitrate,* $Mg(NO_3)_2 \cdot 6H_2O$, is a colourless, deliquescent, crystalline solid obtained by dissolving magnesium or its carbonate in nitric acid, and concentrating the solution. The crystals melt at 90° C. *Magnesium nitride,* Mg_3N_2, is obtained as a greenish-yellow amorphous mass by passing a current of nitrogen or ammonia over heated magnesium. *Magnesium sulphate,* $MgSO_4$, occurs (with $1H_2O$) as kieserite. A hexahydrate is also known. The heptahydrate is known as Epsom salts (*q.v.*).

Organic Compounds.—The most important organic compounds of magnesium are known as Grignard reagents (*q.v.*). They are of the composition RMgX (where R=an alkyl or aryl group and X=a halogen).

Detection.—In the absence of barium, strontium, calcium and aluminium the magnesium salts may be detected by the colourless crystals formed by adding sodium phosphate (in the presence of ammonia and ammonium chloride) to their solutions. The same reaction is made use of in the quantitative determination of magnesium, the white precipitate of magnesium ammonium phosphate being converted by ignition into magnesium pyrophosphate.

Medicine.—The salts of magnesium may be regarded as the typical *saline purgatives.* Their aperient action is dependent upon the minimum of irritation of the bowel, and is exercised by their abstraction from the blood of water, which passes into the bowel to act as a diluent of the salt. Magnesium salts have a powerful depressant action, especially on nervous tissue.

MAGNETIC ANALYSIS, broadly, the art of determining the constitutional and structural state of ferro-magnetic materials through study of the co-existing magnetic characteristics. In the United States the use of the term is restricted to denote the process of interpreting the magnetic characteristics of ferrous or other magnetic materials in terms of their physical characteristics that have a bearing on their qualifications for a given service.

The practicability of magnetic analysis rests upon the hypothesis that in a ferrous material there is a definite connection between the magnetic and the mechanical properties. Variations in chemical composition, inhomogeneities in structure, the presence of cracks and internal strains, processes of mechanical and thermal treatment, etc., all result in variations in magnetic characteristics which are more or less open to measurement and interpretation. Magnetic analysis predicates a test procedure which is non-destructive and may be applied at any stage in manufacture.

Both direct and alternating current are used as the primary means of magnetization. Various types of indicating means are employed, such as instruments of the deflected pointer type, galvanometers or oscillographs reflecting a light ray, the latter permitting of photographic recording. Magnetization by direct current offers advantages where it is desired to make tests at high inductions, or where the cross-section of the material is large. The alternating current method permits of greater speed in measurement. It also allows of obtaining separate indications representing different summations of permeability and watt loss characteristics, from which more than one property of the article under test may be inferred. Thus far its application in practice has been confined mainly to the examination of relatively small articles.

T. Spooner (*Proc. Am. Soc. Testing Materials,* pt. ii., 26, 1926) has carried out an extended investigation on high speed steel which consolidates much of the information on the subject of testing under alternating magnetization. Fig. 1 shows a series of oscillograms obtained by means of a cathode ray oscillograph of specimens of high speed steel of one composition which have undergone different heat treatments. The ordinates represent the differential of the magnetic flux for individual specimens of stated heat treatment and a standard specimen, both being subjected to the same magnetizing force. The abscissae represent time on a harmonic scale which is varied in phase with respect to the cycle of magnetization, so as to give prominence to that portion of the loop which has been found to carry special significance. Each vertical column, reading downward, shows for a given quenching temperature the changes in form as the drawing temperature is increased.

See *Proc.* Am. Soc. Test. Mat. (1913–27), R. L. Sanford, "Magnetic Analysis," *Trans.* Am. Inst. Elect. Eng. (1929); and bibliography of the Congrès International pour L'essai des Matériaux (Amsterdam, Sept. 1927).

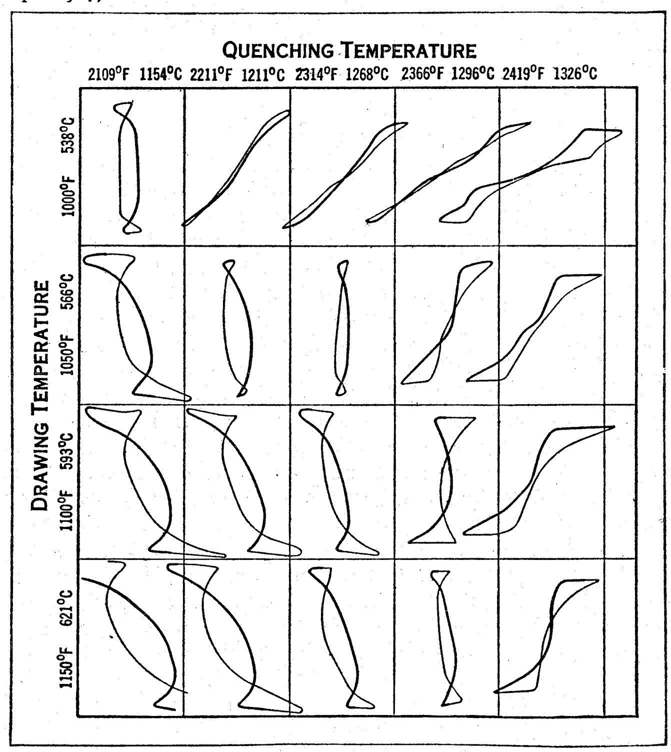


FIG. 1.—CLOSED LOOP OSCILLOGRAMS SHOWING MAGNETIC EFFECTS OF DIFFERENT HEAT TREATMENTS ON HIGH-SPEED STEEL BARS

MAGNETISM. This article is divided into the following sections:

This subject may be divided into three parts: (1) *ferromagnetism,* a property possessed by iron and a few other metals, and characterized by strong attraction of one magnetized body to another; (2) *paramagnetism,* a quality of many substances which causes them to be attracted by the poles of an electromagnet or magnetized body; and (3) *diamagnetism,* by virtue of which materials possessing this property are repelled by an electromagnet. Ferromagnetism is an important branch of paramagnetism, and ferromagnetic bodies are differentiated from other paramagnetic bodies by the magnitude of their reaction with a magnetic field, and in other ways described in detail in the following paragraphs.

For practical purposes, ferromagnetism is much the most important kind of magnetism.

After an historical introduction, ferromagnetic phenomena and materials will be described, and the effect of various factors on magnetic properties discussed. Following this, diamagnetism and paramagnetism and the theory of ferromagnetism will be considered, and finally an account of methods used for measuring magnetic quantities.

1. HISTORY

Centuries before the Christian era the Greeks knew that the mineral lodestone, a magnetic oxide of iron (magnetite, Fe_3O_4), had the ability to attract iron and other pieces of the same mineral. This natural magnet was mentioned by Thales of Miletus (*c.* 624–548 B.C.); and according to Plato, Socrates states in *Ion* that it will support a chain of iron rings, each held to the one above it by magnetic attraction.[1]

The Roman Lucretius Carus states in his *De Rerum Natura,* in the first century B.C., that ". . . iron can be drawn by that stone which the Greeks call Magnet by its native name, because it has its origin in the hereditary bounds of the Magnetes,"[2] the inhabitants of Magnesia, in Thessaly. The Romans knew also of the repulsive action of magnetism, as shown by a quotation from the same passage: "Sometimes, too, iron draws back from this stone; for it is wont to flee from and follow it in turn." No reference to the directive property of the magnet, as used in the compass, is found in old Greek and Roman literature.

To account for magnetic attraction some in this period believed that there were hooks on the surface of the magnet and little rings on the surface of the iron to catch them; others that particles were emitted by the magnet and created an empty space toward which the iron would move. Of all the phenomena of electricity and magnetism, frictional electricity and ferromagnetism are the oldest known to man, and perhaps the least understood today.

Beginning in the period A.D. 1000–1200 the history of magnetism is closely connected with the compass and its use in navigation. According to G. Sarton, the first clear mention in any literature of a magnetic needle for indicating direction appears to have been made by Shen Kua (1030–1093), a Chinese mathematician and instrument maker, who, however, mentions only its use on land.

Soon after 1100, the Chinese Chu Yu reported that in the period 1086–1099 the compass was used for navigation by "foreign" sailors going between Canton and Sumatra. Since the trade in this region was practically a Moslem monopoly it is concluded that they were the first to use the compass for directing ships.

The earliest known European reference to the compass is by Alexander Neckam (1157–1217), an English cyclopaedist. In 1269 Petrus Peregrinus de Maricourt, a French crusader, gave the first detailed description as an instrument of navigation. He wrote of the floating compass as an instrument in common use and described a new pivoted compass in some detail. He fashioned a sphere of lodestone and explored its surface with bits of iron, and applied the term pole to the places in which the magnetic power appeared to be concentrated. He believed that the magnet derived its power from the sky.

After his time little progress was made for almost 300 years. In 1600 William Gilbert of Colchester, England, published his *De Magnete* which summarizes the knowledge of magnetism at the time of Queen Elizabeth, whose court physician he was, and reports some of his own experiments. He mentions the dip and declination of the compass and propounds his own great contribu-

[1] *Ion.* 533 ff.
[2] Book vi, lines 906 ff., translated by T. Jackson (Oxford, 1929).

tion, the discovery that the earth itself is a magnet. He showed that magnetized iron lost its magnetism when heated to a bright red heat and regained it when cooled again to room temperature. His chapter xii, of book v is entitled "Magnetick force is animate, or imitates life; and in many things surpasses human life, while this is bound up in the organick body."[1]

After the time of Gilbert, during the period when Isaac Newton was formulating the law of gravitation and Robert Boyle was investigating the laws of gases, little of importance for magnetism was recorded.

Magnetostatics and the Nature of Magnetism.—In 1785 Charles Augustin Coulomb established with some precision the inverse square law of attraction (and repulsion) between unlike (and like) magnetic poles, a proposition that had been favoured or opposed by many before him. This was made the basis of Poisson's mathematical theory giving the forces between magnetized bodies in terms of their intensities of magnetization. Simon Denis Poisson (1781–1840) assumed magnetization to be a molecular phenomenon, but believed that a molecule became magnetic when the two fluids which it contained became separated. In 1852 Wilhelm Weber proposed that each molecule is a permanent magnet, subject to a frictional force that tends to maintain it in its established orientation. This explained the limit of magnetization (saturation) and gave a rather unsatisfactory explanation of residual magnetization, the magnetization remaining after the removal of the magnetizing field. Later James Clerk Maxwell (1831–79) improved upon Weber's explanation of residual magnetization by suggesting that the molecular magnet had no friction but had more than one fixed position of equilibrium.

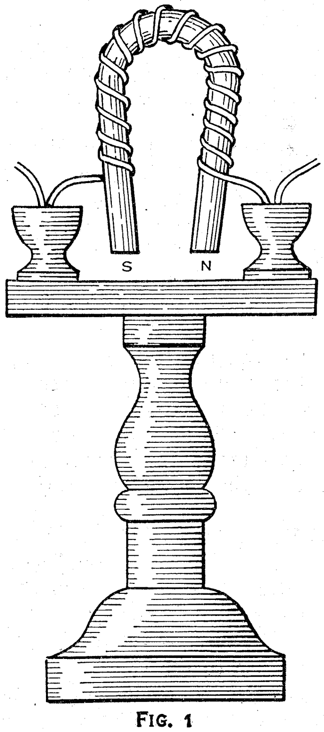


Fig. 1
A drawing of the first electromagnet that could be so called, constructed by William Sturgeon in 1825. The soft iron horseshoe is 5 in. high and is magnetized by the copper wire connected to a battery not shown

Before the time of Weber, Hans Christian Oersted made the important discovery (1820) that an electric current would affect a magnetic needle. Quickly following up this lead, André Marie Ampère investigated experimentally and mathematically the mutual forces between currents and showed (1825) that a current in a circuit is equivalent to a "magnetic shell" of calculable strength. He considered a magnet to be due primarily to electric currents circulating within the molecules, and this concept, though not accepted immediately because there was no way either to prove or to disprove it, stood the test of time and was elaborated only by the advent of electron theory and the modern era.

Electromagnetism. — Using Oersted's discovery, both Ampère and Dominique Arago (1786–1853) magnetized steel needles by placing them in a helix of wire carrying an electric current. This was the prelude to the construction in 1825 of the first electromagnet which could be so-called, by William Sturgeon (1783–1850) of Lancashire (fig. 1). This was made of soft iron bent in the form of a horseshoe and wound with a loose helix of 18 turns of wire, and when excited by a wet battery could lift 20 times its own weight.

Several years later Joseph Henry in the United States built a much improved electromagnet with many turns of wire efficiently applied. While experimenting with this in 1829 he noticed the spark that occurred when the circuit was broken and was led to discovery of self-induction, a treatise on which he published in 1832. The same phenomenon was independently discovered and published several years later by Michael Faraday (1791–1867). This great English experimentalist also shared with Henry the important discovery of electromagnetic induction, the "conversion" of magnetism into electricity. Although Henry is believed to have performed the experiment first and understood its significance, his results were unknown to Faraday who likewise made the crucial experiment and was the first to publish the results and thereby establish priority. Faraday and Henry made the first transformers (fig. 2) and prepared the way for the construction of the dynamo and motor and the age of electricity.

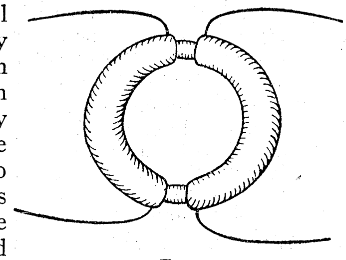


Fig. 2
Faraday's first transformer, with two windings of copper wire on an iron core. Connection of one winding to battery causes momentary flow of electricity in other winding connected to galvanometer

The laws of electricity and magnetism were formulated systematically in mathematical language by Maxwell, and his famous treatise was published in 1873.

Kinds of Magnetism.—The ancients knew the kind of magnetism that we observe in lodestone and iron and call *ferromagnetism.* Nickel and cobalt were discovered in the 18th century and nickel was soon thereafter known to be ferromagnetic while the ferromagnetism of cobalt was proved by Faraday in 1845. In 1846 Faraday observed that a bar of glass was repelled by his electromagnet, and named this property diamagnetism; he did not know that S. J. Brugmans (in 1778) and others had previously observed the same phenomenon in bismuth and antimony. Similarly he used the word paramagnetic for substances that were attracted by an electromagnet, and showed that this was a property of the substance and not the effect of an impurity of iron. He classified all of the substances that he examined—solids, liquids and gases—as para- or diamagnetic. Ferromagnetism is thus one kind of paramagnetism.

Almost 20 years after Faraday's death Pierre Curie (1895) made careful measurements of the effect of temperature on many materials of these three categories and found that diamagnetism is usually independent of temperature whereas paramagnetism usually decreases as the temperature increases.

A connection between ferromagnetism and light was finally established experimentally by J. Kerr who in 1876 observed the rotation of the plane of polarization of light reflected from a magnetized surface. Previously Faraday (1845) had observed a similar rotation in light transmitted by transparent bodies, and later (1896) Pieter Zeeman discovered the broadening of the spectral lines of sodium when the light was emitted in the presence of a magnetic field.

Modern Theory.—One difficulty with Weber's theory was that it gave no satisfactory explanation of residual induction and hysteresis. Maxwell's suggestion of multiple fixed positions for the molecular magnet left unexplained the fact that hysteresis (*see* below) is found when a magnetizing force, after being once applied, is removed and reapplied. J. A. Ewing proposed (1890) that the constraints on the orientations of the molecular magnets were imposed by the magnetic forces of the surrounding molecules, and showed by means of calculations and models that such forces can account qualitatively for the shape of the magnetization curve and the major and minor hysteresis loops. He first used the word *hysteresis*. J. Swinburne predicted on the basis of Ewing's theory that in a rotating magnetic field the hysteresis should disappear, and F. G. Baily's experiment (1896) confirmed this in a striking way (*see* fig. 29 below).

The first important influence of modern concepts on the theory of magnetism came when P. Langevin (1905) used statistical theory to explain the variation of paramagnetic susceptibility with temperature. He assumed each molecule to have a definite magnetic moment that tended to be oriented by the applied field and at the same time disturbed by thermal agitation. In 1907 this was seized upon by P. Weiss who postulated that the molecules are exposed both to the applied field and to a so-called

[1]Translation by the Gilbert Club, S. P. Thompson (ed.) Chiswick Press (London, 1900).

molecular field proportional to the intensity of magnetization, and so developed the first important quantitative theory of ferromagnetism. This molecular field is co-operative in nature, in that it depends on the mutual action of many atoms, and is now attributed to the "exchange forces" derived from quantum theory by W. Heisenberg.

It is a consequence of the Weiss theory that ferromagnetic materials must be spontaneously magnetized, that is, small regions or "domains" of the material are magnetized to saturation even when the specimen as a whole has zero intensity of magnetization; in this latter condition the magnetic moments of the regions are oriented at random. Previously such regions were considered identical with the molecules or atoms of the substance, but Weiss's deduction was later supported by many experiments (*e.g.* those on the Barkhausen effect) and is the basis of the domain theory now used in the interpretation of many magnetic phenomena.

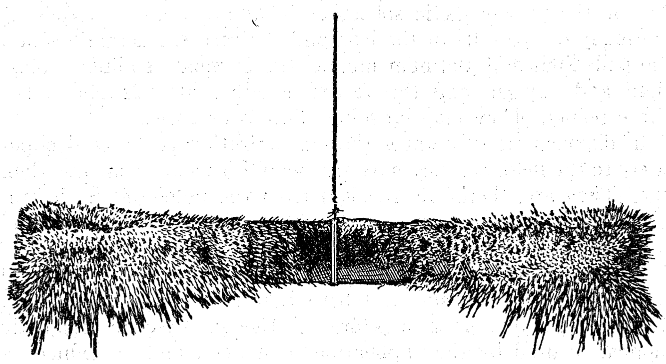


FIG. 3

A magnetized bar attracts iron filings that cling most strongly near the poles of the bar

The quantum theory by its clarification of atomic structure has had a great influence on magnetic theories. W. Pauli in 1920 showed that there is a natural unit of magnetic moment, the Bohr magneton, and in 1926 S. Goudsmit and G. E. Uhlenbeck proposed the spinning electron as the fundamental magnetic particle having a moment of one Bohr magneton. The quantum theory of paramagnetism and ferromagnetism was developed rapidly by the contributions of W. Heisenberg, J. H. Van Vleck, E. C. Stoner, H. Bethe, F. Bloch, J. C. Slater and others. The temperature dependence of saturation magnetization, as calculated by P. Debye (1925) was a notable success of the quantum theory of ferromagnetism. Advances in the theory of diamagnetism have also been made after P. Langevin's pioneering work of 1905.

The advances in useful materials, and in methods of measurement of magnetic quantities, are mentioned in appropriate places in the body of the article.

2. GENERAL DESCRIPTION OF MAGNETISM

The quality of magnetism first apparent to the ancients, and to us today, is the attractive force that exists between a natural magnet (lodestone) or an artificial magnet (a "permanent magnet") and a piece of soft iron. When a magnet is dipped into iron filings they cling to it, especially in certain places called poles that are usually located near the ends of the magnet (fig. 3). Such poles always occur in pairs, and in a magnet used as a compass needle the pole that points to the north is the north-seeking pole, or simply the north pole, and the other the south pole. When a magnet is broken, new poles appear near the break so that each piece contains at least one pole of each kind.

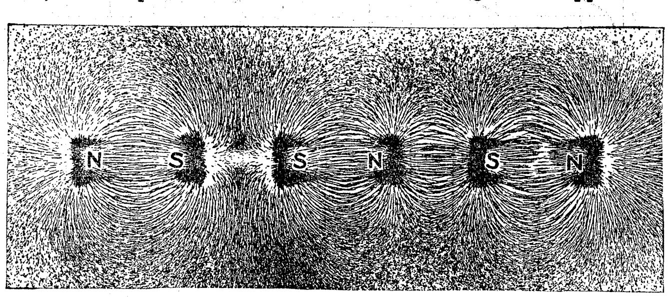


FIG. 4

Iron filings indicate the direction of the magnetic field near a group of bar magnets, show the lines of force emanating from S. poles and converging on N. poles

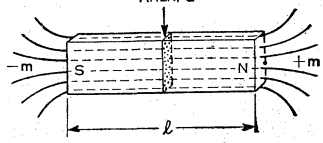


FIG. 5

A pole of strength m and area a corresponds to an intensity of magnetization I=m/a, equal also to magnetic moment per unit volume, ml/v. Lines of induction are endless, pass into the magnet at the S. pole and leave at the N. pole

Magnetic Field.—A magnet will attract a piece of iron even though the two are not in contact, and this action-at-a-distance is said to be due to the magnetic field, or field of force around the magnet. This field may be explored by sprinkling iron filings around a magnet, whereupon they form in lines that converge on the poles and indicate also the direction a small compass needle would take if placed at any point (fig. 4).

Poles exert forces on each other, north and south poles attract each other and like poles repel with a force that varies inversely as the square of the distance between them. A unit pole is a convenient concept defined so that two unit poles of like kind, one centimetre apart, repel each other with a force of one dyne. The strength of the field of force, or simply the magnetic field strength, or magnetizing force, may be defined in terms of magnetic poles: one centimetre from a unit pole the field strength is one oersted. A magnetic field may be produced by a current of electricity as well as by a magnet and the unit of field strength can also be defined in terms of current. A magnetic field has direction as well as strength; the direction is that in which a north pole, subjected to it, tends to move, or that indicated by a small compass placed at the point. The field strength is represented by the symbol H, and the unit defined above is the oersted.

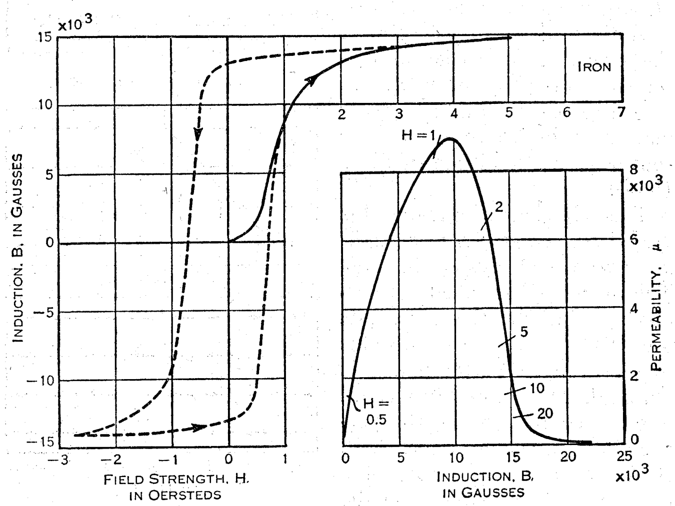


FIG. 6

Properties of materials are described by magnetization curves (solid line) and hysteresis loops (broken line) obtained by plotting I or B against H; they may also be described by permeability curves (μ vs. B)

Intensity of Magnetization and Magnetic Induction.—In order to describe the magnetic properties of materials, one must have a quantitative measure of magnetization. Such a measure is the intensity of magnetization, defined in terms of the number of unit poles in a piece of given cross-sectional area. Suppose that a uniformly magnetized bar, of length l and cross-sectional area a, has m unit north poles at one end and m unit south poles at the other (fig. 5). The intensity of magnetization is then m/a, and is represented by the symbol I. It may be easily shown that I is also the magnetic moment per unit volume; for the magnetic moment is pole strength times interpolar distance ($M=ml$), and $I=M/v$, if v is the volume al.

Maxwell showed that some of the properties of magnetism may be likened to a flow, and conceived endless lines of induction that represent the direction and, by their concentration, the flow at any point. The lines pass from a magnetized material into the air at the north pole, and enter again at a south pole, and pass through the material from the south pole back to the north to form a closed loop.

The total number of lines crossing a given area at right angles is the flux in that area. The flux per unit area is called the flux density, or magnetic induction, and is represented by the symbol, B. The lines of induction are due to both H and I, but in magnetic materials they are due mainly to the magnetization, I. The magnetic induction is defined by the relation

$$B=H+4\Pi I$$

The occurrence of the factor 4Π is due to the fact that a unit pole gives rise to a unit field everywhere on the surface of a sphere of unit radius enclosing the pole, and this sphere has an area of 4Π. The lines of induction may be visualized with the aid of fig. 4 showing the pattern obtained with iron filings.

Magnetization and Permeability Curves.—When a piece of iron is brought near a magnet, or subjected to the magnetic field of an electric current, the magnetization induced in the iron by the field is described by a magnetization curve obtained by plotting the intensity of magnetization, I, or the magnetic induction, B, against the field strength, H. Such curves are of fundamental importance for describing the magnetic properties of materials, and many of them are shown on the following pages. A magnetization curve for iron is shown as the solid line of fig. 6 (left).

The behaviour of a material is also described by its permeability curve and hysteresis loop. The ratio B/H is called the permeability, μ, and this represents the relative increase in flux due to the presence of the magnetic material. The permeability curve is obtained by plotting the permeability, μ, against either I, B, B-H, or H. In any case the curve rises from a point on the μ axis above the origin (the *"initial permeability"*) to a maximum (the *"maximum permeability"*) and falls off rapidly and then more slowly toward a value of one (not zero). When plotted against B-H, the curve ends at a definite point, *i.e.*, when B-H reaches its highest possible value, the saturation (fig. 6).

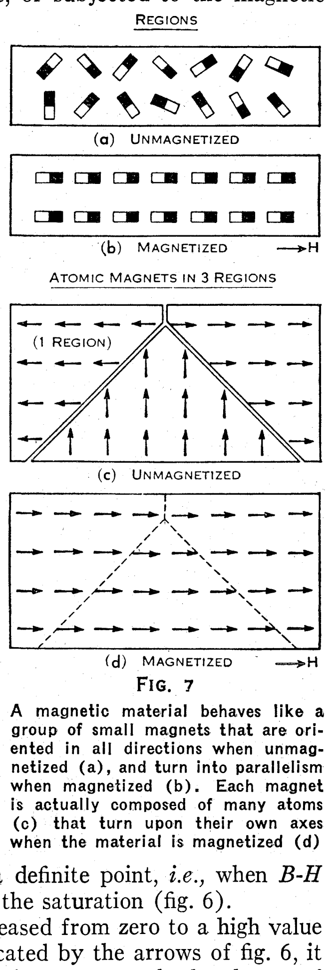


FIG. 7

A magnetic material behaves like a group of small magnets that are oriented in all directions when unmagnetized (a), and turn into parallelism when magnetized (b). Each magnet is actually composed of many atoms (c) that turn upon their own axes when the material is magnetized (d)

If the field strength is first increased from zero to a high value and then decreased again, as indicated by the arrows of fig. 6, it is observed that the original curve is not retraced; the change of induction "lags behind" the change in field and follows the characteristic curve shown by the broken line. This phenomenon was named hysteresis by Ewing, and the characteristic curve is called a hysteresis loop. On this loop, the value of H for which $B=0$ is called the coercive force, H_c, and this is often used as a measure of quality of the material. Sometimes it is desirable to have H_c large, sometimes small; for different materials H_c may be higher than 1,000, or lower than 0.01 oersted. The value of B for which $H=0$ is called the residual induction, B_r.

Ferromagnetism, Paramagnetism and Diamagnetism.—Materials which have magnetic properties similar to iron (*e.g.*, nickel and cobalt and many alloys of these three elements) are ferromagnetic. They have permeabilities of considerable magnitude that vary with the field, they exhibit hysteresis, and they lose these properties rather abruptly when heated to a temperature called the Curie point of the material. All ferromagnetic materials known are solids.

Another class of materials, more numerous, have permeabilities only slightly greater than one, usually between one and 1.001. These do not show hysteresis. The permeability is generally independent of field strength, and as a rule is either independent of temperature or decreases with increasing temperature. These materials, and also the ferromagnetic materials, are paramagnetic. Among the paramagnetic substances that are not ferromagnetic are many of the salts of the iron and the rare earth families and the palladium and platinum metals, the elements sodium, potassium and oxygen, and the ferromagnetic materials above the Curie points. They may be solids, liquids or gases.

In diamagnetic substances the magnetization is directed oppositely to the field, *i.e.* they have permeabilities somewhat less than one. They are, therefore, repelled from the poles of an electromagnet, and move toward a weaker field. Many of the metals and most of the nonmetals are diamagnetic.

Paramagnetic and diamagnetic substances are described more conveniently by their susceptibilities than by their permeabilities. The susceptibility is a measure of the increase in magnetic moment caused by the application of a field, and is defined as

$$k=I/H,$$

or the equivalent,

$$k=\frac{\mu-1}{4\pi}$$

For diamagnetic materials the susceptibility is negative, and for bismuth has a value of −0.000013. For paramagnetic substances like iron the susceptibility may be as high as 500, or higher.

Nature of Magnetism.—A ferromagnetic substance has long been regarded as an assemblage of small permanent magnets (fig. 7(a))—when the material is unmagnetized the magnets are arranged with haphazard orientations, when it is magnetized they are lined up with their axes parallel. The nature of this small magnet, or "domain," has been the subject of much consideration over a period of years, and now it is known that the material is composed of many small regions or domains, each of which consists of many atoms (fig. 7c). Within a domain all of the atoms are aligned parallel, and when the magnetization of the material is changed, the atoms in a domain turn together, while remaining parallel, so that they are aligned more nearly with the magnetic field applied to the material. The domain theory is discussed in more detail later.

The magnetic properties of materials depend mainly on the chemical composition and on the heat treatment they receive after fabrication, and sometimes they are influenced in an im-

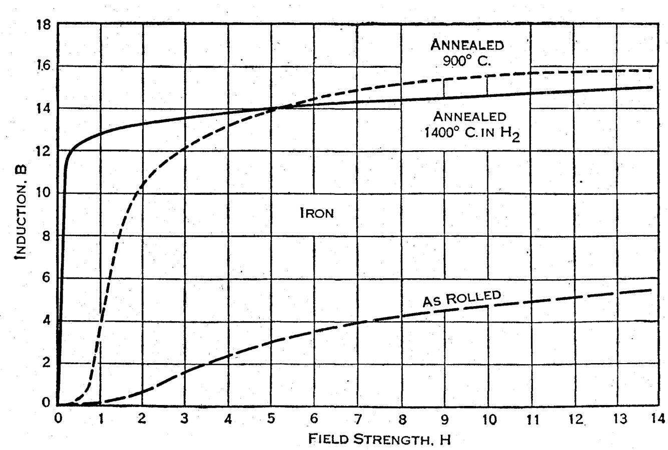


FIG. 8

Magnetization curves of iron in various conditions (P. P. Cioffi). B is expressed in kilogausses

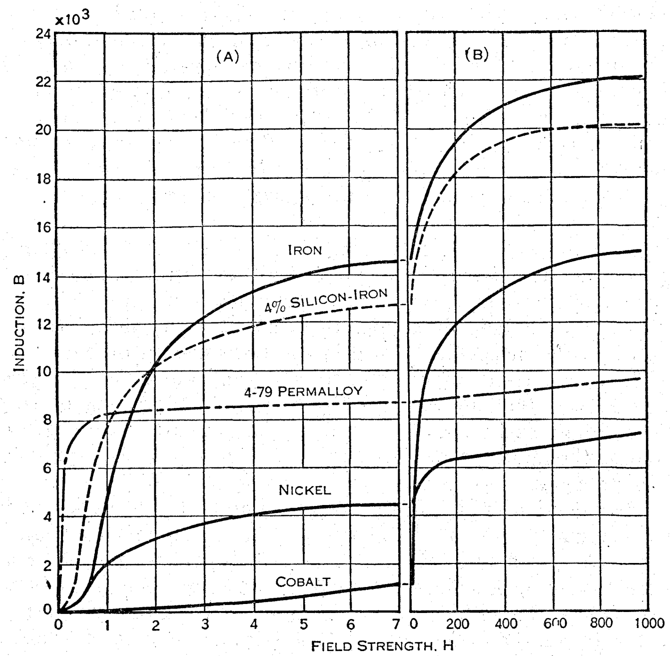


FIG. 9

Magnetization curves of some common materials in the annealed condition in low (A) and high (B) fields

portant way by the kind of fabrication used. Some ferromagnetic properties, such as saturation induction and Curie point, change but slowly with chemical composition, and are usually quite insensitive to methods of fabrication and heat treatment. On the other hand properties like permeability and hysteresis are highly sensitive to small amounts of impurities and to heat treatment—they are extremely "structure sensitive." In some cases the permeability (*e.g.*, of iron) will increase a thousandfold when 0.1% of an impurity is removed by heat treatment, and an equal change in the reverse direction will be caused by bending the material or stretching it so that its form is permanently changed or strained. The susceptibilities of paramagnetic and diamagnetic substances are not usually affected to any considerable extent by fabrication and heat treatment.

3. PERMEABLE MATERIALS

Magnetic materials are essential for the operation of many of the devices and machines used in modern industry. Without them the production, distribution and use of electricity, and also communication by wire and radio, would be seriously limited or even impossible. After the use of iron in the compass became commonplace, the important new uses of magnetic materials were first in the transformer and electric motor and generator, and later in electromagnetic devices such as relays, telephone receivers, loading coils, loud speakers, indicating instruments and many other devices upon which all of our industries depend. It is estimated that several million tons of metal are produced annually for use as magnetic material.

Useful magnetic materials either have high permeability and are magnetized and demagnetized easily, or are permanent magnets and magnetize with difficulty but retain their magnetism tenaciously. The latter will be discussed in the next section headed *Permanent Magnets*.

As stated above, the magnetic properties depend mainly on the chemical composition and heat treatment. Permeable materials are usually processed, or annealed, by heating to some temperature between 800° and 1,400° C., often about 1,000° C., and cooling at any specified rate to room temperature. The permeability will be lowered if they are deformed beyond the elastic limit, consequently materials are made in final size and shape and are then heat treated and assembled directly in apparatus for use or for test, without bending. For each material there is a specific heat treatment that must be used to develop the desired property to the greatest extent. Magnetization curves of iron as rolled, after a conventional anneal, and after a special anneal in which harmful impurities are removed, are shown in fig. 8.

Iron, cobalt and nickel are the common ferromagnetic elements and were the only ones known until 1935 when gadolinium was also shown to be ferromagnetic. The magnetism of iron, as well as steel and lodestone, were known to antiquity, while cobalt and nickel were first investigated about the middle of the 18th century. Most of the ferromagnetic substances are alloys containing one or more of the elements iron, cobalt and nickel; some are

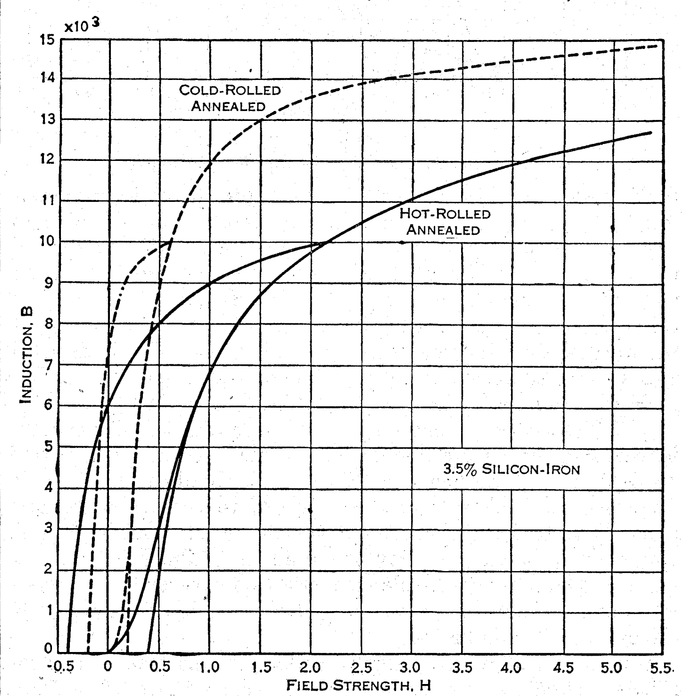


FIG. 10

Permeability of annealed silicon iron is higher and hysteresis lower if sheets have been fabricated by rolling cold

nonmetallic compounds of iron, cobalt, nickel or (rarely) manganese or chromium; and some are alloys containing no iron, cobalt or nickel but composed of manganese and certain other elements such as aluminium and copper (Heusler alloys).

Magnetization curves for iron, cobalt and nickel are shown in fig. 9. In iron one observes the highest magnetization and also the highest permeability. Cobalt has a lower magnetization and

TABLE I.—*Some Properties of Commercial Silicon-Iron Alloys in 0.014 In. Sheet, Annealed.*
$B_m = 15{,}000, f = 60$ *cycles/sec.*

Grade	Silicon (per cent)	Power Loss (watts/lb.)	μ_m (gausses/oersted)	μ for $B=100$	H_c (oersteds)	Resistivity (microhm-cm.)	Density (g/cm^3)
Armature	0.5	4.3	5,500		0.9	19	7.83
Electrical	1.2	3.6	6,100		0.85	27	7.79
Motor	2.5	2.65	5,800		0.75	42	7.70
Dynamo	3.25	2.15	5,800	1,100	0.65	50	7.65
Transformer (1)	4.0	1.65	7,000	1,600	0.5	59	7.60
Transformer (2)	4.5	1.4	9,000	2,000	0.3	65	7.57
Oriented Grain*	3.0	0.9	30,000	3,000	0.15	47	7.65

*Properties as measured in direction of rolling.

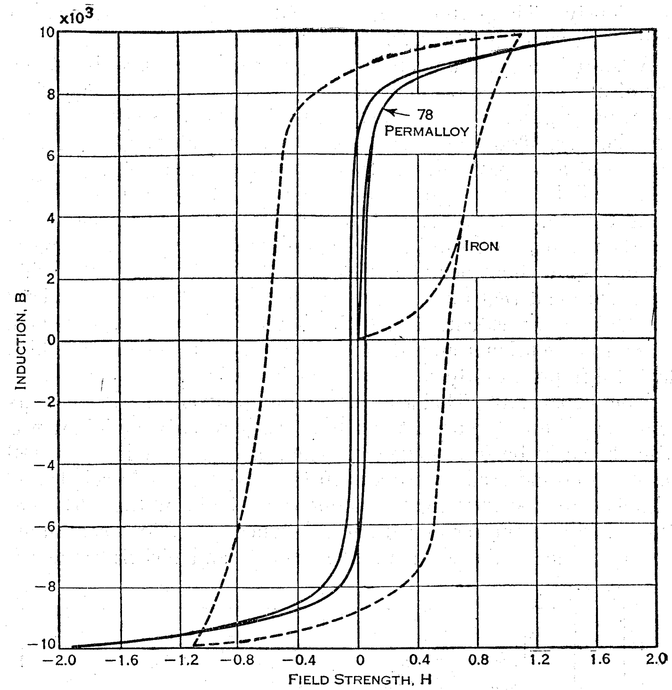


FIG. 11

Comparison of properties of permalloy and iron

the lowest value of maximum permeability. Of these materials iron is by far the most important and is the only one used to any considerable extent in industry as a magnetic material in elementary form. The most used material of all, however, is an alloy of iron and silicon, sometimes called silicon steel or electrical sheet steel even though it is not a steel in the strict sense of the word because it contains no essential carbon. The iron-nickel alloys are used for many purposes when very high permeability is desired and cost is not too important.

Iron silicon alloys containing a few per cent of silicon were invented by Sir Robert Hadfield, and came into use in the period 1900–10, mainly through the efforts of E. Gumlich in Germany. At present these alloys contain usually 3% to 4% silicon, but any amounts up to 6% silicon are occasionally used. A magnetization curve for a commercial alloy containing 4% silicon is drawn in fig. 9, and on a different scale magnetization curves and hysteresis loops of two kinds of commercial product, each containing 3.5% silicon, are given in fig. 10.

Iron silicon alloys are usually made from pig iron and ferrosilicon melted and refined in the basic open hearth (*see* IRON AND STEEL), or from ingot iron remelted with ferrosilicon in the electric furnace. Ingots are poured and rolled to slabs and the latter rolled either hot or cold to sheets of the required thickness, usually 0.014 in. These are then cut to the appropriate size for use in transformers or other apparatus and are preferably annealed by heating to some temperature lying between 800° and 1,200° C., usually nearer 800° C.; or, they may be annealed before cutting. Iron-silicon sheet or strip that has been fabricated by cold rolling is finding increased use as compared with the hot rolled product (fig. 10) because in the former the crystals composing the material are so oriented that the sheets have an especially high permeability when magnetized in one direction—that in which the material passed through the rolls during fabrication.

Some magnetic and physical characteristics of commercial silicon iron alloys are given in Table I. The watt loss there referred to is the power dissipated in the alloy when it is magnetized to a maximum induction of $B = 15{,}000$ by an alternating field of frequency 60 cycles per second. Such losses (*see* TRANSFORMER) objectionably raise the temperature of a transformer core in operation. They are due partly to hysteresis and partly to eddy currents, the nature of which latter will be discussed further below under *Magnetization in Alternating Fields.*

Iron-nickel Alloys (Permalloys).—These alloys have properties that are unusual and interesting from both a scientific and a commercial point of view. It became generally recognized about 1920 as a result of the work of G. W. Elmen that the alloys containing from 35% to 90% nickel have permeabilities very much greater than those of iron. These alloys were named "permalloys." A magnetization curve and hysteresis loop for 78 permalloy are shown in fig. 11, and curves for iron are given for comparison.

An iron-nickel alloy containing 50% nickel was investigated by T. D. Yensen and named hipernik. As distinguished from 78 permalloy, suitable for transformers transmitting the weak signals of communication apparatus, this alloy has high permeabilities in the higher fields used in the transmission of power.

These commercial alloys, 78 permalloy and hipernik, have the compositions that are scientifically the most interesting of the binary iron-nickel series. This is illustrated in part (a) of fig. 12 showing the induction of the alloys at low, intermediate and high field strengths.

The induction in high fields has a minimum at 30% nickel and a maximum at 45% to 50% nickel. The maximum occurs not only when the field strengths are large but persists and is even more marked in low fields. A second maximum appears for low fields when the nickel content is about 80%, and this corresponds to the commercially useful alloy, 78 permalloy. The high initial permeability (permeability for very low values of B) of 78 permalloy (fig. 12b) is associated with its very low magneto-

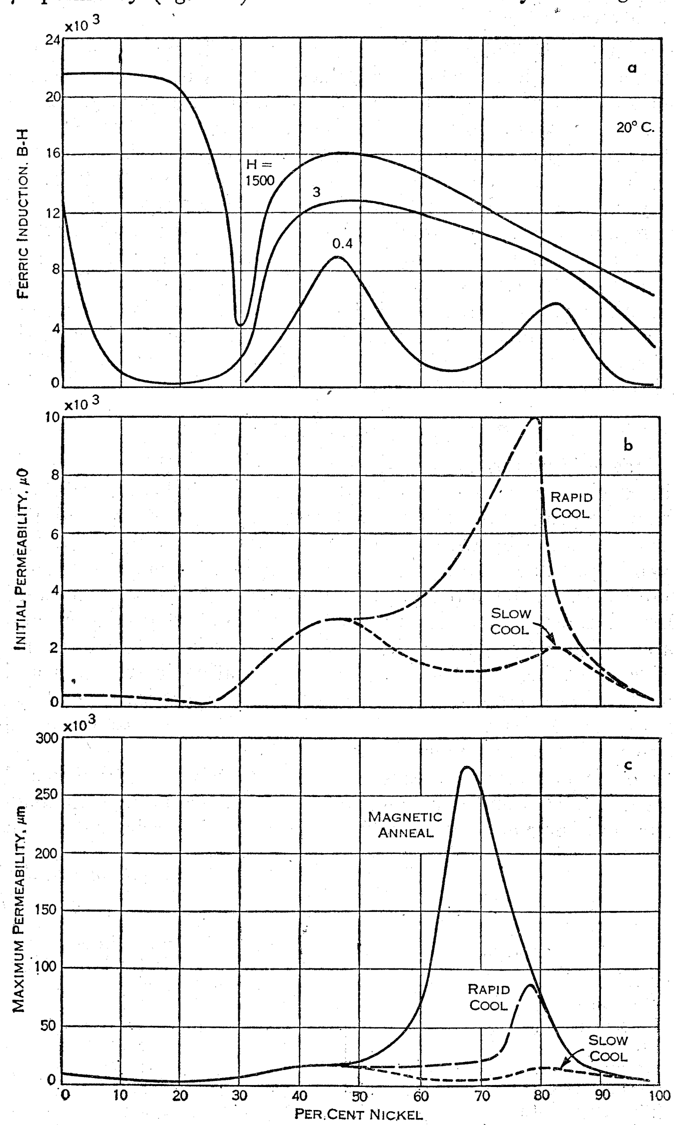


FIG. 12

Some magnetic properties of iron-nickel alloys (G. W. Elmen, R. M. Bozorth)

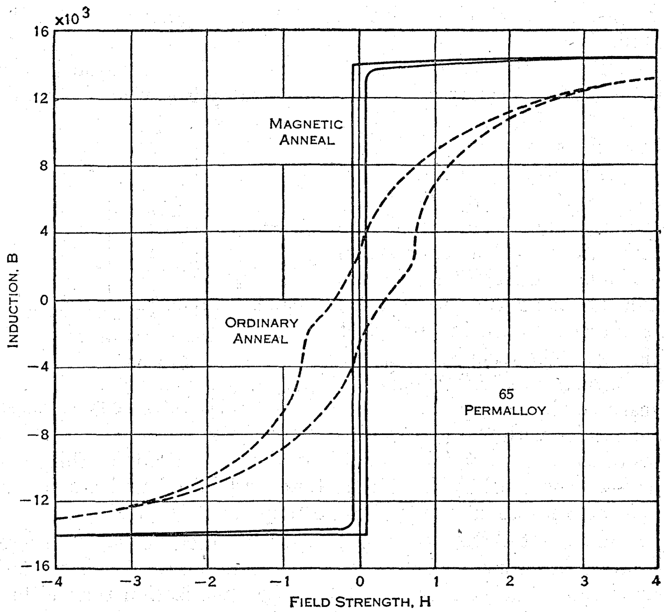


FIG. 13

Effect of annealing in presence of magnetic field (R. M. Bozorth and J. F. Dillinger)

striction (see *Stress and Magnetostriction* below).

Even more remarkable magnetic properties are exhibited by iron-nickel alloys given a still different kind of heat treatment. After heating at a higher temperature the material is maintained for a short time at 400° to 600° C. and at the same time a magnetic field of several oersteds is allowed to act on it. After cooling to room temperature the maximum permeability is found to be greatly increased and the coercive force diminished. This effect, often called the "magnetic anneal," depends on the com-

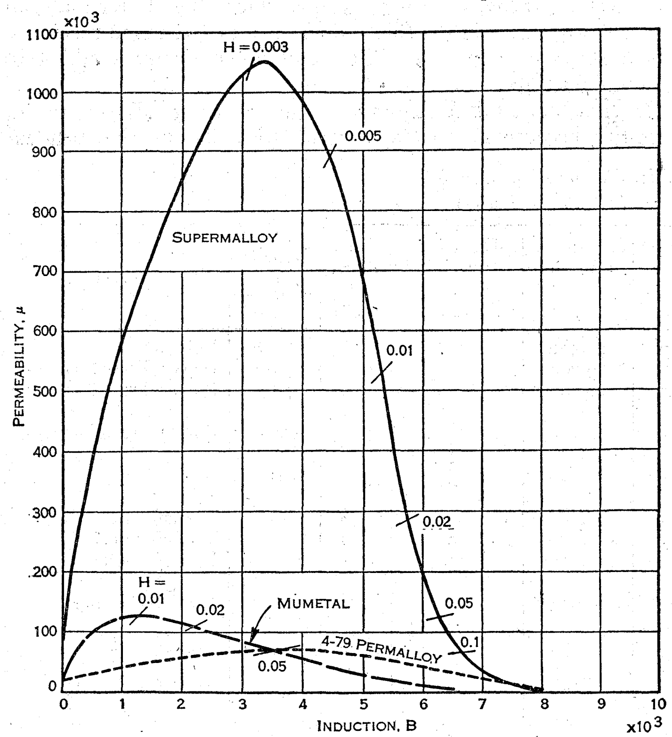


FIG. 14

Comparison of supermalloy with other high-permeability alloys (O. L. Boothby and R. M. Bozorth)

position and is most pronounced when the nickel content is 65% to 70%, as illustrated in fig. 12c. The hysteresis loops of material given the magnetic anneal have the characteristic rectangular shape illustrated in fig. 13. The sides are vertical and the corners often perfectly square, and the coercive force much smaller than

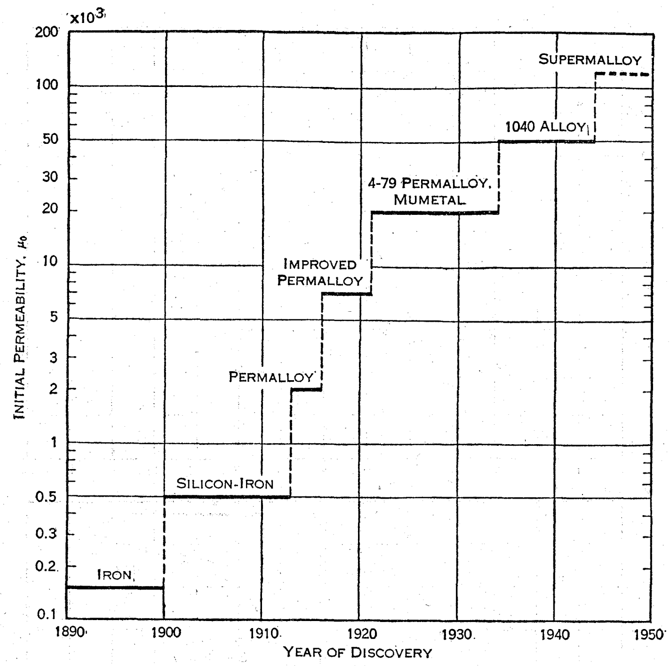


FIG. 15

Initial permeabilities of some useful materials plotted against the year in which they were discovered. Note logarithmic scale

that of the same material heat treated in the absence of a field.

Additions to the Permalloys.—Molybdenum, chromium and copper have been added to permalloy to advantage. The most used alloys of this kind are "4-79 permalloy," containing 4% molybdenum 79% nickel and 17% iron, and "mumetal" containing usually 5% copper, 2% chromium, 75% nickel and 18% iron. These are both used in transformers operating at high frequencies and are meritorious primarily on account of their high

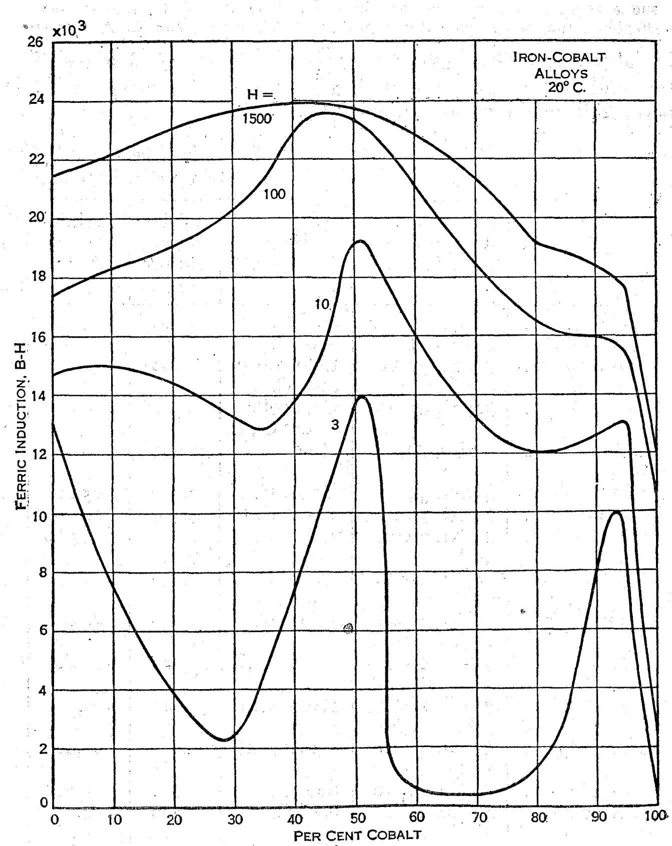


FIG. 16

Magnetic properties of iron-cobalt alloys. Note high magnetization of 50% alloy in intermediate and high fields (G. W. Elmen)

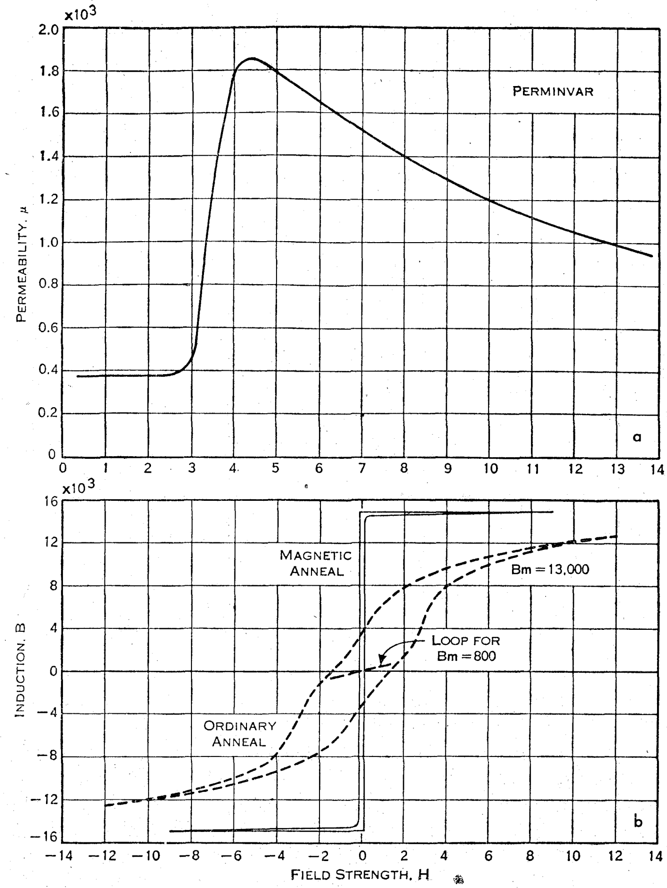


FIG. 17

Perminvar (45% Ni, 25% Co, 30% Fe) has remarkably constant permeability in low fields (a). It has extremely low hysteresis at low inductions (b) and a characteristic wasp-waisted hysteresis loop at high inductions, and is affected strongly by magnetic anneal. (G. W. Elmen and G. A. Kelsall)

initial permeabilities, but also because they have higher resistivities and can be prepared with a simple heat treatment. Their permeabilities at various inductions are indicated by the curves of fig. 14. Initial permeabilities of 10,000 to 30,000 are usually attained.

During World War II a great improvement was made in the permalloys by heat treating them in pure hydrogen at 1,200° to 1,300° C. The most useful of these alloys, called "supermalloy" (su-perm′-al-loy) contains 5% molybdenum and 79% nickel, the balance mainly iron. Initial permeabilities as high as 125,000 and maximum permeabilities of more than 1,000,000 can be attained commercially even in thin sheet (fig. 14). The technical progress in magnetic materials may be measured by comparing these magnitudes with the permeabilities of the best materials available in the first decade of this century—silicon steel made at that time had initial and maximum permeabilities about 1/300 those of supermalloy (fig. 15).

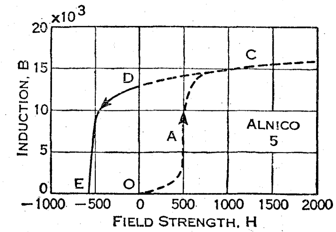


FIG. 18

Magnetization curve (OAC) and demagnetization curve (DE) of Alnico 5 (Alcomax)

Iron-cobalt Alloys.—It is a surprising fact, for which there is no satisfactory explanation, that some alloys of iron and cobalt can attain greater intensities of magnetization than either of these elements alone. The saturation magnetization is highest for the alloys containing 35% to 40% cobalt, and then is 10% to 15% higher than for pure iron. When the field strength is 1,000 or below, the highest inductions are attained in the alloy containing equal proportions of the two elements (fig. 16), except that in fields weaker than two oersteds pure iron has the highest permeability.

As a material the 50% alloy, under the name of "permendur," is a useful component of the magnetic circuits of electromagnets and permanent magnets, where it is used for yokes and pole pieces. Since it is rather brittle and cannot be rolled to thin sheets, 2% vanadium is sometimes added and this permits the fabrication of sheets a few thousandths of an inch thick. The latter material is used in quantity in the thin diaphragms of telephone receivers. Some alloys contain 35% cobalt and other elements added to increase ductility.

Iron-cobalt-nickel Alloys.—Some of these alloys are interesting because they have permeabilities that are independent

TABLE II.—*Some Properties of High-Permeability Materials*
(*Properties important in use are indicated by italics*)

Name	Composition %	Heat Treatment*	Initial Permeability μ_o	Maximum Permeability μ_m	Coercive Force H_c (Oersteds)	Saturation Induction B_s (Gausses)	Electrical Resistivity ρ (microhm-cm)	Curie Point θ (°C.)	Density δ (g/cm^3)	Uses
Iron	99.9 Fe	900° C.	200	5,000	1.0	21,500	10	770	7.87	Relays
Silicon-Iron	4 Si, 96 Fe	800° C.	400†)	*7,000*	.6	19,700	59	690	7.60	Power Transformers
Silicon-Iron	3.3 Si, 97 Fe	Cold rolled 800° C.	600†)	*10,000*	.2	20,000	50	700	7.65	Power Transformers
Hipersil‡)	3.3 Si, 97 Fe	Cold rolled 1,200° C., H_2	1500†)	*40,000*	.1	20,000	48	700	7.65	Power Transformers
Sendust	9 Si, 5 Al, 85 Fe	Cast	30,000	120,000	.05	10,000	80	500	7.1	
45 Permalloy	45 Ni, 54 Fe	1,050° C.	*2,500*	25,000	.3	*16,000*	50	440	8.17	Transformers, Relays
Hipernik	50 Ni, 50 Fe	1,200° C., H_2	4,000	*80,000*	.05	16,000	35	500	8.25	Transformers
Radiometal	47 Ni, 3 Cu, 49 Fe	1,050° C.	*2,500*	25,000	.3	*15,600*	55	—	8.3	Transformers
78 Permalloy	78 Ni, 21 Fe	1,050° C. 600° C.	*8,000*	100,000	*.05*	10,000	16	580	8.60	Sensitive Relays
4-79 Permalloy	79 Ni, 4 Mo, 16 Fe	1,100° C.	*20,000*	80,000	.05	8,700	57	420	8.72	Transformers
Mumetal	75 Ni, 2 Cr, 5 Cu, 18 Fe	1,100° C., H_2	*20,000*	110,000	.03	7,200	60	430	8.58	Transformers
1040 Alloy	72 Ni, 14 Cu, 3 Mo, 11 Fe	1,100° C., H_2	40,000	100,000	.02	6,000	56	290	8.76	
Supermalloy	79 Ni, 5 Mo, 15 Fe	1,300° C., H_2	*100,000*	800,000	.004	8,000	60	400	8.77	Transformers
Permendur	50 Co, 50 Fe	800° C.	800	5,000	2.0	*24,500*	7	980	8.3	Electromagnets
V-Permendur	49 Co, 2 V, 49 Fe	800° C.	800	4,500	2.0	*24,000*	26	980	8.2	Telephone Diaphragms
Powdered Permalloy	81 Ni, 2 Mo, 17 Fe	Pressed, 650° C.	*125*	130	—	—	10^6	480	7.8	Loading Coils

*"H_2" indicates heat treatment in pure hydrogen. †Measured at $B=20$ rather than $B=0$. ‡Also called Corosil.

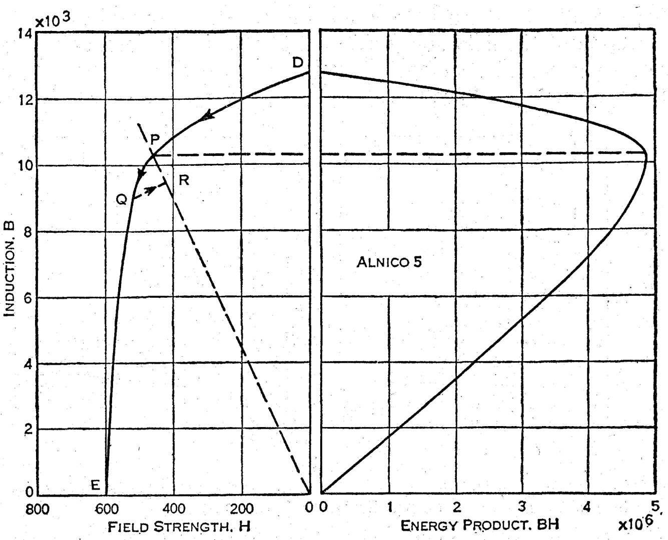


Fig. 19

Demagnetization curve (DE) and corresponding energy product curve (BH vs. B), showing desirable point of operation, P, where energy product is maximum

of field strength over a relatively large range. The same alloys have hysteresis loops of peculiar shape with low residual induction and a constricted middle portion. A representative alloy, called perminvar, contains 30% iron, 25% cobalt and 45% nickel. The constancy of permeability with field strength at low fields is brought out by annealing in the usual way at about 1,000° C. and then heat treating for several hours at a relatively low temperature, 350° to 500° C. The hysteresis loss is then extremely small. A μ *vs.* H curve and a hysteresis loop for an alloy of the above composition, heat treated for 24 hours at 400° C., are shown in fig. 17. This material responds to heat treatment in a magnetic field, and a loop for a specimen so treated is also shown in the figure.

Heusler Alloys.—These alloys, discovered in 1903, are of unusual scientific interest because they contain no ferromagnetic element. A typical Heusler alloy has the composition corresponding approximately to the formula Cu_2MnAl (61% copper, 26% manganese, 13% aluminum). This has a saturation induction (B_s) of about 5,500, almost as high as that of nickel, but its permeability is much lower—about 250 at maximum. In the alloy containing tin (Cu_2MnSn) a saturation of more than 8,000 has been attained. The coercive force is rather high for a permeable material and varies with composition and heat treatment, but may be as low as 4 or 5.

To bring out their best magnetic properties these must be quenched from temperatures up to 800° C. and then aged or heated for some time at a relatively low temperature, often 200° C. This last treatment is necessary for effecting a highly ordered arrangement of the atoms in the crystals, a situation necessary for the development of the magnetic properties.

The atom primarily responsible for the magnetism of the Heusler alloys is manganese, but copper also may contribute to the magnetic moment. The distribution of the other atoms around the manganese is also important, as the effect of atomic ordering shows. Ferromagnetism still occurs when the aluminum or tin is replaced by arsenic, antimony, bismuth or boron, or when copper is replaced by silver. A number of the more important alloys of high permeability are described in Table II.

4. PERMANENT MAGNETS

Permanent magnets, like electromagnets, are used to produce magnetic fields of considerable strength and constancy. Many devices depend on them for operation, *e.g.*, loud speakers, magnetos, meters of many kinds, magnetrons, telephone receivers, and a host of others. In all of these the magnet necessarily contains

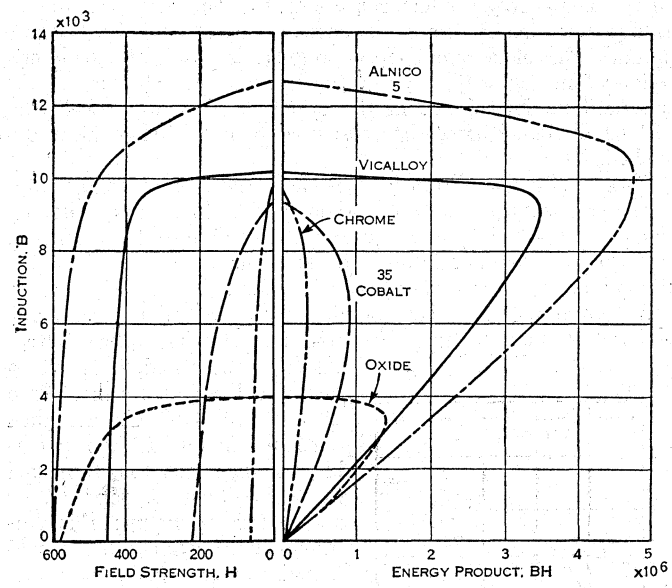


Fig. 20

Demagnetization and energy product curves for several materials important for use in permanent magnets

Table III.—*Some Properties of Permanent Magnet Materials*

Name	When Used	Typical Composition (%)*	Coercive Force H_c (Oersteds)	Retentivity B_r (Gausses)	Energy Product $(BH)_m$ x 10^{-6}	Fabrication	Heat Treatment
Tungsten Steel	1855	6W, 0.7C, 0.3Mn	65	10,500	0.3	Forged	Q850°C
Low Chrome Steel	1916	0.9 Cr, 0.6C, 0.4Mn	50	10,000	0.2	Forged	Q800
High Chrome Steel	1916	3.5Cr, 1C, 0.4Mn	65	9,500	0.3	Forged	Q825
KS Magnet Steel†	1917	36Co, 7W, 3.5Cr, 0.9C	230	10,000	0.9	Forged	Q950
Cobalt Chrome Steel‡	1921	16Co, 9Cr, 1C, 0.3Mn	180	8,000	0.6	Forged	Q975
Remalloy§	1931	12Co, 17Mo (or W)	250	10,500	1.1	Forged	Q1200, B675
Mishima Alloys‖	1931	25Ni, 12Al	500	7,000	1.4	Cast	Q1200, B650
Oxide Magnet	1933	15Co, 28O	900	2,000	0.6	Sintered	A1000‡‡
Alnico 2¶	1934	12Co, 17Ni, 10Al, 6Cu	560	7,300	1.7	Cast	A1200, B650
Magniflex**	1935	20Ni, 60Cu	450	5,300	1.1	Cold Rolled	B600
New KS‖‖	1935	35Co, 18Ni, 6Al, 8Ti	900	5,700	1.8	Cast	B650
Platinum Cobalt Alloy	1936	77Pt, 23Co	2,650††	4,530	3.8	Forged	Q1200, B650
Vicalloy	1938	52Co, 11V	200	11,500	1.5	ColdRolled§§	B600
Alnico 5 (Alcomax)	1940	24Co, 14Ni, 8Al, 3Cu	550	12,500	4.5	Cast	A1300, B600‡‡

*Balance iron.
†Called Koerzit in Germany.
‡Also alloys containing 3, 6, 9 cobalt with variable chromium.
§Also called Comol.
‖Also called Alnico 3. Alnico 1 and 4 contain cobalt.
¶Called Alnico in England and Oerstit in Germany.
**Also called Cunife 1. Cunife 2 and Cunico contain cobalt.
††H for $B = O$.
‡‡Must be cooled in strong magnetic field.
§§Cold rolled in grooved rolls. Higher values in drawn wire, lower in rolled sheet.
‖‖Composition is given for Alnico 12. Nipermag and Alnico 7 contain smaller amounts of titanium.
Q—quenched from centigrade temperature indicated, in oil (or water).
A—cooled in air from indicated temperature.
B—aged or baked, cooling rate not important.
Forged alloys may also be hot rolled or cast to size.
Cast alloys (unless forgeable) must be ground to size.
Cold rolled alloys are usually hot rolled before cold rolling.

an air gap; consequently it always operates under the influence of a demagnetizing field (*see* section on *Measurement of Magnetic Quantities*), such as that existing at the middle of a short bar of magnetized material. Thus the magnet operates not at residual induction but at some lower value of the induction, B.

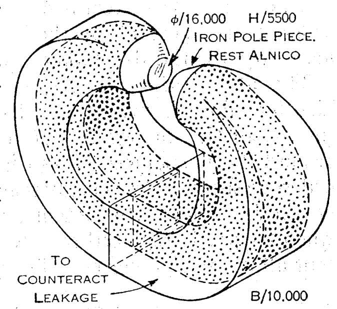


FIG. 21

Practical design of magnet operating at H_g=5500, with B_0=10,000 almost everywhere in material. Unshaded portion is part of magnet necessary to carry "leakage flux" (P. P. Cioffi)

The important curve for evaluating the quality and behaviour of material for permanent magnets is that portion of the hysteresis loop that lies in the second quadrant, between residual induction, B_r, and coercive force, H_c, and is called the demagnetization curve. Magnetization and demagnetization curves for Alnico 5 (Alcomax) are shown in fig. 18. The quality of a permanent magnet is characterized not only by B_r and H_c, but also by the so-called energy product, the product of B and H for various points on the demagnetization curve. The energy product curve (fig. 19), showing this product as dependent on B, has a characteristic shape, and its greatest product, the maximum energy product, is the best single criterion of magnetic quality for these materials. The reason for this, and its importance in the design of permanent magnets, will be discussed after the most-used materials have been described.

Magnet Steels.—From ancient times until about 1930, materials used as magnets were carbon steels. After 1855 alloying elements were added, especially tungsten, to improve the quality. In 1916–17 chromium began to displace tungsten, and cobalt was added up to 40% with very beneficial effect.

A typical chrome steel contains 3.5% chromium and 1.0% carbon. In manufacture, after the material has been melted, cast and hot rolled, it is cut to final size, heated for a short time at 800° to 850° C. and then quenched in oil. Before assembling in apparatus it is often aged by maintaining at 100° C. or above for 24 hours; this improves the constancy of the field it maintains in operation.

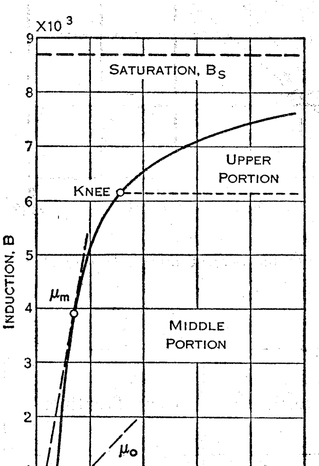


FIG. 22

Three sections of normal magnetization curve separated by "knee" and "instep." μ_m is largest value of B/H, μ_o initial slope of curve

Dispersion - Hardened Alloys.—From the standpoint of magnetic quality the best materials available in 1946 for use in permanent magnets were not steels but dispersion-hardened (precipitation-hardened) alloys containing no essential carbon (*see* ALLOYS). The first materials of this kind to find commercial use were the iron-cobalt-molybdenum and iron-nickel-aluminum alloys (Table III), and others were coming into use constantly. The hardness is caused by the presence of very small particles of one kind highly dispersed in a matrix of another composition.

Important materials used in 1946 for magnets are listed in Table III. This includes data on steels and indicates the mechanical operations required in preparation and the heat treatment used to bring out the best magnetic properties. Demagnetization curves for some of these alloys are reproduced in fig. 20. Special attention is called to the alloy called Alcomax in England and Alnico 5 in the United States. In order to develop its remarkable properties it must be cooled at a definite rate in a strong magnetic field (*c.*, 1,000 oersteds) so directed in the specimen that it is parallel to the field required in use. At right angles to the direction of the field applied during treatment the properties are not so good, the energy product being then only about one-third as high. Although Alnico 5 is not forgeable and must be

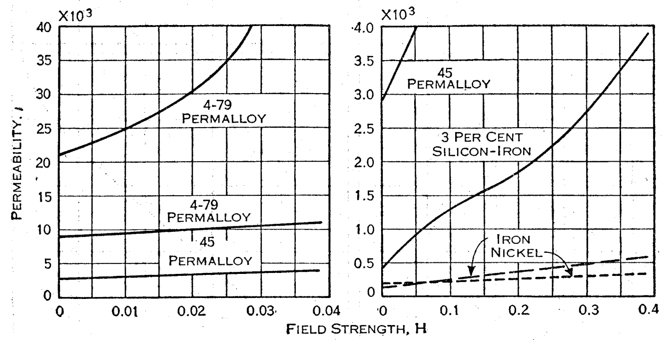


FIG. 23

Curves showing μ vs. H for initial portions of magnetization curves for various materials. Lines are usually straight near axis

cast and ground to final form, its magnetic properties are outstanding and its uses numerous.

Alloys With Special Properties.—In contrast to their usual brittle character, some materials used as permanent magnets have sufficient ductility to permit cold forming. In 1935 it was discovered that an alloy of iron, nickel and copper could be rolled to thin tape and then heat treated to have high coercive force and residual induction (Table III). Later the iron-cobalt-vanadium alloy known as vicalloy was found to have superior quality for the purpose for which these alloys are used—the magnetic recording of speech.

A material of quite different kind is made of powdered oxides of iron and cobalt (Fe_2CoO_4), pressed and heated to sinter, and cooled from 850° C. in a magnetic field of 4,000 oersteds. This usually has a coercive force of about 600 and residual induction of about 4,000. Its properties differ from those of most other materials in that the density is small and the resistivity high.

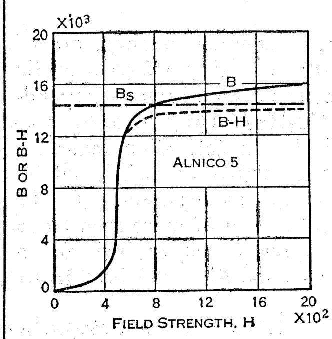


FIG. 24

In high fields B-H approaches asymptotically to limit, B_s (saturation)

Design of Permanent Magnets.—In the design of permanent magnets it is important to use the appropriate material and to shape it so that the minimum amount is used to produce the desired field strength in a given gap. As already pointed out, this result is accomplished when the product of B and H everywhere in the material has its maximum product, $(BH)_m$. The magnet of fig. 21 is designed with that in mind. The material is Alnico 5. The length of the material along the curved path, in relation to the length of the gap, determines the position of the line OP of fig. 19, and this should be placed so that it cuts the demagnetization curve at $B=10{,}000$, corresponding to $(BH)_m$. The cross-sectional area of the magnet is adjusted to take account of leakage; a heavier section is necessary at the lower part because all of the leakage flux must pass through this, and B must at the same time be maintained at its proper value.

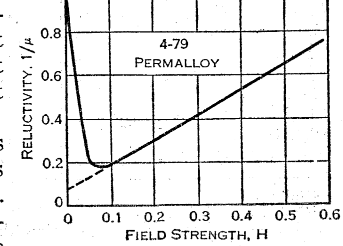


FIG. 25

Reluctivity, reciprocal of permeability, is linear at high field strengths (O. Fröhlich-A. E. Kennelly)

After a permanent magnet is designed and constructed it is magnetized with a high field. After removal of this magnetizing field it is usually desirable to apply momentarily a relatively weak field in the opposite direction, whereupon the magnetic state of the material changes as indicated by the points PQR of fig. 19. This stabilizes the magnet against the effect of stray fields or mechanical shocks or changes in temperature, so that the field in the gap is less likely to change.

5. THE MAGNETIZATION CURVE

Three Portions of Curve.—A typical magnetization curve, showing the relation between B and H in a specimen initially unmagnetized, may be divided into three main parts separated from each other by the "knee" and the "instep" (fig. 22). These three regions are identified with different physical mechanisms of change of magnetization, and also with different engineering uses of the materials.

The initial portion of the curve, the "toe," is not horizontal at the origin but has a definite slope called the initial permeability, μ_o, equal to B/H for $H=O$. For low inductions Lord Rayleigh found that the relation

$$B=\mu_o H+aH^2$$

was obeyed, and when the permeability μ is plotted against the field strength H the points usually lie on a straight line corresponding to the equation

$$\mu=\mu_o+aH.$$

Data for several common materials are shown in fig. 23. The value of H at which the line begins to bend upward, varies over wide limits from one material to another. In some abnormal materials such as the iron-silicon alloy the curve first becomes convex upward before it begins to rise rapidly at higher values of H. Curves of the kind shown in the figure are used to determine the value of μ_o by extrapolating them to $H=0$.

The upper portion of the magnetization curve (fig. 22) bends over and approaches the horizontal line marked B_s. In high fields, however, it is found (fig. 24) that B approaches no definite limit but B-H does approach a limit, called the saturation induction or simply saturation, designated B_s. Since $B\text{-}H=4\pi I$, I approaches the limit I_s, the saturation magnetization.

The upper part of the curve may be represented fairly well by O. Fröhlich's equation:

$$B-H=H/(a+bH)$$

in which $b=1/B_s$ and a is a constant which measures the magnetic hardness and is larger the stronger the field necessary to attain any given fraction of saturation. When H is small enough to be neglected in comparison with B, this equation may be expressed in the equivalent form used by A. E. Kennelly:

$$1/\mu=a+bH$$

and so a linear relation is found when $1/\mu$ is plotted against H. From a graph of this kind (fig. 25) one can easily determine the constants a and b, and interpolate to find the value of μ for intermediate values of H. The slope of the line, b, may be used to estimate the saturation induction ($b=1/B_s$), but this method cannot be depended on for accuracy for in some materials such as iron the slope changes markedly at inductions close to saturation. The ratio $1/\mu$ is termed the reluctivity.

In its middle portion the magnetization curve is the steepest, and the permeability has its greatest value. It is here that irreversible changes in magnetization are a maximum, as indicated by the fact that curves for increasing and decreasing field strength differ markedly. These irreversible changes and the consequent losses in energy will now be discussed.

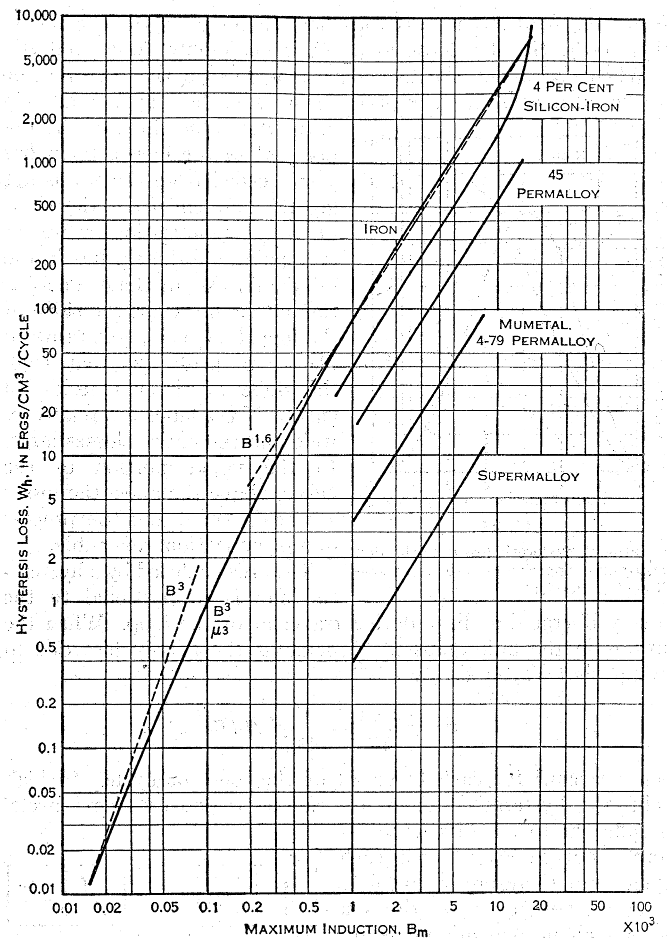


FIG. 27

Hysteresis loss as dependent on maximum induction for some important materials

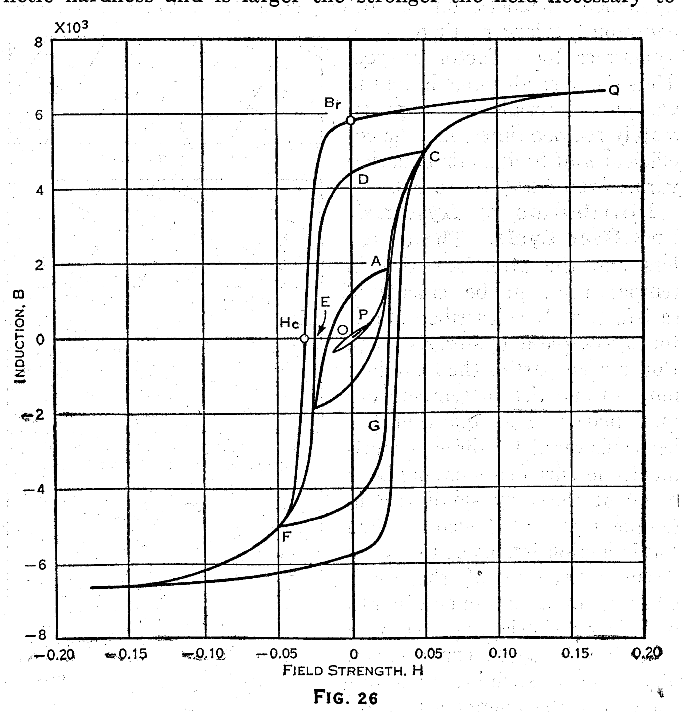


FIG. 26

Normal hysteresis loops for low, intermediate and high inductions. Residual induction, B_r, and coercive force, H_c, are values of B and H where curves cross axes

Hysteresis Loops.—A set of normal hysteresis loops is shown in fig. 26. In forming one of these the field strength is first increased from zero and the induction follows the magnetization curve OAC. H is then decreased, and the induction decreases slowly so that the hysteresis loop passes successively through the points D, E and F, and the field is reversed and the loop passes through G and back to C. At D the induction is called residual induction (B_r) and at E, when

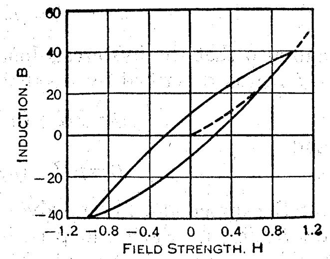


FIG. 28

Form of hysteresis loop for low inductions (Lord Rayleigh)

$B=0$, the field strength is the coercive force (H_c). The induction at the tip of a loop, as at C, is commonly designated B_m.

When the tip of the hysteresis loop lies on the first portion of the magnetization curve (OP in fig. 26), the loop is relatively narrow and the slope of the upper part of the loop after it has just receded from the tip, is not greatly different from the slope of the magnetization curve at that point. If the tip lies in the middle portion of the magnetization curve, however, the slope of the loop (*e.g.* at C, going toward D) is markedly different from the slope of the magnetization curve. These loops are relatively wide and the energy losses large. In the upper portion of the curve, above the knee, the losses are again small and the process of magnetization reversible.

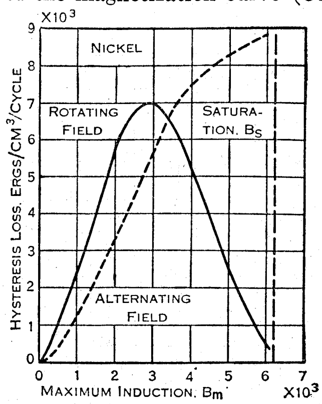


Fig. 29

Rotational hysteresis loss goes through maximum, approaches zero at saturation (A. Perrier)

The area enclosed by a hysteresis loop is proportional to the energy liberated as heat during traversal of the loop. When the area is in the units gausses × oersteds the energy loss due to hysteresis (Warburg's law) is

$$W_h=\frac{\text{area}}{4\pi}=\frac{1}{4\pi}\oint HdB$$

ergs per cm.³ for each traversal of the loop, or cycle. In high fields the hysteresis loss in iron, about 10,000 ergs/cm.³/cycle, is sufficient to raise its temperature about 0.0003° C. for each cycle, and therefore if the field is alternated 50 or 60 times a second about one minute is required for the iron to heat one degree.

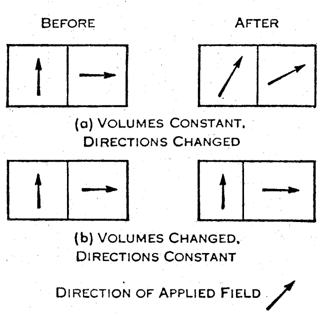


Fig. 30

Change in magnetization results from (a) change in direction (rotation) of magnetization in small regions of material, called domains, or (b) increase in size of some domains (boundary displacement) at expense of neighbours

The hysteresis loss rises rapidly as the maximum induction of the loop, B_m, increases. The curve of fig. 27 shows the relation between W_h and B_m for ordinary iron having a maximum permeability of 4,500. When B_m is very small W_h varies as B^3, and in the range $B_m=1{,}000$ to $15{,}000$, of special interest for work on power transformers, it varies approximately as the 1.6 power of B, in accordance with the empirical law of Steinmetz:

$$W_h=\eta B_m^{1.6}$$

in which the Steinmetz coefficient, η, is approximately constant for any one material.

The B^3 relation at low inductions was derived by Rayleigh. He showed, as noted above, that the magnetization curve near the toe followed the equation

$$B=\mu_0H+aH^2$$

and also that the hysteresis loop with tips at B_m, H_m and $-B_m$, $-H_m$ was described by parabolic equations

$$B=\mu H+(a/2)(H_m^2-H^2)$$

and

$$B=\mu H-(a/2)(H_m^2-H^2)$$

for the upper and lower halves of the loop, respectively. (Here $\mu=B_m/H_m$). Such a loop is shown with the corresponding magnetization curve in fig. 28. Measurements have been made for values of B_m as low as 2 gausses, and only slight deviations from the Rayleigh form observed. The area of a Rayleigh loop may

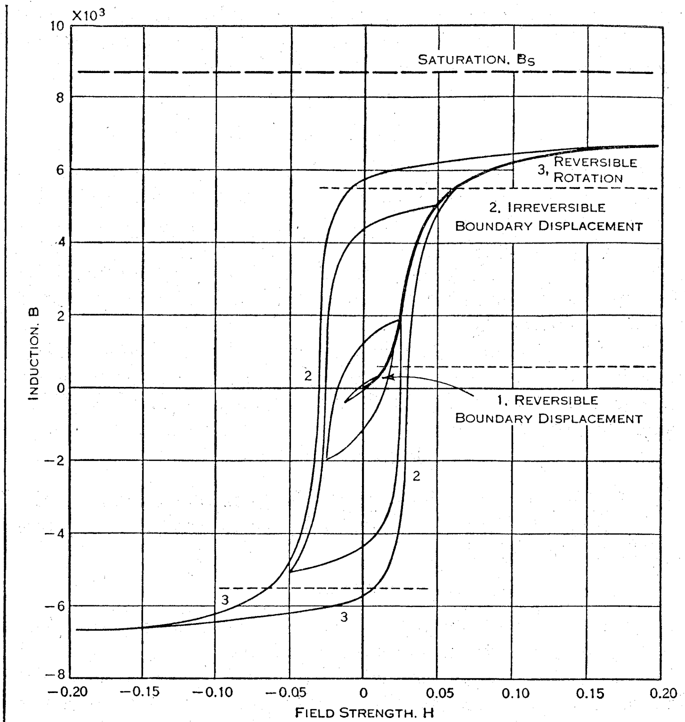


Fig. 31

Nature of change in magnetization in relation to position on magnetization curve and hysteresis loop

be calculated from the above equations, and the corresponding hysteresis loss, expressed in ergs/cm.³/cycle, is

$$W_h=\frac{aH_m^3}{3\pi}=\frac{aB_m^3}{3\pi\mu^3}.$$

This equation corresponds to the lower part of the long curve of fig. 27, and is valid in iron when B_m is below about 500 gausses.

The hysteresis losses of various materials vary over a wide range. Losses of some of the common permeable materials are indicated by curves in fig. 27, and one of these has about 1/200 the loss of iron at the same value of B_m. Materials used for permanent magnets, on the other hand, have hysteresis losses enormously larger than iron, sometimes by a factor of 500. Thus the over-all range in loss in various materials is approximately 100,000 times; *i.e.*, the coefficient η of Steinmetz' equation varies from 0.6×10^{-5} to 0.6.

Distribution of Hysteresis Loss Over Cycle.—The energy loss and the attendant rise in temperature can be calculated satisfactorily as described above for a complete hysteresis loop. But in what part of the loop does most of the rise in temperature take place? This question has been answered by direct experiment, measurements having been made of the very small rise in temperature that occurs when the induction is changed by only a small fraction of the total. Changes of about one-millionth of a degree centigrade have been measured in these experiments. The results of such investigations show that the energy losses are largest where the hysteresis loop is steepest. In addition to this

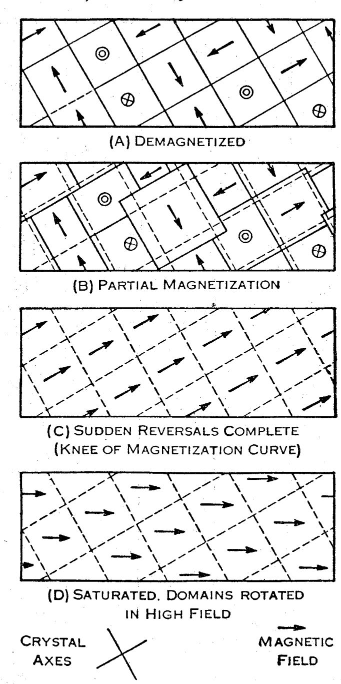


Fig. 32

Schematic of changes in domains at various stages of magnetization

irreversible loss, there is a heating of the specimen in strong fields as the field is increased, and an equal cooling as the field is decreased. This reversible heat does not, therefore, contribute to the hysteresis loss over a complete cycle.

Hysteresis in Rotating Fields.—The hysteresis loops mentioned so far have been measured with B and H either parallel or

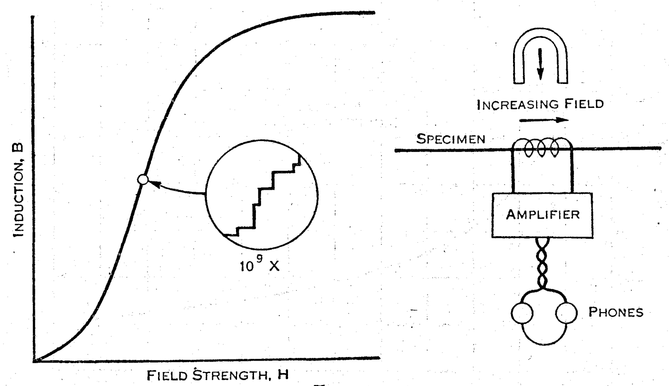


FIG. 33

Barkhausen effect shows that magnetization changes in discrete steps. Movement of magnet changes magnetization and causes noise to be heard in phones

antiparallel to each other. A different result is obtained if the field acting on a specimen is maintained constant in strength and varied continually in direction. This is usually called simply rotational hysteresis as compared with the usual alternating hysteresis. Measurement of rotational hysteresis is accomplished by placing a disk of the material to be examined between the poles of an electromagnet and rotating the disk so that H always lies in its plane. The force necessary to turn the disk is then a measure of the rotational hysteresis loss.

As the field strength increases from zero the rotational hysteresis first increases rapidly (fig. 29), more rapidly than the alternating hysteresis, but when the induction is half to three-quarters of saturation the alternating hysteresis goes through a maximum and decreases rapidly, approaching zero at saturation.

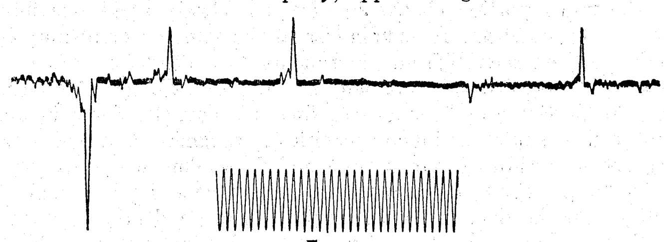


FIG. 34

Oscillographic records of impulses detected in experiments on Barkhausen effect. Each impulse corresponds to change of magnetization in a domain. Timing line has frequency of 60 cycles per second (R. M. Bozorth)

The disappearance of hysteresis in a high rotating field was predicted as a result of Ewing's theory, and its confirmation in 1896 indicated the fundamental soundness of the theory. Rotational hysteresis is of practical importance in the magnetic material forming the segments or teeth of rotating dynamo-electric machinery.

Domain Theory of Magnetization.—Many of the phenomena of the magnetization curve and hysteresis loop can be described to advantage in terms of the domain theory. The theory that a ferromagnetic material is composed of many small regions, each magnetized to saturation in some direction, was first stated by P. Weiss in 1907, and the description he gave at that time is accepted with but slight modification. The existence of such domains is evident from H. Barkhausen's experiments and even more definitely from the study of powder patterns (*see* below). In the unmagnetized state the directions in which the domains are saturated (the directions of easy magnetization) are distributed either at random or in some other way such that the resultant magnetization of the specimen as a whole is zero. Application of a field changes only the direction of magnetization in a given volume. The three main parts of the magnetization curve are distinguished from each other by the nature of this change in direction, which may take place in any of several ways.

The magnetic moment of any one domain is specified by the magnitude and direction of its magnetization and by its volume. Ordinarily at constant temperature the moment of a domain, and therefore the magnetization of the ferromagnetic body of which it is a part, is changed by

(a) a change in the direction of magnetization of the domain—"rotation"—, or
(b) a change in the volume of the domain—"moving boundary."

These processes are indicated graphically in fig. 30. It has been shown by R. Becker that the moving boundary is particularly important for changes occurring in low and medium fields. Processes may be classified also as reversible or irreversible accordingly as the energy dissipated in heat is a relatively small or large fraction of the potential energy.

In each of these portions of the magnetization curve, one type of process preponderates as indicated here:

(1) Initial portion—reversible boundary displacement.
(2) Middle portion—irreversible boundary displacement.
(3) Upper portion—reversible rotation.

Fig. 31 shows the three important processes in relation to the magnetization curve and hysteresis loops, and the corresponding energy losses due to hysteresis, for a specimen of a high permeability alloy. Fig. 32 (a) is a highly schematic representation of the domains in a part of an unmagnetized single crystal that may itself be a portion of an ordinary polycrystalline specimen of iron. The arrows, circles and crosses indicate the directions of local magnetization, and the sides of the squares the directions of the crystal axes. Figs. 32 (b) and 32 (c) represent the states of magnetization corresponding to the instep and knee of the curve, attained by reversible and irreversible boundary displacement, respectively, and 32 (d) represents saturation attained in high fields by the process of rotation. Although the domains have been represented here by squares, implying that the actual domains are cubes, actually no such conclusions should be drawn regarding the shape of domains. There is some evidence to be considered below to show that they are rodlike or platelike in form.

The factors which determine the direction of magnetization in a single domain of a specimen are the crystal structure, the state of strain, and, of course, the direction and strength of the magnetic field. The effect of crystal structure and of strain will be discussed in some detail in later sections of this article. It may be mentioned here in a preliminary way that the nature of the

FIG. 35

Pattern of fine powder on surface of iron crystal is due to domain structure beneath. In middle section magnetization of specimen is zero (L. W. McKeehan and W. C. Elmore). Magnification 1000 X

crystal structure affects mainly the upper part of the magnetization curve of a permeable material. In iron, for example, the crystal structure is such that the magnetic properties of a single crystal vary considerably with direction, and as a result of this variation exceptionally high fields are necessary to approach saturation in ordinary polycrystalline iron. The rotation of the domain by the field must be made against relatively powerful forces, and so the magnetization curve above the knee rises slowly over a considerable distance. This behaviour may be contrasted with that of permalloy containing 60% to 80% nickel and 40 to 20% iron—here the magnetic properties vary but little with the direction in the crystal, the domains therefore rotate

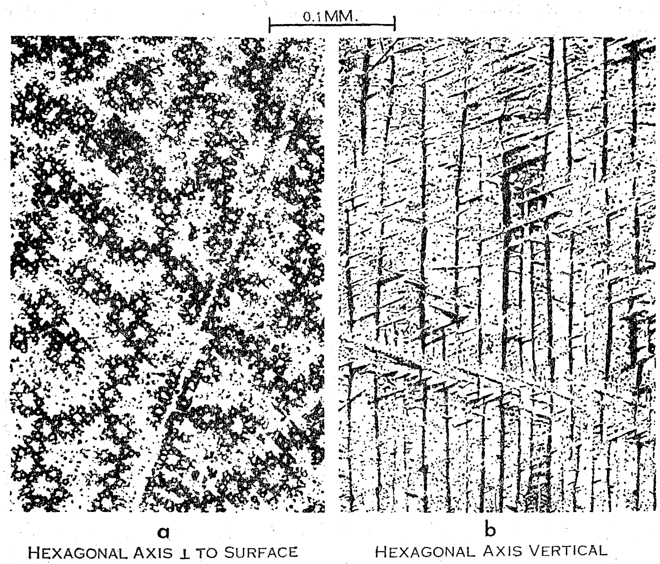


FIG. 36

Powder patterns of cobalt on surfaces perpendicular (a) and parallel (b) to hexagonal axis of crystal. (H. J. Williams)

easily, and the magnetization curve flattens out quickly above the knee, attaining saturation in relatively weak fields (fig. 9).

Just as strain affects magnetic properties, so magnetization changes the dimensions of a ferromagnetic body, or the body is said to exhibit magnetostriction. If the length of a material changes by a relatively large amount when magnetized to saturation, this material will be relatively sensitive to strain, *i.e.*, magnetostriction and strain-sensitivity are reciprocal properties. Strain affects mainly the lower and middle portions of the magnetization curve, and the strain and magnetostriction together determine the ease with which the interdomain boundary is moved by a change in the magnetic field. Thus the highest initial permeabilities are found in materials having very small magnetostriction, *e.g.*, permalloy containing about 80% nickel.

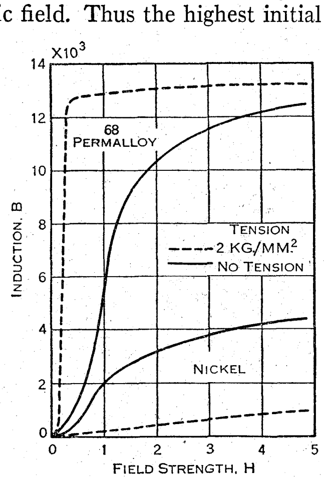


FIG. 37

Effect of tension on magnetization of 68 permalloy and nickel is opposite in direction. Tension is held constant while field is increased from zero

Barkhausen Effect.—In 1919 H. Barkhausen discovered the effect known by his name, and interpreted it as demonstrating that the magnetization of iron proceeds by steps and not in a continuous manner. This effect may be demonstrated simply as shown by the right side of fig. 33, which is self-explanatory. As the field is changed slowly the succession of clicks heard in the phones, or in a loud speaker, persists only when the magnetization is changing along the steep part of the magnetization curve or hysteresis loop. The clicks are identified with irreversible changes in magnetization (process (2) above) and are direct

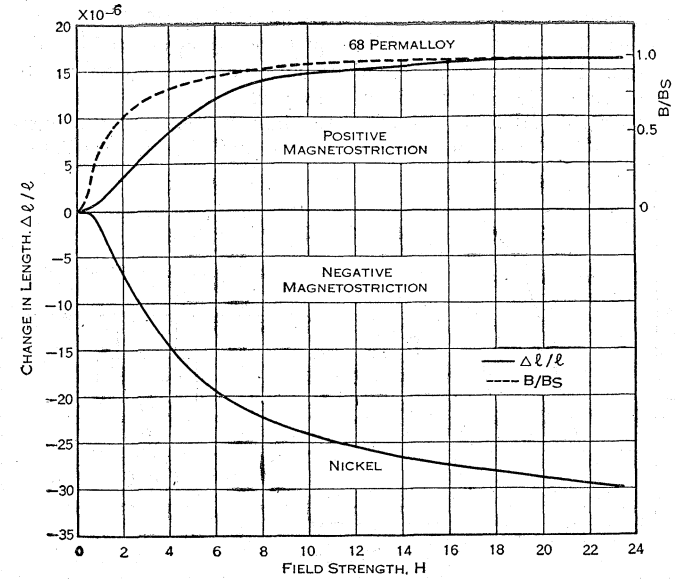


FIG. 38

Application of field causes increase in length of 68 permalloy (positive magnetostriction), and a decrease in nickel (negative magnetostriction). Compare with reciprocal effect of fig. 37

evidence of the existence of domains.

An oscillographic record of the Barkhausen effect is shown in fig. 34. Here each impulse is due to the sudden change of magnetization in some part of the specimen. The area under each impulse is a measure of the volume of the domain, the magnetization of which changed suddenly in direction at the time. The largest domains reverse on the steep portions of the magnetization curve and hysteresis loop, where the average volume of the domains is about 10^{-6} mm.^{3}, equal to the volume of a cube 0.01 mm. on an edge, and the farther one goes along the magnetization curve beyond the knee the smaller the impulses become. This agrees with the domain theory, according to which the domains in the upper portion change in direction slowly and reversibly and not by impulses. A domain size of the same order of magnitude has been derived from experiments on neutron scattering.

Powder patterns.—For many decades iron filings have been used to portray the directions of lines of magnetic force in air and to detect flaws or inhomogeneities in magnetic materials. In 1931 it occurred to L. von Hàmos and P. A. Thiessen to use fine magnetic powder to detect the local inhomogeneities in magnetization that the domain theory predicts. Independently F. Bitter applied a suspension of siderac (Fe_2O_3), having particles about 10^{-4} cm. in diameter, to a polished magnetized surface and observed under the microscope that the powder formed parallel lines regularly spaced about 0.1 mm. apart and aligned approximately perpendicularly to the direction of magnetization.

The technique and interpretation of such patterns were then the subjects of study by a number of workers. A notable advance was made by W. L. McKeehan and W. C. Elmore who first observed a well-defined pattern on a demagnetized single crystal. Fig. 35 shows such a pattern (middle) and also the patterns observed when the magnetization is directed into (left), or out of (right) the same portion of the surface. These striking pictures are probably the most direct evidence of the existence of magnetic domains. The suspension used for the experiments was a true colloid of Fe_2O_3 particles small enough to show Brownian movement, and a change in magnetization of the magnetic specimen was accompanied by a movement of the lines immediately visible to the eye.

Elmore simulated a magnetic crystal composed of domains by putting together small bars of permanent magnets, and found that the stray fields produced at the surface were similar to those observed on real crystals by the powder method.

Experiments on cobalt have been particularly instructive. Bitter observed two types of patterns on polycrystalline material and Elmore, working with single crystals, found the hexagonal lacelike patterns on surfaces perpendicular to the crystal axis and the straight line patterns on planes parallel to the axis (fig. 36). These patterns are in accord with the magnetic properties of cobalt, known to have a direction of easy magnetization parallel to the crystal axis. The domains are then expected to be long in the direction of the axis and packed together like a bundle of needles. The boundaries of such domains are outlined by the concentrations of powder shown in the patterns. Moving pictures of the patterns of cobalt taken with slowly changing field show sudden displacements much larger than those usually attributed to the Barkhausen effect.

6. STRESS AND MAGNETOSTRICTION

The magnetic properties of many ferromagnetic materials are sensitive to the application of stress, to such an extent that stress may be ranked with field strength and temperature as one of the primary factors affecting magnetic change. Stresses of two kinds should be distinguished: large stresses, that cause a permanent deformation of the material, almost invariably cause a decrease in permeability; stresses within the elastic limit may cause either an increase or a decrease in the permeability, depending on the nature of the material.

When a moderate tension is applied to a specimen of nickel, its permeability is decreased. The magnetization curve taken with tension applied always lies below that for the unstrained material (fig. 37), and the curve is always lower the greater the tension. The effect of stress on the magnetization curve is greatest in the middle portion of the curve, and approaches zero when the specimen is either unmagnetized or saturated.

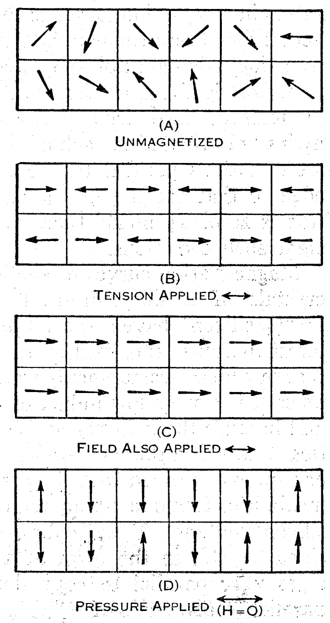


FIG. 39

Schematic domain interpretation of effect of stress and magnetic field applied to material with positive magnetostriction

With some materials, on the other hand, the effect of tension is to increase the permeability. For example, in permalloy containing 68% nickel and 32% iron the maximum permeability is higher by a factor of 8 when the tension is 2 kg./mm.^{2} and by a factor of about 30 when the tension is 11 kg./mm.^{2} (15,600 lb./in.^{2}), the elastic limit of this material. As the stress exceeds the elastic limit the permeability of permalloy, and indeed that of any material, decreases rapidly.

The effect of stress on magnetization is closely related to the change of dimensions that occurs when a magnetic body is magnetized (magnetostriction); that is, the effect of strain on magnetization and the effect of magnetization on strain are interdependent. When nickel is magnetized it contracts a small fraction of its original length, at most 40 parts per million. The fractional change of length, $\Delta l/l$, with field strength, H, (fig. 38) is first slow, then rapid, then again slow as it approaches a finite limit called "saturation magnetostriction," $(\Delta l/l)_s$. When 68 permalloy is magnetized it increases in length as shown.

Nickel and 68 permalloy are representative of materials with negative and positive magnetostriction, respectively. Tension increases the magnetization of a body having positive magnetostriction, decreases the magnetization if it has negative magnetostriction. The effect of compression is opposite to that of tension, consequently the magnetization of magnetostrictively positive materials is decreased by pressure. In referring to tension and compression it has been assumed that they are applied along a line parallel to the direction of the magnetic field; if pressure is applied in a direction at right angles to the field the effect on magnetization is opposite to the effect of compression applied parallel to the field, *i.e.*, compression applied to nickel at right angles to the field will increase the magnetization measured parallel to the field.

Iron and some other materials have magnetostriction that is sometimes positive and sometimes negative. The magnetostriction of iron is positive in weak fields, negative in strong fields; and the effect of tension is, as expected, to increase magnetization in low fields, decrease it in high fields.

Generally the magnetostriction begins to increase rapidly with field strength at about the knee of the magnetization curve. The magnetization reaches to one-half to two-thirds of its saturation value while the magnetostriction is still only one-fourth to one-third of its final value, $(\Delta l/l)_s$. For example when nickel is subjected to a field of $H=3.6$, $B/B_s=0.64$ while $(\Delta l/l)/(\Delta l/l)_s=0.33$ only (fig. 38).

Iron-nickel and Iron-cobalt Alloys.—Both the strain-sensitivity and magnetostriction of the iron-nickel alloys are of special interest. The saturation magnetostriction (the greatest change in length) goes through zero at about 81% nickel, a composition close to that of the permalloys having the highest permeability, and McKeehan has pointed out the close theoretical connection between the low magnetostriction and high permeability of these alloys. The strain-sensitivity of the permalloys is also zero at about 81% nickel, as would be expected. The greatest changes in length of any materials are observed in iron-cobalt alloys having 40% to 60% cobalt—here the expansion is as large as 60 to 80 x 10^{-6}, about twice the change in nickel.

Changes in Volume.—When iron is magnetized in not too strong a field its length increases, and its cross-sectional area decreases in about the same proportion, so that the volume remains approximately constant. However, there is a small change in volume, usually an expansion, that can be detected with sensitive apparatus. When the field is about 2,000 oersteds, the fractional change in volume in iron is about 10^{-6}, and in nickel about one-third of this amount. It is especially large in the iron-nickel alloys containing about 30% nickel, and here amounts to about 40 x 10^{-6} when $H=2{,}000$.

Closely connected with the change in volume with field strength is the change of magnetization with hydrostatic pressure. As indicated by the magnitude of the volume magnetostriction,

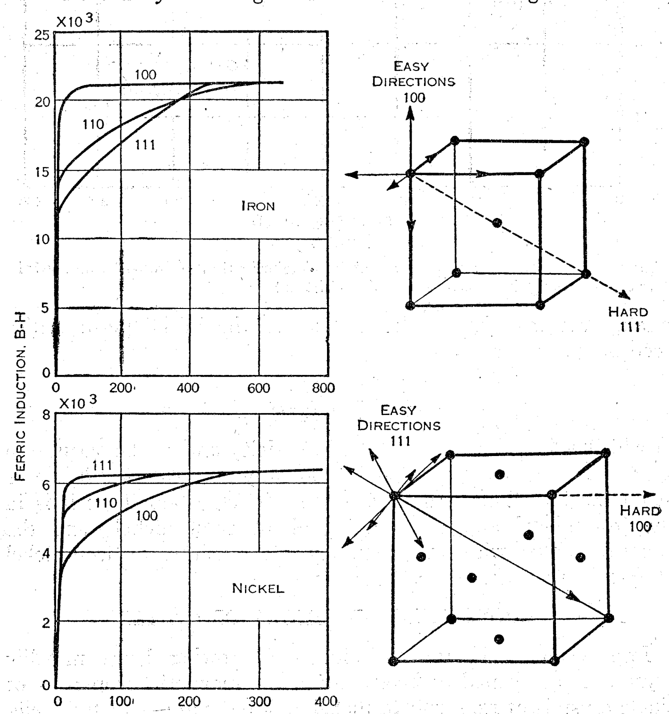


FIG. 40

Magnetic properties and crystal structures of single crystals of iron and nickel. The groups of arrows at the corners of the cubes—six for iron and eight for nickel—indicate the directions of easy magnetization (K. Honda and S. Kaya, W. L. Webster)

this change is small.

Domain Interpretation of Stress.—According to the domain theory, when tension is applied to a material with positive magnetostriction, the magnetization of a single domain will tend to be aligned parallel to the direction of the tension. In an unmagnetized material with domains oriented initially at random the domains are rotated by a sufficiently large tension as shown in fig. 39 (a) and (b), because the directions of easy magnetization in the various domains have been changed by the stress. If a field is then applied, half of the domains reverse in direction and the material is saturated. (No magnetostrictive change in length accompanies such domain reversals.) Compression causes the domains to orient transversely (fig. 39d). If a material has negative magnetostriction, tension will effect the same result, and a field subsequently applied will rotate the domains toward saturation.

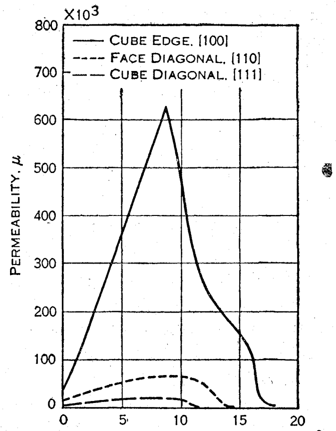


FIG. 41

Magnetic properties of single crystals of iron-silicon alloy (3.8% Si), measured in different directions in the crystal (H. J. Williams)

The domain theory has been successful in predicting the highest value of the initial permeability that can be attained when impurities have been reduced to a minimum and internal strains relieved as much as possible by annealing. The small strain then remaining is due to the magnetostriction of the separate domains and is proportional to the saturation magnetostrictions; and the smaller the magnetostriction the larger the initial permeability according to the relation

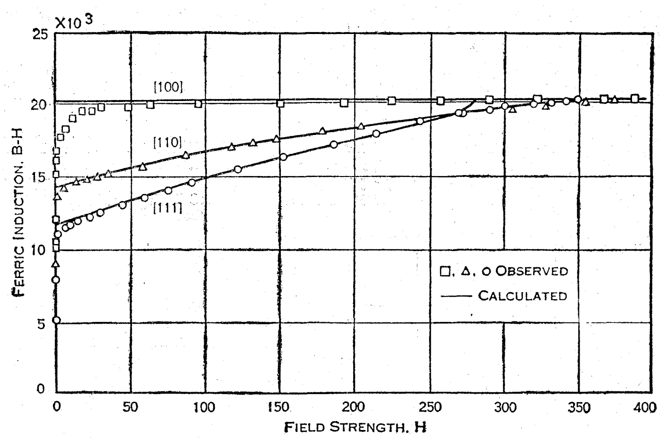


FIG. 42

Comparison of theory and experiment for magnetization of iron-silicon crystal in three principal directions (H. J. Williams)

$$\mu_0 = \frac{4I_s^2}{(\Delta l/l)_s^2 E}$$

in which E is Young's modulus of elasticity and I_s the saturation magnetization. This equation, although by no means exact, states again the fact that μ_o is large when $(\Delta l/l)_s$ is small, as it is in the iron nickel alloys containing about 80% nickel; and the equation holds with fair accuracy for a series of iron-nickel alloys. It was derived by M. Kersten.

7. PROPERTIES OF SINGLE CRYSTALS

Improvements in the technique of growing large metallic crystals have opened to investigation the magnetic properties of single crystals of iron, cobalt, nickel and many alloys of these elements. Crystals of some metals such as nickel and nickel-iron alloys, are grown by slow freezing of a melt of pure material. This method is not adapted to iron, because of its phase transformation at about 900° C.; single crystals of this element are grown by stretching a pure specimen a definite amount and then heating it for a long time just below the transformation temperature.

In the cubic crystals of iron and nickel the magnetic properties depend on the direction, with respect to the crystal axes, in which these properties are measured. Fig. 40 shows the magnetization curves for iron and for nickel, taken with B and H measured in the three principal directions, namely: (1) parallel to an edge of the cube—the [100] direction; (2) parallel to a diagonal of a cube face—the [110] direction; and (3) parallel to the space diagonal—the [111] direction. The direction for which the magnetization curve lies highest is the direction in which magnetization is most easily acquired, and is called the direction of easy magnetization. In iron this direction is parallel to a cube edge; in nickel it is parallel to a cube diagonal.

According to the domain theory the direction of easy magnetization in a crystal determines the actual direction of magnetization in a single domain not subjected to magnetic field or strain, and in unmagnetized iron the domains are oriented in each of the six directions parallel to a cube edge so that the net magnetization is zero. In nickel there are eight such directions.

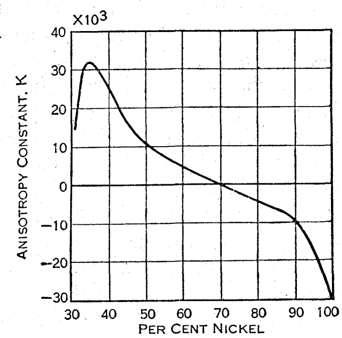


FIG. 43

Dependence of crystal anisotropy of iron-nickel alloys on composition. Note that anisotropy constant is zero near 70% nickel (H. J. Williams and R. M. Bozorth)

Magnetization curves of single crystals of a silicon-iron alloy (3.8% silicon) have a special interest because this is the first case in which measurements were extended to very low inductions, and because the high permeabilities obtained in these crystals are enormous compared with the permeabilities found in commercial silicon-iron sheet having the same silicon content. These data were made available by cutting a single crystal in the form of a hollow parallelogram so that all sides were parallel to equivalent directions in the crystal, *e.g.*, parallel to diagonals of cube faces, and so forming a closed magnetic circuit and measuring in the usual way. The highest permeability observed is about 100 times that of commercial transformer sheet (fig. 41).

Calculation of Magnetization Curves.—A theoretical study of the properties of crystals has made it possible to calculate the magnetization curve for any direction in a single cubic crystal like iron or nickel, provided a single constant of the crystal, the anisotropy constant, K, is known. This constant is a measure of the difference between the magnetization curves in different directions, and is numerically equal to four times the area between the I *vs.* H curves for the [100] and [110] directions. The constant is positive for iron and negative for nickel, and is approximately zero for iron-nickel alloys containing 60% to 70% nickel.

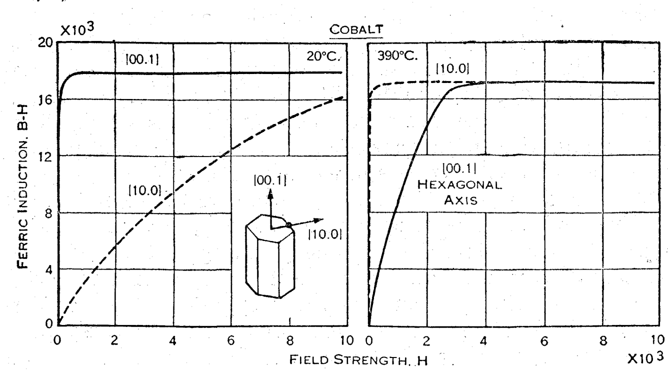


FIG. 44

Crystal anisotropy of cobalt reverses sign at about 270° C., direction of easy magnetization changing from hexagonal axis [00.1] by 90° to [10.0] (K. Honda and H. Masumoto)

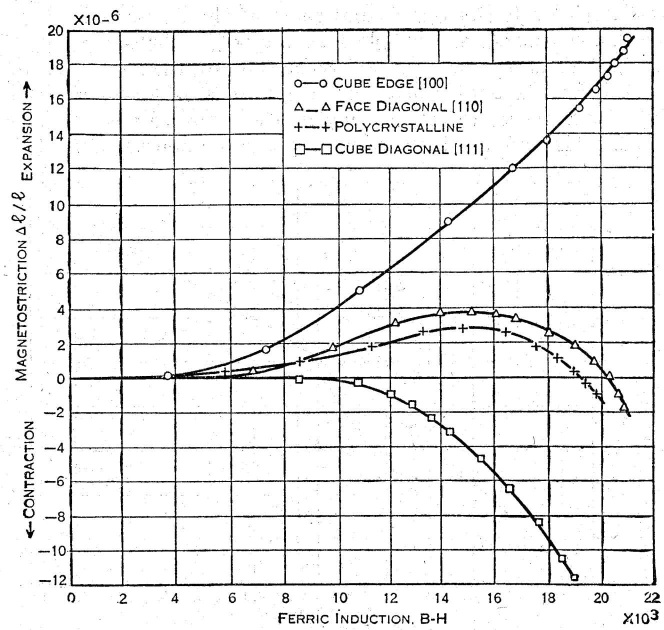


FIG. 45

Dependence of magnetostrictive change in length on crystal direction in iron (W. L. Webster)

Comparison of theory and experiment is made in fig. 42 using H. J. Williams' data for a single crystal containing 3.8% silicon, for which $K = 280{,}000$ ergs/cm³. The theory does not take account of the energy associated with the lower and middle portions of the magnetization curve; therefore, the calculated curves do not correspond to the true magnetization curve below its knee. In a polycrystalline material the magnetization curve is a combination of the separate curves for the many small single crystals of which it is composed. The calculation of such a composite curve has been made to show in what manner the magnetization curve approaches saturation, and fair agreement with observation has been found.

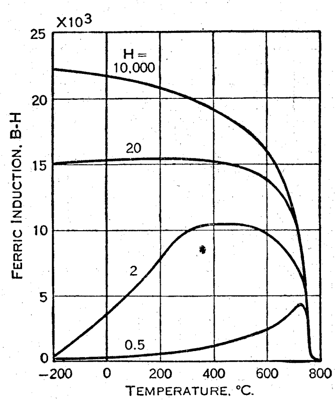


FIG. 46

Effect of temperature on magnetization of iron subjected to fields of various strength. Magnetization drops to low value at Curie temperature, 770° C. (E. M. Terry)

In iron and nickel the anisotropy constants decrease as the temperature increases, so that these metals are isotropic over a considerable range of temperature before they become nonmagnetic at the Curie point. At very low temperature, 20°K., the constant for nickel is 10 to 15 times what it is at room temperature, while for iron the corresponding ratio is only 1.5.

Anisotropy of Iron-nickel Alloys.—Unusual magnetic properties are found in alloys having small values of the anisotropy constant. Such alloys are the permalloys having nickel contents between 60% and 80% nickel, in which range of composition the constant goes from positive to negative (fig. 43). When the anisotropy is small, and the orientation of the domain therefore controlled only weakly by the crystal structure, the material responds easily to either magnetic field or to mechanical stress and therefore saturates in relatively low fields and is unusually strain sensitive.

The small anisotropy of the permalloys containing 60% to 80% nickel is also responsible for the fact that these alloys show unusual properties when heat treated in a magnetic field. A hysteresis loop of material so treated, and the high values of maximum permeability associated with the permalloys (fig. 12), have already been mentioned.

Anisotropy of Cobalt.—Cobalt differs from the other ferromagnetic elements, iron and nickel, by having a hexagonal crystal structure instead of a cubic one. At room temperature the direction of easy magnetization is parallel to the hexagonal axis of the crystal, and when unmagnetized the domains therefore lie in one of the two orientations parallel to this axis. This small number of easy directions, compared with the six or eight in a cubic crystal, means that the domains are needlelike and that the whole magnetic structure may be regarded as a bundle of needles magnetized initially in either direction at random. This picture is supported by powder patterns (*see* above) and by the measurements made by L. H. Germer of magnetic fields close to the surfaces of a single crystal of cobalt.

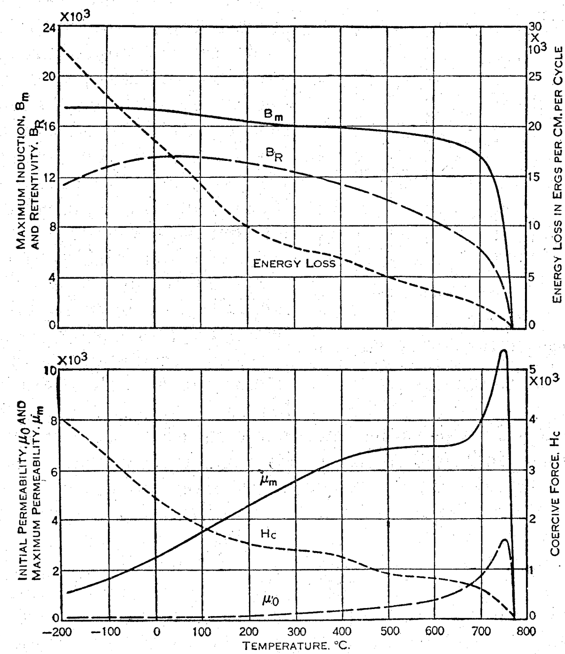


FIG. 47

Variation of some magnetic properties with temperature. Material is electrolytic iron annealed at 800° C. (E. M. Terry, 1910)

The crystal anisotropy of cobalt is large, consequently a strong field is necessary to saturate a crystal in the direction of most difficult magnetization. More than 10,000 oersteds are required for this purpose at room temperature (fig. 44), compared with 600 oersteds for iron and 300 for nickel.

At higher temperatures cobalt becomes isotropic, and above 300° C. the hexagonal axis is the direction of most difficult magnetization, all directions at right angles to the axis being equally easy. Magnetization curves for the principal directions at room temperature and at 390° C. are shown in fig. 44.

Magnetostriction in Single Crystals.—The magnetostrictive change in length of a single crystal is not the same in all crystallographic directions. Especially is this true in iron which expands when the field is applied parallel to a crystal axis, [100], contracts when it is applied parallel to a cube diagonal, [111] (fig. 45). In the direction of the face diagonal, [110], the crystal expands in low fields and contracts in high fields. Nickel con-

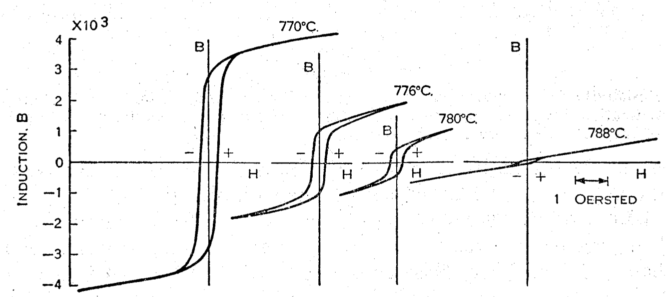


FIG. 48

Change in form of hysteresis loop of iron near the Curie point (H. Kühlewein) tracts in all field strengths in all directions.

8. TEMPERATURE AND THE CURIE POINT

It has been known for many years that when iron is heated to a high temperature it loses its ferromagnetism and is no longer strongly attracted by a magnet. The temperature at which any ferromagnetic material loses its magnetism is known as the Curie point; it is 770° C. for iron and 358° C. for nickel. The highest known Curie point is 1,120° C., for cobalt. For some materials the Curie point lies near the absolute zero of temperature.

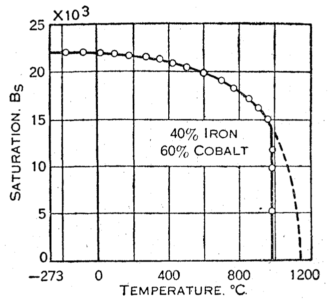


FIG. 49

Curie point determined by change in phase, at 980° C., of iron-cobalt alloy (60% cobalt). (A. Preuss)

When a magnetic material is subjected to a high constant field, an increase in temperature brings about a continuously accelerating decrease in induction. The induction comes down abruptly, almost to zero, at the Curie point (fig. 46), and the curve is retraced when the temperature is lowered again. On the other hand when the iron is subjected to a weak field the induction will first increase with increase in temperature and after passing through a maximum will drop to a low value at the Curie point as before.

The way in which other magnetic quantities change with temperature is indicated in fig. 47 for iron. In any material which may be called normal the curves are likely to have this same general character; *e.g.*, the initial and maximum permeabilities first increase and then decrease with increasing temperature, and the coercive force and hysteresis loss continually decrease. The characteristic maximum in the initial and maximum permeabilities, just below the Curie point, is associated with the low magnetic anisotropy at this temperature. The way in which the size

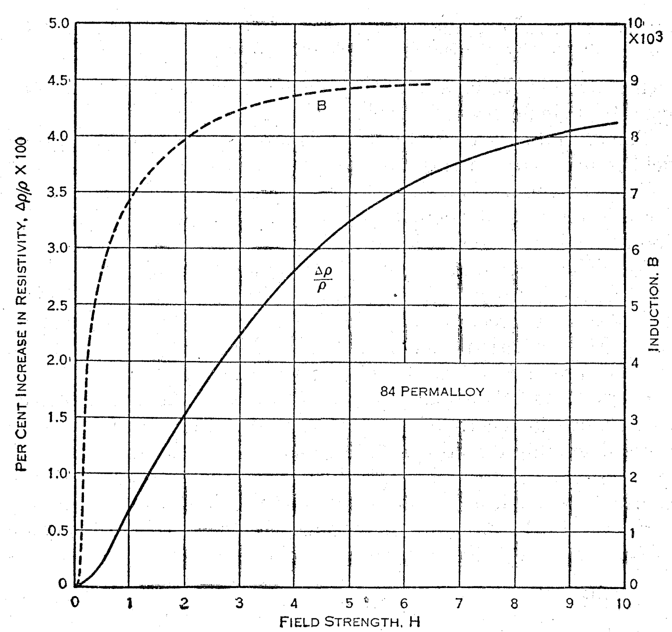


FIG. 50

Resistivity (ρ) of magnetic material (permalloy) increases slightly with magnetization. Most of increase occurs after magnetization is well beyond knee of magnetization curve. (L. W. McKeehan)

and shape of the hysteresis loop of iron change as the temperature approaches the Curie point is shown in fig. 48.

Effect of Phase Changes.—Iron and nickel are normal as to their magnetic behaviour with change of temperature. No changes in their crystal structures occur between room temperature and the Curie point. On the other hand such changes in structure do occur in many alloys, among which the so-called irreversible alloys of iron and nickel (5% to 30% nickel) investigated by J. Hopkinson, and some of the iron-cobalt alloys may be considered as examples. In the 60% cobalt-iron alloy a change in phase, due to a rearrangement of the atoms in the crystal, from a body-centred cubic (α) to a face-centred cubic (γ) form, occurs when the alloy is heated above 980° C. The α phase is ferromagnetic, the γ phase is nonmagnetic (*i.e.*, paramagnetic), consequently the material loses its ferromagnetism when heated through the temperature of change of phase, 980° C., and the magnetization (measured in a high field) drops toward zero precipitously (fig. 49) instead of in the normal fashion as it does for iron (fig. 46).

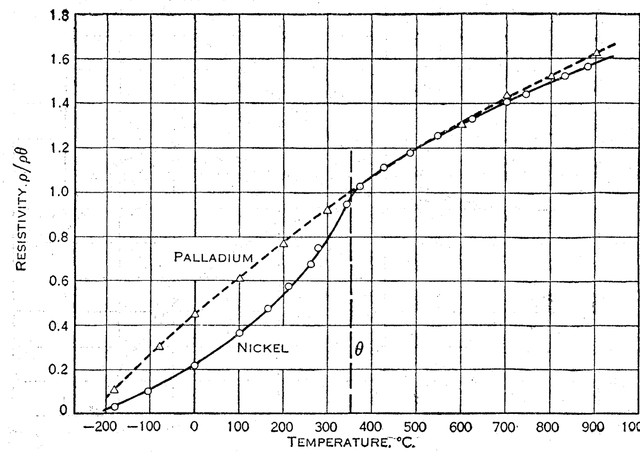


FIG. 51

Resistivity of magnetic material is abnormally low, as long as it is ferromagnetic (H. H. Potter and J. G. G. Conybeare)

9. EFFECT OF MAGNETIZATION ON OTHER PROPERTIES

Preceding paragraphs have described the magnetostriction that occurs during magnetization. Magnetization also effects changes in many other physical properties; and a ferromagnetic material, even though unmagnetized, possesses certain physical properties

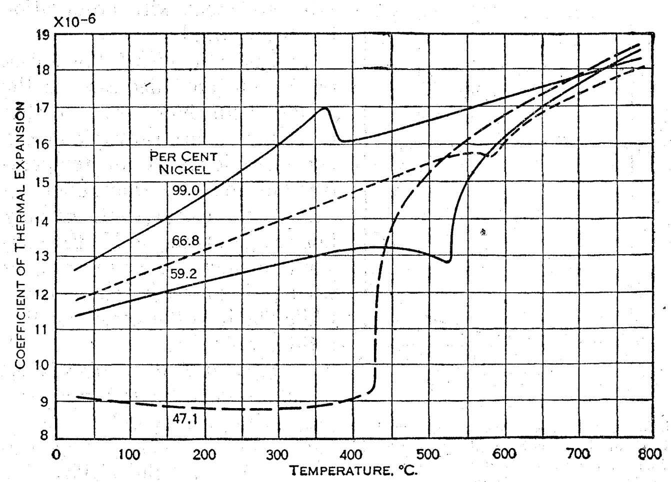


FIG. 52

Thermal expansion curves of magnetic materials show anomalies near and below Curie points. (P. Chévenard)

that are characteristic of its ferromagnetism. The more important of these properties are the following: (1) electrical resistance; (2) thermal expansion; (3) Young's modulus and other elastic constants; (4) magnetocaloric effect; (5) specific heat. The resistivity of magnetic materials is affected also by stress—tension may either increase or decrease the resistivity, depending on whether the material has positive or negative magnetostriction.

Magnetism and Resistivity.—When nickel is magnetized in a high field, its electrical resistivity is increased by about 2%, and a similar but smaller effect is found in iron. Such changes were first reported by W. Thomson (Lord Kelvin) in 1851. A larger change in resistivity, as high as 4% to 5%, is shown by the iron-nickel alloys having 70% to 85% nickel. The increase in resistivity with field strength for the 84% permalloy (fig. 50) illustrates the general rule that most of the change occurs when the magnetization is well beyond the knee of the magnetization curve, and suggests that the change in resistivity, like the magnetostrictive change in length, is associated with domain rotations and not with domain reversals. There is a close relation between changes in length and changes in resistivity, and these quantities usually have a constant ratio.

The resistivity of a ferromagnetic material is abnormally low by virtue of the fact that it is ferromagnetic. This may be illustrated by comparison of the resistivities of nickel and palladium, elements occupying similar positions in the periodic table. The resistivity-temperature curves (fig. 51) are drawn so that they coincide at a temperature just above the Curie point of nickel, when both metals are nonmagnetic, and the

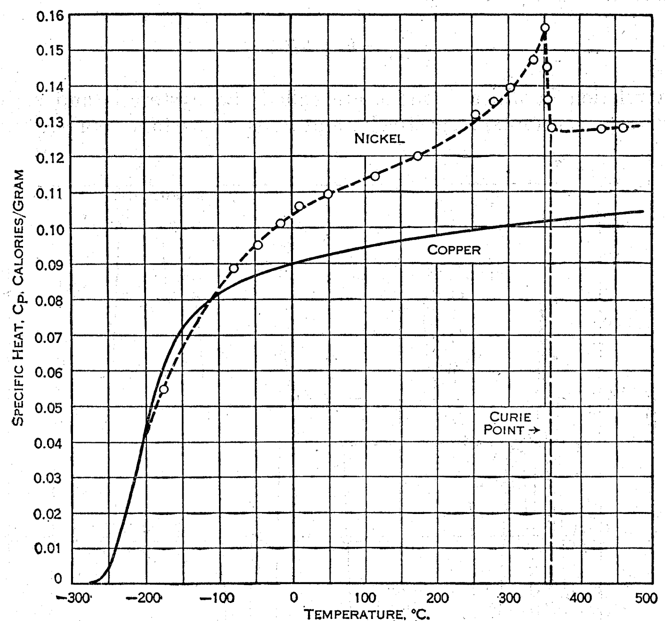


FIG. 53

Specific heat of a magnetic substance is unusually high. Curves for nickel (E. Lapp) and copper (H. Klinkhart) are compared

separation of the curves below this temperature indicates the lowering of the resistivity due to the ferromagnetism. The ferromagnetism becomes progressively weaker as the Curie point is approached, and the separation of the curves in the figure correspondingly less.

Magnetism and Thermal Expansion.—The thermal expansion of magnetic materials is abnormal to such an extent that occasionally such a material will contract instead of expand as the temperature is raised in the vicinity of the Curie point. In some alloys, such as invar, the expansion is very small over a range of temperatures that includes room temperature, and this property is of great technical importance.

The origin of the abnormal expansion lies in the change in the forces between atoms that occur when the material becomes ferromagnetic. The iron nickel alloys show these changes in a striking way (fig. 52). As nickel and the alloys containing more than 70% nickel cool through the Curie point, the expansion coefficients first increase and then decrease rapidly. In contrary fashion, the coefficients of alloys with 30% to 70% nickel first decrease sharply and then increase.

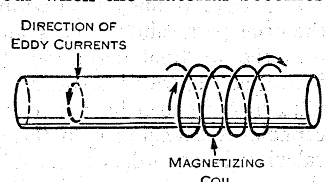


FIG. 54

Direction of eddy currents in solid bar is opposite to that of applied magnetizing current giving rise to them

These changes may be regarded as the result of the superposition of a "magnetic" expansion or contraction on the normal; in invar, containing about 36% nickel, the anomalous and normal expansion neutralize each other at room temperature. When the nickel content is about 70%, there is no anomalous magnetic expansion or contraction at any temperature; this is associated with the fact that at this composition the Curie point of these iron-nickel alloys

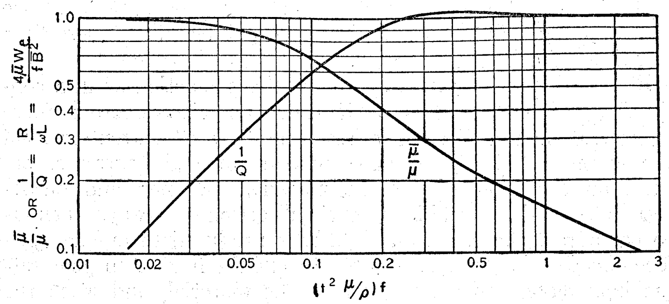


FIG. 55

Theoretical change of apparent permeability, $\bar{\mu}$, and energy loss, W_e, due to eddy currents, with frequency, f, for sheets of given thickness, t(cm), permeability μ, and resistivity ρ (ohm-cm. x 10^9)

is a maximum and independent of composition.

Abnormal Stress-Strain Relation.—In almost all substances a small mechanical stress, σ, (tension) will produce a strain, ϵ, (expansion) that is proportional to the stress, as required by Hooke's law

$$\epsilon=\sigma/E$$

in which Young's modulus, E, is constant. In an unmagnetized magnetic material, however, a tension will change the direction of local magnetization (fig. 39), and with such changes is bound a change in length equal to the magnetostriction of the material. Therefore when tension is applied to a magnetic material, the whole expansion will be the sum of the normal expansion and the magnetostrictive expansion, consequently Young's modulus will vary with stress and deviations from Hooke's law occur.

In a magnetic material Young's modulus will therefore vary both with the amount of strain and with the intensity of magnetization. The change of E with magnetization has been studied in a variety of materials and may be 10% or larger.

Specific Heat and Magnetocaloric Effect.—In comparing the specific heats of nickel and copper at various temperatures (fig. 53) it is apparent that there is an unusual effect in nickel in the neighbourhood of the Curie point. Such a rapid rise and still more rapid drop in the curve, occurring with rising temperature, is characteristic of a ferromagnetic material and is accounted for qualitatively and to a considerable extent quantitatively by theory. The heat necessary to raise the temperature of a magnetic material like nickel is equal to that necessary for a similar but nonmagnetic material (*e.g.*, copper), plus the heat necessary to overcome the mutual interatomic forces that hold the magnetic moments of neighbouring atoms parallel.

This characteristic specific heat of ferromagnetic bodies occurs whether or not the substance under examination is magnetized in the usual sense of the word. The existence of this phenomenon is strong evidence in favour of the existence of spontaneous magnetization in certain regions or domains in ferromagnetic materials.

Similar evidence for spontaneous magnetization is supplied by the magnetocaloric effect. According to theory, at temperatures near the Curie point high fields should increase the spontaneous magnetization, and with this increase there should be a rise in temperature of the material. Experimentally, P. Weiss and R. Forrer observed increases in temperature of more than 1° C. when a field of 18,000 oersteds was applied to nickel just below its Curie point. The change of spontaneous magnetization with temperature, derived from the data, is in good accord with the theory.

10. MAGNETIZATION IN ALTERNATING FIELDS

In many of their uses magnetic materials are subjected to an alternating field, produced by an alternating current in the wire associated with the material. The effects of the frequency of alternation on the magnetic properties of the material are primarily of three kinds: (1) the effective permeability of the material is reduced; (2) the energy loss in the material is increased; and (3) there is a time lag between the field strength and the corresponding induction. There also is some evidence that at ultra high frequencies the true permeability is less than it is at low frequencies.

Effect of Eddy Currents.—When the magnetic flux in a conducting medium changes with time, an electromotive force is generated, and there is a resulting flow of currents within the material. These Foucault currents, or eddy currents, depend on the geometry of the material specimen and on its resistivity and permeability; their direction is always such as to counteract the change in field that produced them (fig. 54). The effect of eddy currents is to prevent the field from penetrating immediately to the interior of the material, and when the applied field is varying continually, as it is in much of the apparatus in which magnetic material is used, the field strength in the interior of the material may never be more than a small fraction of the field strength at the surface. The magnetic induction, therefore, decreases from the surface toward the interior.

To avoid this reduction in field strength, and resultant decrease in alternating flux, the magnetic cores of transformers and other apparatus are laminated, each lamination being insulated electrically from its neighbour. The flux-carrying capacity of such a lamination depends on the thickness (t in cms.), permeability (μ) and resistivity (ρ in ohm-cm.. 10^9) of the material and on the frequency (f in cycles/sec.) of alternation of the magnetic field. It can be calculated accurately provided the permeability does not vary with field strength, and can be expressed in terms of the effective permeability, $\bar{\mu}$, defined as the ratio of the amplitude of the induction, $\bar{B}$, (averaged over the section of the lamination) to the amplitude of the applied field strength, H_a. When H_a varies sinusoidally with time, $\bar{\mu}/\mu$ varies with frequency is shown graphically in fig. 55.

In laminations as commonly used in power transformers, the reduction in permeability is only a fraction of 1%, and therefore negligible. When the frequency is high, $\bar{\mu}/\mu$ is inversely proportional to $\sqrt{f}$, or

$$\bar{\mu}=\frac{\sqrt{\mu\rho}}{2\pi t}\cdot\frac{1}{\sqrt{f}}.$$

In a transformer working at radio frequencies the constants of the materials used are such that 95% of the true permeability is lost. At these high frequencies the flux carrying power or value of a material of given resistivity and thickness is directly proportional to the square root of its permeability.

Energy Losses in Alternating Fields.—Eddy currents in a magnetic material consume power and raise the temperature of the material. The power loss, W_e, may be calculated with some precision provided μ does not vary with B. At low frequencies it is proportional to f^2. At high frequencies it is proportional to $f^{3/2}$, if the material is always magnetized to the same value of $\bar{B}$:

$$W_e=\frac{\pi t\bar{B}^2}{\sqrt{\mu\rho}}\cdot f^{3/2}.$$

If the amplitude of the magnetizing current is held constant, the loss is proportional to $f^{1/2}$. The hysteresis loss of a magnetic material at intermediate and high inductions is given approximately by Steinmetz' relation (*see* above).

$$W_h=\eta B^{1.6}f.$$

The total loss due to hysteresis and eddy currents at low frequencies may then be written

$$W=W_h+W_e=\eta B^{1.6}f+AB^2f^2$$

where A can be calculated theoretically under certain conditions, as shown above. This relation is sometimes used for the separation of the total loss (as measured with a wattmeter at a given value of B) into its hysteresis and eddy components.

When apparatus operates at low inductions, as it often does for transmission of the feeble signals used in communication, the energy losses incurred are usually measured with a Maxwell bridge, as described below under *Measurement of Magnetic Quantities*. The data obtained are the A.C. resistance, R, in ohms, and the inductance, L, in henries, of a coil surrounding the material under test. The ratio R/L is characteristic of the magnetic material and is related to the energy losses in ergs/cm.³ by the equation

$$\frac{R}{2\pi fL}=\frac{8\pi\bar{\mu}W}{B^2}.$$

The reciprocal of $R/(2\pi fL)$ is often called the quality factor, Q. When the frequency is low, the losses due to eddy currents and hysteresis may now be separated by plotting $R/(2\pi fL)$ against frequency. W_h varies as B^3f (see *Hysteresis Loops* above) and W_e as B^2f^2, and

$$\frac{R}{2\pi fL}=h_o+hB+ef$$

a relation in which h and e are called the hysteresis and eddy current constants, respectively, and h_o is a constant representing

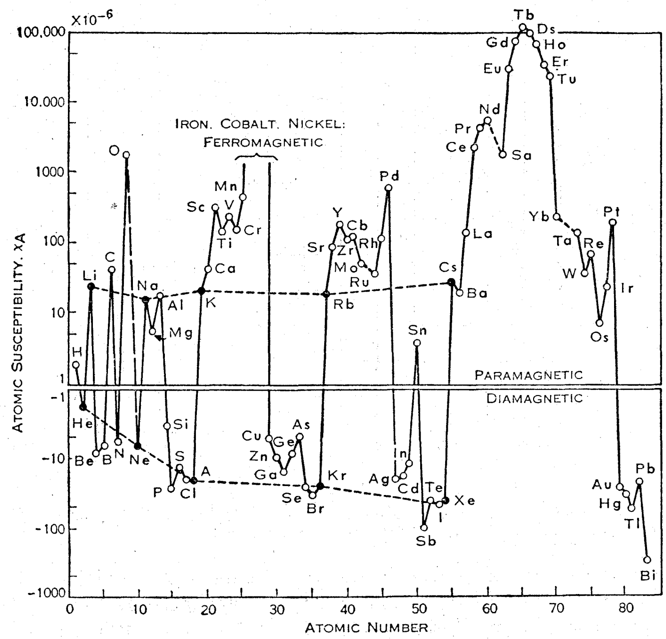


FIG. 56

Atomic susceptibilities of the elements at room temperature. Dotted lines connect alkali metals (paramagnetic) and rare gases (diamagnetic)

an energy loss of unknown origin, important only at very low inductions.

At high frequencies and low inductions the losses in a material of high permeability are usually due predominantly to eddy currents. These can be calculated as described above and for them $R/(2\pi fL)$, or Q, is shown by the curve of fig. 55.

Permeability at Very High Frequencies.—In considering the effect of frequency on permeability it has been assumed that the true permeability, μ, is independent of frequency and that only the apparent permeability, $\bar{\mu}$, diminishes as the frequency increases. There is some reason to believe, however, that at ultra high frequencies the magnetic moment of a domain is not capable of changing with the required rapidity. R. Becker has calculated the order of magnitude of the frequency at which the magnetization should fail to respond. By considering the magnetic energy required to move the surface separating one domain from its neighbour, assuming a reasonable value of the thickness of a domain, he estimates that the permeability will begin to decrease seriously when the frequency is about 2 x 10^9 cycles/sec., corresponding to a wave length in air of 15 cm. The existence of decrease in permeability at wave lengths under 50 cm. is indicated by the work of K. F. Lindmann.[1]

Time Lag in Magnetization.—As already mentioned, eddy currents cause a delay in magnetization so that after a sudden change in H from one value to another, a perceptible time elapses before B acquires its final corresponding value. There are other reasons, too, why B continues to change with time after H has become constant. One well-known cause of such change is metallurgical aging. This is usually observed in permanent magnets, the induction in which can be observed to change over a period of years, and this change is attributed to the slow precipitation of metallic phases from supersaturated solution at room temperature. Similar changes occur also in ordinary annealed iron to such an extent that the coercive force may eventually be doubled even though the material has not been heated above 100° C. Materials that have been severely cold worked sometimes become magnetically softer on account of the slow relief of the internal strains caused by the working.

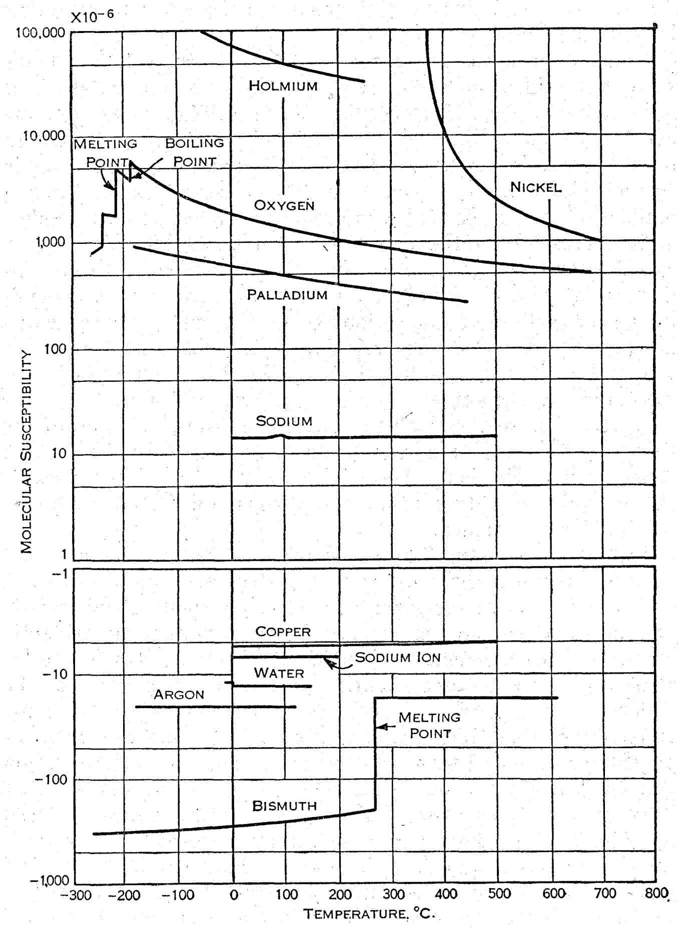


FIG. 57

Variation of atomic or molecular susceptibility with temperature, for some representative materials. Susceptibilities of diamagnetic and weakly paramagnetic substances are normally independent of temperature, those of strongly paramagnetic substances decrease with increasing temperature

A more rapid change of induction with time has been observed repeatedly since Ewing's experiments of 1885. One method of experimenting is to change H suddenly, then observe the change in B as dependent on time. Observable changes may last as long as 15 or 20 minutes, or as short a time as $\frac{1}{10}$ second, depending on the nature of the specimen and the temperature. In some materials the only lag observed can be accounted for by eddy currents. A second way of observing a change of magnetic state with time is to measure the permeability at very low inductions, at various times after demagnetizing and after the measuring current has been applied. It is particularly noticeable that in commercial silicon iron, subjected to a small alternating field of fixed amplitude, the permeability will continue to decrease measurably with time for more than a day. Such changes are associated in some way with the impurities present, for they disappear when these are removed by heat treatment at a high temperature in hydrogen. It has been suggested that the diffusion of small traces of nitrogen or oxygen in iron will impede the movement of domain boundaries in such a way as to account for the observed changes of permeability with time.

[1] K. F. Lindmann, *Z. Techn. Physik*, 19;158 (1938).

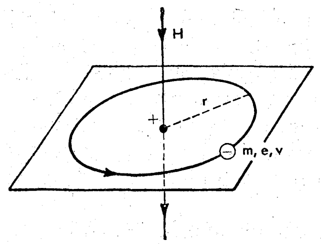


FIG. 58

Velocity of electron is changed by application of field H so that induced magnetic moment is in direction opposite to that of field

11. DIAMAGNETISM

Faraday showed in 1845 that all substances may be classified as diamagnetic and paramagnetic. He distinguished between the paramagnetism and diamagnetism of feebly magnetic substances by suspending them in a strong inhomogeneous field and noting whether they were drawn into or repelled from the strongest part of the field. The force with which a diamagnetic material is repelled by a field is proportional to the strength H and gradient dH/dx of the field and to the susceptibility κ and volume, v, of the material:

$$f = \kappa v H dH/dx.$$

The susceptibilities of solid diamagnetic substances are usually about -1×10^{-6} or -2×10^{-6}, and are normally independent of field strength. Bismuth has the exceptionally large value of -13×10^{-6}, but even in this substance the numerical value of the susceptibility is millions of times less than that of the ferromagnetic metals. Bismuth is also exceptional in that its susceptibility varies somewhat with the field at low temperatures (50° K.).

While diamagnetic and paramagnetic materials are not often of technical use, as such, a study of their behaviour is very important for our scientific knowledge of the nature of matter. Diamagnetism is an atomic property, and usually occurs when the atom has a symmetrical electronic structure and no permanent magnetic moment. In discussing diamagnetism it is appropriate to use the term atomic susceptibility defined as $\chi_A = \kappa A/d$, A being the atomic weight and d the density. Then $\chi_A H$ is the magnetic moment of one gram atomic weight, and when divided by Avogadro's number is the average magnetic moment per atom

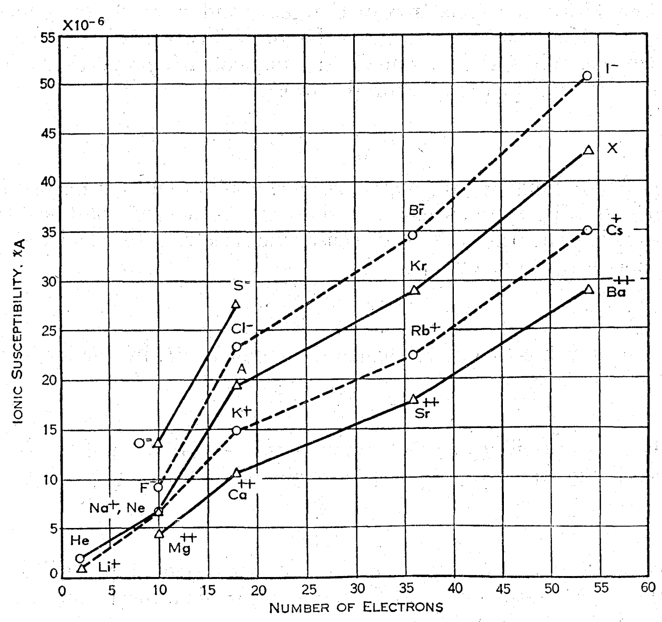


FIG. 59

Ionic susceptibilities of similar structures increase with number of electrons in ion resolved parallel to the magnetic field. Similarly $\chi_M = \kappa M/d$ is the molecular susceptibility, M being the molecular weight.

As P. Curie showed in his classical researches (1895), diamagnetism is usually independent of temperature, and so is not disturbed markedly by atomic collisions or the positions of nearby atoms. However, some change in the diamagnetic susceptibility is generally noted when a substance changes from the solid to the liquid state.

Following the work of Curie, K. Honda and M. Owen in 1910 and 1912 reported measurements of the susceptibilities of many elements. Fig. 56 shows the atomic susceptibilities as dependent on atomic number according to more recent data summarized by P. W. Selwood. Here it is apparent that the rare earth metals

TABLE IV.—*Contribution of Atoms and Bonds to Susceptibility of Organic Molecules*
(Pascal)

Element	$-\chi_A \times 10^6$	Element	$-\chi_A \times 10^6$	Bond	$-\chi_B \times 10^6$
H	2.93	Cl	20.1	C−C	0
				C=C	−5.5
C	6.00	Br	30.6	C=C	−0.8
N(chain)	5.57	I	44.6	N=N	−1.8
N(amine)	2.11	Na	9.2	C=Cl	−3.1
O(alcohol)	4.61	K	18.5	C−Br	−4.1
S	15.0	Zn	13.5	Benzene Ring	1.4
P	26.3	Si	20		

are strongly paramagnetic, that the metals of the "transition groups" containing palladium and platinum are rather strongly paramagnetic, and that most good metallic conductors of electricity are weakly paramagnetic. This implies what is in fact the case, that in a metal the conducting electrons are paramagnetic. The other metals, and the nonmetals, are weakly paramagnetic or diamagnetic, except that antimony and bismuth have moderately strong diamagnetism.

Most ionic and molecular compounds are also diamagnetic because their electrons are paired and their permanent moments tend to cancel each other; however, gaseous oxygen, O_2, and nitric oxide, NO, are paramagnetic. Fig. 57 shows the atomic or molecular susceptibilities of some typical materials and the way in which they change with temperature.

Theory.—Our understanding of the origin of diamagnetism is due largely to P. Langevin who published his celebrated paper on magnetism and electron theory in 1905. He considered an atom with a single electron of charge, e, and mass, m, travelling with velocity, v, in a circular orbit of radius, r (fig. 58). This "current" gives rise to a magnetic moment, M, proportional to the current and the area of the orbit:

$$M = \frac{ve/c}{2\pi r} \cdot \pi r^2 = \frac{ver}{2c}.$$

As pointed out by Sir Joseph Larmor, application of a magnetic field H will create an e.m.f. in the orbit, as a result of the flux threading it, and this will cause the electron to change its velocity by an amount

$$\Delta v = -\frac{eHr}{2mc}$$

in such a direction as to change the moment, M, by the amount

$$\Delta M = \frac{er\Delta v}{2} = \frac{e^2 H r^2}{4mc^2}.$$

The susceptibility of this "atom" is then $-\Delta M/H$, and the susceptibility of one gram atomic weight is

$$\chi_A = -\frac{Ne^2 r^2}{4mc^2}.$$

If an atom contains many electron orbits, oriented in all directions with respect to the field, the expression for atomic susceptibility becomes

$$\chi_A = \frac{Ne^2 \Sigma \overline{r^2}}{6mc^2} = -2.83 \times 10^{10}\, \Sigma \overline{r^2}$$

in which the mean square orbital radius is summed over all the orbits in the atom.

The equation above, known as Langevin's equation of diamagnetism, is applicable to every substance, whether it be diamagnetic or paramagnetic. If an atom has a permanent moment and the material is consequently paramagnetic, it is still true that its susceptibility has the diamagnetic component given by this equation.

Knowing the number of electrons in the atom, one may calculate from the diamagnetic susceptibility the average (r.m.s.) radius of an atom and compare this with the radius determined by other means. Values so obtained are consistent with our other knowledge of atomic structure.

In quantum mechanics (*q.v.*) the Langevin formula still holds when the field of the nucleus is spherically symmetrical, as it is in atoms or ions. The meaning of the orbital radius, r, however, is somewhat different, since the electrons are assumed to be distributed in less localized orbits. Calculation of diamagnetic susceptibilities by wave mechanics has been attempted for a number of the simple atoms and molecules and has been moderately successful for the rare monotomic gases He, Ne, A, Kr, and Xe, and molecular hydrogen, H_2. For helium, theory indicates an atomic susceptibility (x 10^6) of 1.65 to 1.90, depending on the method of calculation; G. G. Havens' measured value is 1.91. For hydrogen the calculated and observed values are 2.10 and 2.01. For the other elements listed both theoretical and measured susceptibilities vary over a greater range.

Positive ions of the alkali and alkaline earth metals, and of the halogens, have the rare gas structure and can also be treated theoretically. The lack of precision in the calculation arises in the approximate nature of wave functions and the effective molecular charge assumed.

Simple Salts and Their Solutions.—Most salts are diamagnetic because the ions of which they are composed (*e.g.*, Na^+ and Cl^-) have the completed electron shells characteristic of the rare gases and consequently have no permanent magnetic moment. Measurements are made either on solid salts or on solutions, and the susceptibilities of the separate ions can be deduced from a series of such measurements. There is some ambiguity in separating the susceptibility of the salt into its component parts, and there is also some change with concentration and state of aggregation, but each ion has a value of χ_A that is approximately constant. Values of the separate ions, deduced by Miss V. C. G. Trew and others, are plotted in fig. 59 against the number of extra-nuclear electrons in the ion. The increase of χ_A with the number of electrons, n, is to be expected according to simple theory; the relative large increase between $n = 10$ and $n = 18$ is shown also by ionic radii deduced quite independently from investigations of crystal structure and of the refraction of light. In ions having the same number of electrons but a different nuclear charge, as in the series I^-, Xe, Cs^+ and Ba^{++}, the diamagnetic susceptibility decreases numerically with increasing charge because the larger charge draws the electrons

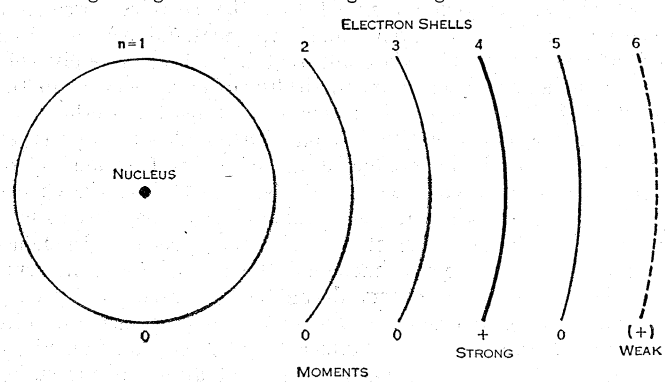


FIG. 60

Paramagnetism occurs when inner shell is incomplete (heavy line) and therefore has permanent moment (strong paramagnetism), or when electrons of outer shell (broken line) become conduction electrons in metal (weak paramagnetism) closer to the nucleus and so diminishes the value of $\Sigma\overline{r^2}$ of Langevin's equation.

The principle of additivity of the diamagnetism of ions may be extended to include also the more complex ions NO_3^-, SO_4^{--}, PO_4^{---}, NH_4^+ and others. Values for these are less certain than those for the simple ions already considered.

Organic Compounds.—In his early comprehensive experiments (1908–13) P. Pascal found that the molecular susceptibility of many organic compounds is the sum of the susceptibilities of the atoms composing them, plus additional terms characteristic of the various bonds occurring in the molecule. The atomic susceptibilities and constants of some elements and bonds are given in Table IV.

The method of using these numbers may be illustrated for ethyl bromide, C_2H_5Br. The calculated value of $-\chi_M \times 10^6$ is $(2 \times 6.00) + (5 \times 2.93) + 30.6 - 4.1 = 53.1$, and is close to the observed value of 53.3. Pascal's constants have been extended to many more complicated organic structures and groups of atoms. His work was also the basis of the additivity relations of inorganic ionic compounds discussed in previous paragraphs.

Diatomic Molecules.—While the Langevin theory is not very illuminating when applied to a simple diatomic molecule like H_2, quantum mechanics can be called upon provided the wave functions are known with sufficient accuracy. In the expression for χ_M there is a term, always positive, added to the negative term of the Langevin equation.

J. H. Van Vleck and N. H. Frank have used the wave functions of molecular hydrogen to calculate both terms of the expression, and found them to be -4.66×10^{-6} and $+0.51 \times 10^{-6}$. The net result of -4.15×10^{-6} may be compared favourably with the experimental values ranging from about -3.9 to -4.0×10^{-6}.

Calculation of heavier diatomic molecules cannot be carried out so rigorously, and the approximate wave functions generally used for these substances give too high a value of χ_M. Our knowledge of gases is also limited by the fact that measurements are difficult to make with accuracy.

Susceptibility of Water.—The magnetic properties of water are interesting for three reasons: (1) it is often used for calibration of apparatus; (2) its susceptibility must be subtracted from that of a solution to obtain the value for the solute; and (3) the variation of its susceptibility with temperature has been measured accurately and this gives us a conception of the amount and nature of the temperature variation of susceptibility of diamagnetic substances generally. The value of $\chi_M \times 10^6$ is 0.7218 at 20° C., and increases about 0.013% per ° C. The opinion of various investigators is that this change is due to depolymerization of the water with increase in temperature. Experience with water supports the general conclusion that diamagnetism is independent of temperature except for the slight change in the effect of surrounding molecules on the electron distribution of the atom or molecule under consideration. Such changes occur, of course, during melting and vapourization (fig. 57) and when molecules combine to form groups, as in polymerization.

12. PARAMAGNETISM

The paramagnetism of the materials examined by Curie was dependent on temperature, the susceptibility decreasing with increasing temperature. After that time it was found that there was a large class of paramagnetic substances for which the susceptibility was practically independent of temperature (fig. 57); this class includes many of the metallic elements when, and only when, they are in the solid conducting state, and the paramagnetism of these materials is due to the conduction electrons. This kind of paramagnetism is referred to as weak paramagnetism, whereas the former class has strong paramagnetism and is due to a permanent magnetic moment of the component atoms or molecules.

The origin of the two kinds of paramagnetism is shown schematically in fig. 60, where the curved lines represent electron shells in an atom. The outer line is broken to indicate that the electrons in this shell are loosely bound and become conduction electrons in a solid metal or valence electrons in a compound. In a metal the spins of a portion of these electrons can be changed by an applied field in a way that can be explained by quantum mechanics, and therefore give rise to weak paramagnetism as shown, for example, by metallic sodium. Most of the other shells have their full complement of electrons, and the magnetic moments due to their orbital and spin motions are self-neutralizing so that they contribute only diamagnetism to the atom. On the other hand some of the shells in some atoms are incomplete and therefore have a resultant moment that is large compared with the spin of the conduction electrons or the diamagnetic moment of the closed shells. Such incomplete shells occur notably in the iron group and rare earth group of elements, also in the palladium and platinum groups, and all of these show strong paramagnetism. In the extreme cases of the rare earth elements dysprosium and holmium, the fourth shell (fig. 60) contains electrons whose spin and orbital moments combine to give the largest magnetic moment of any atoms.

Before discussing the experimental results further it is desirable to outline the classical and quantum theories of strong paramagnetism, and the quantum theory of weak paramagnetism.

Langevin Theory.—Curie found that his measurements at various temperatures could be expressed by the law now known by his name:

$$\chi_M = C_M/T,$$

in which T is the absolute temperature and C_M the Curie constant characteristic of the substance. The classical theory of this kind of paramagnetism was developed by Langevin who investigated mathematically the behaviour of an ensemble of magnetic dipoles, each of moment μ_M, in a field of strength H. The effect of the field is to cause alignment, the thermal agitation to destroy this alignment. Assuming that the "molecules" are far enough apart so that their mutual forces can be neglected, the energy due to the field is

$$W = \mu_M H \cos\theta$$

for each dipole oriented so that μ_M makes the angle θ with H. If the ensemble is subject to thermal agitation, the principles of statistical mechanics show that at any temperature, T, the num-

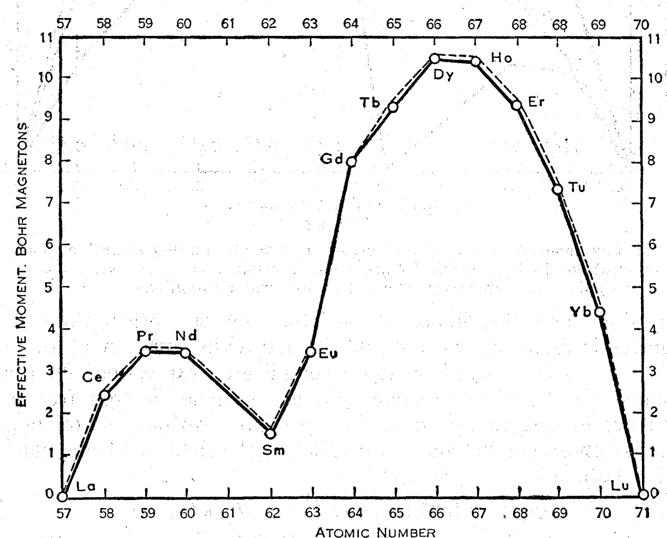


FIG. 61

Effective moment of the trivalent ions of the rare earth elements, at room temperature. Broken line shows values calculated by Van Vleck theory

ber of dipoles oriented in the solid angle $d\omega$ about the direction θ, is proportional to

$$e^{-W/kT}d\omega = e^{(\mu_M H \cos\theta)/kT}d\omega$$

(Boltzmann's equation). For all the molecules the average value of the moment in the direction of the field, $\bar{\mu}_M$, is calculated, and the ratio of this to the total moment, or the moment when all magnets lie parallel, is found to be

$$\frac{\bar{\mu}_M}{\mu_M}=\text{ctnh}\,\frac{\mu_M H}{kT}-\frac{kT}{\mu_M H}.$$

This is Langevin's equation of paramagnetism. At ordinary temperatures $\mu H << kT$, and this equation may be expanded in series form:

$$\frac{\bar{\mu}_M}{\mu_M}=\frac{\mu_M H}{3kT}-\frac{1}{45}\left(\frac{\mu_M H}{kT}\right)^3+\cdots.$$

Now the moment of a gram molecule is $N\bar{\mu}_M$ and the molecular susceptibility is then $\chi_M=N\bar{\mu}_M/H$, so that at ordinary temperatures, where the first term of this equation is sufficient, we have

$$\chi_M=\frac{N\mu_M}{H}=\frac{N\mu_M{}^2}{3kT}=\frac{C_M}{T}.$$

This is Curie's law, with the Curie constant given by

$$C_M=N\mu_M{}^2/3k.$$

Thus Langevin's work explained Curie's law and showed how the moment per molecule could be determined from the results of experiment.

Quantum Theory.—The advent of quantum theory has changed our notions of atomic structure in fundamental ways, and our interpretation of paramagnetic phenomena in several particular ways now to be discussed under four headings.

(1) Langevin assumed that any orientation of magnetic moment with respect to an applied field is possible; quantum theory requires that only discrete changes of angular momentum are possible, and this imposes restrictons on the orientations of magnetic moment. As a result the Langevin equation of paramagnetism is replaced by more complicated expression. In the simplest case, when an atom contains a single electron free to change its direction of spin, there are just two possible orientations—those parallel and antiparallel to the field—and the function becomes

$$\bar{\mu}_M/\mu_M=\tanh(\mu_M H/kT)=\mu_M H/kT+\cdots$$

the last part being applicable when H/T is not too large. When many orientations are possible the function approaches Langevin's as a limit.

(2) There is a natural unit for magnetic moment, the Bohr magneton, equal to the moment of one electron spinning about its own centre. Its value is

$$\beta=eh/4\pi mc=9.27\times10^{-21}\text{ erg/gauss}.$$

Here e is the charge and m the mass of the electron, h is Planck's constant, and c the velocity of light. It is convenient to convert susceptibility data to the apparent number of Bohr magnetons per atom, by dividing the moment per atom, determined from Langevin's expression for the Curie constant, by β. This number is called the effective Bohr magneton number: $\mu_{eff}=\mu_M/\beta$. In terms of the Langevin theory it may be expressed

$$\mu_{eff}=\frac{\mu_M}{\beta}=\sqrt{\frac{3k\,\chi_M T}{N\beta^2}}=2.83\sqrt{\chi_M T}=2.83\sqrt{C_M}$$

and can be calculated provided enough is known of the structure of the atom.

(3) The effective moment of an atom may change with temperature or field strength in a calculable way, and Curie's law will not then be obeyed. Under certain conditions χ_M will be of the form

$$\chi_M=\frac{N\mu_M{}^2}{3kT}+N\alpha.$$

Such an expression with the constant α included, accounts quantitatively for the behaviour of some of the rare earth ions, and is applicable in principle in other cases where, however, it cannot often be worked out in detail.

(4) The temperature-independent or weak paramagnetism of many metals (fig. 57) and of some conducting oxides and salts was quite inexplicable on classical theory. Quantum theory, however, provides an explanation by showing that conduction electrons, behaving as an electron gas, have just this observed character, as previously stated. Comparison of theory with experiment is discussed below.

The applications of these items to substances of various types will now be considered.

Rare Earths.—The ions of the rare earth elements cerium (58) to ytterbium (70) are good examples of strongly paramagnetic substances. The permanent magnetic moment is due to the 4f subshell of the 4th electron shell in the usually trivalent ions. This inner shell is protected by the outer shells from the influence of neighbouring atoms and so the assumptions underlying the theory are fairly well satisfied.

Ionic susceptibilities are deduced from measurements on solutions and on solid salts and oxides, by subtracting the contributions of water and other ions (fig. 61). The susceptibilities decrease with increasing temperature, as expected, except that χ_M for the samarium ion Sm^{+++} is almost constant above room temperature and that for europium shows also some unusual behaviour with temperature.

Calculation of the susceptibilities of the rare earth ions by quantum mechanics is one of the important successes of the Van Vleck theory (fig. 61), based on the earlier work of F. Hund. Both terms of the last equations above, those dependent on and independent of temperature, were derived quantitatively from theory, and the unusual change of χ_M with temperature for Sm and Eu satisfactorily explained.

Rare earths in metallic form have large susceptibilities, and gadolinium when cooled below 16° C is ferromagnetic. Values of χ_A x 10^6 are more than 100,000 for terbium and dysprosium at room temperature. Important deviations from Curie's law are observed, and a law of the form

$$\chi_A=C/(T-\theta)$$

is closely followed. This is the Curie-Weiss law applicable to many solid paramagnetics, particularly those in which the magnetic cores of the atoms are under the influence of magnetic or electric fields of nearby atoms, and the Langevin assumptions, therefore, not satisfied. For gadolinium, as for the other ferromagnetic elements, θ is approximately the Curie point (*see Theory of Ferromagnetism,* below), but the existence of θ in the Curie-Weiss equation does not mean necessarily that the material will be ferromagnetic below the temperature $T=\theta$; rather, the law breaks down before this point is reached.

Ions of the Iron Group.—Strong paramagnetism occurs also in the ions of the elements lying between (but not including) scandium and copper, and is most marked in the ions of manganese, iron and cobalt. The moments of the ions are generally less than those of rare earth ions, because the incomplete shell

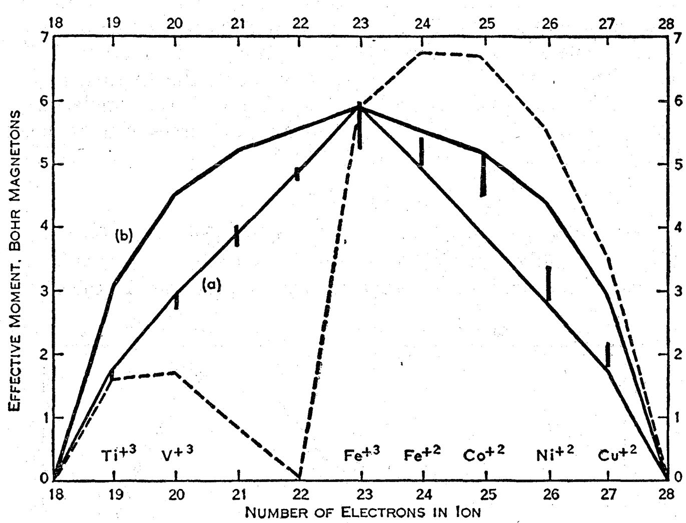


FIG. 62

Effective moment of ions of iron group of elements, plotted against number of electrons in ion. Vertical lines indicate range of observed values, connecting lines theoretical values based on different assumptions responsible for the paramagnetism has a capacity of 10 instead of 14 electrons.

In calculating the moments from quantum theory the method used for the rare earths is not at all successful, as shown by the broken line of fig. 62. Results of calculations made with other assumptions are shown by the solid lines (a) and (b), and it is seen that the observed values lie between these curves. E. C. Stoner has indicated the reason for this. The shell responsible for the moment is the outermost shell of the ion and so is subject to the influence of surrounding ions. These affect the orbital motions in a way difficult to calculate, but if the effect is severe only the spin moments will be influenced by the magnetic field and curve (a) results. On the other hand if the interaction between neighbouring ions is weak, the orbital motions will be affected and curve (b) is calculated; the further assumption is here made, that the energy of thermal agitation is capable of changing the distribution of electron spins in the unfilled shell, an assumption consistent with known facts concerning the structures of these ions. When the influence of surrounding ions on the unfilled shell is moderate, the actual ionic moments may be expected to lie between the two theoretical limits, as in fact they do.

Paramagnetism at Low Temperatures.—At ordinary temperatures the Langevin equation may be represented with sufficient accuracy by the first term of the series expansion, as noted above. However, at low temperatures and in strong fields $\mu_M H/kT$ may be so large that the complete equation, or its quantum equivalent, must be used. Under these conditions the susceptibility is no longer independent of the field strength, and the magnetic moment of the material approaches a limiting

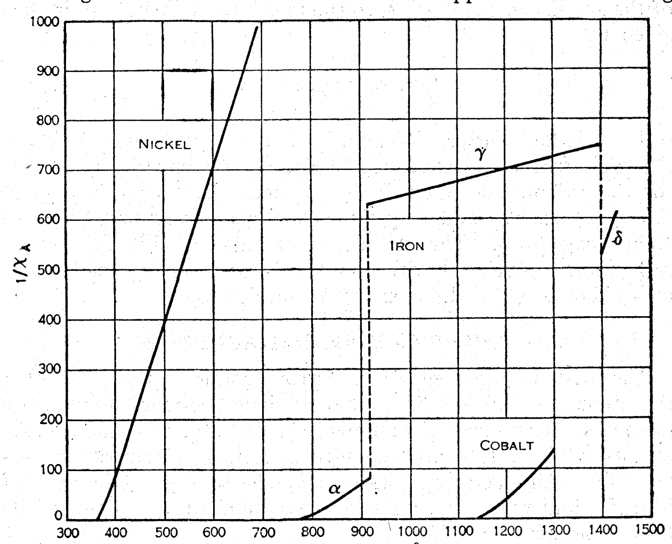


FIG. 63

Reciprocal of atomic susceptibility, χ_A, of iron, cobalt and nickel above their Curie points (P. Weiss and G. Foex)

value corresponding to alignment of the molecular magnets parallel to the field.

The first experimental test of this phenomenon was carried out at temperatures down to 1.3° K. and field strengths up to 22,000 oersteds, and the results confirmed the theory in a satisfactory manner. A slightly different relation was predicted by quantum theory, and this agrees with experiment entirely within the limits of accuracy of the experiments.

The magnetic behaviour of certain paramagnetic salts is important in the attainment of very low temperatures. A temperature just 0.004 degree above absolute zero was attained by W. S. de Haas and E. C. Wiersma in 1935.[1]

Paramagnetic Gases.—Most monotomic gases, such as those in the eighth column of the periodic table, are diamagnetic because they have complete electron shells and, therefore, no residual magnetic moments. Metal vapours, however, have

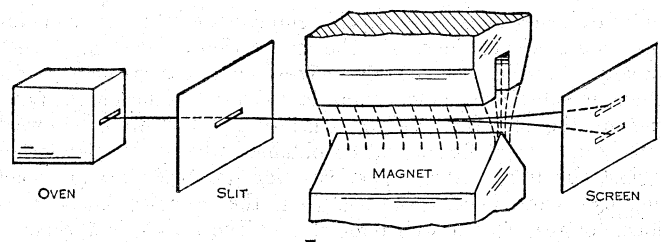


FIG. 64

Diagram of Stern-Gerlach experiment for determining magnetic moments of gaseous atoms (e.g., sodium). Beam of vapourized metal is split by strong inhomogeneous magnetic field

monatomic molecules in which the single electron in the outer shell should give rise to paramagnetism. Measurements on such vapours are difficult, but potassium and thallium are reported to be paramagnetic and the former obeys Curie's law over a limited range of temperatures and has a susceptibility, according to the rather inaccurate measurements, corresponding to a single uncompensated electron ($\chi_M = 1.06/T$).

Molecules containing more than one atom are generally diamagnetic because they contain an even number of electrons whose moments neutralize each other. There are two well-known exceptions to this rule, oxygen (O_2) and nitric oxide (NO). The former has an even number of electrons that remain uncompensated in a way not understood, the latter has an odd number of electrons. The paramagnetism of many other "odd" molecules has been studied to a lesser extent.

Oxygen follows Curie's law ($C_M = 1.00$) except at high pressures when the Curie-Weiss law is obeyed, with the constant θ small and negative. Liquid oxygen also follows the Curie-Weiss law, and the susceptibility increases with decreasing temperature through the solidification point.

The molecular susceptibility of nitric oxide has been measured from 20 to −160° C. (below its normal boiling point) and the effective Bohr magneton number, μ_{eff}, found to vary by about 15% over this range of temperature. Accurate calculation of μ_{eff} and its variation with temperature has been carried out by Van Vleck, who based his work on the electronic structure derived from spectroscopic data. The close agreement found between calculated and observed values is a tribute to the adequacy of the theory.

Paramagnetism of Free Electrons.—The weak temperature-independent paramagnetism of many of the metals (figs. 56 and 57) was inexplicable on the Langevin theory, according to which all paramagnetism should decrease with increase in temperature. According to modern theory the conduction electrons of a metal have spin moments that can be oriented slightly by a magnetic field. In the simplest case with one free electron per atom, quantum theory predicts an atomic susceptibility of $1.88 \times 10^{-6} (A/d)^{2/3}$, where A is the atomic weight and d the density in $g/cm.^3$. There is also a smaller diamagnetism predicted by quantum theory, equal to one-third the paramagnetic contribution when the electrons are free.

In actual metals the electrons are not wholly free but are partially bound to the atoms, and are influenced by the so-called correlation and exchange forces, quantum mechanical in nature. Also, the ionic core of the atom has an important diamagnetic contribution to the susceptibility. These various components have been calculated for sodium, and when summed they come within about 10% of the observed susceptibility. For other elements the calculations are less satisfactory.

The paramagnetic contributions of the electrons will vary with the nature of the metal, and the diamagnetism of the ionic cores will be different for different atoms, and it is easy to see qualitatively that these and other factors will cause some metals to be weakly paramagnetic, others weakly diamagnetic. The order of magnitude of the susceptibility is explained by theory; more exact calculations must await further quantitative development of atomic theory.

Ferromagnetic Materials Above the Curie Point.—All materials that exhibit ferromagnetism are paramagnetic when

[1] W. S. de Haas and E. C. Wiersma, *Physica* 2: 335 (1935).

they are heated above the Curie temperature. As the temperature continues to increase, the susceptibility decreases continually according to the Curie-Weiss law for strongly paramagnetic substances, unless there is a change in the phase structure of the material. If the Curie-Weiss law were followed exactly, a straight line would be obtained when $1/\chi_A$ is plotted against the temperature. The data for iron, cobalt and nickel (fig. 63) show some variations from the expected linear relations, for reasons not well understood. The breaks in the curve for iron are caused by changes in its crystal structure at these temperatures.

One should be able to calculate from the slope of each of these lines the magnetic moment per atom, and compare this with the moment calculated from the saturation magnetization determined at lower temperatures when the material is ferromagnetic. For nickel the ferromagnetic moment is 0.61 Bohr magnetons per atom, and the moment calculated from the Curie constant is 1.6 in the same units. Similar discrepancies occur for iron and cobalt. These results show that there is not an integral number of electron spins per atom, therefore the atoms will not all have the same moment at any instant. This means that the calculation of magnetic moment from the Curie constant cannot properly be made by the relation used. Modifications of the theory are necessary.

Molecular Beams.—According to the quantum theory, the magnetic moment of a molecule may have only a limited number of orientations with respect to the direction of a magnetic field in which it is placed. A direct test of this was made successfully by O. Stern and W. Gerlach in 1921. In this experiment silver atoms, issuing from an oven containing melted silver (fig. 64), are formed into a beam by using small slits, and then pass into the nonuniform field of an electromagnet. In the field the atoms are oriented so that the magnetic moment of each is either parallel or antiparallel to the direction of the field. Those oriented parallel to the field are deflected in the direction of the stronger field by a force proportional to the gradient (downward in the diagram), those oriented in the opposite direction are deflected toward the weaker field (upward). Thus the beam is split into two components, as detected by the image formed on the screen, and from the separation of the images the atomic moment can be estimated. It is necessary to know the velocity of the beam (calculated from the temperature of the oven) and the gradient of the field (about 200,000 oersteds/cm. in some experiments).

Later experiments, designed for more precise determination of the atomic moment, show that for the alkali metals and Cu, Ag and Au the moment has the theoretical value of one Bohr magneton, within the experimental error of about 1%. The elements Zn, Cd, Hg, Sn, Pb, etc., have zero atomic moment, as expected, because the two electrons in the outer shell are mutually compensating. Other elements, *e.g.,* thallium, are found to have the nonintegral number of Bohr magnetons derived by quantum theory from spectroscopic data.

Nuclear Moments.—The nucleus of an atom may itself have a magnetic moment. This is always much smaller than a Bohr magneton, and is detected most readily when the outer electronic structure is balanced magnetically so that its net moment is zero. Nuclear moments do not have any important influence on the magnetic properties of materials, but they are very important for our knowledge of nuclear structure, and techniques for their determination have been developed almost continually after 1931. Here the particular method known as "radio-frequency spectroscopy," used first by I. I. Rabi in 1939, will be outlined briefly.

As in other experiments a molecular beam is provided and defined by slits as shown in fig. 65. When the molecules enter the field, the vector representing the magnetic moment precesses around the direction of the field. Molecules are deflected downward by the field gradient produced by magnet *A,* and upward by the gradient of magnet *B,* and arrive at the point *D* where they are detected by a suitable device. Molecules of different velocities are focused at the same point after traversing other paths, provided no change occurs in the magnetic moment along the path.

A change in the vertical component of the moment is produced in the uniform field, *H,* of magnet *C* by superposing upon the field a rather weak alternating field, of frequency, *f,* produced

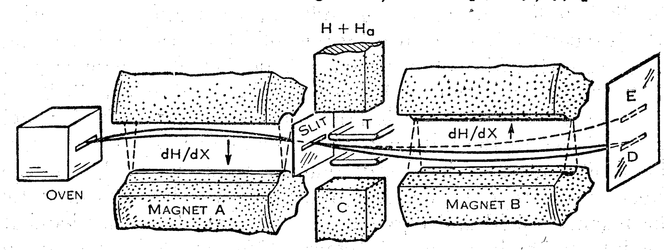


FIG. 65

Rabi method of determining nuclear moments by "radio frequency spectroscopy." Beam of atoms is bent by magnets as shown, is also acted upon by high frequency field generated in copper tubes T

by current in the copper tubes, **T**. The disturbing action of this field may best be explained by analogy with a spinning top precessing about a vertical axis under the influence of gravity. If a disturbing force is produced, as by oscillating the point of support, the top will become unstable provided the frequency of oscillation is equal to the frequency of precession. In the case of the molecules, instability is produced when their frequency of precession (proportional to the field strength *H*) and the frequency of oscillation of the weaker field are equal, and unstable molecules then deviate from their previous paths as indicated by the dotted line *E. H* is varied slowly until the number of molecules arriving at *D* is a minimum, and *H* and *f* noted. The ratio of the angular momentum, *J,* to the magnetic moment, μ, is then given by

$$\frac{\mu}{J} = 0.001312\, f/H.$$

The method derives its name from the fact that *f* lies in the radio-frequency range, *e.g.,* $f = 5{,}585$ megacycles per second for the Li^7 nucleus when $H = 3{,}420$ oersteds. For this nucleus $J = (3/2)\ (h/2\pi)$ and $\mu = 3.25$ nuclear magnetons or 3.25/1,840 Bohr magnetons. The nuclear moments of Li^7 atoms are rather large compared with those of other nuclei, but each is only about 0.2% of the moment of an electron.

13. THEORY OF FERROMAGNETISM

The first requirement of a ferromagnetic material is that the atoms, of which it is composed, have permanent magnetic moments. The magnetic moment of an atom is due to the electrons which it contains, since the nuclear contribution is negligible. An electron possesses a magnetic moment because of its spin, and may have an additional moment by virtue of its orbital motion.

A second requirement of ferromagnetism is the existence of some kind of interatomic force that maintains the magnetic moments of many atoms parallel to each other. Without such forces the atoms would be disordered by thermal agitation and the moments of neighbouring atoms would neutralize each other, and the large magnetic moment characteristic of ferromagnetic material would not exist.

Our knowledge of these interatomic forces and of the structure of the atom now permits a general description of the origin of ferromagnetism. The following steps in the theory may be enumerated: (1) the ultimate magnetic particle is the spinning electron, and a change in magnetization is fundamentally a change in the directions of spin of certain electrons, not to any appreciable extent to a change in their orbital motions; (2) in iron, cobalt and nickel the electrons responsible for ferromagnetism lie in the incomplete third shell of these atoms. In complete shells the electrons are arranged symmetrically so that the spins neutralize one another and the combined moment is zero; (3) in ferromagnetic materials the moments of neighbouring atoms are held parallel by strong quantum mechanical forces, whereas in the atoms of other substances the forces usually tend to make the moments of neighbouring atoms antiparallel and self-neutralizing. The circumstances under which these quantum forces effect parallel orientations and form ferromagnetic domains, or antiparallel orientations that lead to paramagnetism, will be discussed in the following paragraphs. Before considering these steps in modern theory in detail, however, it is appropriate to recall the earlier theories and their development.

Early Theories.—Sir James Ewing was one of the first to attempt to explain ferromagnetic phenomena in terms of the forces between atoms. He assumed with Weber that each atom was a permanent magnet free to turn in any direction about its centre. The interatomic forces holding neighbouring atoms parallel were assumed to be the usual magnetic forces known to act between large-scale bar magnets. The I, H curve and hysteresis loop were calculated for a linear group of such magnets and were determined experimentally using models having as many as 130 magnets arranged at the points of a plane square lattice. The calculations for a linear chain show that as the field is gradually increased in magnitude from zero there is at first a slow continuous rotation of all the magnets together, then sudden change in orientation and finally a further continuous rotation until the magnets lie parallel to the field. The I, H curves calculated for such a group of magnets resemble in general form the actual curves of iron: they show a permeability first increasing, then decreasing, and saturation and hysteresis.

G. S. Mahajani has calculated the magnetic potential energy of a group of magnets arranged in space in the same way that the iron atoms are arranged in a crystal. In agreement with Ewing's theory the magnets tend to be parallel, and some directions in the space-array are more stable or "preferred" than others. On the other hand our present knowledge of the structure of atoms and crystals makes it clear that such magnetic forces between atoms are not large enough to maintain the magnetic moments

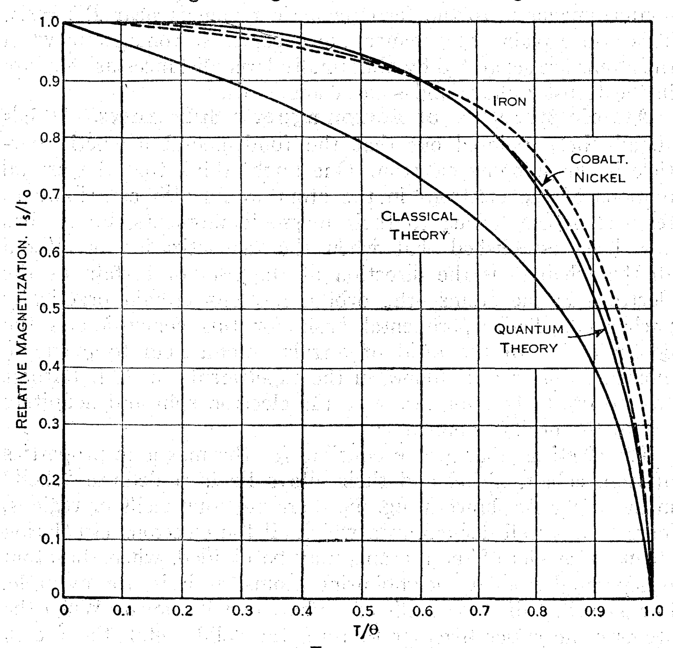


FIG. 66

Saturation magnetization as dependent on absolute temperature in relative units. Solid curves are theoretical, for classical (Weiss) and quantum theories

of neighbouring atoms parallel, as they must be if ferromagnetism is to exist. Such weak forces would be readily disturbed by the thermal motion of atoms at room temperature and even at temperatures a few degrees above absolute zero.

It is now well established that there are very powerful forces not contemplated when Ewing made his model and proposed his theory, which maintain the dipole moments of neighbouring atoms parallel. These are the electrostatic forces of "exchange" which will be discussed below in connection with the quantum theory.

Molecular Field Theory.—In order to understand how atomic forces give rise to ferromagnetism it is desirable to review briefly Weiss's theory of ferromagnetism, which introduces a

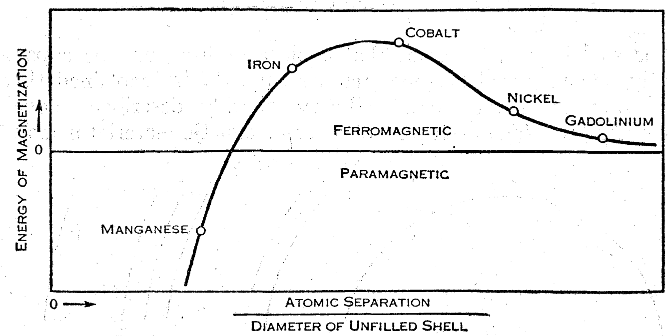


FIG. 67

Bethe's curve showing that ferromagnetic substances must have favourable ratio of distance between atoms to diameter of unfilled inner electron shell responsible for permanent moment

so-called "molecular field" that presently will be identified with the nature of these forces. Using an approach different from Ewing's, Weiss did not attempt to explain the nature of the interatomic forces but treated them empirically by assuming that they exerted a powerful effect that aided the applied field in lining up the atomic moments. This theory is an extension of Langevin's theory of a paramagnetic gas, which culminated in a formula relating the magnetization, I, to the field strength, H, and the temperature, T—the hyperbolic cotangent law,

$$\frac{I}{I_0} = \operatorname{ctnh} \frac{\mu_A H}{kT} - \frac{kT}{\mu_A H}$$

already referred to in the section on *Paramagnetism*. In deriving this, the assumptions are made that the elementary magnets, each of moment μ_A, are subject to thermal agitation and momentarily may have any orientation with respect to the direction of the field, and that they are too far apart to influence each other. Quantum theory alters the first of those assumptions by stating that in such an ensemble of elementary magnets (atoms) there will be only a limited number of possible orientations, in the simplest case only two, one parallel and the other antiparallel to the direction of the field. In this case the equation corresponding to Langevin's is

$$\frac{I}{I_0} = \tanh \frac{\mu_A H}{kT}.$$

Weiss assumed that there exists in a ferromagnetic material a "molecular field," proportional to the intensity of magnetization, that aids the magnetic field present. He therefore replaced the H of Langevin's equation by $H+NI$, calling N the molecular field constant. The resulting equation,

$$\frac{I}{I_0} = \tanh \frac{\mu_A(H+NI)}{kT},$$

is perhaps the most important in the theory of ferromagnetism. It indicates that even in zero field there is still a magnetization of considerable magnitude, provided the temperature is not too high. Putting $H=0$ and $\theta = \mu_A N I_0/k$, this equation reduces to

$$\frac{I}{I_0} = \tanh \frac{I/I_0}{T/\theta}.$$

This purports to specify the magnetization at zero applied field by a function that is the same for all materials, when the magnetization is expressed as a fraction of its value at absolute zero (I_0) and the temperature as a fraction of the Curie temperature on the absolute scale. This magnetization vs. temperature relation, plotted as the upper solid line of fig. 66, means that at all temperatures below θ the intensity of magnetization has a definite value even when no field is applied.

According to this conception the I of the last equation represents the magnetization of a domain, and is determined experimentally by measuring the magnetization of a specimen when all domains are parallel, *i.e.*, at saturation ($I=I_s$). This equation should then be written

$$\frac{I_s}{I_0}=\tanh\frac{I_s/I_0}{T/\theta}.$$

It is well known, however, that a piece of iron may be apparently unmagnetized at room temperature. Weiss explained this by formulating the domain theory, already described above, according to which each part of a ferromagnetic material is mag-

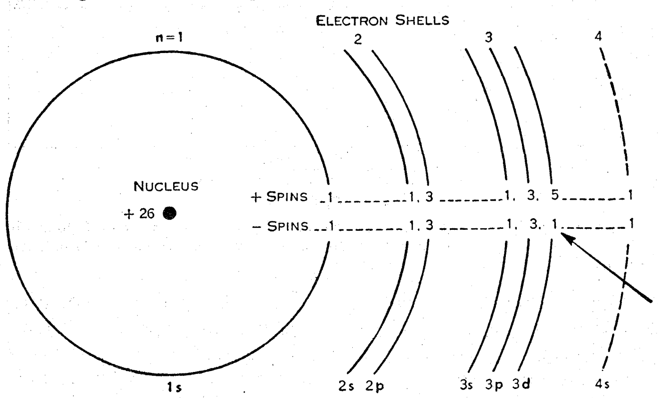


FIG. 68

Electron shells in an iron atom, showing location of inner unfilled shell (3d) responsible for magnetic moment. Electrons of outer shell (4s) of isolated atom become "free" electrons of metal

netized to saturation, the magnetic moments of the separate parts being oriented in different directions so that the over-all effect is zero.

These relations are also important for ferromagnetic materials above the Curie point, when they are paramagnetic. Then I is small compared to I_0 and we may write

$$\frac{I}{I_0}=\frac{\mu_A(H+NI)}{kT}.$$

If we put $\theta=\mu_A NI_0/k$ as before, and $C=I_0\mu_A/k$, this becomes

$$I=\frac{CH}{T-\theta},$$

the Curie-Weiss law. Thus θ is explained by the existence of the molecular field, NI, that aids the applied field, H, in orienting the elementary magnets. However, as pointed out above, the fact that a paramagnetic substance follows this law does not mean necessarily that it will become ferromagnetic at temperatures below $T=\theta$.

Quantum Theory.—The nature of the molecular field was unknown to Weiss when he developed his theory; he knew only that its power in orienting the elementary magnets was equal to that of a magnetic field of millions of oersteds (in iron, NI is as high as 7×10^6 oersteds). A rational explanation of this was first proposed in 1928 by W. Heisenberg who showed that it can be explained in terms of the quantum mechanical forces of exchange (*see* QUANTUM MECHANICS) acting between electrons in neighbouring atoms. Imagine two atoms some distance apart, each atom having a magnetic moment of one Bohr magneton due to the spin moment of one electron. A force of interaction, the exchange force already referred to, has been shown to exist between them in addition to the better-known electrostatic and (much weaker) magnetic forces. It is known that such quantum forces are negligible, as one would expect, when the atoms are

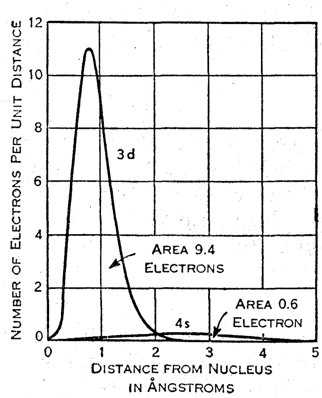


FIG. 69

Distribution of electrons in 3d and 4s shells of iron

two or three times as far apart as they are in crystals. It is supposed also, on the basis of discussions by H. Bethe, and by J. C. Slater, that as two atoms are brought near to each other from a distance, these forces at first cause the electron spins in the two atoms to become parallel (positive interaction). As the atoms are brought nearer the spin moments are held parallel more firmly until at a certain distance the force diminishes and then becomes zero, and with still closer approach the spins set themselves antiparallel with relatively strong forces (negative interaction). In the curve of fig. 67 the energies corresponding to these forces, as estimated by Bethe, are shown as a function of the distances between atoms.

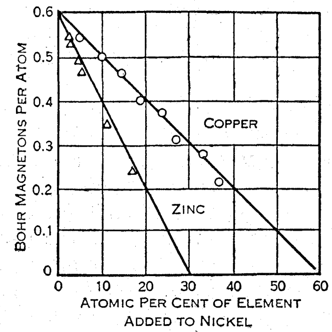


FIG. 70

Reduction in magnetic moment per atom of nickel, caused by adding copper (with one extra electron per atom) or zinc (two per atom). Extra electrons go into unfilled shell and therefore decrease its moment

Bethe's curve was drawn originally for atoms with definite shell radii and varying distances from atom to atom. It may equally well be used for a series of elements if we take account of the different radii of the shell in which the magnetic moment resides. The criterion of interaction for the metals of the iron group is the radius, R, of the atom (half the internuclear distance in the crystal) divided by the radius, r, of the 3d shell, in which the magnetic moment resides. In fig. 67 this ratio R/r has been used as abscissa and the elements iron, cobalt and nickel have been given appropriate positions on the curve. Slater has shown that the ratio R/r is larger in the ferromagnetic elements than in other elements having incomplete inner shells, and that the point at which the curve crosses from the nonferromagnetic to the ferromagnetic region is near $R/r=1.5$. This also explains why manganese becomes ferromagnetic when the atoms are separated by abnormally large distances as they are in the Heusler alloys and some compounds.

Atomic Structure of Ferromagnetic Substances.—It has already been pointed out that the fundamental magnetic particle is the spinning electron. One might think that the orbital motions of the electrons in the atom would also contribute to ferromagnetism, owing to their magnetic moments, but it has now been established that when the magnetization is altered all that changes is the direction of the spin of certain of the electrons in the atoms—the orbital motions remain practically unchanged. The experimental basis for this conclusion is the determination of the ratio of angular momentum to magnetic moment; this ratio is found, in the experiments of S. J. Barnett and others, to be appropriate to the electron spin and definitely not to the orbital moment.

The electrons that are responsible for the magnetic properties of iron, cobalt, nickel and their alloys lie in a definite "shell" in the atom. As shown in fig. 68, there are four shells or regions, more or less well defined, into which all the electrons circulating about the nuclei of these atoms may be divided, when the atom is separated from its neighbouring atoms, as it is, for example, in a gas. Two of these shells are subdivided as shown. When the atoms come closer together to form the solid metal, the fourth or outermost shell of each becomes disrupted, and the two electrons which comprised it wander easily from atom to atom and are the "free" electrons responsible for electrical conduction. The electrons in the outer part of the third shell are those responsible for the ferromagnetic moment. Some of these electrons spin in one direction and some in the opposite, as indicated, so that their magnetic moments neutralize each other partially but not wholly, and the excess of those spinning in one direction (+) over those spinning in the other (−) causes each atom as a whole to behave as a small permanent magnet.

The average moment of the atom in a ferromagnetic material may be determined from the saturation magnetization, I_0, at the absolute zero of temperature by dividing I_0 by the number of atoms in a cubic centimetre. Expressed in Bohr magnetons, β, the average or "effective" atomic moment is

$$\mu_{eff} = \frac{I_0 A}{N \beta d}$$

A being the atomic weight, N Avogadro's number and d density. Moments of iron, cobalt and nickel atoms, so calculated, are

Fe	2.22 Bohr magnetons
Co	1.70
Ni	0.61

The meaning of these nonintegral values may be discussed in either of two different ways used for many problems of the solid state. In the Heisenberg method of approach the atoms have their own electrons (some atoms necessarily more than others), and the disturbing effect of the interaction between neighbours is estimated as well as possible. The other approach, followed by F. Bloch, E. C. Stoner and others, is to consider the metal as composed initially of ions and free electrons, and to calculate the way in which the ionic fields modify the behaviour of the electrons, making them less free. According to the latter or "collective electron" description both the 3d and 4s shells of iron, cobalt and nickel atoms are incomplete and there is a distribution of electrons between them determined by the specific nature of the atomic fields. The calculations indicate that in iron the electrons in these shells are distributed (on the average) about the nuclei as indicated in fig. 69. The 3d shell is a rather dense ring of electrons, as contrasted with the 4s shell which extends farther from the nucleus, so far that in the solid the shells of neighbouring atoms overlap considerably.

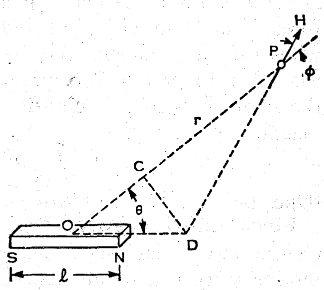


FIG. 71

Field produced at any point P by presence of bar magnet NS depends on distance r and angle θ

The above description of electron distributions in their relation to ferromagnetism is supported beautifully by experiments on the alloying of nickel with copper, zinc and other elements. The substitution of one copper for one nickel atom in the lattice is equivalent to adding one electron to the alloy. This electron seeks the place of lowest energy in the alloy and finds it in the 3d—shell of a nickel atom rather than in the copper atom to which it originally belonged. This lowers the magnetic saturation of the alloy by one Bohr unit, since the added electron in the 3d— shell just neutralizes the moment of one in the 3d+ shell. Addition of more copper to nickel decreases the average moment until the empty spaces in the 3d— shell are just full; this should occur when 60% of the atoms are copper, and then the magnetic saturation at 0° K. should be just zero. The theory is well confirmed by the data (fig. 70). When divalent zinc, having two available electrons per atom, is added to nickel the 3d shell is filled twice as fast as when monovalent copper is added, again in accordance with theory, and metals of higher valences behave accordingly.

14. MEASUREMENT OF MAGNETIC QUANTITIES

BASIC RELATIONS

As a prelude to a discussion of the production and measurement of magnetic fields, and the measurement of magnetization, it is desirable to consider quantitatively the fields and forces excited by currents and magnets. These may be discussed according to the following list:

(1) the fields produced by magnets; (2) the fields produced by currents; (3) the force on a magnet in a field; (4) the force on a current in a field; (5) the electromotive forces produced in coils by changes in induction within them. It is on these relations that most of the measurements of induction and field strength are based.

Field of a Magnet.—Consider a bar magnet NS (fig. 71) of pole strength m and interpolar distance l and therefore magnetic moment $M = lm$. Using the fundamental relation according to which the field strength varies inversely as the square of the distance, d, from a pole,[1]

$$H = m/d^2, \qquad (1)$$

and adding vectorially the fields produced by both poles it may be shown that the field strength at distant r from the centre of the magnet is given by

$$H = (M/r^3)\sqrt{1+3\cos^2\theta}$$

provided r is large compared with l. Here θ is the angle between the axis SN of the magnet and the line OP drawn from its centre to the point, P, at which the field is observed. The direction of the field at this point is defined by φ, the angle it makes with OP prolonged, and is determined by

$$2 \tan \varphi = \tan \theta.$$

A graphical construction based on this relation may be made easily by trisecting OP so that $OC = 2\ CP$, drawing CD at right angles to OP to cut SN produced at D. Then DP is the direction of the field at P. Here, as elsewhere in this article, H is expressed in oersteds, B in gausses, dimensions in centimetres, forces in dynes and currents in amperes.

Important special cases are the end-on position (first Gaussian position) for $\theta = 0$, and the broadside position (second Gaussian) for $\theta = 90°$. For these the fields are respectively

$$H_1 = (2M/r^3)(1 + l^2/2r^2),$$
$$H_2 = (M/r^3)(1 - 3l^2/4r^2).$$

When two magnets are placed very close together end-to-end, with opposite poles m_1 and m_2 separated by a distance, d, small compared with the extent of the surfaces, the two magnets are attracted with a force that may be very strong. For each portion of one of the nearby surfaces the corresponding part of the other has an attraction given by the fundamental relation

$$f = \frac{m_1 m_2}{d^2}.$$

Summing for the effect of all parts of one surface on all parts of the other one can obtain

$$f = AH^2/8\pi$$

proportional to the pole area, A, but independent of the distance between as long as this is small.

Fields Produced by Currents.—The simplest way of producing a magnetic field of known strength and direction is by the use of a long coil or solenoid of wire. The field is parallel to the axis of the coil, and when a current of i amperes flows in the windings (having n turns per cm.) the field strength within the coil is

$$H = 4\pi n i/10. \qquad (2)$$

When many layers of wire are used in a solenoid that is not very long in comparison with its diameter, the field strength varies with the position, and can be calculated with the help of the appropriate formula.[2]

When a field is produced by the current in a long straight wire of radius a, the direction of the field is everywhere at right angles to the wire axis, and at distance x from the axis the field strength is

$$H = \frac{2i}{10x}$$

outside the wire, while inside it the field strength is

$$H = \frac{2ix}{10a^2}$$

To create a relatively uniform field in a large volume Hermann Helmholtz proposed the arrangement of two thin circular

[1]This relation applies exactly when the magnet is surrounded by a vacuum; when the surrounding medium is air a very small modification may be necessary. In general, when surrounded by a medium of permeability μ the law is $H = m/\mu d^2$.

[2]G. C. Foster and A. W. Porter, *Electricity and Magnetism*, 3rd ed., p. 364 (London, 1913).

coaxial coils of diameter $2a$ and axial separation a. At the centre of symmetry, O, the field strength is

$$H = 0.899\, Ni/a.$$

N is the total number of turns of wire in each coil.

Other forms of coils may be used, and the strength and direction of the field calculated by summing the fields due to each current element. The magnitude of the field dH caused by a

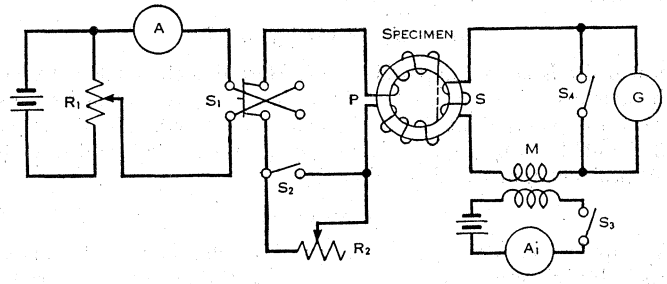


FIG. 72

Diagram of method of measurement of B and H in ring specimen. Current in primary winding P is controlled by resistances R_1 and R_2 and switches S_1 and S_2, and is read on Meter A. Secondary winding S is connected through mutual inductance M to ballistic galvanometer G. A_1 and S_3 are used for calibration

current i flowing in an element of wire dl cm. long, at a point r cm. from the current, is given by the equation

$$dH = (i/10r^2)\ dl\ \sin\theta$$

θ being the angle between the direction of the current and that of the line, r, connecting dl to the point. The direction of the field is at right angles to both the current and r.

Force on Magnet in Field.—The force on a single magnetic pole of strength m in a field of strength H is

$$f = Hm$$

dynes acting parallel to the field. In a uniform field a magnet of moment M' is acted on by a torque tending to turn the magnet upon an axis at right angles to its length and to the field so that it will lie parallel to the field. The magnitude of this torque is

$$L = M'H \sin\alpha$$

where α is the angle between the field and the length of the magnet. If the field is produced at P by a magnet of moment M placed at O (fig. 71), the torque acting on M' is

$$L = MM'\sqrt{1+3\cos^2\theta}(\sin\alpha)/r^3.$$

If a pivoted magnet is suspended in a field it will have a natural period of oscillation equal to

$$T = 2\pi\sqrt{K/MH}$$

seconds, if K is the moment of inertia about its point of suspension. If an additional known moment of inertia, k, is added to that already present, without changing the magnet moment, and this increases the period to T_1, the expression

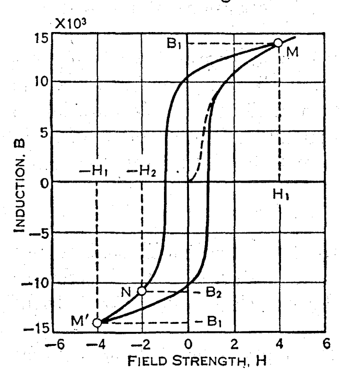


FIG. 73

Hysteresis loop illustrating ballistic method of measurement of B. When field strength is changed from H_1 to $-H_1$, B changes from B_1 to $-B_1$, and galvanometer deflection measures this change in B

$$MH = 4\pi^2k/(T_1^2 - T^2)$$

can be used to determine either H or M provided the other is known.

In a nonuniform field a magnet will experience a translational force as well as a torque, because the force pulling one pole parallel to the field will be opposed by a larger force caused by a larger field acting on the other pole. If the gradient of the field is dH/dx, the force on a magnet of moment M is

$$f = MdH/dx.$$

When the moment is induced by the field and is therefore

$$M = Iv = \kappa Hv,$$

the force acting on the volume, v, is

$$f = \kappa vHdH/dx. \qquad (3)$$

Force on Current in Field.—When a current i flows in an element of wire of length dl in a field of strength H, a force acts on the wire of magnitude

$$f = Hidl(\sin\theta)/10. \qquad (4)$$

Here θ is the angle between dl and H, and the direction of the force is at right angles to both. In two long parallel straight wires carrying currents the field of each acts on the current in the other to produce an attractive force if the currents are in the same direction, a repulsive force if they are antiparallel, of magnitude

$$f = 2ii'/(100a)$$

dynes per cm. length of wire.

Electromotive Force Due to Changing Flux.—When an electric circuit encloses a changing magnetic flux, φ an electromotive force is generated in the circuit, proportional to the time rate of change of flux, $d\varphi/dt$, and to the number of times, N, the circuit threads the flux. Thus if N turns of wire are wrapped around a piece of iron of cross-sectional area A, and a change in the induction, B, is produced in the iron, a voltage is produced at the ends of the wire equal to $10^{-8}\,NA$ times the rate of

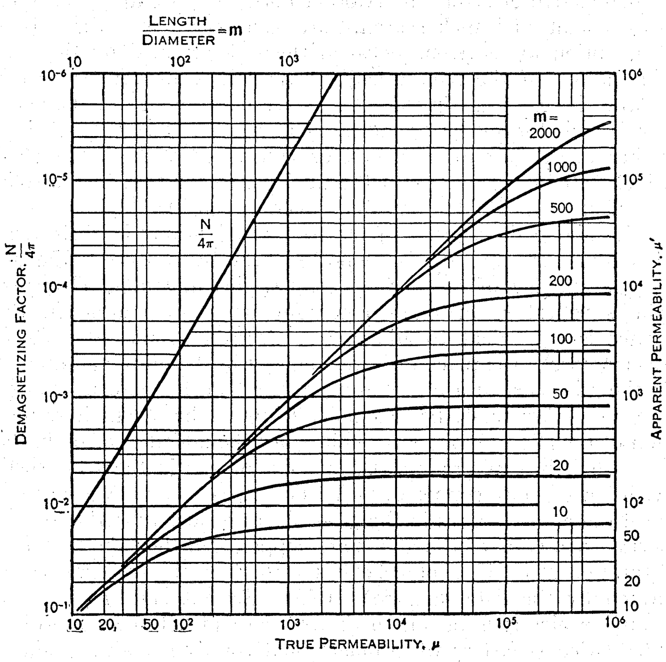


FIG. 74

Chart for converting apparent to true permeability, μ' to μ, of cylinders of given ratio m of length to diameter. Also demagnetizing factors, $N/4\pi$

change of induction in gausses per second:

$$E = 10^{-8}\,NA\,dB/dt.$$

The total change in B that has occurred in a specified time may be evaluated by integrating this equation with the result

$$B = 10^8 \textstyle\int E\,dt/NA. \qquad (5)$$

COMMON METHODS

Ballistic Method with Ring.—In determining magnetization curves and hysteresis loops the ballistic method, employing a ring specimen, is generally the most satisfactory. H. A. Rowland used this method in 1873, and was the first to express the results of measurement in an absolute system. A ring is cut with a radial thickness small compared with its diameter and two windings of wire are applied (fig. 72); a secondary winding (S), usually consisting of many turns of fine wire, is wound close to the specimen and connected to a ballistic galvanometer or fluxmeter (G), and a primary winding (P) of turns evenly spaced

TABLE V.—*Demagnetizing factors, $N/4\pi$, for rods and ellipsoids magnetized parallel to long axis*

Dimensional Ratio (length/diameter)	Rod	Prolate Ellipsoid	Oblate Ellipsoid
0	1.0	1.0	1.0
1	.27	.3333	.3333
2	.14	.1735	.2364
5	.040	.0558	.1248
10	.0172	.0203	.0696
20	.00617	.00675	.0369
50	.00129	.00144	.01472
100	.00036	.000430	.00776
200	.000090	.000125	.00390
500	.000014	.0000236	.001567
1,000	.0000036	.0000066	.000784
2,000	.0000009	.0000019	.000392

is applied and connected to a current source. In the primary circuit means are provided for adjusting the current and for changing it rapidly from one value to another in the same or opposite direction. In the secondary circuit a mutual inductance (M) with an air core is provided for calibration and a switch for short circuiting the galvanometer. The field strength, H, is calculated according to Eq. (2) from the number of turns and the dimensions of the coil and the current indicated by the ammeter (A).

When H is changed suddenly from one value to another the resulting change in B induces a voltage in the coil S and causes a deflection of the galvanometer that is proportional to the change in B, according to Eq. (5) above (the ballistic galvanometer has a deflection proportional to $\int E dt$ provided the voltage impulse occurs in an interval of time short compared with the natural period of oscillation of the galvanometer coil and mirror). Since ballistic measurements always involve differences one must start with a known value of B. The most common procedure for accomplishing this is first to reduce the magnetization to zero, or demagnetize the core, by subjecting it to an alternating field of high strength and gradually reducing the amplitude to zero. To determine a point such as M in fig. 73, current corresponding to H_1 is applied and reversed several times with the galvanometer short-circuited, to establish a steady cyclic state, and then the galvanometer is connected in and the

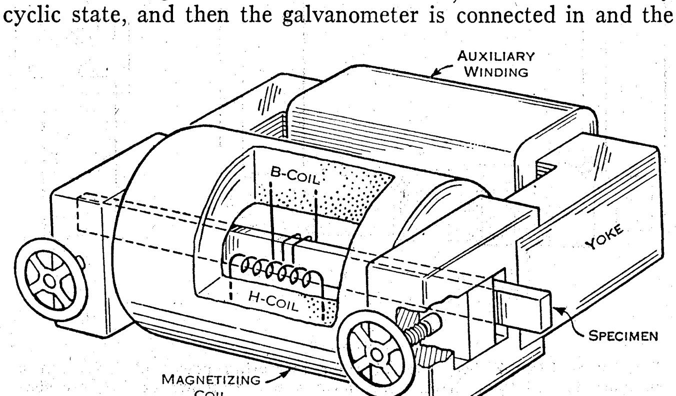


FIG. 75

Simple yoke method of compensating demagnetizing effect of ends of short specimen

deflection for reversal of H_1 noted. This deflection then corresponds to a change in B of $2B_1$, and B_1 can easily be calculated from the constant obtained by calibration. The point M on the normal magnetization curve is thus established and other points on the curve are determined similarly.

To determine a point, N, on a hysteresis loop the field is alternated several times between the points of the loop (*e.g.*, MM'), then H_1 is changed suddenly to $-H_2$ and the deflection noted and the corresponding change in B is subtracted from B_1, already determined, to give the value of $-B_2$ at N. By varying H_2, a sufficient number of points on the whole loop can be obtained.

The ring specimen is not adapted to rapid testing, for some time is consumed in machining the ring and in winding it with wire. However, several methods are available for the rapid application of turns. Stiff wires may be held in fixed positions and arranged so that the ring will slip over many of them at once, the wires being connected together by a plug-and-socket arrangement or with mercury contacts to make a single circuit. Also, toroidal winding machines are made that apply more than 25 turns a second to a closed ring.

Ordinarily the ballistic galvanometer and ring specimen are used for fields of intermediate strength. When the field strength is high, *e.g.*, 1,000 oersteds, the number of turns in the primary winding, or the current through it, must be large and the consequent heat generated interferes with the measurements. If the field strength is too low many turns must be wound on the secondary in order to obtain a sufficiently large galvanometer deflection, and this process is tedious and under some circumstances there may not be enough space available inside the ring. In very low fields A.C. methods should be considered.

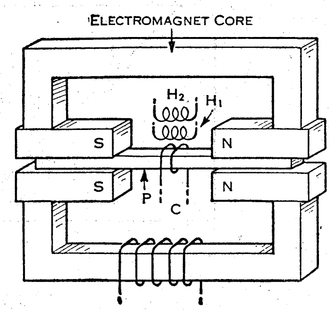


FIG. 76

Permeammeter for measuring B and H in strong fields. Yoke is core of powerful electromagnet having poles NS adjacent to specimen P. Field is measured with similar coils H_1 and H_2, and induction with search coil C

Rod Specimens; Demagnetizing Factors.—The ballistic method may be used with a straight specimen in the form of a rod, this being magnetized with the same procedure as that used for a ring. The specimen may easily be slipped into a long solenoid previously prepared, and the secondary winding or search coil should be placed around a small central portion of the specimen. Under these circumstances the more difficult quantity to determine is the field strength, because the field created by the solenoid will be disturbed by the magnetic poles of the specimen. The field created by the specimen itself is called the demagnetizing field, ΔH, and is proportional to the intensity of magnetization. It is usually specified by the demagnetizing factor, N, which depends on the ratio length/diameter of the rod:

$$\Delta H = NI.$$

The field acting on the middle of the rod is then the resultant of the field in the solenoid, H_0, and the demagnetizing field, ΔH, and (when I is replaced by $(B-H)/4\pi$) is

$$H = H_0 - \frac{N}{4\pi}(B-H).$$

Values of $N/4\pi$ have been determined by a number of experiments and selected values are given in Table V.

The term apparent permeability, μ', is often applied to the ratio B/H_0, and its relation to the (true) permeability, μ, can be derived from the above equation:

$$1/\mu = 1/\mu' - N/4\pi$$

by considering $N/4\pi$ to be negligibly small compared with one. The relation between μ and μ' for rods of various dimensional ratios m = length/diameter is shown graphically[1] in fig. 74. It is apparent that rods having dimensional ratios as large as 1,000 must be used to determine accurately the value of the permeability when it is more than 100,000.

In rods the induction varies from place to place in the bar, decreasing from the middle toward the ends. It is only when the specimen is in the form of an ellipsoid that the induction is uniform throughout. In specimens of such form the demagnetizing

[1] R. M. Bozorth and D. M. Chapin, *Jl. Appl. Physics*, 13:320–6 (1942).

factor may be calculated accurately from the lengths of the three axes of the ellipsoid, and the direction of the induction determined. Equations are given below for the two most useful cases: (1) the prolate ellipsoid having the major axis m times the two equal minor axes, and magnetized parallel to its major axis, and (2) the oblate ellipsoid or ellipsoidal disk having two

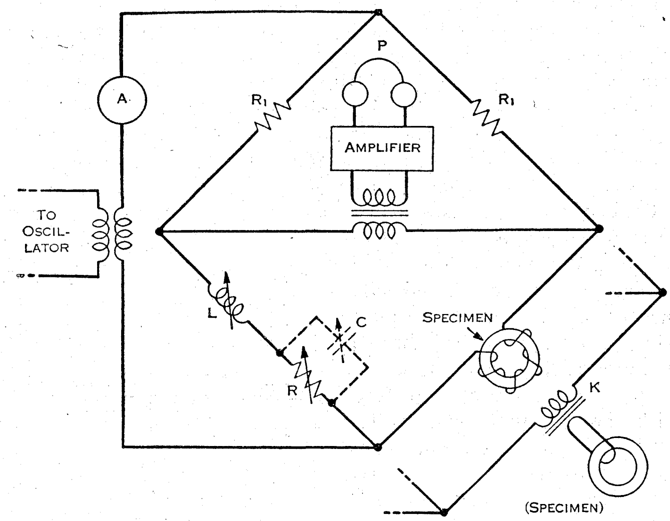


FIG. 77

Inductance bridge for measuring resistance and inductance of winding surrounding specimen. Alternatively, L may be omitted and a variable condenser, C, inserted in parallel with R. Specimen may be connected through transformer K having single turn secondary looped with specimen

long axes each m times the short axis, the specimen being magnetized parallel to a long axis.

$$\text{Prolate:}\quad \frac{N}{4\pi}=\frac{1}{m^2-1}\left[\frac{m}{\sqrt{m^2-1}}\log_e(m+\sqrt{m^2-1})-1\right],$$

$$\text{Oblate:}\quad \frac{N}{4\pi}=\frac{1}{2}\left[\frac{m^2}{(m^2-1)^{3/2}}\arcsin\frac{\sqrt{m^2-1}}{m}-\frac{1}{m^2-1}\right].$$

Values of $N/4\pi$ for various values of m are given in Table V.

Yokes and Permeameters.—When the specimen is in the form of a straight rod or tube or tape the demagnetizing field may be partially or completely annulled by connecting the two ends, outside the magnetizing solenoid, with magnetic material of high permeability and large cross-sectional area. Such a yoke may be used for specimens of high dimensional ratio, and measurements made with considerable accuracy.

More often, in the testing of permanent magnets or commercial materials in the form of bars or strips, it is desirable to use a yoke with a relatively short specimen and in this case the demagnetizing field must be taken into account or annulled in some way. One way[1] that has been satisfactorily used to accomplish both of these things is to measure the field with a ballistic galvanometer connected to a coil ("H-coil") of many turns placed in the magnetizing coil near the middle of the specimen but not surrounding it (fig. 75), and at the same time to magnetize the yoke with the current that passes through the magnetizing coil. The turns through which this current passes are adjusted to overcome the reluctance of the yoke and the air gaps that exist at each end of the specimen no matter how much care is taken to obtain good joints at these points. The search coil used in determining B is wound on the middle of the specimen as usual.

A further step toward increased accuracy was taken in the construction of the Burrows and the Niwa permeameters. These use auxiliary magnetizing and search coils to effect a uniform magnetization of the specimen by compensating for the air gaps that must be present. The induction is determined with a ballistic galvanometer.

Other methods of testing with a yoke have been proposed by F. P. Fahy and by A. Koepsel and these have been used extensively for routine testing of samples of standardized materials of moderate or low permeability. In the Fahy permeameter B and H are determined with the help of coils extending the full length of the specimen and connected to a galvanometer. An auxiliary magnetizing coil is used on the yoke. The Koepsel permeameter has the advantage of being a direct-reading instrument since it requires no galvanometer. To indicate the induction in the specimen a coil of wire is placed on a delicate bearing in an air gap in the yoke, and when a constant current is passed through this coil it deflects in accordance with Eq. (4) by an amount proportional to the field strength in the gap, which in turn depends on the flux in the specimen.

In determining the magnetic properties of materials in high fields, of the order of 300 to 10,000 or more, it is necessary to use some kind of an electromagnet (*q.v.*) to create the field. A modification[1] of the isthmus method used originally by J. A. Ewing and W. Low is shown in fig. 76. The heavy square yokes are wound with many turns of heavy wire, and when energized create a high field in the space between the pole faces, N and S. The specimen P is clamped between the pole pieces as indicated, and is surrounded by a search coil connected to a galvanometer for determining B. The field strength, H, is determined by measuring the change in the air flux in a coil placed near the specimen (H_1), and then in the same coil placed somewhat farther away (H_2). The field in this region varies approximately linearly with the distance from the surface of the specimen and its strength at the surface is obtained by extrapolation from the values H_1 and H_2. By making the core of the electromagnet of laminated material the magnetizing field can be changed quickly enough to make satisfactory ballistic measurements provided the period of the galvanometer is large. In investigations of properties in still higher fields, *e.g.*, 10,000 to 50,000, special methods have been used (*see* below).

Alternating Current Methods.—The principal uses of A.C. testing methods are for determining (1) permeability and energy

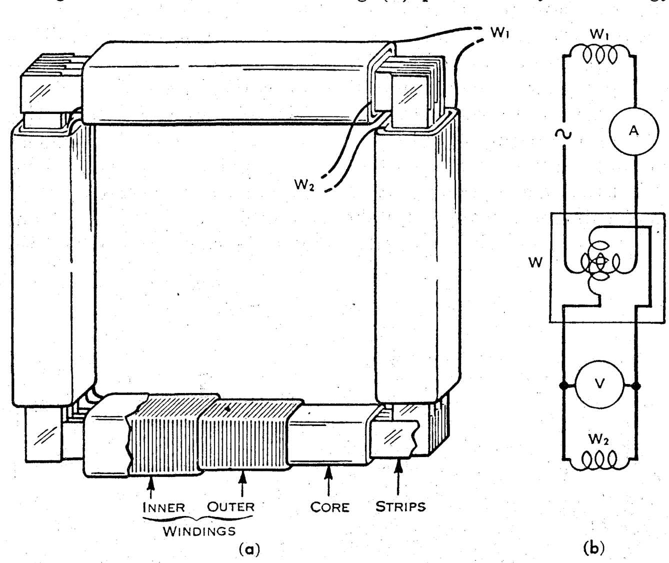


FIG. 78

Epstein, or Lloyd-Fisher, apparatus for measuring power dissipated in a specimen formed from strips. Coils, form wound as shown at (a), are connected as shown at (b) to voltmeter V and wattmeter W. Same coils are also used for ballistic measurements

losses of thin sheet at low inductions, usually not more than a few hundred gausses, using an inductance bridge, and (2) energy losses at high inductions, usually $B=15{,}000$, using the Epstein method.

A diagram of the inductance bridge is shown in fig. 77. Current of the desired frequency, f, is supplied by an oscillator and fed to opposite corners of the bridge through a transformer and a thermal ammeter, A. Two equal fixed resistances R_1 constitute

[1] B. J. Babbitt, *J. Opt. Soc. Am.*, 17:47–48 (1928); C. E. Webb and L. H. Fort, *Jl. Inst. El. Engrs.*, 67:1302–16 (1929).

[1] R. L. Sanford and E.G. Bennett, Bur. of Stand. *J. of Res.*, 10:567–73 (1933), 23:415–25 (1939); A. Neumann, *Zs. Techn. Phys.* 15:473–7 (1934).

two arms of the bridge, and in the others are the specimen, S, and variable inductance L and resistance R. When the bridge is balanced by adjusting L and R until no voltage is detected by the phones P or other instrument connected as shown through a transformer and amplifier, then L and R are equal to the inductance and A.C. resistance of the winding enclosing the specimen. The permeability can be calculated from L and the dimensions of the specimen, the field strength from the current through the core winding, and the energy loss in the specimen from the resistance R, correction being made for the losses in the copper wire. In another common modification of the Maxwell bridge the variable inductance L is removed and a variable condenser is connected in parallel with the variable resistor.

To save the application of many turns of wire to the specimen, necessary when low inductions are measured, G. E. Kelsall has used a device indicated schematically at K in fig. 77. Instead of connecting the windings of a specimen directly to one arm of the bridge, in the usual way, there is substituted a transformer having a many-turn primary and a single-turn secondary. This turn is wound on the specimen also, and the bridge is balanced as before. The core of the transformer is made of high quality laminated material and has low losses which, however, must be taken into account and subtracted from the bridge measurement to obtain the loss in the specimen. This instrument has been adapted for use at high temperatures as well as at ordinary temperatures.

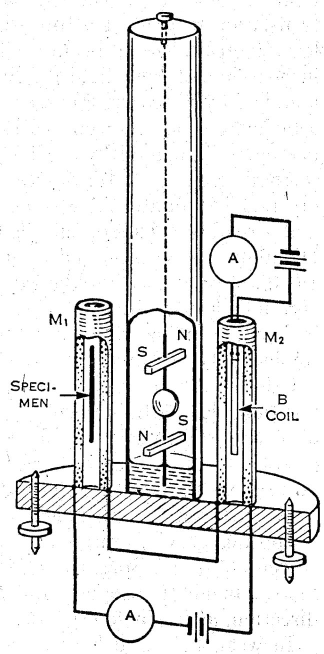


FIG. 79

Magnetometer for small specimen of wire or foil. M_1 and M_2 are similar magnetizing coils. Moment of specimen is balanced by adjusting current through small coil B placed inside of M_2, until suspended needles NS return to original position as indicated by light reflected from mirror (Tobusch-Bozorth)

In interpreting the permeability and energy losses measured by A.C. methods one must consider the apparent reduction of permeability due to skin-effect or shielding caused by eddy currents, and the separable losses attributable to eddy currents and hysteresis. This data obtained with the A.C. bridge are especially important in the study of materials used in communication engineering where small magnetic fields are important in the transmission of weak or undistorted signals.

The Epstein or Lloyd-Fisher apparatus is used primarily for measuring magnetic losses in material for power and other transformers operating at high inductions. The material in the form of strips is built into a hollow square. An alternating field is applied, in one winding, to magnetize it to a high induction measured by the voltage induced in a second winding, and the loss is indicated by a wattmeter connected to the circuits of both windings (fig. 78). Both windings are placed evenly on forms with square sections, and four such forms are placed to form a hollow square. The strips are slipped into the forms and carefully clamped at the corners after being abutted or overlapped there. Standard specifications control the manner of cutting and stacking the specimens, of correcting for the air flux in the coils, and of taking into account the wave form of the exciting current. Measurements are commonly made at $B=15{,}000$ and at a frequency of 60 cycles/sec. in the U.S. and 50 cycles/sec. in England.

In principle a simple method of testing a specimen by A.C. is by determining the current-voltage characteristics of a specimen having two windings, the current being a measure of H and the voltage a measure of B. Several ways have been used for accomplishing this, involving potentiometric measurements or rectification. From the results one can determine not only B and H, but also by taking account of the phase can determine the total energy loss in the material.

SPECIAL METHODS

Methods other than those described may be used advantageously for special investigations.

Measurements of very small quantities of materials, of single crystals in definite directions, of paramagnetic or diamagnetic solids, liquids or gases, all require specific arrangements for obtaining results of high accuracy with a minimum of effort.

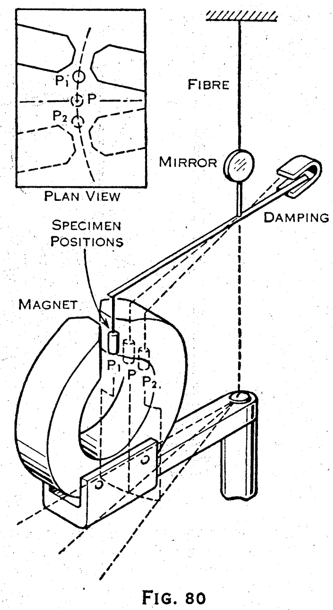


FIG. 80

Curie-Chéveneau balance for dia- and paramagnetic measurements. Specimen is placed on one arm of torsion balance and magnet is rotated in one direction about axis of torsion balance until maximum deflection of balance is recorded, using mirror. Magnet is then rotated in opposite direction and deflection in opposite direction recorded. Sum of two deflections is proportional to susceptibility

Magnetometers.—Years ago the intensity of magnetization of a specimen was usually measured by the torque it exerted on a small magnetic needle of known moment suspended nearby. The deflection of a light beam by a mirror attached to the delicate suspended system is still a very sensitive indicator of the state of magnetization of a specimen under investigation, but for most purposes the uncertainty in the positions of the magnetic poles of the specimen makes the magnetometer an instrument of low precision.

In principle the magnetometer measures field strength at a known distance from the poles of the specimen, in accordance with Eq. 1, $H=m/d^2$. It has been used recently for measuring with not too great accuracy, the magnetic properties of very small specimens in the form of fine wires or thin films deposited by evaporation or electrodeposition. In the arrangement proposed by H. Tobusch and modified by others (fig. 79), two oppositely directed needles of equal moment are placed one above the other on the same suspension, and the specimen made with a length about equal to the distance between the needles and placed parallel to the suspension. In this arrangement one pole of the specimen produces a twist on the nearest needle and the other pole a twist in the same sense on the other needle. The resultant twist is neutralized by a small solenoid (B-coil) place opposite the specimen and energized with a current that is proportional to the magnetization of the specimen. In this way films as thin as 10^{-5} cm., weighing considerably less than a milligram, have been investigated in fields of various strengths and at different temperatures.

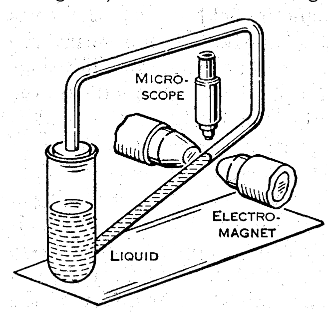


FIG. 81

Susceptibility of liquid is determined by noting (with microscope) the displacement of its meniscus in a capillary tube when the field of an electromagnet is applied in direction at right angles to tube (L. Gouy, G. Quincke)

Para- and Diamagnetic Materials.—Measurements of weakly magnetic substances usually depend on the translational force exerted on a magnetized body in a nonuniform magnetic field. Faraday suspended the material to be measured between the poles of an electromagnet, displaced from the central position so that the field gradient was large, and used a torsion balance to measure the force pulling the material toward the stronger part of the field or repelling it therefrom. This method was developed by P. Curie and used in his classical researches on the effect of temperature on paramagnetic and diamagnetic materials.

When the field-gradient is dH/dx, the force on material of magnetic moment M is MdH/dx dynes, and when expressed in terms of susceptibility and volume (Eq. 3) the force is

$$f = \kappa v H dH/dx.$$

The force is zero at the central position between the poles of the magnet because here dH/dx is zero, and the force is a maxi-

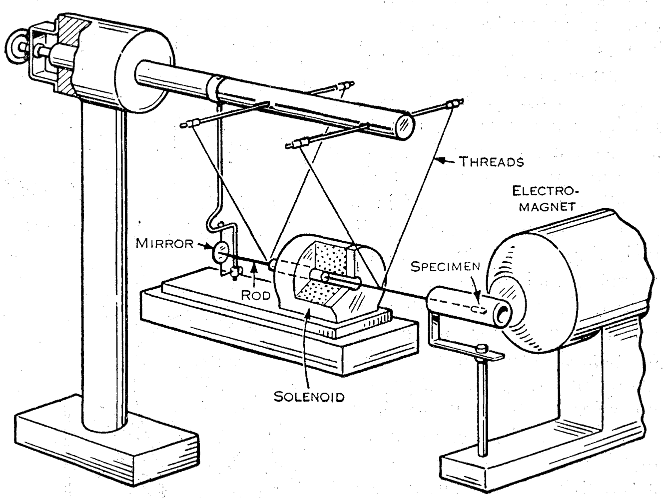


FIG. 82

Pendulum magnetometer has specimen on light frame hung from threads. Inhomogeneous field of electromagnet (half of which is shown) causes horizontal motion of frame, detected by tilting of mirror. Motion is compensated by magnetic plunger in solenoid, current through which is measure of magnetization of specimen (P. Weiss and G. Foëx)

mum at some point as shown by P_1 in fig. 80 and falls off again toward zero at points distant from the magnet.

To avoid the laborious mapping of the field to determine the product HdH/dx, and the careful setting of the sample at a given position, C. Chéveneau proposed that the magnet be moved until the sample deviates a maximum amount from its zero position P (fig. 80), against the restoring force of the torsion balance shown in the upper part of the figure. The deflection is then proportional to the susceptibility and to the maximum value of HdH/dx, and the proportionality factor is determined by calibration with a substance of known susceptibility.

Various refinements of these methods have been suggested. In one the torsion is measured electrically by the current in a solenoid that reacts with the field of a permanent magnet to produce a torque on the suspending fibre. P. Théodoridès has used a translational instead of a torsional balance, following the method of P. Weiss and G. Foëx described below. An ingenious quick-reading device has been described by W. Sucksmith.

Liquids and Gases.—The force exerted upon a magnetic material in an inhomogeneous magnetic field is also the basis of the methods of L. Gouy and G. Quincke for measuring the susceptibilities of liquids. There are numerous modifications of the original methods and adaptation has been made to the measurement of gases. The force on the liquid in the field is measured by its rise in a capillary tube, against the force of gravity. A simple modification is shown diagrammatically in fig. 81 which shows the poles of an electromagnet producing a high field at the surface of the liquid, the movement of which is measured by a microscope when the field is applied or removed. In using the method for gases a standard liquid of known susceptibility is employed and the gas fills the remainder of the tube. The force on the gas, caused by the field, adds vectorially to that on the liquid and the displacement of the meniscus is a measure of the resultant.

The force on a column of liquid (or gas) extending from a place where the field is H_1 to where it is H_0 may be obtained by integration of Eq. 3 to give

$$F = \kappa A (H_1^2 - H_0^2)/2$$

A being the cross-sectional area of the column. If a column of liquid (susceptibility κ_1) is opposed by a column of gas (susceptibility κ_2), the relation becomes

$$F = (\kappa_1 - \kappa_2) A (H_1^2 - H_0^2)/2.$$

Usually H_1 is the field strength directly between the poles of the magnet at the boundary between liquid and gas, and H_0 at the other end of the column is negligibly small. The susceptibility of gases has also been measured with the aid of a sensitive torsion balance.

Other Special Measurements.—The measurement of the saturation induction of ferromagnetic materials has been made with great accuracy by P. Weiss and his students in fields up to 20,000 oersteds, at temperatures ranging from about -250 to $+800°$ C. For this purpose they have used some modification of the scheme shown in fig. 82, in which the force is produced by a field gradient as in the Faraday method, but is measured as a translation instead of a torsion. Such a pendulum magnetometer has a light horizontal beam with the specimen mounted at one end in a region of high field gradient. The force due to the field is annulled by adjusting a current in a solenoid in which is a plunger attached to the other end of the beam, and the point of zero deflection is indicated by a tilting mirror. In a refinement of this method, used by L. W. McKeehan, the specimen (*e.g.*, of a single crystal) is mounted in a strong uniform field, easily measurable, and a readily calculable gradient is applied by means of two thin Helmholtz coils mounted near each other with fields opposing. In this way one avoids the mapping of the field, and also the uncertainty in the direction of the field and the rotational hysteresis in the specimen, difficulties likely to be encountered when a torsion balance is used.

Other methods of measurement in strong fields deserve brief mention. H. DuBois measured the intensity of magnetization by observing the rotation of the polarization of light reflecting from a magnetized surface (Kerr effect). The strength of a field can be measured by noting the change in the electrical resistance of a bismuth wire immersed in the field or by observing the force (opposing gravity) produced on a conductor carrying a known current (Eq. 4). Special methods have been devised for measuring the magnetic properties of materials in which these vary with direction, as in single crystals.

In weak fields, such as that of the earth, the methods of geomagnetism can be used (*see* TERRESTRIAL MAGNETISM). In 1936 an apparatus was constructed[1] for measuring and recording rapid changes in fields as small as one gamma (10^{-5} oersted), and during World War II this method was developed to even higher sensitivity. A piece of high permeability material is subjected to an alternating field of moderate amplitude, and if an additional steady field (that to be measured) is also present an alternating voltage of twice the exciting frequency will be produced and can be amplified and recorded. Its amplitude is proportional to the field strength to be determined.

A number of curve tracers have been made for taking magnetization curves and hysteresis loops so that a permanent accurate record may be obtained in a short time. Among the more accurate and convenient of these are the devices of F. E. Haworth, W. Thal and P. P. Cioffi. For the investigation of magnetic properties at high frequencies special techniques of some complexity must be used. (*See* also ELECTRICITY; ELECTROMAGNET; TERRESTRIAL MAGNETISM.)

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[1]H. Aschenbrenner and G. Goubau, *Hochfr. u. Elektrot.* 47:177–181 (1936).

netic Materials (New York, 1927); O. von Auwers, *Gmelin's Handbuch der Anorganische Chemie*, 8th ed., "Iron," Part D (1936), *Ergänzungsband* (1937); E. C. Stoner, *Magnetism and Matter* (London, 1934); R. Becker and W. Döring, *Ferromagnetismus* (Berlin, 1939); L. F. Bates, *Modern Magnetism* (Cambridge, 1939); R. M. Bozorth, "The Physical Basis of Ferromagnetism," *Bell System Technical Journal*, vol. 19, pp. 1–39 (1940); J. H. Van Vleck, *Theory of Electric and Magnetic Susceptibilities* (Oxford, 1932); W. Klemm, *Magnetochemie* (Leipzig, 1936); P. W. Selwood, *Magnetochemistry* (1943). (R. M. B.)

MAGNETITE or **MAGNETIC IRON-ORE,** a member of the spinel group of minerals with the formula, $Fe_2O_3.FeO$, corresponding to 72.4 per cent. of iron, hence its value as an iron-ore product. It is a black, opaque mineral with metallic lustre. Hardness about 6. Sp. g., 4.9 to 5.2. Streak, black. It is strongly magnetic and polar and has been known from very early times for this remarkable property which was described by Pliny. It crystallizes in the cubic system, in which it occurs usually in octahedra, and is frequently twinned. There is no distinct cleavage.

Magnetite is a mineral of wide distribution, especially as a constituent of igneous rocks, both intrusive and volcanic. It appears to have crystallized from the magma at an early period of consolidation, and marginal segregation has led in many cases to the formation of important ore-deposits (*see* NATURAL RESOURCES). Being a mineral not prone to decomposition, it is also found in detrital deposits, sometimes in a concentrated form, as *magnetite-sand*. The existence of pseudomorphs of magnetite after haematite (*q.v.*) and vice versa, however, prove that these minerals may be converted into one another by a change in the state of oxidation. Oxidation and hydration in the zone of weathering lead to limonite (*q.v.*). *Titaniferous magnetite* or *titano-magnetite* is a variety containing titanium. It consists of an intergrowth in various proportions of the minerals magnetite and ilmenite (*q.v.*).

MAGNETO, HIGH-TENSION. The magneto is a special application of the electric generator employed where the output of energy required is very small. It is used to furnish energy for ignition of compressed gases in various types of internal combustion engines. The elements of construction comprise a permanent magnetic field, an armature, rotated within that field, a circuit breaker and a distributing mechanism which serves to convey the generated voltage to a desired point. The *low-tension* magneto consists merely of a permanent magnet, of inverted U form, and, rotating between its poles, a shuttle-wound armature containing a number of turns of comparatively coarse wire, as shown in fig. 1. The changes of flux in the armature core, due to its rotation in the permanent field, generate in the armature winding an electro-motive force, the magnitude of which is proportional to the field strength, the speed of rotation, and the number of turns of wire on the armature. As the armature core rotates into a position in a plane with the flux lines, the flux in the core increases to a maximum. As the rotation progresses, the flux in the core decreases until one-half cycle is completed. In the second half cycle, the coil direction is reversed with relation to the flux.

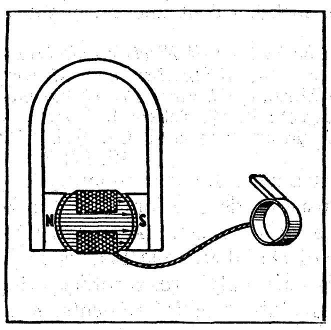

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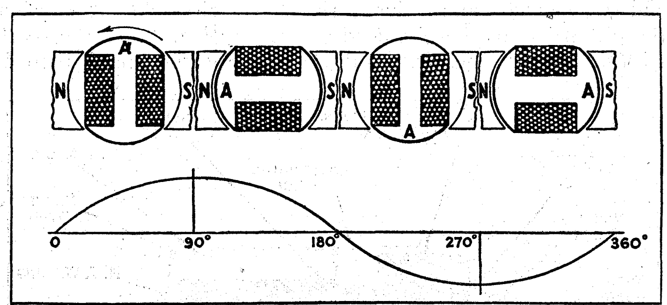
FIG. 1.—SIMPLE MAGNETO SHOWING MAGNET PRIMARY WINDING

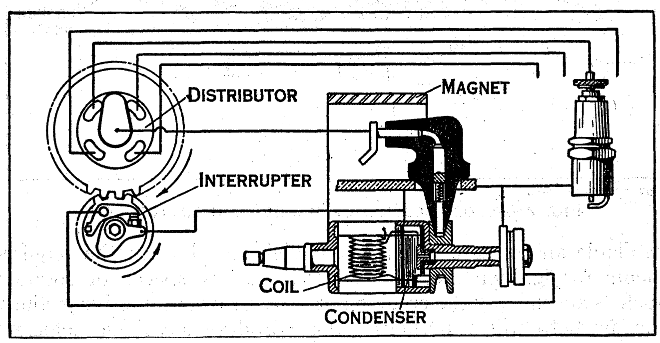
The generated electro-motive force, consequently, is alternating in direction and magnitude, and follows the variation of flux in the core. The change of electro-motive force with change of position of the armature is shown in fig. 2. The low-tension magneto has been used in conjunction with an induction coil as an ignition source, the coil serving to transform the voltage to a value sufficient to cause a spark across the terminals of a spark plug.

High-tension Magneto Construction.—The high-tension magneto has a secondary winding, comprising a great many turns of fine wire, superimposed upon the primary winding. The primary winding is short-circuited by means of an auxiliary device, during the building up of the field in the armature core. When the energy in the primary circuit has reached a maximum, this circuit is opened, and at the same instant, due to the rotation of the armature, the magnetic field is removed. The energy of the primary winding is discharged through the secondary, and due to the ratio of primary to secondary turns, a considerable increase in voltage is effected. This value may vary between 7,500 and 18,000 volts. The high-tension magneto when employed as a source of ignition for gas engines is operated synchronously with the engine by direct connection.



BY COURTESY OF J. H. CROWNE
FIG. 2.—SIMPLE ELECTRIC WAVE FORMED IN A MAGNETO, SHOWING POSITION OF THE ARMATURE AND THE CURRENT PHASE FOR EACH POSITION

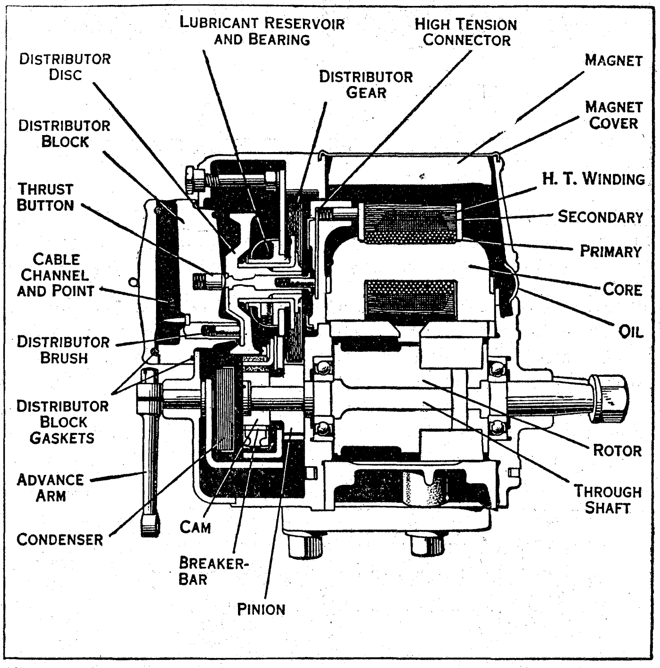
Fig. 3 shows the construction of a shuttle-armature type of high-tension magneto. The circuit breaker is operated by means of a cam, upon which the bumper or cam follower on the breaker bar, bears. Since the armature is directly connected to the engine, the frequency of the discharges through the secondary circuit is thus determined. (A shuttle-armature, having two poles, can generate two spark discharges per revolution.) The distributor serves to convey the voltage to each of the spark plug cables, in a desired sequence. Operating in synchronism with the armature, from which it is driven by means of a gear and pinion, the brush or firing pin of the distributor arm makes contact with a segment in the distributor block each time the secondary discharge occurs. By this means, the high-tension energy is carried to each spark plug in order. For a four cylinder engine, the distributor block carries four segments, and since the shuttle-armature generates two sparks per revolution, the gear ratio between armature and distributor is 2:1. The primary and secondary windings are common at one point and are there connected to the frame of the magneto. The return circuit of the secondary is thus completed through the body of the engine. The contact points of the circuit breaker, or interrupter, are made of an arc-resistant alloy.



BY COURTESY OF J. H. CROWNE
FIG. 3.—UNIT COIL FOR GASOLINE MOTOR IGNITION SYSTEM

A recent improvement in magneto design is offered in the inductor type instrument in which the coil is stationary and the flux changes are brought about by means of magnetic shunt segments which rotate between the magnet poles and bridge between them and the coil core. A cross-sectional drawing of this type is shown in fig. 4. By the use of four rotor segments, spaced 90° apart, four sparks per revolution may be generated. In addition, the flux direction through the coil core is reversed each quarter revolution. The direction of current through the contact points of the interrupter is thus alternated, and the excessive point pitting, due to a unidirectional arc is eliminated.

In order to vary the time of occurrence of the spark in the engine cylinder, the magneto cam, or the circuit breaker, is made rotatable through part of a revolution, and is connected, by means of a linkage, to a convenient advance-retard lever. This makes it possible to alter the relationship between the engine crank shaft and the magneto, and to ignite the charge either before or after the piston has reached its dead centre position. Since the spark intensity of a magneto varies directly with engine speed, there is



BY COURTESY OF J. H. CROWNE

FIG. 4.—CROSS SECTION OF MAGNETO, INDUCTOR TYPE

available an increase of energy at high speed when the requirements for ignition are most severe. At low speeds of rotation such as accompany the cranking or starting of automotive engines, the magneto will sometimes fail to produce a voltage sufficient to spark across the gap. There have been in use various impulse devices, such as "impulse couplings," which serve to couple the magneto to the engine and to accelerate its rotation in starting.

The magneto is employed on aircraft engines, where the highest engine efficiency must be maintained; on tractor engines, motorcycles, marine engines, and to a great extent on motorbuses and motor trucks. Stationary engines are also magneto-equipped. Minor commercial uses are found in the igniting of blasting charges (detonators), in igniters, for oil or gas burners; and, in conjunction with neon lamps, as stroboscopic indicating instruments. The total world production of magnetos for all uses, in the year 1927, was in excess of 525,000. (*See* also INDUCTION COIL and MOTOR CAR.) (I. H. C.)

MAGNETOCHEMISTRY. Iron is strongly attracted by a magnet; the iron is said to be ferromagnetic. There are few ferromagnetic materials, but all other substances experience either a weak attraction or a very weak repulsion by a magnet. Substances thus weakly attracted to a magnet are said to be paramagnetic, those repelled are diamagnetic. The measure of the attraction or repulsion is called the magnetic susceptibility. Magnetochemistry is the application of magnetic susceptibilities, and of closely related quantities, to the solution of chemical problems.

There are four major applications of magnetism to chemistry. These are (1) testing for traces of certain kinds of impurities in various substances; (2) the study of free radicals; (3) examination of inorganic solids with a view to finding their structures; and (4) the study of complex compounds. These four applications will be described more fully in the following paragraphs.

Magnetic susceptibility balances may be made very sensitive for the detection of paramagnetic impurities in diamagnetic substances, and especially so for ferromagnetic impurities. Three examples will be cited. The sand used for making glass must often be as free as possible from iron. Use of the magnetic balance will often detect a very small trace of such impurity and the measurements may be made in such a routine fashion as to be simpler and cheaper than any other method of detection. Similarly, traces of iron or of other ferromagnetic substances may be detected in metals such as magnesium. A third analytical application is in measuring the concentration of oxygen in mixtures of gases. The magnetic method is a convenient analytical tool for a variety of chemical and metallurgical operations.

The second use of magnetic measurements is in the study of free radicals. These substances, of which triphenylmethyl is an example, are of very considerable theoretical interest to chemists. Most chemical substances have an even number of electrons, and are diamagnetic, but free radicals have an odd number of electrons, and are paramagnetic. Magnetic susceptibility measurements may be used to establish the presence of free radicals, to estimate their amount, and to follow the chemical changes which they undergo, all in a very satisfactory manner.

A field of much interest and promise is the application of magnetic methods to the study of inorganic solids, particularly those solids of interest in catalysis. The possibility of relationships between catalytic activity on the one hand and magnetic properties on the other has interested many workers. It cannot be denied that those chemical elements, such as chromium and nickel, which show the most pronounced catalytic activity are the elements which show the most interesting magnetic effects. This is not to say that all catalytic activity is due to magnetism, but rather that catalysis and magnetism may, in some cases at least, have some common underlying basis. In a few cases it is possible to predict whether or not a substance will show catalytic activity, solely on the basis of magnetic measurements. Superactive catalysts, and catalysts showing undesirable side effects, may not infrequently be identified through use of the magnetic method.

The final application which will be mentioned is to complicated compounds, of which haemoglobin will serve as an example. Haemoglobin is the red matter in blood. It serves in the blood as the carrier of oxygen. Haemoglobin is composed in part of a complex compound containing iron. This substance is paramagnetic. When haemoglobin takes up oxygen, as it does in passing through the lung tissues, it becomes diamagnetic. From this change it is possible to draw conclusions concerning the spatial arrangement of the various atoms which make up the molecule of haemoglobin. Conclusions may also be drawn as to the mode of linkage between the haemoglobin and the oxygen. Similar studies have been made on a very wide range of complex compounds containing iron, nickel, cobalt and many other elements. *See* MAGNETISM; CATALYSIS.

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MAGNETOGRAPH, an instrument for continuously recording the magnetic elements, usually declination (D), horizontal force (H) and vertical force (V), but sometimes two rectangular force components in place of D and H. (*See* TERRESTRIAL MAGNETISM.) In each case variations only are recorded, the absolute values being determined by absolute instruments, *e.g.*, the unifilar magnetometer and the inclinometer.

Declination.—A suspended magnet carries a mirror, immediately below which is a second fixed mirror. Light passing through a vertical slit falls on the mirrors. After reflection the light passes through a plano-cylindrical lens with axis horizontal, and falls on a sheet of photographic paper, wrapped round a drum, which is rotated uniformly about a horizontal axis by clockwork. The two images due to the mirrors appear as dots of light on the paper. The light from the fixed mirror answers to a fixed direction, that from the magnet mirror to a direction which alters with the pointing of the magnet. The distance apart of the dots thus shows the changing inclination of the two mirrors, and so the changes of D. When the sheet is taken off and developed, we have a straight (base) line from the fixed mirror, and a curved line from the magnet mirror. The variations in the length of the ordinate measure the variations of declination.

Horizontal Force.—The suspension of the H magnet may be bifilar or unifilar, in the latter event a quartz fibre or fine metal wire. The suspension depends from a "torsion head" resting on the top of the suspension tube. By turning the torsion head the magnet is brought to be perpendicular to the magnetic meridian. A magnet of moment M inclined to the meridian at an angle θ experiences a magnetic couple $MH\sin\theta$ urging it towards the meridian; the change in the couple for a small change $d\theta$ in θ is $MH\cos\theta d\theta$. Thus when the magnet is perpendicular to the meridian the couple is MH and is insensitive to small changes in θ. Balancing this is the torsional couple $\tau\ (d-\theta)$. where τ and d are constants. If H increases, the magnet turns in the direction diminishing θ, and small changes in the angle are proportional to the changes in H. There is a magnet mirror and a fixed mirror, as for D, and similar optical arrangements. As before, the change in ordinate is proportional to the change in angle between the two mirrors and so to the change in H. Owing to the secular change of the magnetic meridian the instrument requires readjustment from time to time.

Vertical Force.—In what is often called the "Lloyd balance" the V magnet is mounted on a knife-edge in the Kew and Watson patterns, but on a frame standing on fine points in the Eschenhagen instrument. In either case it can turn freely about a horizontal axis, at right angles to its length. The magnet is balanced so as to be horizontal, the final adjustment being made with a horizontal screw. The magnetic moment being M, the couple VM is balanced by a gravitational couple, the centre of gravity being slightly on the opposite side of the knife edge from the dipping end of the magnet. Supposing V to alter, the magnet tilts one way or the other according as V increases or diminishes. The tilt shows itself by a change in the distance between two dots of light, one due to light reflected from a mirror carried by the magnet, the other to light reflected from a fixed mirror closely adjacent. In this case the axis of the drum carrying the photographic paper is naturally vertical. But in the Eschenhagen pattern the vertical motion of the dot of light is converted into horizontal motion by means of a reflecting prism. This enables a single drum with horizontal axis, carrying a single sheet of paper, to record the D, H and V traces, in addition to the trace of a thermograph. In another type of V instrument, first devised by W. Watson, the magnet is carried by a stretched wire or quartz fibre, the torsion in which opposes tilting caused by changes in V.

Temperature Effects.—All except D magnetographs suffer from temperature effects. A rise of temperature causes a fall in M, and so has the same effect on MH, for example, as a fall in H. There is a consequent decline in the H ordinate and similarly with V. Temperature again alters the torsion in a unifilar H suspension, and the position of the centre of gravity in the V magnet. There are various compensation devices, *e.g.*, in the case of V a horizontal zinc rod whose excess of expansion over steel helps to neutralize changes in M by changes in the centre of gravity. In the Eschenhagen pattern changes produced in an auxiliary field due to auxiliary magnets neutralize the direct effects of temperature on the principal magnet system. Compensation is usually imperfect, and corrections to the curve ordinate are calculated with the aid of a continuous thermograph record. The ideal thing is the use of a constant temperature room.

Scale Values.—The *time scale* is usually 15 mm. per hour, but is 20 mm. in the Eschenhagen pattern. There is usually provision for a time break every hour or second hour, enabling the time of a magnetic change to be fixed to perhaps the nearest half-minute. There is often provision for a "quick run," the drum being rotated at 12 times the usual speed.

Deflection Scale.—In the case of D, when torsion is negligible, as is usual in the Kew pattern, the scale value is invariable, depending only on the optical distance between the magnet mirror and the paper; the usual value is about 1′ per 1 mm. *i.e.*, 1 minute (1′) per 1 millimetre (1 mm.). When torsion is not negligible, its effect must be found by observing the change in the D ordinate produced by turning the torsion head through a given angle, and a corresponding correction must be applied to the scale value calculated from the optical measurements.

In the case of H, when the suspension is bifilar, the scale value can be altered by altering the distance apart of the two arms of the suspension. Similarly in the case of V the height of the centre of gravity, and so the sensitiveness, can be altered by means of a vertical screw. In these cases a pre-arranged scale value can be secured and maintained. Auxiliary magnets are sometimes used, the scale values altering with their position. Regular redeterminations of scale value are necessary in all force magnetographs. At some stations the magnet is at the centre of a large coil. A measured electric current produces a known change of magnetic field, and the scale value is calculated from the change of curve ordinate. In other cases an auxiliary magnet of known moment is used to deflect the H and V magnets. In Broun's method a knowledge of the moment of the deflecting magnet is unnecessary. The D magnet is deflected as well as the H and V magnets, the distance between the deflecting and deflected magnets and their relative positions being the same. The scale values are inversely as the changes of ordinate, the deflecting forces being the same, and the D scale value (in terms of force) can be calculated using an approximate value of H. Broun's method really assumes the D, H and V magnets closely alike, as in the Kew pattern, or else the deflection distances large.

The force equivalent of 1 in D is H x.000291, and so is .00005 C.G.S. (or 5 γ) when H equals 0.172, a value met with in northern England. In the absence of reasons to the contrary it is natural to aim at equal sensitiveness in D, H and V. Thus in England scale values per 1 mm., of 1′ in D and 5 γ in H and V are consistent especially as natural changes in H and in D (in terms of force) are very similar. But in India, where H may exceed 0.39 and D is a very quiet element, 0.5′ per 1 mm. would be more suitable. In high latitudes 2′ or even 5′ per 1 mm. may be desirable. In fact a D magnetograph is then so troublesome that it may be better to measure the changes of force in and perpendicular to the geographical meridian. For some purposes open scale magnetographs, say 1 γ or 2 γ per 1 mm., have advantages, but there is great risk of loss of trace at disturbed times. This risk can be reduced by the attachment to the magnet of two mirrors inclined at a small angle. This double mirror arrangement is usually carried by one at least of the Eschenhagen magnets. Eschenhagen also made use of a mirror inclined to the horizon, to give a supplementary trace of much lower sensitiveness. In really big magnetic storms a multi-mirror Eschenhagen magnetograph sheet may have a great mix up of traces. It is simpler, if funds permit, to run two magnetographs, one of high, the other of low sensitiveness.

Base Values.—Observations with the absolute instruments, e.g., the unifilar magnetometer, give the absolute values of the elements. The corresponding curve ordinates are measured, and their angular or force equivalents calculated from the known scale values. Subtracting the ordinate equivalent from the result of the absolute observation we have the base line value.

Use of Coils.—A wholly different way of measuring magnetic changes from that described above is the use of a coil in a circuit including a galvanometer, a continuous record being obtained of the current. The current gives the rate of change of the magnetic field normal to the coil. For complete registration three rectangular coils would be needed. A horizontal coil was installed at Parc St. Maur in 1892 by T. Moureaux and was in use for some time, and a large number of records have been obtained by A. Crichton Mitchell from a horizontal coil at Eskdalemuir. This method seems specially fitted for the study of short rapid changes of magnetic force.

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(C. Chr.)

MAGNETOMETER, in its most general sense an instrument used to measure the intensity of any magnetic field, but often used in the restricted sense adopted in this article of an instrument for measuring the horizontal component, H, of the earth's magnetic field. The earth's magnetic elements which are usually measured directly (*see* Terrestrial Magnetism) are declination, horizontal force and inclination. For the last named, *see* Inclinometer; the two other elements, D and H, are usually measured with the same instrument, the unifilar magnetometer.

Measurement of Declination, D.—Two operations are involved, the determination of (a) the geographical meridian and (b) the magnetic meridian, the angle between the two being D. For the former operation at an observatory, use is made of a distant mark, the bearing of which has been accurately determined once for all; but in field work the geographical meridian is deduced from an observation of the pole star, or from a transit observation of the sun or ordinary star. In the case of the Kew pattern unifilar shown in fig. 1, when a distant horizontal mark is available the mirror N is removed, and the distant mark is sighted through the small glass windows of the magnet box A, which must be truly plane parallel. When a transit observation is necessary, the mirror N must be carefully adjusted. The axis about which it rotates should be parallel to the surface of the mirror, *i.e.*, horizontal, and perpendicular to the line of collimation of the telescope. When adjusting the mirror the magnet box A is replaced by a long hollow tube to prevent stray light falling on the object glass of the telescope B. The mirror having been adjusted, the time of transit of, say, the sun across the vertical wire of the

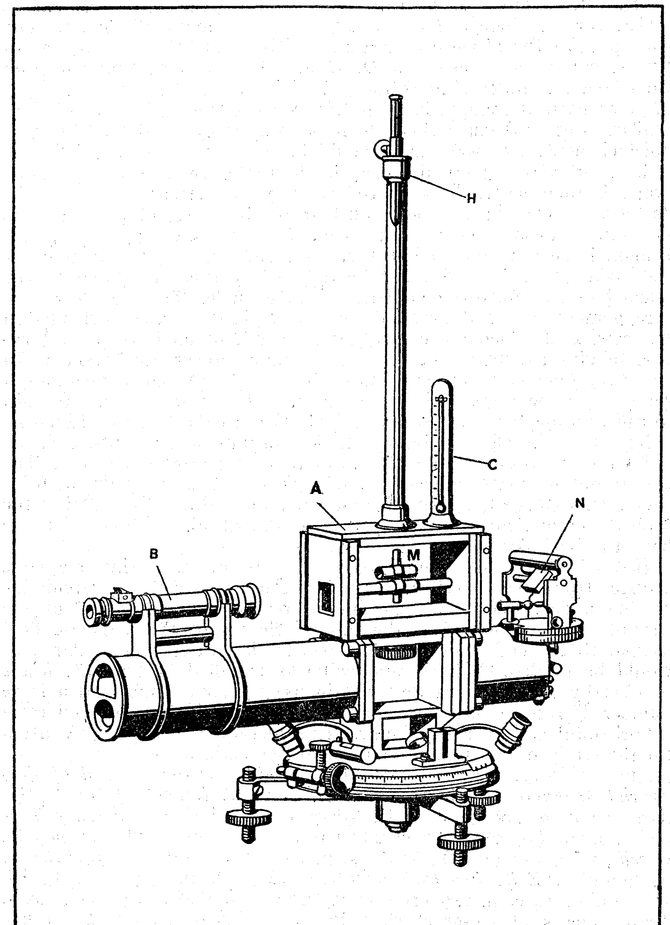


FIG. 1.—UNIFILAR MAGNETOMETER, ARRANGED TO INDICATE DECLINATION

telescope is determined with the aid of a chronometer. The sun's azimuth can be calculated if the latitude and longitude of the place are known. Thus the readings of the verniers on the azimuth circle made when the transit was observed enable us to deduce the reading which corresponds to the geographical meridian. Before determining the magnetic meridian, the torsion must be taken out of the suspension, usually a long thread of unspun silk, with the aid of a brass plummet. The collimator magnet, shown suspended in fig. 1 is a hollow steel cylinder, about 10 cms. long and 1 cm. in diameter, fitted with a lens in the end nearest the telescope and a scale in the other end. The scale is at the principal focus of the lens, and so can be sighted by B when focused on a distant object. The scale is illuminated by light reflected from the mirror N. During an observation the sides of the box A are closed by shutters, to protect the magnet from draughts. The upper end of the magnet's silk suspension is carried by a brass rod, which can be raised or lowered by a screw. The rod passes tightly through and can be clamped in the torsion head H, seen at the top of the suspension tube in fig 1. The magnet having been brought to a level suitable for invision, and the position of the mirror N adjusted for good illumination, the instrument is rotated about its vertical axis until the central vertical division on the scale appears to coincide with the vertical cross wire of the telescope. The two verniers on the azimuth circle having been read, the magnet is inverted, *i.e.,* turned 180° round its horizontal axis, and the setting is repeated. A second independent setting is generally made with the magnet inverted, and then another setting with the magnet in its original position. The mean of all the vernier readings is taken as corresponding to the magnetic meridian. The difference between this and the reading corresponding to the geographic meridian is the desired declination. The object of inverting the magnet is to eliminate error due to non-coincidence of the magnetic and optical axes. The magnet shown suspended in fig. 1 is intended only for H observations. To fit it for D observations it should have another shank. The most usual arrangement is to employ a single double-shanked magnet, of the type M in fig 1, which serves for both the D and the H observations. The short horizontal tube seen in fig. 1 above the magnet is the holder of the inertia bar, used in the special experiments for determining the moment of inertia of the magnet.

Measurement of Horizontal Force, H.—Two operations are involved. We first determine the time of vibration of the collimator magnet. This enables us to calculate $M\ H$, where M is the magnetic moment of the magnet. We then use the same collimator magnet to deflect an auxiliary magnet, and from the observed deflection angle we can calculate M/H. Combining the two results, we obtain H and M as well. For the vibration observation the magnet is suspended as in fig. 1, the shutters being attached. The time of vibration, deduced from several groups each of 100 vibrations, is obtained from transits of the collimator magnet, taken to 0.1 second by means of a chronometer, using the eye and ear method. The temperature is observed with the thermometer C before and after taking the vibrations. The magnetic couple is aided during the vibrations by a small torsion couple from the suspension, which necessitates the determination of a torsion coefficient by observing the effect of a torsion of 180° or 360° on the pointing of the magnet.

In the deflection experiment the magnetometer is arranged as shown in fig. 2. The collimator magnet K on a carriage L, which slides on the deflection bar D, deflects a smaller auxiliary suspended magnet. This carries a mirror, the normal to which is in the same vertical plane as the axis of the magnet. The auxiliary magnet is raised or lowered until its axis is level with that of K. Wooden panels which slide in vertical grooves are then inserted to protect it from draughts. When the unifilar has been turned until the deflection bar and the collimator K are approximately perpendicular to the magnetic axis of the auxiliary magnet, a reflection of the ivory scale B from the mirror becomes visible in the telescope A, suitably focussed. The position is further altered by a slow-motion screw until the centre of the scale coincides with the vertical wire in A, and the verniers are then read. The difference between this reading and that obtained when the magnet K is turned end for end is double the deflection angle θ produced by K at that particular distance r. The value of M/H is obtained from the equation $M/H=\frac{1}{2}\, r^3 \sin\theta\, (1+Pr^{-2}+Qr^{-4})^{-1}$ where P and Q are the two so-called "distribution constants." In reality

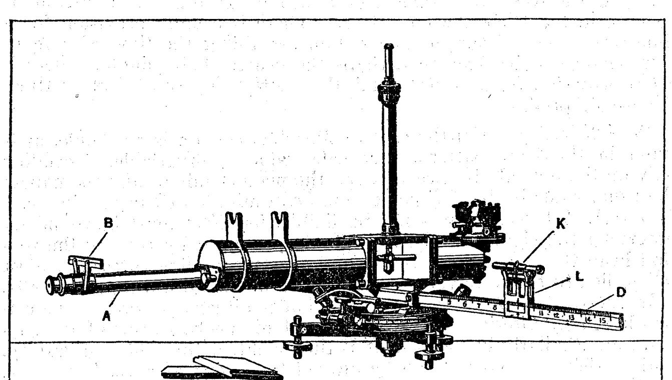


FIG. 2.—UNIFILAR MAGNETOMETER, ARRANGED TO SHOW DEFLECTION

deflections are taken with K at equal distances from the deflected magnet on the two arms of the bar. Also the arm opposite to that carrying the magnet carries a thermometer in a symmetrical position to K, which is read immediately before or after reading the verniers. With the thermometer is a counterpoise, the counterpoise and thermometer together equalling in weight the magnet and its carriage. The elimination of P and Q and the final calculation of M/H really involve the taking of deflections at three distances, *e.g.*, 25, 30 and 40 cms. In practice P and Q are derived from the mean of a large number of observations. Theoretically it is possible to make either P or Q zero by suitably choosing the relative dimensions of the deflecting and deflected magnets. For example, assuming the two magnets exactly similar in every way, Q should vanish when the length of the deflected magnet is 0.467 times that of the deflecting magnet. If Q is zero, or even very small, and the deflection distances are large, deflection at two distances suffices. In an old magnet carefully handled M changes very slowly. When pressed for time the best course may be to omit the vibration experiment, and assume a value obtained for M by interpolation from previous and later complete observations.

Corrections.—A number of corrections are necessary, *e.g.*, for temperature, temporary induction and even for the bending of the deflection bar. The practical use of the instrument postulates the determination of various constants and the calculation of several tables. The most important "constant"—which may be expected to change in the process of time—is the moment of inertia of the collimator magnet.

Variations of Pattern.—Silk suspension, though supplying a satisfactorily small torsion, is affected by mixture and somewhat uncertain, and use is sometimes made of a fine metal suspension. The method described above of taking solar transits assumes a very accurate knowledge of time. Less accuracy suffices if one can measure the altitude of the transiting sun or star. To accomplish this some patterns, *e.g.*, Cooke's India pattern designed by Capt. Denholm Fraser, replace B in fig. 1 by a transit telescope with vertical scale, while the department of terrestrial magnetism of the Carnegie institution, Washington, uses a combined magnetometer and theodolite. The magnet K when unprotected, as shown in fig. 2, and remote from the thermometer, has a somewhat uncertain temperature, especially in field work. In the India pattern it is enclosed along with a thermometer in a wooden box, which has a stud in its base which fits in one of several holes bored in the upper surface of the deflection bar; this calls for a large compensating weight. A single telescope, in this pattern, serves both for vibrations and deflections. The scale is in the telescope, the collimator magnet having the scale replaced by a cross. The auxiliary magnet used in the deflection experiment carries parallel to itself a hollow aluminum tube, fitted like the collimator magnet with a lens and a cross. When the auxiliary magnet is level with the deflecting collimator magnet the aluminum tube is at the height suitable for sighting by the telescope. The latest form of German magnetometer with an auxiliary arrangement for determining the "distribution constants" P and Q, has been described by R. Bock.

Other Instruments.—For less exact measurements of D use may be made of compasses of the ordinary or more complicated types. Explorers having to travel light sometimes calculate H from observations of total force F with a dip circle. (*See* INCLINOMETER.) We have $H=F\cos I$ where I is the angle of dip. A portable instrument in which measurements of the departure in the value of H from the value at a base station was measured through the varying torsion of a quartz suspension was devised in 1915 by G. W. Walker. A number of instruments suitable, like Walker's instrument, for the minute survey of small areas have been enumerated recently by L. Palazzo.

Coil Magnetometers.—H can be derived by comparisons with an artificial magnetic field produced by a measured current in a carefully constructed coil. W. Watson in 1902 constructed an experimental instrument of this kind with which he obtained results of high accuracy. Of late years coil magnetometers of various kinds have been designed in different countries, *e.g.*, by F. E. Smith in England, S. J. Barnett in the United States and N. Watanabe in Japan. Observations with these instruments occupy a very short time, and if sufficient pains be taken with the coil measurements and the auxiliary electrical outfit, a higher order of accuracy should be obtainable than with the unifilar. Until, however, international comparisons have been made some uncertainty must prevail on this point.

For taking observations at sea the instrument is naturally carried in gimbals. For measurements of D alone compasses of various kinds are available. An instrument consisting fundamentally of a compass but having an auxiliary magnet was designed by L. A. Bauer to measure H as well as D. The sea-deflector, as it is called, has the auxiliary magnet with its axis at right angles to the magnetic axis of the compass, the centres of the two magnet systems being a fixed distance apart in the same vertical. Using a Lloyd-Creak dip circle (*see* INCLINOMETER) H can be calculated, as on land, from an observation of total force.

BIBLIOGRAPHY.—References: Abbreviations *T.M.*, for *Journal of Terrestrial Magnetism; P.R.S.*, for *Proceedings of the Royal Society; R.D.T.M.*, for *Researches of the Department of Terrestrial Magnetism*, Carnegie institution, Washington. *Admiralty Manual Scientific Enquiry* (annual); D. L. Hazard, *Directions for Magnetic Measurements*, U.S. Coast and Geodetic Survey (1911, 2d ed. 1921); E. Mascart, *Traité de Magnétisime Terrestre* (1900); *R.D.T.M.*, especially vols. i and ii; B. Stewart and W. W. Gee, *Elementary Practical Physics*, vol. ii (1885, 2nd ed. 1895); S. J. Barnett, *R.D.T.M.*, vol. iv, p. 373; R. Bock, *Zeit. fur Instrumentenkunde*, heft 1, p. 1 (1928); C. Borgen, *T.M.*, 1, p. 176 (1896); C. Chree, *P R.S.*, 65, p. 375; *Phil. Mag.* 7, p. 39, and 8, p. 113 (1904); *Meteorological Office Geophysical Memoirs*, No. 30; H. C. D. Fraser, *T.M.*, 6, p. 65 (1901); H. Lloyd, *Proc. Roy. Irish Acad.*, 4, p. 57 (1848); L. Palazzo, *Mem. della Pont. Accad. delle Sci. Nuovo Lincei*, x., p. 271 (1927); F. C. Smith, *Phil. Trans. Roy. Soc.*, A. 223, p. 175; G. W. Walker, *P.R.S.* A. 92, p. 313; W. Watson, *Phil. Trans. Roy. Soc.*, A. 198, p. 431; *Phil. Mag.*, 10, p. 130 (1905).

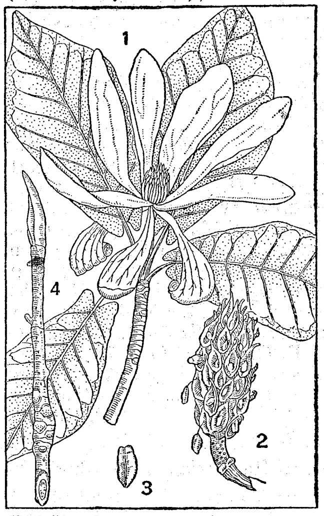
(C. CHR.)

MAGNIFICAT, the *Canticum beatae Mariae Virginis*, the song of praise of Mary in the house of Zacharias, with which she answered the greeting of Elizabeth—"Magnificat anima meum Dominum." It constitutes the most important canticle of the vesper service in the Roman Catholic church and of the evening office in the Anglican church. Besides having been set to plain song melodies in all the eight church modes, it has received countless settings by later composers.

MAGNITUDE of a star is the measure of its brightness adopted in astronomy. The higher the number expressing the magnitude the fainter the star. A step of 1 magnitude corresponds to a decrease in light intensity in the ratio 2.512, so that 5 magnitudes correspond to a decrease in the ratio 100 : 1. The absolute magnitude of a star is the apparent magnitude it would have if placed at a standard distance of 10 parsecs or about 33 light-years. The bolometric magnitude is an analogous measure of the heat-intensity of a star (*see* PHOTOMETRY: *Celestial;* STAR).

MAGNOLIA, a town in southwestern Arkansas, U.S.A., and the seat of Columbia county. It is situated about 150 mi. southwest of Little Rock and 50 mi. southeast of Texarkana at the junction of U.S. highways 79 and 82. It is served by the Louisiana and Northwest railroad. The altitude is 207 ft. The population was 2,158 in 1920; 3,008 in 1930; and 4,326 by the federal census of 1940. In 1940, 2,940 of the population were native white and 1,378 were Negro. The town was settled about 1840. The surrounding region produces valuable timber, farm produce, oil, cotton and cottonseed products and gas. Cotton ginning, marketing and a textile mill were the principal commercial activities until 1938 when the development of an oil field brought an additional source of income. The textile mill is one of the few plants in the region producing high quality broadcloth. The state-supported agricultural and mechanical college located in the town was established in 1910 as a vocational school and high school. Junior college courses were added in 1925. A general hospital was established in 1939, under city management. The town has a weekly and a daily newspaper with circulations of 2,154 and 1,979 respectively.

MAGNOLIA, the typical genus of the botanical family Magnoliaceae, named after Pierre Magnol (1638–1715). It contains about 35 species, distributed in Japan, China and the Himalayas and in North and Central America. Magnolias are trees or shrubs with deciduous or rarely evergreen foliage. They bear conspicuous, and often large fragrant white, rose or purple flowers. The sepals are three in number, the petals six to twelve, in two to four series of three in each, the stamens and carpels being numerous. The conelike fruit consists of a number of carpels which are borne on a more or less conical receptacle and dehisce along the outer edge to allow the scarlet or brown seeds to escape; the seeds, however, remain suspended by a long slender thread (the funicle). Of the old world species, the earliest in cultivation appears to have been *Magnolia denudata*, of China, of which the buds were preserved as well as used medicinally and to season rice; together with the closely related banana shrub (*Michelia fuscata*), it was transported to Europe in 1789 and thence to North America and is now cultivated in the middle states. There are many fine hybrid magnolias, among the best being *Magnolia soulangeana*, white tinted with purple, and the variety *M. soulangeana lennei.*



FROM HARRAR, "GUIDE TO SOUTHERN TREES" (MCGRAW-HILL BOOK COMPANY, INC.)
MOUNTAIN MAGNOLIA. 1. LEAVES AND FRUIT. 2. OPEN FRUIT. 3. SEED. 4.TWIG

Of the Japanese magnolias, *M. kobus* and the purple-flowered *M. obovata* were introduced into England in 1709 and 1804 respectively. *M. pumila,* the dwarf magnolia from the mountains of Amboyna, nearly evergreen and bearing deliciously scented flowers, was introduced in 1786. The Indian species are three in number, *M. globosa,* allied to *M. conspicua* of Japan, *M. sphenocarpa,* and the most magnificent of all magnolias, *M. campbellii,* which forms a conspicuous feature in the scenery and vegetation of Darjeeling. It is a large forest tree, abounding on the outer ranges of Sikkim, 80 to 150 ft. high and from 6 to 12 ft. in girth. The flowers are 6 to 10 in. across, appearing before the leaves, and vary from white to a deep rose colour.

The first of the American species brought to Europe (in 1688 by John Banister) was the sweet bay, *M. virginiana,* a beautiful deciduous or half-evergreen species about 15 ft. high with obtuse leathery leaves, blue-green above, silvery underneath, and globular, very fragrant flowers, creamy white or pale yellow in age. It is found in low situations near the sea from Massachusetts to Louisiana—more especially in New Jersey and the Carolinas. *M. acuminata,* the cucumber magnolia or cucumber tree, from the resemblance of the young fruits to small cucumbers, ranges from western New York and southern Ontario to Missouri and southward to North Carolina and Arkansas. The wood is yellow and is used for bowls; the flowers, 3 to 4 in. across, are glaucous green tinted with yellow. It was introduced into England from Virginia about 1736. A yellow-flowered variety of the cucumber tree (*M. acuminata cordata*), native to restricted areas in the southeastern states, was known only in cultivation for more than 100 years previous to its rediscovery in Georgia in 1913. It ranges in size from a large shrub to a fine tree 40 ft. or more high; it bears heart-shaped leaves, woolly beneath, and yellow flowers lined with purple. *M. tripetala* is known as the "umbrella tree," because the arrangement of the leaves at the ends of the branches resembles somewhat that of the ribs of an umbrella. The flowers, 5 to 8 in. across, are white and have a strong but not disagreeable scent. It was brought to England in 1752. *M. fraseri,* the mountain magnolia, discovered by John Bartram in 1773, is a native of the western parts of the Carolinas and Georgia, extending through northern Alabama to Louisiana to western Florida and southern Alabama. It grows 30 to 50 ft. high, has leaves a foot or more long, heart-shaped and bluntly auricled at the base, and fragrant pale yellowish-white flowers, 3 to 4 in. across.

The most beautiful species of North America is *M. grandiflora,* the bull bay, usually called evergreen or laurel magnolia in the U.S. It is native chiefly near the coast from North Carolina to Florida and westward to Arkansas and Texas. It was introduced into England in 1734. It grows a straight trunk, 2 ft. in diameter and upwards of 70 ft. high, bearing a profusion of large, powerfully lemon-scented creamy-white flowers. It is an evergreen tree, easily recognized by its glossy green oval oblong leaves with a rusty-brown under surface. The large-leaved magnolia, *M. macrophylla,* is a handsome deciduous tree, with smooth whitish bark and very large oblong leaves, 1 ft. to 3 ft. long and 8 in. to 10 in. broad. The sweet-scented, bell-shaped flowers, when open 8 in. to 10 in. across, are white with a purple blotch at the base of the petals. It occurs in the southern Allegheny mountains.

(*See* TULIPTREE.)

For a description of the principal species under cultivation *see* L. H. Bailey, *Standard Cyclopedia of Horticulture* (1943) and *Manual of Cultivated Plants* (1924). *See* also J. G. Millais, *Magnolias* (1926); A. Rehder, *Manual of Cultivated Trees and Shrubs* (2nd ed., 1939). (N. TR.)

MAGNUS, HEINRICH GUSTAV (1802–1870), German chemist and physicist, was born at Berlin on May 2, 1802. His father was a wealthy merchant; and of his five brothers one, Eduard (1799–1872), became a celebrated painter. After studying at Berlin, he went to Stockholm to work under Berzelius, and later to Paris, where he studied for a while under Gay-Lussac and Thénard. In 1831 he returned to Berlin as lecturer on technology and physics at the university. As a teacher his success was rapid and extraordinary. His lucid style and the perfection of his experimental demonstrations drew to his lectures a crowd of enthusiastic scholars, on whom he impressed the importance of applied science by conducting them through the factories and workshops of the city; and he further found time to hold weekly "colloquies" on physical questions at his house with a small circle of young students. From 1827 to 1833 he was occupied mainly with chemical researches, which resulted in the discovery of the first of the platino-ammonum compounds ("Magnus's green salt" is $Pt(NH_3)_2Cl_2$) of "sulphovinic," "ethionic" and "isethionic" acids and their salts, and, in conjunction with C. F. Ammermueller, of periodic acid. Among other subjects at which he subsequently worked were the absorption of gases in blood (1837–1845), the expansion of gases by heat (1841–1844), the vapour pressures of water and various solutions (1844–1854), thermo electricity (1851), electrolysis (1856), induction of currents (1858–1861), conduction of heat in gases (1860), and polarization of heat (1866–1868). From 1861 onwards he devoted much attention to the question of diathermancy in gases and vapours, especially to the behavior in this respect of dry and moist air, and to the thermal effects produced by the condensation of moisture on solid surfaces.

In 1834 Magnus was elected extraordinary, and in 1845 ordinary professor at Berlin. He was three times elected dean of the faculty, in 1847, 1858 and 1863; and in 1861, rector magnificus. His great reputation led to his being entrusted by the government with several missions; in 1865 he represented Prussia in the conference called at Frankfort to introduce a uniform metric system of weights and measures into Germany. For forty-five years his labour was incessant; his first memoir was published in 1825 when he was yet a student; his last appeared shortly after his death on April 4, 1870. In 1840 he married Bertha Humblot by whom he left a son and two daughters.

See *Allgemeine deutsche Biog.* The Royal Society's *Catalogue* enumerates 84 papers by Magnus, most of which originally appeared in *Poggendorff's Annalen.*

MAGNUS, SIR PHILIP (1842–1933), English educator, was born in London on Oct. 7, 1842. He was educated at University college, London, from which institution he graduated with first class honours in arts and science. After lecturing on applied mathematics at various institutions he served the London institute from 1880 to 1915 as organizing director and secretary of city and guilds and after 1888 as superintendent and secretary of the institute's technology department. He was president of the Council of College Preceptors and from 1881 to 1884 a member of the Royal Commission on Technical Instruction. He was knighted in 1886. He died on Aug. 29, 1933. His published works include *Hydrostatics and Pneumatics; Industrial Education; Educational Aims and Efforts.* He was editor of *Education Library* and joint-editor of *London Science Class-books.*

MAGNUSSON, ARNI (1663–1730), Icelandic historian and antiquarian, was born in Vestland, Iceland, on Nov. 13, 1663, and died at Copenhagen on Jan. 6, 1730. He studied theology at Copenhagen, and in 1696, on his return from a visit to Germany, was appointed to the post of secretary of the secret archives. In

1701 he was elected professor of Danish antiquities and the next year was sent on a royal mission to Iceland, where he stayed ten years, collecting documents relative to the history of that country which he bequeathed to the university of Copenhagen.

Magnusson's most important works are *Incerti auctoris Chronica Danorum, et praecipue Islandiae* (Leipzig, 1695); and *Testamentum Magni regis Norvegiae* (Copenhagen, 1719). *See* also his letters, *Arne Magnusson's Private Brevveksling* (Copenhagen, 1920).

MAGNY, CLAUDE DRIGON, Marquis De (1797–1879), French heraldic writer, was born in Paris. After being employed for some time in the postal service, he devoted himself to the study of heraldry and genealogy, his work in this direction being rewarded by Pope Gregory XVI with a marquisate. He founded a French college of heraldry, and wrote several works on heraldry and genealogy, of which the most important were *Archives nobiliaires universelles* (1843) and *Livre d'or de la noblesse de France* (1844–52). His two sons, Edouard Drigon and Achille Ludovice Drigon, respectively comte and vicomte de Magny, also wrote several works on heraldry.

MAGO, the name of several Carthaginians. (1) The reputed founder of the military power of Carthage, *fl.* 550–500 B.C. (Justin xviii. 7, xix. 1). (2) The youngest of the three sons of Hamilcar Barca. He accompanied Hannibal into Italy, and held important commands in the great victories of the first three years. After the battle of Cannae (216 B.C.) he sailed to Carthage to report the successes gained. He was about to return to Italy with strong reinforcements for Hannibal, when the government ordered him to go to the aid of his other brother, Hasdrubal, who was hard pressed in Spain. He carried on the war there with varying success in concert with the two Hasdrubals until, in 209, his brother marched into Italy to help Hannibal. Mago remained in Spain with Hasdrubal, the son of Gisco. In 207 he was defeated by M. Iunius Silanus, and in 206 the combined forces of Mago and Hasdrubal were scattered by Scipio Africanus in the decisive battle of Silpia. Mago maintained himself for some time in Gades, but afterwards received orders to carry the war into Liguria. He wintered in the Balearic isles, where the harbour Portus Magonis (Port Mahon) still bears his name. Early in 204 he landed in Liguria, where he maintained a desultory warfare till in 203 he was defeated in Cisalpine Gaul by the Roman forces. Shortly afterwards he was ordered to return to Carthage, but on the voyage home he died of wounds received in battle.

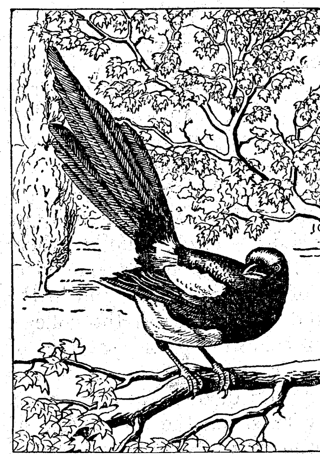
See Polybius iii.; Livy xxi.–xxiii.; xxviii.; chs. 23–37; xxix., xxx.; Appian, *Hispanica,* 25–37; T. Friedrich, *Biographie des Barkiden Mago;* H. Lehmann, *Der Angriff der drei Barkiden auf Italien* (Leipzig, 1905); and further J. P. Mahaffy, in *Hermathena,* vii. 29–36 (1890).

(3) The name of Mago is also attached to a great work on agriculture which was brought to Rome and translated by order of the senate after the destruction of Carthage. The book was regarded as a standard authority, and is often referred to by later writers.

See Pliny, *Nat. Hist.* xviii. 5; Columella, i. 1; Cicero, *De oratore,* i. 58.

MAGPIE or **PIE,** a bird once abundant throughout Great Britain, but now much scarcer, though since the World War its numbers have increased. It did not reach Ireland until the 17th century, but is now common enough in that country. This species is extending its range where not molested.

In Norway, the magpie is very tame, nesting in the gardens even of town houses, but in Britain persecution has made it shy, and most people know it only as a captive in a wicker cage, where its vivacity and natural beauty are lessened or lost. At large, few European birds possess greater beauty, the pure white of its scapulars and inner web of the flight-feathers contrasting vividly with the deep glossy black on the rest of its body and wings, while its long tail is lustrous with green, bronze, and purple reflections. The pie's nest is a wonderful structure, placed either in trees or bushes, and massively built. Its foundation consists of stout sticks, turf and clay, wrought into a deep, hollow cup, plastered with earth, and lined with fibres; but around this is erected a basket-like outwork of thorny sticks, forming a dome over the nest, and leaving a hole in the side for entrance and exit. Herein are laid from six to nine eggs, of a pale bluish-green freckled with brown and blotched with ash-colour. The magpie, in common with the raven, the jay, and many birds of prey, has a remarkable capacity, when its mate is killed, for obtaining a new mate within a day or two. In the case of the pie and the jay, a large gathering of birds of the species is said to appear on the scene, and apparently the new mate is selected from these.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY
THE MAGPIE (PICA PICA OR PICA RUSTICA)

The pie belongs to the crow family and is scientifically termed *Pica pica.* It inhabits Europe, North-west Africa and Asia, and is replaced in western North America by a sub-species. In California *P. nuttalli* is distinguishable by its yellow bill and the bare yellow skin round its eyes.

MAGWE, a district and division of Burma. In 1941 the division included the district of Thayetmyo, Minbu, Magwe, Pakôkku and Pakôkku hill tract and the Chin hills district. The district has an area of 3,724 sq.mi.; pop. (1941) 559,926. Magwe may be divided into two portions: the low, flat country in the west, forming part of the surrounding valley, and the undulating high forested ground in the east forming part of the Pegu Yomas, which at some parts reaches a height of 1,500 feet. In the heart of the district there is a low fertile plain which is about 45 mi. from north to south and as much as 30 mi. wide in places. The railway from Pyinmana runs through this plain and beyond. The chief streams are the Yin and the Pin, which form the northern boundary. The only perennial stream is the Yanpè. The annual rainfall averages about 27 inches. The maximum temperature rises to a little over 100° F. in the hot season, and falls to an average minimum of 53° F. and 54° F. in the cold season. Rice is the staple product, and considerable quantities are exported. Sesamum, maize, and millet are also cultivated, as well as cotton, while an important crop in the sandy soil is ground nuts (peanuts).

In this district are included the well-known Yenangyaung and Chauk oilfields. A block of 80 sq.mi. was demarcated by the government as the area of the Yenangyaung oilfields but only about 2 or 3 sq.mi. are occupied by the actual field and the bulk of the production has been from an area of only 1¼ sq.mi. The state lands were leased to the Burmah Oil company but two large blocks in the richest part (the Beme and Twingôn reserves) were reserved for the hereditary Burmese owners called twinsa. Although there are still some primitive hand-dug wells nearly all the native owners have sold their rights to companies operating with modern plant. Hence it is in these reserves that competition between the competing companies has been extraordinarily keen, though methods of working have been carefully and wisely supervised by government agents. There is now scarcely a well site of value left. The town of Yenangyaung had a pop. (1931) of 11,098. A great advance has been made in recent years by electrifying the field. The oil is sent by pipe line to the refineries at Syriam near Rangoon.

The town of MAGWE, on the Irrawaddy, is the headquarters of the district and of the division; pop. (1931) 8,209.

MAGYARS, the name of the people called in English, Hungarians. Though they have become physically assimilated to the western peoples, they belong in origin and language to the Finno-Ugrian (*q.v.*) division of the Alpo-Carpathian stock. Before World War I they formed barely half of the population of Hungary, but were by far the largest and most compact of all its racial groups. Magyar was the official language of Hungary, the official name of which (*Magyarország,* or "country of the Magyars") enshrined the Magyar claim to predominance. The Magyars themselves sometimes applied the name *Magyarország* to Hungary "proper," excluding Croatia-Slavonia, the whole kingdom being called *Magyarbirodalom,* the Magyar monarchy or realm.

Hungary, as constituted now, does not include the whole of the *Magyarország.* (W. A. P.)

MAHABALESHWAR or MALCOLMPETH, a hill station in Satara district, and the principal sanatorium in the Bombay presidency, India. Pop. (1941) 5,090. It is reached from Wathar railway station (39 m.) by motor from Poona (75 m.). Mahabaleshwar occupies the summit of a ridge of the Western Ghats, about 4,500 ft. above sea-level. It was established in 1828 by Sir John Malcolm, governor of Bombay, who obtained the site from the raja of Satara in exchange for another patch of territory. It lies higher and is therefore cooler than Matheran, but the rainfall (from 150 to 409 in. a year) is very heavy. The climate is pleasant, particularly from October to March.

MAHAFFY, SIR JOHN PENTLAND (1839–1919), Irish classical scholar, was born in Switzerland on Feb. 26, 1839, and was educated abroad and at Trinity college, Dublin, where he was professor of ancient history. In 1913 he became vice-provost, and in Nov. 1914, provost of Trinity college, and in the Irish rebellion (Easter 1916) directed the defence of the college. He was made a G.B.E. in 1918 in recognition of the services of the college during the World War. From 1911 to 1916 he was president of the Royal Irish Academy. He died on April 30, 1919. Some of his many works, especially those on the Silver Age of Greece, have become standard authorities. He also translated Fischer's *Commentary on Kant* (1866) and edited the Petrie Papyri in the *Cunningham Memoirs* (3 vols. 1891–1905).

BIBLIOGRAPHY.—His works include, besides those mentioned above; *History of Classical Greek Literature* (4th ed., 1903 *seq.*); *Social Life in Greece from Homer to Menander* (4th ed., 1903); *The Silver Age of the Greek World* (1906); *The Empire of the Ptolemies* (1896); *Greek Life and Thought from Alexander to the Roman Conquest* (2nd ed., 1896); *The Greek World under Roman Sway from Polybius to Plutarch* (1890); *An Epoch in Irish History, 1591–1660* (1904); *The Particular Book of Trinity College* (1904); *Plate in Trinity College* (1918). *See* obituary notices in *The Times* and in *Hermathena,* XLII. (1920), which contains a bibliography.

MAHAN, ALFRED THAYER (1840–1914), Rear-Admiral, American naval historian was born on Sept. 27, 1840 at West Point on the Hudson where his father was professor of military engineering. The boy's fancy was for the sea. He revelled in Marryat. Columbia college and the Naval academy at Annapolis qualified him for the United States navy in which he served forty years. He saw active service in the Civil war and when 21 designed a "mystery ship" and volunteered to command it. After being lecturer on naval history and strategy at the naval war college in 1885 he became its president. An indefatigable student with a prodigious memory, he steeped himself in the strategy of Jomini, Napoleon and Nelson and made critical analyses of the conclusive battles of the world on land and sea. *The Influence of Sea Power upon History, 1660–1783,* published in 1890 was inspired by a conviction that the historic significance of the control of the sea had never been fully revealed. It was followed in 1892 by *The Influence of Sea Power upon the French Revolution and Empire, 1793–1812.* These masterly works captured the imagination of naval men, statesmen and scholars and profoundly influenced the naval policy of the great powers. In breadth of vision and originality of treatment they were unrivalled. No previous writer had so convincingly established the dominating influence of sea power upon the destinies of nations. The famous trilogy was completed by *The Life of Nelson* in 1897. Mahan was acclaimed an authority upon naval strategy especially in Great Britain where his genius was first recognized. His doctrines may be said to have governed the naval political thought of the world. Degrees were conferred upon him by Oxford and Cambridge in 1894 and later by leading American Universities. He commanded the cruiser "Chicago" in European waters 1893–1895 and was accorded a notable reception in England and elsewhere. Mahan served on the naval War Board during the Spanish-American War of 1898 and as delegate to the Hague Peace conference 1899. President Roosevelt declared "There is no question you stand head and shoulders above the rest of us." He was in 1900 awarded the Chesney Gold Medal for his three masterpieces, which were translated into several foreign languages. He was president of the American Historical Association in 1902 and chairman of a commission on naval affairs in 1908. Mahan possessed historic insight and the mind of a statesman. Calm impartiality governed his conclusions. He excelled as a strategist rather than as a tactician. His chief aim was to make clear the paramount importance of the sea as a decisive factor in history. He analysed the elements of sea power in all its bearings, military, national, territorial and commercial. With masterly touch he dissected the strategic features of the Caribbean. He stressed the interdependence of the military and commercial control of the sea and confirmed the doctrine that commerce dominates war. In *The Interests of America in Sea Power* 1897 and in most of his twenty volumes he sought to arouse his countrymen to a realisation of their maritime responsibilities. His doctrines stimulated the growth of navies between 1900 and 1914. The extreme views of the "Fleet in Being" School he considered unsound. He doubted the infallibility of arbitration in international disputes. He consistently advocated a solid understanding between Great Britain and America. In Anglo-American naval supremacy he saw the surest hope of peace. His writings abound in appreciations of the British navy. He foresaw the menace to the United States in the attempt to cripple Britain's naval power by the proposal to grant immunity from capture to sea-borne belligerent commerce in time of war. With steadfast courage against powerful political opposition he persistently condemned this proposal. In timely warnings to Britain in 1910 he foreshadowed the events of 1914–1918. Discussion of sea power compels recourse to his works which are invaluable to students of international affairs. (*See* SEA POWER.) Mahan married in 1872 Ellen Lyle Evans. He died on Dec. 1, 1914, having foretold the defeat of the Central powers and the surrender of the German navy. He was a deeply religious man, high-minded, chivalrous and unassuming. As an exponent of sea power he had no peer in the annals of literature.

For complete list of works and bibliography *see* Charles Carlisle Taylor *The Life of Admiral Mahan* (1920). (C. C. TAY.)

MAHANADI ("The Great River"), river, India. It rises in 20° 10′ N., 82° E., 25 m. S. of Raipur town, in the wild mountains of Bastar in the Central Provinces. At first an insignificant stream, taking a northerly direction, it drains the eastern portion of the Chhattisgarh plain, then a little above Seorinarayan it receives its first great affluent, the Seonath; thence flowing for some distance due E., its stream is augmented by the drainage of the hills of Uprora, Korba, and the ranges that separate Sambalpur from Chota Nagpur. At Padampur it turns towards the south, and struggling through masses of rock, flows past the town of Sambalpur to Sonpur. From Sonpur it pursues a tortuous course among ridges and rocky crags towards the range of the Eastern Ghats, which it pierces by a gorge overlooked by forest-clad hills. Since the opening of the Bengal-Nagpur railway, the Mahanadi is little used for navigation. It reaches the Orissa delta at Naraj, about 7 m. west of Cuttack town; and after traversing Cuttack district from west to east, and throwing off numerous branches, it falls into the Bay of Bengal at False point by several channels.

The Mahanadi has an estimated drainage area of 50,000 sq.m., and its rapid flow renders its maximum discharge in time of flood second to that of no other river in India. During high floods over 1,500,000 cu.ft. of water pour every second through the Naraj gorge. In the dry weather the discharge dwindles to 500 cu.ft. per second in a normal year. Efforts have been made to husband and utilize the vast water supply thrown upon the Orissa delta during seasons of flood. Each of the three branches into which the parent stream splits at the delta head is regulated by a weir. The four canals which form the Orissa irrigation system irrigate 292,000 acres. Two take off from the Biropa weir, and one, with its branch, from the Mahanadi weir. A new canal to protect the Raipur district, with headworks at Rudri on the Mahanadi, which was in course of construction in 1926, will irrigate a further 300,000 ac. when completed.

MAHANOY CITY, a borough of Schuylkill county, Pennsylvania, U.S.A., 35 m. S.S.W. of Wilkes-Barre, in the shadow of Broad mountain, at an altitude of 1,240 feet. It is served by the Lehigh Valley and the Reading railways. The population in 1940 was 13,442 (12% foreign-born white). Anthracite-mining is the dominant industry. There are iron works and shirt factories. The borough was incorporated in 1863.

MAHAR, the name of a servile caste in the Deccan, India. Their special function, apart from that of scavenger, is to act as village watchman, as guardian of the village boundaries, and as public messenger. In some parts they are also weavers of coarse cotton cloth.

MAHARAJPUR, a village in Gwalior state, Central India. Population 366. It was the scene of a battle (Dec. 29, 1843) in which Sir Hugh Gough, accompanied by the governor-general, Lord Ellenborough, defeated the insurgent army of Gwalior.

MAHAS: *see* BARABRA.

MAHĀVAṂSA, the *Great Chronicle,* a history of Ceylon from the 5th century B.C. to the middle of the 5th century A.D., written (6th cent.) in Pali verse by Mahānāma of the Dīghasanda Hermitage. In historical value it compares well with early European chronicles. In India proper the decipherment of early Indian inscriptions was greatly facilitated by data found in the Mahāvaṃsa. It was composed on the basis of earlier Sinhalese works, now lost, particularly one, also called the Mahāvaṃsa, written in Sinhalese prose with Pali memorial verse interspersed. The extant Pali work gives legends and the genealogy of the Buddha; a sketch of Indian history and an account of Indian Buddhism down to Asoka; a description of the sending out of missionaries after Asoka's council, especially of Mahinda to Ceylon; a sketch of the previous history of Ceylon; a long account of the reign of Devānam-piya Tissa, who received Mahinda, and established Buddhism in the island; short accounts of his successors down to Duṭṭha Gāmīin (Dadagamana or Dutegemunu); then a long account, amounting to an epic poem, of the career of that prince, who drove out the Tamil invaders; and notices of later kings. The Mahāvaṃsa was the first Pali book made known to Europe.

See *The Mahāvamsa,* ed. by Geo. Turnour (Colombo, 1837); ed. by W. Geiger (London, 1908); H. Oldenberg, introduction to his edition of the *Dīpavaṃsa* (London, 1879); O. Franke, in *Wiener Zeitschrift für die Kunde des Morgenlandes* (1907); W. Geiger, *Dīpavaṃsa und Mahāvaṃsa* (Leipzig, 1905, trans. by Ethel M. Coomaraswamy, Colombo, 1908), and *The Mahāvaṃsa* (Pali Text Society, 1912).

MAHĀYĀNA, the name of a development in the later schools of Buddhism, which taught special doctrines about the Buddhas and new metaphysical theories. It originated between the age of Asoka and the Christian era, but nothing of its rise or its authors is certainly known, as this period is one of the darkest of Indian history. The earliest indication of Mahāyāna as a school is found in the Gandhāra sculptures of the 1st century B.C., in which the bodhisattva ideal is prominent. Our actual knowledge is derived from the Mahāyāna sūtras themselves (some of them perhaps as early as the 1st century A.D.), and also from independent expositions by Mahāyāna teachers, the reports of Chinese pilgrims, and the polemical works of Hindu authors. *Yāna* means "career," but *mahāyāna* is usually translated "great vehicle," as the *Lotus* (ch. 3), one of the chief Mahāyāna sūtras, describes the careers taught by the different schools under the parable of the chariots, Mahāyāna being compared to a great bullock chariot, while the older schools are goat and deer chariots.

The older schools, the best known of which are the Theravādins (represented by the Pāli Canon) and the Sarvāstivādins, taught that all that the individual had to do was to follow out the teaching of Buddha and seek Nirvāna. Those who made this their immediate goal were the monks, the disciples (*śrāvaka*) who aimed at the state of arhat each for himself, hence the name of this teaching as *śrāvaka-yāna,* "vehicle of disciples." These old schools recognized also the possibility of attaining buddhahood, though it was not set forth as a practical aim. One who became a private buddha without publicly preaching was a pratyekabuddha and his career was the *pratyekabuddha-yāna.* Both these vehicles are mentioned together as *hīnayāna,* "low vehicle," but this term is extremely rare in the texts. It has become common among western writers owing to its use by the Chinese pilgrims.

Effect of New Doctrine.—The new doctrines did not contradict the older ideals, but supplemented them by teaching that each individual was potentially a Buddha. He should aim both at attaining Nirvāna for himself, and at becoming a Buddha, whereby he can preach to others and serve the welfare of all. One who makes this his goal is a bodhisattva, and sets out on a course of training by which through many rebirths he acquires great merit, and in the stages of his career attains in perfection six virtues known as *pāramitās.* Hence the Mahāyāna is also called the *bodhisattva-yāna.* The actual result of this teaching was not to transform all disciples into saviours, but to make the ordinary man look for salvation to certain great bodhisattvas, who by their accumulated merit save beings from hell, and assure rebirth in heaven to all those who devoutly repeat the name of their favourite bodhisattva. The success of the movement was in fact largely due to the scope it gave to the instincts of worship and religious devotion. These developments were doubtless due to contact with the popular Hindu religions. There was no longer any question as to whether the Buddha who has attained Nirvāna can be said to exist. He abides with other Buddhas in heavens at the ten points of space. This is an approach to the current Hindu polytheism. An approach to monotheism is found in some very late schools in the belief in one universal Buddha, but it is not the predominant doctrine. In the *Lotus* (ch. 15) Buddha declares that when the world becomes bad and unbelieving he manifests himself again. This is exactly the claim that Krishna makes in the *Bhagavadgītā.* But the leading Mahāyāna doctrine concerns bodhisattvas. The bodhisattvas, whatever their origin, are assimilated to current Hindu gods. Avalokiteśvara, one of the most popular of them, is said in the *Kāraṇḍavyūha* to take the form of Śiva, Vishnu, etc., in order to teach the doctrine to the worshippers of these gods. Another hinduizing feature is that of magic and magic formulas (*dhāraṇīs*) and the religious use of sexual symbolism in which each bodhisattva is provided with a female counterpart. The works dealing with this aspect are classed as Tantra. The use of magic is found in the earliest Buddhism, but it is not treated as part of the doctrine. In Tantrism the repetition of meaningless syllables is a means of acquiring merit, and the continuous repetition of Avalokiteśvara's name is enough to assure rebirth in heaven.

Metaphysical Teaching.—The metaphysical teaching of Mahāyāna is known as the doctrine of the void (*śūnyatā*). It is found chiefly in the class of sūtras known as *Prajñāpāramitā,* and is usually termed negativism or nihilism. There is no expounding or discussion in these works, and the method consists in dogmatically stating certain principles or individual facts and then dogmatically denying them or asserting the contrary. The statements are represented as being uttered by Buddha and assented to or expanded by one of the great bodhisattvas, and hence as needing no justification. Whether a coherent metaphysical system lay behind them is not clear. The real metaphysic of Mahāyāna lies in the systems based on the doctrine of the void by Mahāyāna teachers. They sought to find an absolute not merely as ultimate goal, but as a cosmical principle. For Aśvaghosha (1st century A.D.) this was *tathatā* "suchness." His chief philosophical work, *The Awakening of Faith,* is known only through a Chinese translation. The most developed system is that of Nāgārjuna, who is usually placed in the 2nd century A.D. In his system the doctrine of the void becomes a doctrine of relativity. The truth of no individual fact can be asserted because nothing is real apart from the whole. The system is known as Śūnyavāda or Mādhyamika. The system of Asanga and Vasubandhu (5th century A.D.) is known as Yogāchāra or Vijñānavāda, in which everything is denied except consciousness (*vijñāna*). It is thus a system of subjective idealism. These two latter systems are important for the history of Indian philosophy, as they receive elaborate refutations in the commentaries on the orthodox philosophical sūtras, and the vedānta doctrine of māyā, cosmical illusion, has evidently adopted some of the principles of vijñānavāda.

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Kern, Oxford, 1884, in French by Burnouf as *Le Lotus de la bonne loi,* Paris, 1852); *Mahāyāna Texts* contains translations of *Vajracchedikā Prajñāpāramitā* and of several sūtras by Max Müller and others illustrating the worship of bodhisattvas. The most important work on Nāgārjuna's system is T. Stcherbatsky, *The Conception of Buddhist Nirvāna* (Leningrad, 1927); *cf.* A. B. Keith, *Buddhist philosophy* (1923); and D. T. Suzuki, *Outlines of Mahāyāna Buddhism* (1907). Later schools have developed in China and Japan. *See* Yamakami Sōgen, *Systems of Buddhistic Thought* (Calcutta, 1912).

(E. J. T.)

MAHDI (Arab. "he who is guided aright"), a title assumed by the third Abbasid caliph (*see* CALIPHATE). According to Moslem traditionists Mohammed declared that one of his descendants, the Imam of God, who would fill the earth with equity and justice, would bear the name of al-mahdi. The Sunnis hold that this mahdi has not yet appeared. The name of mahdi is also given by the Shiites to the last of the Imams of the house of Ali, who disappeared mysteriously about 874. It was under the name of al-mahdi that Mokhtar proclaimed Ali's son Mohammed as the opponent of the caliph Abdalmalik and, according to Shahrastani, the doctrine of the mahdi, the hidden deliverer who is one day to appear and fill the oppressed world with righteousness, first arose in connection with a belief that this Mohammed had not died but lived concealed at Mount Radwā, near Mecca, guarded by a lion and a panther. The belief in the appearance of the mahdi readily lent itself to imposture. Of the many pretenders to this dignity known in all periods of Moslem history the most famous was the first caliph of the Fatimite dynasty in North Africa, Obaidallah al-Mahdi, who reigned from 909 to 933. After him was named the first capital of the dynasty, the once important city of Mahdia (*q.v.*). Another great historical movement, headed by a leader who proclaimed himself the mahdi (Mohammed Ibn Abdallah Ibn Tumart), was that of the Almohades (*q.v.*).

In 1881 Mohammed Ahmed Ibn Seyyid Abdullah (*q.v.*), a Dongolese, proclaimed himself al-mahdi and founded in the eastern Sudan the short-lived empire which was overthrown by an Anglo-Egyptian force at the battle of Omdurman in 1898. Concurrently with the claim of Mohammed Ahmed to be the mahdi the same title was claimed by, or for, the head of the Senussi, a confraternity powerful in many regions of North Africa.

BIBLIOGRAPHY.—J. Darmesteter, *The Mahdī* (1885); D. S. Margoliouth, *On Mahdis and Mahdiism* (Proceedings of the British Academy, vol. VII, 1916); I. Goldziher, *Vorlesungen über den Islam* (1925).

MAHDIA (also spelt *Mehdia, Mehedia,* etc.), a port of Tunisia, on the coast between the gulfs of Hammamet and Gabes, 47 mi. by rail S.S.E. of Susa. Pop. (1936) 8,488, of whom 511 were Europeans. Mahdia is built on a rocky peninsula which projects eastward about a mile beyond the normal coast line, and is not more than a quarter of a mile wide. The extremity of the peninsula is called Ras Mahdia or Cape Africa—Africa being the name by which Mahdia was designated by Froissart and other European historians during the middle ages and the Renaissance. In the centre of the peninsula and occupying its highest point is a citadel (16th century); another castle farther west is now used as a prison and is in the centre of the native town.

The European quarter and the new port are on the southwest side of the peninsula. The small artificial harbour is available for small boats only; steamers anchor in the roadstead about a quarter of a mile from the shore. On the southeast, cut out of the rock, is the ancient harbour, or *cothon.* There are manufactories of olive oil.

Mahdia occupies the site of a Phoenician settlement on which grew a Roman centre, name unknown. After the Arab conquest of North Africa the town fell into decay. It was refounded in 912 by the first Fatimite caliph, Obaidallah al-Mahdi, after whom it was named. It became the port for Kairawan and was for centuries a city of considerable importance, largely owing to its great natural strength and its position on the Mediterranean. It carried on an active trade with Egypt, Syria and Spain. The town was occupied by the Normans of Sicily in the 12th century, but after holding it for about 12 years they were driven out in 1159 by the Almohades. In 1390 a joint English and French force vainly besieged Mahdia for 61 days. In the early part of the 16th century the corsair Dragut seized the town and made it his capital, but in 1550 the place was captured by the Spaniards, who held it until 1574. Before evacuating the town the Spaniards dismantled the fortifications. Near to Mahdia, about 3 mi. to the northeast of the lighthouse, were found in the sea, in 1908, at a depth of 528 ft., the remains of an ancient galley, of Athenian construction, laden with objects of art, and sunk in the first century A.D. Beautiful statues of bronze and many fragments found by divers are gathered together in the Alaoui museum at Tunis.

MAHÉ, a French settlement in the Malabar district of Madras, India, situated in 11° 43′ N. and 75° 33′ E., at the mouth of a river of the same name. Area, 26 sq.mi.; pop. (1941) 14,092. It is the only French possession on the west coast of India, and is in charge of an administrator, subordinate to the governor-general at Pondicherry. It is now a decaying place, with no foreign trade, but has municipal and local councils, and representation in the general council at Pondicherry and the French *Chambre des députés,* etc.

MAHESHWAR, a town in Indore state, Central India, on the north bank of the Narbada (Nerbudda). Pop. (1931), 6,399. Though of great antiquity, and also of religious sanctity, it is chiefly noted as having been the residence of Ahalyā Bāī, the famous queen of the Holkar dynasty during the last half of the 18th century.

MAHI, a river of western India, which rises in central India and, after flowing through south Rajputana, enters Gujarat and falls into the sea by a wide estuary near Cambay; total length, 300 mi.; estimated drainage area, 16,000 sq.mi. It gave its name to the former Mahi Kantha agency of Bombay.

MAHI KANTHA, former agency, India: *see* SABAR KANTHA.

MAHILLON, VICTOR (1841–1924), Belgian musical scholar, was born at Brussels on March 10, 1841, the son of Charles Mahillon (1813–1877), the founder of the famous firm of wind instrument makers. As honorary curator of the museum of the Brussels conservatoire he got together a magnificent collection of old musical instruments, and had reproductions made of many more. His most important literary work, embodying the results of life-long research, is contained in the catalogues of the museum which he began in 1877.

MAH JONGG, a name given to a Chinese game which enjoyed great popularity in the United States, England and Australia 1922–26, and again in the United States after 1935. The game is played with bone- or ivory-faced tiles similar in construction to dominoes but bearing on their faces Chinese characters together with English index letters and numerals. These tiles were an important export item to China for several years. In 1923 Mah Jongg sets, mostly of Chinese manufacture, outsold radios in the United States, though the two items sold in the same price range.

No game closely resembling Mah Jongg appears in the records of early Chinese games, though cards or dominoes similarly marked were used in other games. The game which came to be known as Mah Jongg was probably of 19th-century origin. It was known by different names in China and each name was differently pronounced in the several Chinese dialects, so that any number of transliterations have been advanced—principally *ma tsiang, ma cheuk, ma tseuk* (hempen birds, or sparrows). W. H. Wilkinson of her majesty's consular service observed the game in China in the last quarter of the 19th century and caused a card game of like nature to be published in London in 1894, calling it Khanhoo; it was unsuccessful. Joseph P. Babcock, a U.S. resident in Shanghai, was another who observed the Chinese game and, in 1919, conceived a plan for its introduction to the United States. He modified the rules somewhat and added to the tiles index letters and numerals such as the ones to which western card players were accustomed. He coined and trademarked the term *mah jongg* as the announcement of the winner. He formed a company which bought sets manufactured to this design in China and exported them to the United States. However, so many other Chinese manufacturers exported sets under names devised to evade the trade-mark (including the simple change to *mah jong*) that Babcock's original company made only a small portion of the sets which were sold before the fad ended.

The extensive literature which grew out of the mah jongg fad engendered dozens of fantastic legends as to the origin and romantic history of the game. None of these stories was documented and apparently none was authentic. The striking feature of mah jongg is its resemblance to coon-can and rummy (*qq.v.*), which appeared contemporaneously with Khanhoo. There is some reason for thinking that the Chinese domino game inspired the occidental card games, but it could have been the other way around.

Pieces.—Modern mah jongg sets are usually made of synthetic resins ("plastics") instead of bone. A full mah jongg set contains 136 or 144 tiles. These are named and numbered as follows:

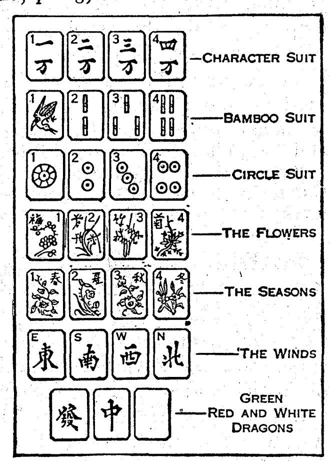
1. *Bamboos*, numbered 1 to 9, four of each number	36 tiles.
2. *Circles*, numbered 1 to 9, four of each number	36 tiles.
3. *Characters*, numbered 1 to 9, four of each number	36 tiles.
4. *Honours*, 4 red dragons, 4 green, 4 white dragons	12 tiles.
5. *Winds*, 4 east winds, 4 south winds, 4 west winds, 4 north winds	16 tiles.
	136 tiles.
In addition:—	
6. *Flowers and Seasons*, 4 of each or 8 of either	8 tiles.
	144 tiles.

The bamboos are often called *sticks*, the circles *dots*, the characters *cracks*. The set also includes two dice, a quantity of tokens used for scorekeeping and a rack for each player whereon he can place 14 tiles so that their faces will be visible only to himself.

Method of Play.—The usual game is for four, though variants have been devised for smaller and larger groups. The dice are thrown to assign one of the four "winds" or compass positions to each player. The tiles are shuffled face down, and a wall is built as a hollow square, two tiles high and 17 or 18 wide on each side (depending on whether the flowers are used).

East wind takes 14 tiles from the walls, and each other player 13; the order in which the tiles are taken is determined by throwing the dice. If the flowers are used, a flower in the hand is immediately *grounded* face up and another tile drawn to replace it.

The object is to form sets: *chow*, a sequence of three tiles in numerical order in the same suit; *pung*, three tiles of the same suit and rank, or three dragons of the same colour or three winds of the same direction; *kong*, a pung plus the fourth matching tile. The first player to hold four sets and a pair calls mah jongg and wins.



TILES OF COMMON SUITS AND HONOURS USED IN MAH JONGG

A full set contains 144 tiles, divided into 6 suits, but sometimes only 5 are used

East wind begins the play by discarding one tile, face up. Thereafter each player in rotation (which is counter-clockwise) draws either the last discard or a tile from the wall, then discards any one tile. Any player may claim the previous discard if it gives him a set; if two or more claim it, order of the precedence is: *woo* (ability to complete the hand with that tile); pung, kong, chow. As between equal claims, the player next in turn to play has precedence. A discard may be used only if it can at once be *grounded* (exposed face up on the table) as part of a set.

When a player wins, settlement is made on a schedule which assigns different values to different sets and combinations of sets. East wind always pays or collects double. Each player settles not only with the winner but also with each other player individually.

The style of play which became popular in the United States in the 1930s greatly complicated the schedule of values and made the play largely a matter of trying for the higher-scoring combinations.

There is a considerable element of skill to the play of mah jongg.

See J. P. Babcock, *Mah Jongg* (1920); Lee Foster Hartman, *Standardized Mah Jong*, (1924); E. S. Winters, *Ma Cheuk, as played by the Chinese* (1923); and on the later development of the game, Viola L. Cecil, *The New Mah Jongg* (1945).

MAHLER, GUSTAV (1860–1911), Austrian composer and conductor, was born at Kalischt, Bohemia, July 7, 1860. From 1885 onwards he conducted in Prague, Budapest, Hamburg and London, becoming director of the Vienna Opera in 1897. By unremitting zeal and tireless enthusiasm he brought the Viennese opera to a high state of perfection, but the strenuous work which he exacted from all earned him the name of "the tyrant" and made him many enemies, and in 1907 he was obliged to resign his post. He immediately received the offer of a conductorship in America, which he visited for three seasons, returning to Vienna in 1911, where he died on May 18. Mahler reflected to some extent in his works the classical tradition inherited from Schubert and Bruckner. In addition to his songs and chamber music, he wrote no fewer than nine symphonies, planned on a gigantic scale for an orchestra nearly doubled in strength.

See R. Specht, *Gustav Mahler*, etc. (1913); P. Stefan, *Gustav Mahler, a Study of his Personality and Work* (1913); G. Adler, *Gustav Mahler* (Vienna, 1916); P. Bekker, *Gustav Mahler's Sinfonien* (1921); R. Mengelberg, *Gustav Mahler* (Leipzig, 1923).

MAHLSTICK, a stick with a soft leather or padded head, used by painters to support the hand that holds the brush. The word is an adaptation of the Dutch *maalstok*, *i.e.*, the painter's stick, from *malen*, to paint.

MAHMUD I (1696–1754), sultan of Turkey, the son of Mustafa II, succeeded his uncle Ahmed III in 1730. After the suppression of a military revolt the war with Persia was continued with varying success, and terminated in 1736 by a treaty of peace restoring the *status quo ante bellum*. Turkey had next to face Russia, later joined by Austria. War went on for four years; the successes gained by Russia were outweighed by Austria's various reverses, terminating by the defeat of Wallis at Krotzka, and the peace concluded at Belgrade was a triumph for Turkish diplomacy. The sultan, throughout desirous of peace, is said to have been much under the influence of the chief eunuch, Haji Beshir Aga. In 1754 Mahmud died of heart-disease. He built numberless kiosques, where nocturnal orgies were carried on by him and his boon companions. In this reign the system of appointing Phanariote Greeks to the principalities of Moldavia and Walachia was instituted. (*See* PHANARIOTES.)

MAHMUD II (1785–1839), sultan of Turkey, was the son of Abdul-Hamid I, and succeeded his brother, Mustafa IV, in 1808. He had shared the captivity of his ill-fated cousin, the ex-sultan, Selim III, whose efforts at reform had ended in his deposition by the janissaries. The reforming efforts of the grand vizier Bairakdar, to whom he had owed his life and his accession, broke down on the opposition of the janissaries; and Mahmud had to wait for more favourable times. Meanwhile the empire seemed in danger of breaking up. In 1812 the war with Russia was closed by the Treaty of Bucharest, which restored Moldavia and the greater part of Wallachia to the Ottoman Government. But the terms of the treaty left a number of burning questions, both internal and external, unsettled; notably in the case of the claim of Russia to Poti and the valley of the Rion (Phasis), which was still outstanding at the time of the congress of Vienna (1814–15) and prevented the question of a European guarantee of the integrity of Turkey from being considered.

Meanwhile, within the empire, ambitious valis were one by one attempting to carve out dominions for themselves at the expense of the central power. The ambitions of Mehemet Ali of Egypt were not yet fully revealed; but Ali (*q.v.*) of Jannina, who had marched to the aid of the sultan against the rebellious pasha Pasvan Oglu of Widdin, soon began to show his hand, and it needed the concentration of all the forces of the Turkish empire to effect his overthrow and death (1822). The preoccupation of the sultan with Ali gave their opportunity to the Greeks whose disaffection had long been organized in the great secret society of the *Hetaeria Philike,* against which Metternich had in vain warned the Ottoman Government. In 1821 occurred the abortive raid of Alexander Ypsilanti into the Danubian principalities, and in May of the same year the revolt of the Greeks of the Morea began the war of Greek Independence. (*See* GREECE: *Modern History.*) The rising in the north was easily crushed; but in the south the Ottoman power was hampered by the defection of the sea-faring Greeks, by whom the Turkish navy had hitherto been manned.

After three abortive campaigns Mahmud was compelled, infinitely against his will, to summon to his assistance the already too powerful pasha of Egypt, Mehemet Ali, whom he had already employed to suppress the rebellious Wahhabis in Arabia. The disciplined Egyptian army, supported by a well organized fleet, rapidly accomplished what the Turks had failed to do; and by 1826 the Greeks were practically subdued on land, and Ibrahim was preparing to turn his attention to the islands. But for the intervention of the Powers and the battle of Navarino Mahmud's authority would have been restored in Greece. The news of Navarino betrayed Mahmud into one of those paroxysms of rage to which he was liable, and which on critical occasions were apt fatally to cloud his usual good sense. After in vain attempting to obtain an apology for "the unparalleled outrage against a friendly power" he issued on Dec. 20 a solemn *hatti sheriff* summoning the faithful to a holy war. This, together with certain outstanding grievances and the pretext of enforcing the settlement of the Greek Question approved by the Powers, gave Russia the excuse for declaring war against Turkey. After two hardly fought campaigns (1828, 1829) Mahmud was at length, on Sept. 14, 1829, compelled to sign the Peace of Adrianople.

From this moment until his death Mahmud was, to all intents and purposes, the "vassal of Russia," though not without occasional desperate efforts to break his chains. (For the political events of the period between the first revolt of Mehemet Ali [Sept. 1832] and the death of Mahmud *see* MOHAMMED ALI.) The personal attitude of the sultan, which alone concerns us here, was determined throughout by his overmastering hatred of the upstart pasha, of whom he had stooped to ask aid, and who now defied his will; and the importance of this attitude lies in the fact that, as the result of the success of his centralizing policy, and notably of the destruction of the janissaries (*q.v.*), the supreme authority, hitherto limited by the practical power of the ministers of the Porte and by the turbulence of the privileged military caste, had become concentrated in his own person.

This omnipotence of the sultan in deciding the policy of the Government was in striking contrast with his impotence in enforcing his views on his subjects and in his relations with foreign powers. Mahmud, in spite of—or rather because of—his well-meant efforts at reform, was hated by his Mussulman subjects and stigmatized as an "infidel" and a traitor to Islam. Mahmud's policy was the converse of that recommended by Machiavelli, viz., in making a revolution to change the substance while preserving the semblance of the old order. Metternich's advice to Mahmud to "remain a Turk" was sound enough. His failure to do so—in externals—left him isolated in his empire: *rayahs* and true believers alike distrusted and hated him. Of this hatred he was fully conscious; he knew that his subjects, even many of his own ministers, regarded Mehemet Ali as the champion of Islam against the "infidel sultan"; he suspected the pasha, already master of the sacred cities, of an intention to proclaim himself caliph in his stead. This, together with the weakness due to military reforms but recently begun, drove him to rely on the aid of Russia. The long tradition of French friendship for Turkey had been broken, in 1830, by the conquest of Algiers. Austria was, for the time, but the faithful ally of the tsar.

On Aug. 9, 1832, Mahmud made, through Stratford Canning, a formal proposal for an alliance with Great Britain, which Palmerston refused to consider for fear of offending France. Mahmud bitterly contrasted the fair professions of England with the offers of effective help from Russia. His old ally having deserted him, he accepted the aid of his hereditary foe. The Russian expedition to the Bosporus, the convention of Kutaiah, and the Treaty of Unkiar Skelessi (July 8, 1833) followed. Mahmud was under no illusion as to the position in which the latter placed him towards Russia; but his fear of Mehemet Ali and his desire to be revenged upon him out-weighed all other considerations. With his single aim in view he busied himself with the creation of a national militia, with the aid of Moltke and other German officers. In 1834 the revolt of Syria against Ibrahim seemed to give him his opportunity. He pleaded the duty of a sultan to go to the aid of his subjects when oppressed by one of his servants; but the Powers were obdurate, even Russia, much occupied in affairs nearer home, leaving him in the lurch.

Mahmud was astute enough to take advantage of the offence given to the Powers by Mehemet Ali's system of monopolies, and in 1838 signed with Great Britain, and afterwards with others, a commercial treaty which cut at the root of the pasha's system. A few months later his passionate impatience overcame his policy and his fears. The hand of death was upon him, and he felt that he must strike now or never. In vain the Powers, now united in their views, warned him of the probable consequences of any aggressive action on his part. On his sole initiative he sent instructions to Hafiz Pasha, commanding the Ottoman troops concentrated at Bir on the Euphrates, to advance into Syria. The fatal outcome of the campaign that followed he did not live to hear. When the news of Ibrahim's overwhelming victory at Nessib (June 24, 1839) reached Constantinople, Mahmud lay unconscious. He died early in the morning of July 1.

Mahmud II. cannot be reckoned among the great sultans, neither had he any of the calculating statecraft which characterized Abd-ul-Hamid II.; but his qualities of mind and heart, none the less, raised him far above the mass of his predecessors and successors. He was well versed in State affairs and loyal to those who advised and served him, personally brave, humane and kindly when not maddened by passion, active and energetic, and always a man of his word. Unhappily, however, the taint of the immemorial corruption of Byzantium had fallen upon him too, and the avenue to his favour and to political power lay too often through unspeakable paths. When he came to the throne the empire was breaking up from within; one by one he freed the provinces from the tyrannical rulers who, like Ali of Jannina, were carving out independent, or quasi-independent, empires within the empire. If he failed in his wider schemes of reform, it was because it is impossible to impose any system, however admirable, from above on a people whose deepest convictions and prejudices it offends.

There is a great deal of valuable material for the history of Mahmud and his policy in the unpublished Foreign Office records (1832–39), volumes of correspondence marked *Turkey.—From Sir Stratford Canning.—From Mr. Mandeville.—From Lord Ponsonby. See* further works mentioned under TURKEY: *History;* and MEHEMET ALI.

(W. A. P.; X.)

MAHMUD NEDIM PASHA (*c.* 1818–1883), Turkish statesman, was the son of Nejib Pasha, ex-governor-general of Baghdad. He was successively under-secretary of State for foreign affairs, governor-general of Syria and Smyrna, minister of commerce, and governor-general of Tripoli; minister successively of justice and of marine (1869); grand vizier in 1871 and 1872 and in 1875 and 1876. He was high in favour with Sultan Abd-ul Aziz and fell much under the influence of General Ignatiev, the forceful Russian ambassador, before the war of 1877–78, his subserviency to Russia earning for him in the nickname of "Mahmudoff." His administration was most unsuccessful, and he was largely responsible for the issue of the decree suspending the interest on the Turkish funds. He was minister of the interior from 1879 to 1883.

MAHMUD[1] OF GHAZNI (971–1030), son of Sabuktagīn, Afghan conqueror, was born on Oct. 2, 971. His fame rests on

[1]The name is strictly Maḥmūd.

his repeated invasions of India. His military capacity, inherited from his father, Nasir-ud-din Sabuktagīn, was strengthened by youthful experience in the field. Sabuktagīn, a Turki slave of Alptagīn, governor of Khurasan under Abdalmalik I. b. Nuḥ of the Samanid dynasty of Bukhara, early brought himself to notice. (*See* SAMANIDS.) He was raised to high office in the state by Alptagīn's successor, Abū Ishāk, and in A.H. 366 (A.D. 977), by the choice of the nobles of Ghazni, he became their ruler. He soon began to make conquests in the neighbouring countries, and in these wars he was accompanied by his young son Mahmud.

In 994 Mahmud was made governor of Khurasan, with the title of Saif addaula (ud-daula) ("Sword of the State") by the Sāmānīd Nūh II. Two years later, his father Sabuktagīn died in the neighbourhood of Balkh, having declared his second son, Ismail, who was then with him, to be his successor. As soon as Ismail had assumed the sovereignty at Balkh, Mahmud, who was at Nishapur, addressed him in friendly terms, proposing a division of the territories held by their father at his death. Ismail rejected the proposal, and was immediately attacked by Mahmud and defeated. Retreating to Ghazni, he there yielded, and was imprisoned, and Mahmud obtained undisputed power as sovereign of Khurasan and Ghazni (997).

The Ghaznevid dynasty is sometimes reckoned by native historians to commence with Sabuktagīn's conquest of Bost and Kosdār (978). But Sabuktagīn, throughout his reign at Ghazni, continued to acknowledge the Sāmānid suzerainty, as did Mahmud also, until the time, soon after succeeding to his father's dominions, when he received from Qādir, caliph of Baghdad (*see* CALIPHATE, C. § 25), a *khilat* (robe of honour), with a letter recognizing his sovereignty, and conferring on him the titles *Yamīn-addaula* ("Right hand of the State"), and *Amīn-ul-Millat* ("Guardian of the Faith"). From this time it is the name of the caliph that is inscribed on Mahmud's coins, together with his own new titles.

The new honours received from the caliph gave fresh impulse to Mahmud's zeal on behalf of Islam, and he resolved on an annual expedition against the idolaters of India. He could not quite carry out this intention, but a great part of his reign was occupied with his Indian campaigns. In 1000 he started on the first of these expeditions, but he went no farther than the hill country near Peshawar. Mahmud's army first crossed the Indus in 1001, opposed by Jaipāl, raja of Lahore. Jaipāl was defeated, and Mahmud, after his return from this expedition, is said to have taken the distinctive appellation of *Ghāzi* ("Valiant for the Faith"), but he is rarely so-called. On the next occasion (1005) Mahmud advanced, as far as Bhera on the Jhelum, when his adversary Anang-pāl, son and successor of Jaipāl, fled to Kashmir. The following year saw Mahmud at Multan. When he was in the Punjab at this time, he heard of the invasion of Khurasan by the Ilek Khan Nasr I. ruler of Transoxiana whose daughter Mahmud had married. After a rapid march back from India, Mahmud repelled the invaders. The Ilek Khan, having retreated across the Oxus, returned with reinforcements, and took up a position a few miles from Balkh, but was defeated by Mahmud.

Mahmud again entered the Punjab in 1008, this time for the express purpose of chastising Sēwah Pāl, who, having become a Mussulman, and been left by Mahmud in charge of Multan, had relapsed to Hinduism. The Indian campaign of 1009 was notable. Near the Indus Mahmud was opposed again by Anang-pāl, supported by powerful rajas from other parts of India. After a severe fight, Anang-pāl's elephants were so terror-struck by the fire-missiles flung amongst them by the invaders that they turned and fled, the whole army retreating in confusion and leaving Mahmud master of the field. Mahmud, after this victory, pushed on through the Punjab to Nagar-kōt (Kangra), and carried off much spoil from the Hindu temples to enrich his treasury at Ghazni. In 1011 Mahmud, after a short campaign against the Afghans under Mohammed ibn Sūr in the hill country of Ghur, marched again into the Punjab. The next time (1014) he advanced to Thanēsar between the Sutlej and the Jumna.

Before beginning his inroad into Hindustan he had to march north into Khwārizm (Khiva) against his brother-in-law Mamūn, who had refused to acknowledge Mahmud's supremacy. The result was as usual, and Mahmud, having committed Khwārizm to a new ruler, one of Mamūn's chief officers, returned to his capital. Then in 1018, with a very large force, he proceeded to India again, extending his inroad this time to the great Hindu cities of Mathra on the Jumna and Kanauj on the Ganges. He reduced the one, received the submission of the other, and carried back great stores of plunder. Three years later he went into India again, marching over nearly the same ground, to the support, this time, of the raja of Kanauj, who, having made friendship with the Mohammedan invader on his last visit, had been attacked by the raja of Kalinjar. But Mahmud found he had not yet sufficiently subdued the idolaters nearer his own border, between Kabul and the Indus, and the campaign of 1022 was directed against them, and reached no farther than Peshawar. Another march into India the following year was made direct to Gwalior.

The next expedition (1025) is the most famous of all. The point to which it was directed was the temple of Somnath on the coast of the Gujarāt peninsula. After an arduous journey by Multan, and through part of Rajputana, he reached Somnath, and met with a very vigorous but fruitless resistance on the part of the Hindus of Gujarāt. Moslem feet soon trod the courts of the great temple. The chief object of worship it contained was broken up, and the fragments kept to be carried off to Ghazni. For the more recent story of the Somnath gates *see* SOMNATH.

After the successes at Somnath, Mahmud remained some months in India before returning to Ghazni. Then in 1026 he crossed the Indus once more into the Punjab. His brilliant military career closed with an expedition to Persia, in the third year after this, his last, visit to India. The Indian campaigns of Mahmud and his father were almost, but not altogether, unvarying successes. The Moslem historians touch lightly on reverses. And, although the annals of Rajputana tell how Sabuktagīn was defeated by one raja of Ajmere and Mahmud by his successor, the course of events which followed shows how little these and other reverses affected the invader's progress. Mahmud's failure at Ajmere, when the brave raja Bisal-deo obliged him to raise the siege but was himself slain, was when the Moslem army was on its way to Somnath. Yet Mahmud's Indian conquests, striking and important in themselves, were, after all, in great measure barren, except to the Ghazni treasury. Mahmud retained no possessions in India under his own direct rule. But after the repeated defeats, by his father and himself, of two successive rajas of Lahore, the conqueror assumed the right of nominating the governors of the Punjab as a dependency of Ghazni, a right which continued to be exercised by seven of his successors. And for a time, in the reign of Masa'ud II. (1098–1114), Lahore was used as the residence of the reigning Ghaznevid sovereign.

Mahmud died at Ghazni in 1030, the year following his expedition to Persia. He is conspicuous for his military ardour, his ambition, strong will, perseverance, watchfulness and energy, combined with great courage and unbounded self-reliance. But his tastes were not exclusively military. His love of literature brought men of learning to Ghazni, and his acquaintance with Moslem theology was recognized by the learned doctors.

The principal histories of Mahmud's reign are—*Kitāb-i-Yamīnī* (Utbi); *Tarīkh-us-Subuktigīn* (Baihaki); *Tabakāt i Nasiri* (Minhāj el-Sirāj); *Rauzat-us-Safa* (Mir Khond); *Habīb-us-Sivar* (Khondamir). *See* Elliot, *History of India;* Elphinstone, *History of India;* and Roos-Keppel's translation of the *Tarīkh-i-Sultan Mahmūd-i-Ghaznavi* (1901).

MAHOBA, an ancient town in India, in Hamirpur district of the United Provinces. Pop. (1941) 17,224. As the capital of the Chandel dynasty, who ruled over Bundelkhand from the 9th to the 13th century, the neighbourhood is covered with architectural antiquities, prominent among which are artificial lakes, formed by banking up valleys with masonry dams. The largest of these is more than 4 m. in circuit.

MAHOGANY, a dark-coloured wood largely used for household furniture, the product of large trees of the genus *Swietenia* (Meliaceae), indigenous to Central America, northern South America and the West Indies. It was originally received from Jamaica; 521,300 ft. were exported from that island in 1753. The important commercial species of Central America is *S. macrophylla* while that of the West Indies is *S. mahagoni.* They bear compound leaves, resembling those of the ash, and clusters of small flowers, with five sepals and petals and ten stamens which are united into a tube. The fruit is a pear-shaped woody capsule, and contains many winged seeds. The most valuable product is the timber, first noticed by the carpenter on board Sir Walter Raleigh's ship in 1595 for its great beauty, hardness and durability. Dr. Gibbons brought it into notice as well adapted for furniture in the early part of the 18th century, and its use as a cabinet wood was first practically established by the cabinet-maker Wollaston, who was employed by Gibbons to work up some mahogany brought to England by his brother. It was introduced into India in 1795, and is now cultivated in Bengal and as far north as Saharanpur.

The timber of species of *Cedrela* and *Melia,* other members of the family Meliaceae, are used as mahogany, and the product of the West African *Khaya senegalensis* is known as African mahogany. There is much confusion between the product of these various trees. *Kiggelaria dregeana* (family Bixaceae), a native of South Africa, is known as Natal mahogany.

In North America several small trees of the genus *Cercocarpus* (fam. Rosaceae, *q.v.*), with very hard, fine-grained, reddish wood, are called mountain mahogany. The curl-leaf mountain mahogany (*C. ledifolius*), sometimes 40 ft. high, is found from Colorado and Wyoming to California and Washington. The hairy mountain mahogany (*C. paucidentatus*) occurs from western Texas to Arizona. The birch-leaf mountain mahogany (*C. betuloides*), the alder-leaf mountain mahogany (*C. alnifolius*) and the Trask mountain mahogany (*C. Traskiae*) are confined to southern California. The last mentioned, named for its discoverer, Mrs. Blanche Trask, and known only from Santa Catalina (*q.v.*) island, is one of the rarest of American trees. The small-leaf mountain mahogany (*C. parviflorus*) is a common shrub of the chaparral (*q.v.*) throughout the Sierra Nevada and Coast ranges of California. The dry wood of the trunk is so extremely dense that it is difficult to drive ordinary nails into it, whence the name hard tack given to this shrub by mountaineers. The mahogany sumach (*Rhus integrifolia*), a handsome evergreen shrub or small tree of southern California and adjacent Mexico, is sometimes called California mahogany.

MAHONE, WILLIAM (1826–1895), American soldier and senator, was born near Monroe, Va., on Dec. 1, 1826. In 1847 he graduated at the Virginia Military Academy and, having studied civil engineering, became chief engineer of the Norfolk and Petersburg railway. At the outbreak of the Civil War he became lieutenant-colonel of Virginia volunteers in the Confederate army, and soon after colonel of the Sixth Virginia Infantry. He participated in most of the battles of the peninsula and those around Petersburg, winning a reputation for his hardy campaigning. He was commissioned brigadier-general in March and major-general in August 1864 He afterwards commanded a division in Ambrose B. Hill's Corp. After the war he again turned to railway affairs and became president of the Norfolk and Tennessee. He became the leader of the readjuster party in Virginia, was an unsuccessful candidate for governor in 1878, but in 1880 was elected U.S. senator, which position he held until his defeat in 1887. He died at Washington, D.C., on Oct. 8, 1895.

MAHONIA, a genus of unarmed evergreen shrubs (family Berberidaceae), closely allied to the barberry (*q.v.*) and considered by some as a section of *Berberis.* The mahonias differ from the true barberries mainly in having compound leaves and a calyx of 9 sepals. There are about 50 species of *Mahonia,* found chiefly in Asia, western North America and Central America. Several are cultivated for their ornamental foliage, flowers and fruit, including the Oregon-grape (*q.v.*); the Japanese mahonia (*M. japonica*), native to China; and *M. fortunei,* also native to China and named after the English traveller, Robert Fortune.

MAHONY, FRANCIS SYLVESTER (1804–1866), known as "Father Prout," Irish priest and author, son of a woollen manufacturer, was born in Cork in 1804. His classical education was chiefly obtained at a Jesuit College at Amiens, and after studying in Paris he entered the Jesuit College at Rome and was admitted into the Society of Jesus. He served in Switzerland and at Clongoweswood, Ireland, where he was prefect of studies and subsequently master of rhetoric. Here he was involved in scandals that led to his resignation. On going to Italy he was told at Florence that he was expelled from the society. He obtained priest's orders at Rome in 1832, and returned to Ireland, later officiating in the chapel of the Bavarian Legation in London. He fell in with William Maginn, and about 1834 began to contribute his celebrated "Prout Papers" to *Fraser's Magazine.* These consist of episodes in the life of the parish priest "Father Prout," and dialogues after the model of "Christopher North." Of his poetic writings, his "Bells of Shandon" has always been greatly admired. His verse tends to show that with all his sarcastic and cynical wit his genius had also its tender, serious and sentimental side. In 1846 Mahony became correspondent at Rome to the *Daily News,* and his letters from that capital give very vivid pictures of the first years of the reign of Pius IX. He died in Paris on May 18, 1866.

An edition of his works, by Charles Kent, was published in 1881.

MAHOUT, an elephant-driver. The mahout sits on the elephant's neck and directs him by voice and by the use of a goad called *ankus.*

MAHRATTAS. The Mahrattas are a mixed people inhabiting Central India from Gwalior to Goa. Their religion is Hinduism and their language is Marathi. Their origin is obscure, but they seem to have entered India before Mahmud of Ghazni with his Mohammedan horde conquered Indian states in the early 11th century. The real founder of the Mahrattas as a power was Sivaji Bhonsla (1627–80). He gradually succeeded in compelling the independent chiefs to acknowledge his suzerainty, and drawing upon their military resources he subdued much of the territory of the emperor of Delhi. In 1674 he was proclaimed maharajah of the Konkan, and he instituted a levy of a fourth of the land revenues. Sivaji was succeeded by his son, Sambaji, in 1680, and in 1689 the latter was captured and put to death by Aurangzeb (*q.v.*). Thereafter, there being no stable rule in existence, the *peshwas* or chief ministers indulged their ambitions to the full and the Mahrattas began to decline, being divided among themselves.

Sivaji's successor was merely a titular monarch, the *peshwa* becoming the hereditary ruler. These *peshwas* were Brahman by faith and gradually the struggle became one between the military and religious powers. In the early 18th century the five Mahratta states of Baroda, Gwalior, Indore, Nagpur and the "dominions of the Peshwa" were constituted. Owing to internal strife the East India company was forced to intervene. When, in 1739, Nadir Shah invaded the empire of Delhi the *peshwas* saw an opportunity of seizing further territory from the mogul emperor. In 1761 their power was almost irretrievably destroyed in their defeat by Ahmad Shah, ruler of Afghanistan, at the battle of Panipat. In 1779 began a series of wars between the Mahrattas and the British and the names of Wellesley and Lake are famous in connection with the brilliant victories over the soldiers of Indore, Nagpur and Gwalior in the third Mahratta War (1803–05). The efforts of these officers resulted in the accession of much territory to the British flag. In 1817 the Mahratta *peshwa* united with Nagpur and Indore in attacking the British forces, and the result was the annexation of the *peshwa's* territories to the presidency of Bombay. Later, Indore and Nagpur were annexed by the British and the state of Gwalior was brought under British control in the middle of the 19th century. At the present day there are special titles for the rulers of the Mahratta states, the ruler of Indore being known as Holkar of Indore, Sindia of Gwalior, and Gaikwar of Baroda. These are family names.

See J. Grant Duff, *History of the Mahrattas* (3 vols., 1826); T. D. Broughton, *Letters Written in a Mahratta Camp* (1813); M. G. Ranade, *Rise of the Maratha Power* (Bombay, 1900); Index to the *Imperial Gazetteer of India* (1909).

MAHSEER (*Barbus mosal*), a large-scaled barbel of the rivers of India, attaining a weight of over 100 lb. and celebrated as a sporting-fish.

MAI, ANGELO (1782–1854), Italian cardinal and philologist, was born of humble parents at Schilpario in the province of Bergamo, Lombardy, on March 7, 1782, was made a cardinal in 1838, and died at Castelgandolfo on Sept. 8, 1854. He was educated at the Collegium Romanum, and after teaching at Orvieto and elsewhere was made custodian of the Ambrosian library at Milan in 1813. He went to Rome in 1819 as chief keeper of the Vatican library.

It is on his skill as a reader of palimpsests that Mai's fame chiefly rests. To the period of his residence at Milan belong: Fragments of Cicero's *Pro Scauro, Pro Tullio, Pro Flacco, In Clodium et Curionem, De aere alieno Milonis, De rege Alexandrino* (1814); *M. Corn. Frontonis opera inedita, cum epistolis item ineditis, Antonini Pii, Marci Aurelii, Lucii Veri et Appiani* (1815; new ed., 1823, with more than 100 additional letters found in the Vatican library); portions of eight speeches of Quintus Aurelius Symmachus; fragments of Plautus; the oration of Isaeus *De hereditate Cleonymi;* the last nine books of the *Antiquities* of Dionysius of Halicarnassus, and a number of other works. *M. Tullii Ciceronis de republica quae supersunt* appeared at Rome in 1822; *Scriptorum veterum nova collectio, e vaticanis codicibus edita* in 1825–38; *Classici scriptores e vaticanis codicibus editi* in 1828–38; *Spicilegium romanum* in 1839–44; and *Patrum nova bibliotheca* in 1845–53.

See B. Prina, *Biografia del cardinale Angelo Mai* (Bergamo, 1882), a scientific work, which gives a full and, at the same time, a just appreciation of his work; Cozza-Luzi, *Epistolario del card. Angelo Mai* (Bergamo, 1883); life by G. Poletto (Siena, 1887).

MAIA (mī'yạ). (1) In Greek mythology, the eldest of the Pleiades, the seven daughters of Atlas and the Oceanid Pleïone, mother of Hermes (*q.v.*). (2) An obscure Roman goddess, also called Maiesta, the cult-partner of Volcanus; commonly confused with (1) in poetry and later cult.

MAIDAN, a term used in Morocco and other parts of the Arabic-speaking East for an open space, usually in front of a palace. It is used generally in the Middle East to signify an open plain, *e.g.,* Maidan park, Calcutta. It is a common part of place-names in Afghanistan and Persia.

MAIDEN or **MAID,** a young unmarried girl. "Maid" is a shortened form of "maiden," O. Eng. *maegden,* which represents a diminutive of a Teutonic word meaning "young person," of either sex. An old English word "may," meaning a kinsman or kinswoman, and also a virgin or girl, represents the original. In early usage "maiden" as meaning "virgin" is frequently applied to the male sex, thus, in Malory's *Morte d' Arthur,* Sir Percyvale is called a "parfyte clene megden."

The title of "Maid of Honour" is given to an unmarried lady attached to the personal suite of a queen. The custom of sending young girls of noble or good birth to the court of a prince or feudal superior, for the purpose, primarily, of education, goes back to early feudal times, and is parallel with the sending of boys to act as pages and squires to the feudal castles. The regular establishment of maids of honour (*filles d'honneur*) appears first in the French court. As an institution they were suppressed in the reign of Louis XIV., at the instigation of Mme. de Montespan—who had been one of them—and their place was taken by the *dames de palais.* In the English court, this custom of attaching "maids of honour" to the queen's person was no doubt adopted from France. At the present day a queen regnant has eight maids of honour, a queen consort four. They take precedence next after the daughters of barons, and where they have not by right or courtesy a title of their own, they are styled "Honourable."

The Scottish Maiden was an instrument of capital punishment formerly in use in Scotland. It is said to have been invented by the earl of Morton, who is also said to have been its first victim. But the maiden was first used at the execution of the inferior agents in the assassination of Rizzio (1561) and Morton was not beheaded till 1581. The maiden was practically an early form of guillotine. A loaded blade or axe moving in grooves was fixed in a frame about 10 ft. high. The axe was raised to the full height of the frame and then released, severing the victim's head from his body. At least 120 suffered death by the maiden, including the regent Morton, Sir John Gordon of Haddo, President Spottiswood, the marquis and earl of Argyll. In 1710 it ceased to be used; it is now preserved in the museum of the Society of Antiquaries of Scotland, in Edinburgh.

MAIDENHAIR, in botany, the common name for a fern, *Adiantum Capillus-Veneris,* characterized by the spreading hair-like branches of the frond, the ultimate pinnules of which are ½ to 1 in. long with a rounded crenate outer edge and repeatedly forked veins; the sori (or masses of spore-capsules) are in the crenatures of the pinnules, and are protected by kidney-shaped indusia. The plant is widely distributed in temperate and tropical regions and is occasionally found in the western counties of England, the Isle of Man and west Ireland, growing on damp rocks or walls especially near the sea. In the United States it occurs from Virginia to Florida and west to Missouri, southern British Columbia and California. The more northern American maidenhair (*A. pedatum*), a larger and very beautiful fern, grows in woods from Nova Scotia to Alaska, south to Georgia and Arkansas, in the Rocky mountains to Utah and to California. The genus *Adiantum* is a large one containing many handsome species both tropical and temperate, well known in greenhouse and hothouse cultivation.

Maidenhair-tree is a popular name for *Ginkgo biloba,* a remarkable and handsome gymnospermous tree, the fan-shaped leaves of which with their forked veins recall those of the maidenhair. (*See* Ginkgo; Gymnosperms.)

MAIDENHEAD, a municipal borough of Berkshire, England; 24½ mi. W. of London by rail. Pop. (est. 1938) 23,070. Edward I. (1297) gave a grant of pontage in aid of Maidenhead bridge, which was almost broken down; similar grants were made later. In 1451 Henry VI. incorporated the guild of the Brethren and Sisters of Maydenhith to keep the bridge in order: the guild, dissolved at the Reformation, was revived by Elizabeth, who, in 1581 substituted for it a corporation. The governing charter until the 19th century was that of James I. (1685). In the 18th century a considerable river trade was done in malt, meal and timber. The Wednesday market is held under a charter of Elizabeth. Maidenhead is a residential town and a boating centre. A timbered house of the 15th century survives in Ockwells. The present stone bridge carrying the London road over the Thames dates from 1772. Trade is in malt and grain. Area 7.8 sq.mi.

MAID MARIAN, a personage incorporated in the English legend of Robin Hood (*q.v.*). She seems to have been an essential feature of the morris dance, and in the may-game was paired sometimes with Robin Hood, but oftener with Friar Tuck. The well-known pastoral play of Adam de la Hale, *Jeu de Robin et Marion,* and the many French songs on the subject, account for the association of the names. In the ballads on Robin Hood her name is only twice mentioned, but there is a late ballad, by a certain S. G. (F. J. Child, *English and Scottish Ballads,* i. 219), which tells how Maid Marian sought Robin in the forest disguised as a page, and fought with him for an hour before she recognized him by his voice. S. G. was perhaps acquainted with the two plays, written in 1598, of *The Downfall* and *The Death of Robert Earl of Huntingdon,* by Anthony Munday and Harry Chettle. In *The Downfall* Matilda Fitz Walter escapes from the persecution of King John by following her lover to Sherwood forest, where they take the names of Robin Hood and Maid Marian. Perhaps this tale has some connection with the romance of the outlaw, Fulk Fitz Warin. Matilda or Mahaud, widow of Theobald Walter, escaped from John's solicitations by marrying the outlawed Fulk and following him to the forest. There were in semi-historical legends three Matildas pursued by King John, of whom particulars are given by H. L. D. Ward in his *Catalogue of Romances* (i. 502). Their several histories were fused by the Elizabethan dramatists, and associated with the Maid Marian of the morris dance who up to that time had probably only a vague connection with Robin Hood.

MAIDSTONE, market town, municipal borough and county town of Kent, England, in the Maidstone parliamentary division, 41 mi. E.S.E. of London by the Southern railway. Pop. (est. 1938) 47,630. Area 9.3 sq.mi. There is evidence of a Roman settlement, but the name Maidstone (Medwegestun, Meddestane, Maydestan), probably meaning Medway town, is presumably Saxon. At the time of the Domesday survey the town belonged to the archbishop of Canterbury, and from the reign of John to the Reformation the archbishops had a residence there. The shire-moot was held on Penenden heath in the 11th century, and Maidstone was an assize town in the reign of Edward I. Wat Tyler, leader of the peasants' revolt of 1381, was a native of Maidstone. In 1537 Cranmer exchanged the manor of Maidstone with the king, and it was granted by Edward VI to Sir Thomas Wyatt. Edward also incorporated the town but this charter was forfeited through Wyatt's rebellion; a second charter was granted by Elizabeth in 1559 and a new one by George II in 1747. This remained the governing charter until 1835. Four fairs, still held, were granted by the charter of 1559. A Thursday market was granted by Henry III to Archbishop Boniface, and a market every second Tuesday in the month by charter of George II. A corn market on Thursday and a cattle market on Tuesday are still held.

The manufacture of linen and woollen goods was introduced by Walloons, who settled there in 1567. This was succeeded by paper-making, now the chief industry of the town, which is also the principal grain centre in the county. The cultivation of hops has been carried on since the 17th century, and there are large breweries and maltings. Other industries are quarrying for Kentish rag, agricultural implement making, iron founding, and manufacturing hop bags, matting, sacking, etc., besides cement and lime works. The water traffic on the Medway is now comparatively small.

Archbishop Boniface in 1260 established a hospital there (Newark hospital) for poor pilgrims, the chapel of which, with modern additions, is now St. Peter's church. The parish church of St. Mary, which had existed from Norman times, was demolished in 1395 by Archbishop Courtenay, who erected on the site the present Church of All Saints. The ruins of Courtenay's college of secular canons are interesting 14th-century architecture. A Perpendicular building, with an Elizabethan east front, now houses the school of science and art. The grammar school was founded in 1549 and endowed with the estates of the local Corpus Christi fraternity, then dissolved; the gild hall remains, but the school is in modern buildings on a new site. A museum, with public library, was opened in 1858, in an early 16th-century building, which is the headquarters of the Kent Archaeological society. From Saxon times down to 1830 executions and all the great county meetings took place on Penenden heath, a common enclosed as a public recreation ground. In 1929 the corporation bought the Mote estate of 558 ac. and converted it into a public park and housing estate. A new courthouse was opened in 1937.

MAIDU. This Indian group, of Penutian (*q.v.*) stock, lived in California east of Sacramento river. Dialectically it comprises three divisions, north-western, north-eastern and southern or Nisinan; but a physiographically founded cultural cleavage into Maidu of the valley, foot-hills, and mountains is more significant. The valley division was wealthiest and most advanced, and together with the Patwin west of the Sacramento had developed the Hesi form of the Kuksu cult, a spirit-impersonating religion with initiating societies, which appears to mark the culminating point of central Californian culture. The name Maidu, pronounced My-doo, means "people." The population, originally 8–10,000, was 1,100 in 1910, including mixed bloods.

See R. B. Dixon, *Bull. Am. Mus. Nat. Hist.*, vol. xvii. (1905).

MAIHAR, a state in the Central India agency. Area, 412 sq.mi.; pop. (1941) 79,558. The state, which is watered by the Tons river, consists mainly of alluvial soil covering sandstone, and is fertile except in the hilly district of the south. A large area is under forest. The ruler, whose title is raja, claims descent from the Kachwaha Rajput clan. His salute is nine guns. The town of Maihar (pop. 7,678) is on the East Indian railway, 97 mi. N. of Jubbulpore. Ruins nearby indicate that the place was formerly much more extensively occupied.

MAILLOL, ARISTIDE (1861–1944), French sculptor, was born at Banyuls sur Mer, Rousillon. After studying at Perpignan he entered the studio of Cabanel in Paris, at the age of 21, as a student of painting. He belonged to a group of young artists who, inspired by Gauguin, abandoned impressionism for a more decorative form of art. In order to realize his aspirations, he worked on tapestry design; he built majolica vases and experimented with glazes; he modelled wall fountains with figures in relief; and finally he tried his hand very successfully at small figures in clay. He then began his great statues in stone and bronze, which established his reputation as the greatest French sculptor of his time. He found in the early 5th-century art of Greece the confirmation of his artistic aspirations. The sense of proportion and feeling for unity, the harmony of the masses which Greek art displays, became the guiding principles on which he modelled his figures. In 1909 he visited Greece in company of Count Kessler, his enthusiastic admirer and friend, for whose Cranach Press he executed a series of wood engravings to illustrate the Eclogues of Virgil. Maillol was a member of the Salon d'Automne and a regular exhibitor at the Salon des Independants. He worked in close contact with nature in his native fishing village on the shores of the Mediterranean, and spent some months of the year at Marly, near Paris.

Among his monumental works are the standing figures of Flora (1911) and Pomona (1912) in the Morrozoff collection at Winterthur; the two "Crouching Women" of Osthaus, in Hagen, and of Count Kessler's collection, Berlin; the war monuments at Elne, Céret and Port Vendres; the reclining goddess of "Fame" for the monument to Cézanne, on which he worked during ten years, and which he completed in 1925. His little terra-cotta statuettes are among his most attractive work. Maillol died in Oct. 1944.

See Octave Mirbeau, *Aristide Maillol* (1922); Marc Lafargue, *Aristide Maillol* (1925).

MAIL-ORDER BUSINESS, a retail commercial enterprise carried on entirely or almost entirely by mail. Its customers, from illustrated catalogues which are sent to them by mail, order general merchandise of every description and receive their merchandise by parcel post, express or freight from either central storage or shipping points or direct from the factory, permitting in many instances appreciable savings through reduction in transportation and handling costs, which, in turn, are passed along to the benefit of the customers in the form of lower prices.

American mail-order business received its initial impulse from a natural desire on the part of the average individual to buy dependable merchandise at below prevailing retail prices. It took concrete form about 1872 in the organization of farmer grange alliances and similar associations for the purpose of collective buying. The movement was promptly capitalized by the pioneers in the industry, who sought to attract sales from printed lists of merchandise instead of selling over the counter. The complete success of the mail-order business is due to the fact that it not only maintains as its creed lower prices and better quality, but strictly honest dealing and a broad guarantee of satisfaction.

In early days distribution of merchandise was uncertain and was accomplished almost entirely through jobbing houses or manufacturers' representatives, who sold to the retail dealer, who, in turn, sold to the user. The mail-order business cut through those slow and expensive methods of distribution. It eliminated the middleman, with his added profit and expense; saved that amount, and thus materially lowered the cost of merchandise to its customers.

As time went on, improved manufacturing methods produced better goods at steadily lowering costs; transportation facilities grew more efficient; the parcel post was established; and scientifically worked out systems made it easier every year to handle, pack and ship vast quantities of merchandise with precision and dispatch and at a minimum of expenditure. Every advance of this nature lowered retail selling prices still more. Then the mail-order business began to come into its own, its pronounced growth dating from about the beginning of the 20th century.

The early years of the business were not marked by that fine regard for the ethics of the successful commercial enterprise of to-day. Not infrequently overstatement and exaggeration, if not downright misrepresentation, characterized the descriptions in the catalogue. But the conviction gradually grew that misrepresentation was not only immoral, but unprofitable. The mail-order house began to censor its catalogue descriptions with more care and with a keener eye for the truth. To that fact; to the outstanding advantages of this method of shopping, especially to people in rural districts; to its guarantee of satisfaction strictly adhered to; and to the low prices and complete assortments offered, the mail-order house may attribute its remarkable growth.

Reasons for Success.—The mail-order business has materially reduced the cost of living for millions of people; has been one of the biggest factors in establishing the now generally accepted principle of one price to all; has become so thoroughly stabilized that the catalogues of the larger houses of to-day are to a great extent the merchandise price standards of the country. Not only do the successful mail-order houses strive for truth in their advertising and cataloguing, but they exert themselves to a considerable extent to safeguard their customers even against themselves. They refuse to catalogue and sell merchandise which is harmful or against public interest. For instance patent medicines, many of which are injurious, are no longer advertised, only those medicines being offered which are officially approved by leading drug and medical associations. Furthermore, late years have seen a marked increase in laboratory tests to assure serviceability and at least minimum standards of quality in merchandise advertised.

Cutting Costs in Buying.—The first great economy effected by the mail-order houses, is the elimination of the middleman. Almost without exception, they buy from the factory and sell to the user. The big houses buy in vast quantities, and for cash. They not infrequently take over the entire product of a factory. They place huge orders with factories during their otherwise slack seasons, cutting costs still more. Where they find that they can more advantageously manufacture the article themselves, they are prepared to do so. The smaller houses, of course, cannot avail themselves of all these ways of reducing costs; but they all, to a certain extent, employ the same means to the same end.

Operating Economies Developed.—In the operating methods also great economies are brought about, especially in the larger mail-order houses, in the handling, packing and shipping of merchandise. Orders to the mail-order house correspond to customers in the retail store, but the mail-order house has a great economic advantage in that the number of orders (or customers) at any given time of the day can be controlled. Under the schedule system which was originated by Sears, Roebuck and Company of Chicago, the largest of all mail-order houses, and which moves with the smoothness and exactness of a precision instrument, orders are scheduled every ten minutes, the quantity, which varies greatly with the seasons, depending upon the number received during the day. Thus, they have an uninterrupted flow of business which is the same at 8 o'clock in the morning as it is at any other period of the day, and the rush hours and slack periods experienced by retail stores are eliminated. Orders move through the various departments of the house all day long, and in rush seasons far into the night, on this ten minute schedule. An order which is received at, say, 8 o'clock in the morning may be scheduled to be shipped at ten minutes after 1 o'clock that afternoon. At precisely 1.10 P.M. that merchandise is in the shipping room being packed. A few minutes later it is on its way to the customer along with thousands of other orders scheduled for the same hour and minute. The 1.10 shipments out of the way, the packing room occupies itself with those scheduled for 1.20, but not a 1.20 order is touched until every 1.10 order is disposed of. This schedule is feasible only because it is possible to determine at the beginning of the day just how many orders the various merchandise departments will be called upon to handle. And its perfect operation makes possible the 24-hour service which fills and ships 99 out of every 100 orders within 24 hours after they are received. The even, uninterrupted flow of orders to the merchandise departments prevents an overload one hour and a slack time the next. The distribution of these orders is based on the averages which, in this instance, are determined by years of experience.

One single mail-order house, Sears, Roebuck and Company, for example, receives in an average day approximately 4,400lb. of first class mail at all its branches. This more than two tons of mail per day represents a total of 242,000 letters. Before the mail is taken out of the sacks, it is weighed, and by its weight the company is able to determine with sufficient accuracy for all purposes how many orders have been received. A thousand pounds of mail averages 55,000 letters; out of the 55,000 letters a certain percentage contains orders; the balance is given up to miscellaneous correspondence. Experience tells also what the percentage of orders received at 9 o'clock is as compared to the total orders that will be received that day. Therefore, by weighing the mail received and deducting miscellaneous correspondence, how many orders will be received that day can very easily be determined. With this knowledge at the beginning of the day and at intervals throughout the day, it is possible to fix shipping times and pass orders along to the various merchandise departments at a rate which will keep them running easily and steadily without hitch or break.

The average value of the orders varies with the season, but past experience has given the mail-order house an accurate chart of what this seasonable variation is; so that not only is the number of orders approximately determined by this process of calculation, but their gross value as well, and the day's total sales can be computed with amazing accuracy before the day is well begun.

Machines and mechanical aids of every possible sort are employed. Man power is eliminated wherever a machine will do the work better and quicker—particularly quicker. Machines open the mail at the rate of 450 letters a minute, at the same time stamping the date on the envelope. Pneumatic tubes, endless belt conveyors, chutes, electric trucks do their part in the distribution of orders to the merchandise departments and in the handling of the merchandise thereafter. Supplementing all this is the high specialization of head and hand work. One corps of employees does nothing but remove letters and orders from envelopes. They pin the cheques and money orders to the order sheets and letters which they accompany. Another group tallies the amounts sent with the orders, notes the amounts on the orders, detaches the remittances to be sent to the cashier's office, and passes the orders to another division. Here the orders are sorted by still other highly expert persons, recorded and finally distributed to the merchandise departments. All work with great rapidity. A mail-order house is divided into many distinct merchandise departments, such as furniture, piece goods, hardware, phonographs and pianos, hosiery, stoves, etc. These are scattered over many acres of floor space. A single order from a customer may call for merchandise from one or perhaps 20 or more of these departments. The problem then is to bring the merchandise from each of these departments into a certain section of the shipping room at a certain hour and minute in order that they may be packed together, or at least shipped simultaneously.

Let us suppose there is an order on 20 different departments scheduled for shipment at 10 A.M. Expert typists have drawn off on 20 separate sheets the orders for each of the 20 departments involved. These sheets are sent by pneumatic tubes to the departments, where trained stock men and order fillers take them in hand. Carefully checked and rechecked to avoid mistakes, the merchandise goes by chutes, endless belt conveyors and other mechanical devices to that part of the shipping room designated. From all 20 departments it arrives there by 10 A.M.—not more than 20 minutes before—not one minute after. Everywhere is system, precision, intelligently applied energy. There is little room for lost motion anywhere. There are no idle clerks waiting for customers, nor taking time to explain, describe or sell. Thus, throughout the entire system—buying, handling, shipping—substantial savings are made of time and money. And these are reflected in the low retail prices found in the catalogue.

A General Survey.—It is impossible to estimate accurately the number of mail-order houses in America to-day. Besides those carrying a general merchandise line, with business running into hundreds of millions of dollars a year, such as Sears, Roebuck and Company, or Montgomery Ward and Company, there are hundreds of individuals and organizations doing business by mail, selling limited lines of merchandise or specialties only. No authoritative figures as to the aggregate amount of business done by mail in the United States is available, but the magnitude of the business may be seen in some degree from the fact that one mail-order house alone, Sears, Roebuck and Company, for the year 1937 served approximately 11,000,000 families who purchased nearly 48,000,000 separate orders. This volume, handled swiftly and smoothly by the company's efficient schedule system, was moved through large plants located in 10 metropolitan centres of the United States. Making proper allowance for duplications in names (two or more customers in one family), which it is not always possible to avoid, a conservative estimate places the number of people in the United States buying from this one organization alone at probably one-third the entire population.

From the magnitude of the industry and its steady growth, it is evident that the mail-order business is a vital factor in the commercial life of the nation and one which is each year playing a more important part.

Bibliography.—Verneur Edmund Pratt, *Selling by Mail* (1924); H. J. Buckley, *Mail Order and Trade Paper Advertising* (1937); E. A. Buckley, *How to Sell by Mail* (1938). (R. E. W.; X.)

MAIMANA, a town and khanate of Afghan Turkistan. The town is situated 100 m. S.W. of Balkh, and only some 25 m. from the frontier of Russian Turkistan. It is about two-thirds the size of Herat, square built and surrounded by a ruined wall and moat. The khanate was for long in dispute between Bukhara and Kabul, but in 1868 Abdur Rahman laid siege to the town, and it was compelled to come to terms. Its political status as an Afghan province was definitely fixed by the Russo-Afghan boundary commission of 1885. The inhabitants are chiefly Uzbegs.

MAIMBOURG, LOUIS (1610–1686), French Jesuit and historian, was born at Nancy on Jan. 10, 1610. He entered the Society of Jesus at the age of sixteen. After having taken some part in minor controversies he threw himself with energy into the dispute on the Gallican Liberties; for his *Traité historique sur les prérogatives de l'Église de Rome* (4 vols., 1685; mod. ed., 1831) he was by command of Innocent XI. expelled from the Society, but rewarded by Louis XIV. with a residence at the abbey of St. Victor, Paris, and a pension. He died on Aug. 13, 1686. His *Oeuvres complètes* were published in 14 vols. (1686–87); *Oeuvres choisies,* ed. J. P. Migne (1846).

MAIMING, mutilation, a physical injury which involves the loss of, or incapacity to use, a bodily member. Maiming or mutilation is and has been practised by many races with various ethnical and religious significances, and was a customary form of punishment on the principle of an "eye for an eye" (*see* Mutilations and Deformations). In law "maiming" is a criminal offence; the old law term employed for a special case of maiming of persons was "mayhem" (*q.v.*), an Anglo-French variant form of the word. The punishment incurred for maiming of cattle in Great Britain is 13 to 14 years' penal servitude. Malicious injury to other animals is a misdemeanour punishable on summary conviction. For a second offence the penalty is imprisonment with hard labour for over 12 months. (Malicious Damage Act 1861.) Maiming means the permanent injury of the animal but the Statute of 1861 also makes wounding an animal an offence. Maiming of animals by their owner falls under the Cruelty to Animals acts, and the Protection of Animals acts 1911 and 1912.

MAIMON, SALOMON (1754–1800), German philosopher, was born of Jewish parentage in Polish Lithuania, and died at Nieder-Siegersdorf on Nov. 22, 1800. He married at the age of 12, and studied medicine in Berlin. In 1770 he severed his connection with his orthodox co-religionists by his critical commentary on the *Moreh Nebuhim* of Maimonides, and devoted himself to the study of philosophy on the lines of Wolff and Moses Mendelssohn. After many vicissitudes he found a quiet home with Count Kalkreuth at Nieder-Siegersdorf in 1790, and began to publish the works which have made his reputation as a critical philosopher. In 1788 he made the acquaintance of the Kantian philosophy, which was to form the basis of his lifework, and in 1790 he published the *Versuch über die Transcendental-philosophie,* in which he formulates his objections to the system. Maimon takes a view intermediate between Kant and Hume. Hume's attitude to the empirical is entirely supported by Maimon. The casual concept, as given by experience, expresses not a necessary objective order of things, but an ordered scheme of perception; it is subjective and cannot be postulated as a concrete law apart from consciousness. The main argument of the *Transcendentalphilosophie* not only drew from Kant, who saw it in ms., the remark that Maimon alone of all his critics had mastered the true meaning of his philosophy, but also directed the path of most subsequent criticism.

Maimon's other principal works are: *Philos. Wörterbuch* (1791); *Streifereien im Gebiete der Philos.* (1793); *Über die Progresse der Philos.* (1793); *Die Kategorien des Aristoteles mit Anmerkungen erläutert* (1794); *Versuch einer neuen Logik* (1794 and 1798; new ed. by the Kant-Gesellschaft, ed. B.C. Engel, 1912); *Kritische Untersuchungen über den menschl. Geist* (1797).

See *S. Maimons Lebensgeschichte von ihm selbst beschrieben* (1792, ed. K. P. Moritz; Eng. trans. by J. C. Murray, 1888); Wolff, *Maimoniana* (1813); Witte, *S. Maimon* (1876).

MAIMONIDES (Rabbi Moses Ben Maimon) (1135–1204), also known from the initials of these last words as Rambam, Jewish philosopher and master of Rabbinic literature, was born in Cordova on March 30, 1135, and educated by his father and by Arabic masters. When Cordova was taken by the victorious Almohades in 1148 the position of the Jews became intolerable, and Maimonides, after ten years of wandering, decided to settle in Fez. Five years later he moved to Cairo where he became recognized as the greatest Rabbinic authority of his time. He was appointed body physician to Saladin, and married the sister of Ibn al Māli, one of the royal secretaries. Maimonides died on Dec. 13, 1204.

In his important philosophical treatise, *The Guide for the Perplexed,* a work which strongly influenced his Arabian, Jewish and Christian successors, Maimonides seeks to harmonize Biblical and Rabbinic teaching with philosophy, and especially with the philosophy of Aristotle. At the same time, he recognizes that reason is limited and requires to be supplemented by revelation. The first book, which is concerned with the establishment of the spirituality of God, discusses the figurative meaning of anthropomorphic expressions applied to God in the Scriptures, the impropriety of assigning to Him any attributes other than negative ones, and, lastly, the Mutakallmun doctrines of God and their scientific basis. Book II. proves the existence of God by the argument of the unmoved mover, and by the distinction between the necessary and the possible and between the necessary and the contingent. Aristotle's cosmology is then accepted in outline and his separate intelligences moving the celestial spheres are identified with the angels of Scripture. Aristotle's doctrine of the eternity of the world Maimonides finds less acceptable because it obviously clashes with Scripture. He suggests that the account of creation in Genesis must be interpreted allegorically, and seeks to show that while reason cannot prove the *productio ex nihilo* of the world, such a *productio* is not contrary to reason; in fact, it is more acceptable than the theory of Aristotle because it substitutes for the idea of mechanical necessity the conception of an intelligent being acting purposively. On the other hand, Maimonides contends that the objections raised against the eternity of the world are unsatisfactory and that Aristotle's view may have been merely tentative. The second book ends with a discussion of the requisites of prophecy. Book III. treats of evil as the privation of good and as originating in free-will, of the Divine knowledge of singulars and of Providence, of design in nature, in the law and in Biblical narrative, and, lastly, of moral precepts.

The *Guide* was published by S. Munk (3 volumes, Paris, 1856–66), English translation by M. Friedländer (3 volumes, 1881–85), reissued in one volume, of which the last edition appeared in 1925. Of the numerous other works of Maimonides the chief are the commentary on the *Mishnah* (Hebrew translation, Naples, 1492). The eight chapters prefaced to the commentary on tractate Aboth were translated into English by J. I. Gorfinkle (New York, 1912); the *Mishnah Torah* (last edition, Leipzig, 1862, partial English translation by E. Soloweyczik, 1863); *Kitab al-Fara'id* (Hebrew translation, Lisbon, 1497; French translation by M.

Bloch, 1888); *Responsa* (edition 1859); a work on the terminology of logic (Latin translation, Venice, 1552; German translation, Breslau, 1828) and a treatise on poisons (French translation, Paris, 1865).

See D. Yellin and I. Abrahams, *Maimonides* (1903); J. Guttmann, *Moses ben Maimon* (2 vols., Leipzig, 1908 and 1914); L. J. Lévy, *Maimonide* (1911); J. Munz, *Moses ben Maimon* (Frankfurt, 1912); A. Rohner, *Das Schöpfungsproblem bei Moses Maimonides, etc.* (Münster, 1913); I. Husik, *Hist. of Mediaeval Jewish Philosophy* (New York, 1916); A. Cohen, *The Teachings of Maimonides* (1927), and C. Singer, *The Legacy of Israel* (Oxford, 1927).

MAIN, a river of Germany, 310 m. long and the most important right-bank tributary of the Rhine. It has two sources, the Weisse Main (White Main) which rises in the granitic rocks of the Fichtelgebirge, and the Rote Main (Red Main), which, rising on the eastern slope of the Jurassic rocks of the Frankish Jura, flows past Bayreuth. They unite near Kulmbach after which the river, flowing north-west keeps to the Trias, and flows round the north end of the Frankish Jura to Bamberg. Here it receives its chief tributary, the Regnitz (left), and enters upon its middle course. Flowing amid vine-clad hills it passes Würzburg, and thence, dividing the forest-clad ranges of the Spessart and the Odenwald, reaches Gemünden. Here it is joined by the Frankish Saale (right) and turning abruptly south, receives at Wertheim the beautiful Tauber (left). From the latter it proceeds due north to Aschaffenburg, whence passing Frankfort it joins the Rhine just above Mainz. It is navigable from the confluence of the Regnitz for barges and other small craft, and through the Ludwigs canal is connected with the Danube. (*See* RHINE.)

MAIN, power or strength; *e.g.,* the expression "with might and main" (Lat. *magnus,* great). "The main," the high open sea, is for "main sea," *cf.* "mainland," the principal part of a territory excluding islands and sometimes far-projecting peninsulas. The "Spanish main" was the mainland of the north-east coast of South America, stretching from the Orinoco to the Isthmus of Panama, and the former Spanish possessions in Central America bordering on the Caribbean Sea, or more loosely, the Caribbean Sea itself. The principal pipe or cable for gas, water, electricity, etc., is called the "main." In cockfighting, "main" has signified both the match and the birds. In hazard it is the number called by the "caster" before the dice are thrown; this may be any number from five to nine inclusive; hence the expression "main chance." "Main," a shortened form of domain or demesne, survives in Scotland, usually in the plural "mains" for a home farm.

MAINA (or MANI) and **MAINOTES,** a district and people of the Peloponnesus, the modern Morea. Maina is the country occupied by the mountain range of Taygetus from Sparta to Cape Matapan, the ancient Taenarum. It is now divided between the modern districts Oetylos and Gythion. It contained over a hundred villages. The Mainotes claim to descend from the Spartans, and probably represent the Eleuthero Laconians delivered by Rome from the power of Sparta, as is suggested by traces of ancient Greek in their dialect and by their physical type. They did not become Christians till the 9th century.

Their country being a natural fortress, they were able to defend themselves against the Byzantine emperors, the barbarian invaders, the Latin princes of Achaea of the house of Villehardouin, and the Turks. As their country is also poor and maritime, they were early tempted to piratical adventure. Gibbon has referred to "the inhuman pillage of all that is shipwrecked on their rocky shore." Their neighbours gave their country the name of "Kakoboulia" —the land of wicked counsels. The passes of their mountains and their villages were fortified, so leading to their favourite epithet, Maina Polypyrgos—"many-towered." On the western side are the remains of feudal keeps, erected by William II. de Villehardouin (1245–1278) and other Latin princes of Achaea. From the 15th till the 17th century they recognized as head chiefs a family which claimed to belong to the Comneni of Trebizond. But the real power was in the hands of chiefs, a turbulent and martial aristocracy. Feuds were enduring and ferocious.

In the 18th century the family of Mavromicheli (Black Michael), in lower Maina, established a general headship after much strife and many murders. The Mainotes rose against the Turks at Russian instigation in 1770 and managed to gain virtual independence in 1777. During the Greek war of independence the Mainotes were led by Petros (Petro Bey) Mavromicheli, "the king of Maina," who undoubtedly cherished the hope of establishing a principality for himself. The freedom of Greece, for which he had fought in his own way, was the ruin of his ambition. He found the new order less compatible with his schemes than the Turkish dominion, and was imprisoned by the Greek president Capodistrias (*see* CAPO D'ISTRIA, COUNT), who was in revenge murdered by the Mavromichelis. The family were finally content to become courtiers and officials in the reign of King Otho I. In the 19th century Maina was but little affected by civilization, except so far as navies prevented piracy.

See W. Martin Leake, *Travels in the Morea* (1830); M. E. Yemeniz, "La Maina," in *Revue des deux mondes* (March 1, 1865); and Philipson, "Zur Ethnographie des Peloponnes," in *Petermanns Mittheilungen,* vol. 36 (Gotha).

MAINAN, an independent linguistic stock of South American Indians, so called from the Mainas, one of its important tribes. This stock occupies a considerable area in north-eastern Peru, on the north side of the Marañon between the lower Pastaza and Tigre rivers, and south of it on the Samiria and lower Huallaga rivers, extending to the Mayo, and westward to the Potro. The Jeberos (Xeberos), often confounded with the Jivaran (*q.v.*), are members of this group. The tribes of this stock were sedentary agriculturists, pottery and textile makers, and greatly given to taking enemy heads, shrinking and preserving them as do the Jivaros. They now retain little of their original culture.

See F. de Figueroa, "Relación de las Misiones . . . *en el Pais de los Maynas,*" Col. de Libros y Documentos referentes a la Historia de America, vol. i. (Madrid, 1904).

MAINE, SIR HENRY JAMES SUMNER (1822–1888), English comparative jurist and historian, son of Dr. James Maine, of Kelso, Roxburghshire, was born on Aug. 15, 1822. He was educated at Christ's Hospital and Pembroke college, Cambridge. In 1847 he was appointed regius professor of civil law, and he was called to the bar three years later; he held this chair till 1854. Even the rudiments of Roman law were not then included in the ordinary training of English lawyers. Maine's lectures as reader to the Inns of Court were the groundwork of *Ancient Law* (1861), the book which made his reputation at one stroke. Its object was "to indicate some of the earliest ideas of mankind, as they are reflected in ancient law, and to point out the relation of those ideas to modern thought."

From 1863 to 1869 Maine was legal member of council in India. Plans of codification of Indian law were prepared, and largely shaped, under the direction of Maine, and they were carried into effect by his successors, Sir J. Fitzjames Stephen and Dr. Whitley Stokes. The results are open to criticism in details, but form on the whole a remarkable achievement in the conversion of unwritten and highly technical law into a body of written law sufficiently clear to be administered by officers to many of whom its ideas and language are foreign. All this was in addition to the routine of legislative and consulting work and the establishment of the legislative department of the Government of India on substantially its present footing.

Maine brought back from his Indian office a store of knowledge which enriched all his later writings, though he took India by name for his theme only once. Three of his addresses as vice-chancellor of Calcutta university were published, wholly or in part, in the later editions of *Village Communities;* the substance of others is understood to be embodied in the Cambridge Rede lecture of 1875, which is to be found in the same volume. The practical side of Maine's experience was not long lost to India; he became a member of the secretary of State's council in 1871, and remained so for the rest of his life. In 1869, Maine was appointed to the new chair of historical and comparative jurisprudence at Oxford. During the succeeding years he published the principal matters of his lectures in a carefully revised literary form: *Village Communities in the East and the West* (1871); *Early History of Institutions* (1875); *Early Law and Custom* (1883). In all these works the phenomena of societies in an archaic stage, whether still capable of observation or surviving in a fragmentary manner among more modern surroundings or preserved in contemporary records, are brought into line, often with singular felicity, to establish and illustrate the normal process of development in legal and political ideas.

In 1877 Maine became master of Trinity Hall, Cambridge, and in 1887 Whewell professor of international law. This branch of his work is represented by a posthumous volume which had not received his own final revision, *International Law* (1888). Meanwhile he had published in 1885 his one work of speculative politics, a volume of essays on *Popular Government,* designed to show that democracy is not in itself more stable than any other form of government, and that there is no necessary connection between democracy and progress. The book was deliberately unpopular in tone; it excited much controversial comment and some serious and useful discussion.

Maine's health, which had never been strong, gave way towards the end of 1887. He went to the Riviera under medical advice, and died at Cannes on Feb. 3, 1888. His work was promptly and fully appreciated on the Continent, where it has perhaps been understood better than in England that it is as the pioneer of a method that he must be estimated. But his basic conception of the development of law is disputable. A Hegelian in philosophy, he regards law as developing "from status to contract," from a state in which legal relations are independent of the will to one in which they flow from it. But was this conception a part of Roman law at all, or imported into it by the school of Savigny? Is the movement anything more than from the group to the individual, and was the growing importance of contract not due rather to Stoic conceptions of duty than to 19th century conceptions of the value of the will? The tendency he postulated was certainly that of his time; the tendency to-day seems to be the other way.

See Sir A. Lyall and others, in *Law Quart. Rev. iv.* 129 *seq.* (1888); Sir F. Pollock, "Sir Henry Maine and his Work," in *Oxford Lectures,* etc. (1890); "Sir H. Maine as a Jurist," *Edin. Rev.* (July 1893); Introduction and Notes to new ed. of *Ancient Law* (1906); Sir M. E. Grant Duff, *Sir Henry Maine: a brief Memoir of his Life,* etc. (1892); L. Stephen, "Maine" in *Dict. Nat. Biog.* (1893); P. Vinogradoff, *The Teaching of Sir Henry Maine* (1904).

MAINE, an old French province, bounded on the north by Normandy, east by Orléanais, south by Touraine and Anjou, and west by Brittany. Under the Roman empire it consisted of two *civitates* comprised in the Provincia Lugdunensis Tertia—the Civitas Cenomannorum and the Civitas Diablintum, whose chief towns were Le Mans and Jublains. These two *civitates* were united during the barbarian period and formed a single bishopric, that of Le Mans, suffragan to the metropolitan see of Tours. Under the Merovingians and Carolingians the diocese of Le Mans corresponded to the Pagus Cenomanensis, and in the feudal period to the county of Maine. In the 16th century the county of Maine, with the addition of Perche, formed a military government—the province of Maine. Since 1790 this province has been represented approximately by the departments of Sarthe and Mayenne, the respective capitals of which are Le Mans and Laval. In 1855 the bishopric of Laval was separated from that of Le Mans. Roger (*c.* 892–*c.* 898) was perhaps the first hereditary count of Maine. In the 12th century, Maine was attached to Anjou (*q.v.*) till 1204, when it was united to the royal domain. In 1246 it was given by Louis IX. to his brother Charles, count of Provence. Again united to France in 1328, it was given in 1356 as an apanage to Louis, second son of King John II., and did not definitely return to the French crown until 1481, after the death of Charles II., count of Maine. During the Hundred Years' War Maine was taken in 1425 by the English, who lost it in 1448.

MAINE, is the most northeasterly State of the United States of America and the largest State in New England. It lies between 43° 4′ and 47° 27′ 33″ N. and between 66° 56′ 48″ and 71° 6′ 41″ W. and is bounded on the north-west by Quebec; north and east by New Brunswick; south-south-east by the Atlantic ocean; and west by New Hampshire. It has an area of 33,215 sq.mi., 2,175 sq.mi. being water surface. Owing to its forest, it is known as the "Pine Tree State."

Physical Features.—Considering the area as a whole, the surface of Maine is a gently rolling upland, above which rise mountain peaks, isolated and in clusters and below which are numerous river valleys. The highest peak is Mt. Katahdin (5,200ft.) others being: Saddleback mountain (4,000ft.), Mt. Abraham (3,388ft.), Mt. Bigelow (3,600ft.), and Mt. Blue (3,200ft.). A little north of this line of mountain peaks is the water-parting which divides the State into a north slope and a south slope. The north slope though quite hilly in the middle and west is so poorly drained that swamps abound in all sections. The south slope, which contains nearly all the mountains and is generally more hilly, has a mean descent toward the sea of about 7ft. to the mile.

After the uplift, which caused the rivers to cut below the general "uplands" and develop well-marked valleys for themselves, came the period of the great continental glaciation. The glacier or ice sheet overran all Maine, irregularly scouring out the bed rock to produce rock basins, damming up many river valleys with glacial deposits, and completely disarranging the drainage lines. When the ice melted the rock basins and the dammed-up valleys filled with water and became lakes. These lakes are more than 1,600 in number, are scattered in all parts of the State, are especially numerous at high elevations, and have an aggregate area in excess of 2,000 sq. miles. Few other regions have so many large lakes so variously situated and with such beauty of aspect and surroundings. They contribute largely to a constant supply of water-power, for which the rivers of south-west Maine are exceptionally well adapted. Moosehead lake (about 120 sq.m.; 35m. long and from 2m. to 10m. wide), on the boundary between Piscataquis and Somerset counties, is the largest in Maine and the largest inland body of water wholly in New England; the Kennebec river is its principal outlet. Mt. Kineo rises abruptly to about 1,760ft. above the sea and about 700ft. above the lake on its eastern shore. Other lakes, such as the Rangeley lakes, Chesuncook and Twin lakes on the Penobscot, and the Grand or Schoodic lakes, on the eastern boundary at the head waters of the St. Croix river, equal or surpass Moosehead in picturesqueness. Glaciation is responsible for the poor soil of most of the State; for, although the rocks are the same crystallines that give good soils farther south in unglaciated regions, glacial erosion has removed decayed portions of the Maine rocks, revealing fresh, barren rock over great areas, and in other places hardpan or boulder clay has been deposited as a thin coating.

After the uplift came a period of subsidence, during which this region sank one or more thousand feet, allowing the sea to encroach on the land and run far inland into the previously made river valleys. This depression probably occurred during the glacial period, perhaps toward its close, and is responsible for the second most important feature of Maine physiography, the embayed coast. To this subsidence are due the picturesque coastal scenery, the numerous islands and bays, the good harbours and the peculiar coast line. The shortest distance between the north-east and south-west extremities of the coast is only 225m., but, on account of projections and indentations, the coast line measures not less than 2,500 miles. The headlands, the deep indentations and the numerous islands in the bays and beyond produce a beautiful mingling of land and sea, and give to the whole ocean front the appearance of a fringed and tasselled border. West of the mouth of the Kennebec river are a marshy shore and many low grassy islands; but east of this river the shore becomes more and more bold, rising in the precipitous cliffs and rounded summits of Mt. Desert and Quoddy Head, 1,532 and 180ft. high, respectively. All along the coast-line there are capacious and well-protected harbours, Casco, Penobscot, Frenchman's, Machias and Passamaquoddy bays being especially noteworthy. After the subsidence came another period of uplift, possibly still in progress. This uplift has brought up submarine deposits of sand, etc., to form little coastal plains at some points along the coast, providing good land for settlement and clay for brick and pottery. Evidence of this uplift is found in old beach lines now above sea-level.

The principal river systems of Maine are the St. John on the north slope, and the Penobscot, the Kennebec, the Androscoggin and the Saco on the south slope. The Penobscot, Kennebec, Androscoggin and Saco have numerous falls and rapids.

The climate of the state is moist and, for the latitude, cold. The precipitation is about 42·5 in. annually and is distributed very evenly throughout the year, 10 to 11 in. of rain or its equivalent in snow falling each season. The snowfall varies from about 60 in. on the coast to more than 100 in. on the north slope, the average for the state being about 83 in. The summers are short, there being only about four and a half months between frosts, even in the southern section. The heat of summer is tempered by the sea and cool north winds, the mean summer temperature being about 62° F. The mean winter temperature is approximately 20° F., and the mean annual temperature for the entire state is 42° F., that for the north slope being about 5° lower than that for the south slope. Although the temperature remains rather steadily below the freezing point for at least three months of the year, many of the harbours remain unobstructed for the tides and the prevailing off-shore winds break up and drive off the ice.

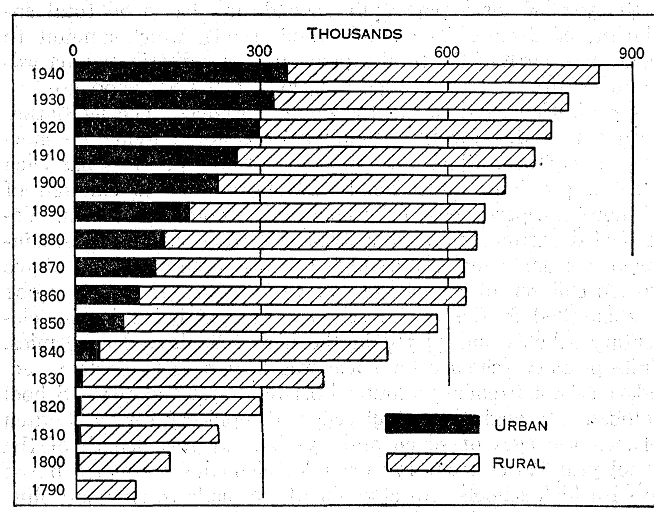
Government.—Maine is the only state in the union in which state elections are not held in November; they are held in September in even-numbered years. The state has had but one constitution; this was ratified in Dec. 1819, about three months before the admission of the state into the union. It admits of amendment by a two-thirds vote of both houses of the legislature, followed by a majority vote of the electorate at the next September election; or, as provided by an amendment adopted in 1875, the legislature may by a two-thirds vote of each house summon a Constitutional Convention. From 1819 to 1875 12 amendments were adopted; in 1875, after nine more were added, the 21 were incorporated in the text; and between 1875 and 1941, 40 more were adopted. The governor is the only executive officer of the state elected by popular vote. There is no lieutenant governor, the president of the senate succeeding to the office of governor in case of a vacancy; but there is a council of seven members elected by the legislature (not more than one from any one senatorial district), whose sole function is to advise the governor. His power of appointment is unusually extensive, and the advice and consent of the council (instead of that of the senate as in other states) are required for his appointments. He appoints all judges, medical examiners and notaries public, besides all other civil and military officers for whose appointment neither the constitution nor the laws provide otherwise. His removal power extends even to the locally elected sheriffs and county attorneys. The seven members of the council, the secretary of state, the treasurer, the attorney-general and auditor are elected biennially by a joint ballot of the two houses of the legislature.

The legislature meets on the first Wednesday in January in odd-numbered years, at Augusta, the capital. It is composed of a senate of 33 members and a house of representatives of 151 members. Members of each house are elected for a term of two years: senators by counties on the basis of one for each 30,000 inhabitants and each fraction additional, and representatives according to the population of towns of 1,500 and over, townships and plantations having less than 1,500 being grouped together to select a representative. There is a new reapportionment for the senate and the house every ten years. In September 1908 a constitutional amendment was adopted providing for referendum and initiative by the people. Any bill passed by the legislature, unless designated an emergency measure, must be referred to popular vote before becoming law, if there is a referendum petition therefor signed by 10,000 voters; and a petition signed by 12,000 voters initiates new legislation.

At the head of the department of justice is the supreme judicial court, which consists of a chief justice and five associate justices appointed by the governor and council for a term of seven years. The court holds eight sessions annually, four each at Augusta and Portland. A superior court of seven justices is also statewide, holding sessions in each county either two or three times a year. In each county there is a probate court for the settlement of the estates of deceased persons, which is presided over by a single judge and which holds monthly or bimonthly sessions. Three county commissioners (two in Waldo county) hold court from two to six times annually in each county according to the volume of business handled. Judgeships on the county probate and county commissioners' courts are elective, unlike those on state courts, the judges and registers of probate courts being chosen every four years and one county commissioner being selected for a six-year term biennially.

The principal units of local government are the town (or township), the plantation, the county and the city. As in other parts of New England, the town or city is the most important of these. At the regular town meeting, ordinarily held in March, the electorate of the town assembles, decides what shall be done for the town during the ensuing year, elects officers to execute its decisions with limited discretion, and votes money to meet the expenses. The principal officers are the selectmen (usually three), town clerk, assessors, collector, treasurer, school committee and road commissioner. Maine is the only state in the union that retains what is known as the organized plantation. This is a governmental unit organized from an unincorporated township having at least 200 inhabitants, and its principal officers are the moderator, clerk, three assessors, treasurer, collector, constable and school committee. The county is an intermediate organization between the state and the towns, to assist chiefly in the administration of justice, especially in the custody of offenders. Its officers are three commissioners, a treasurer, a register of deeds, a judge of probate, a register of probate and a sheriff.

Population.—The population of Maine in 1790 was 96,540; in 1820 it was 298,335; in 1850, 583,169; in 1880, 648,936; in 1910, 742,371; and in 1940, 847,226. This last figure represents an increase of 6·2% over the population in 1930. The population per square mile was 27·3, as compared with 44·2 for the United States as a whole. Of the 1940 population, 343,057, or 40·5%, lived in urban places; that is, in cities and villages of 2,500 or more. The number of occupied dwelling units returned in the housing census of 1940 was 218,999, which is approximately the same as the number of families.



BY COURTESY OF THE U. S. BUREAU OF THE CENSUS

URBAN AND RURAL POPULATION OF MAINE, 1790–1940

The average population per family (occupied dwelling unit) declined from 4·0 in 1930 to 3·9 in 1940. The number of males per 100 females in the entire population of the state was 101·8. The population of the state and of its principal cities is:

Area	Population			Per cent of increase	
	1940	1930	1920	1930–40	1920–30
The State	847,226	797,423	768,014	6·2	3·8
Urban	343,057	321,506	299,569	6·7	7·3
Rural	504,169	475,917	468,445	5·9	1·6
Per cent urban	40·5	40·3	39·0	..	..
Principal cities:					
Portland	73,643	70,810	69,272	4·0	2·2
Lewiston	38,598	34,948	31,791	10·4	9·9
Bangor	29,822	28,749	25,978	3·7	10·7
Augusta	19,360	17,198	14,114	12·6	21·9

Finance.—Before 1912 the state constitution forbad the borrowing of money in excess of $300,000, except for the suppression of a rebellion, for war purposes, or for repelling an invasion. In that year an amendment to the constitution was adopted allowing the state to incur a debt not exceeding $2,000,000 for state highway purposes. Since 1912 several other amendments were adopted, extending the state's borrowing power to a total of about $36,000,000. The chief sources of the state's revenue are a general property tax; excise and franchise taxes of corporations, especially those of railway and insurance companies and savings banks; motor licence fees; a tax on internal combustion engine fuel; and a tax on collateral inheritances. The general property tax for state and local purposes is assessed by local assessors, but their work is reviewed for the purpose of equalization among the several towns and counties by the state assessor who also assesses the corporations. The chief expenditures of the state in 1940 were for highways, old-age assistance, education and charitable and benevolent institutions. The budget report for the fiscal year ending June 30, 1940, showed a cash balance on hand June 30, 1939, of $4,386,551; total receipts for the year, $44,179,595; total expenditures for the period, $43,822,761; and cash balance on hand June 30, 1940, $4,743,385.

Education.—The public-school system of Maine compares favourably with those of states of greater wealth. A well-arranged program providing for school buildings of modern construction has been followed in cities and towns; and in rural communities single-room school buildings have been giving way to consolidated schools, transportation being furnished to pupils from remote homes. In 1939 the total educational expenditures amounted to $11,504,888, or a per caput expenditure, based on total enrolment, of $58.90. The state school funds, which amount to about one-fourth of the total expenditures, are distributed according to children of school age, etc., except for $325,000 used as an equalization fund to aid the poorer districts. The legislature in 1919 provided for the schooling of children living in unorganized territory. Since that time remarkable progress has been made in providing educational advantages for the children of lighthouse keepers, coast fishermen and remote lumbermen. Vocational departments and industrial and trade courses are maintained in a large number of high schools. The state had above 250,000 children of school age (5–21) in 1939. Of these 170,001 were enrolled in the public schools, 125,422 being in the elementary schools and 44,579 in the high schools and academies. While primary school attendance was beginning to decline, secondary school attendance doubled between 1920 and 1940. School attendance through the school year is compulsory for all children between the ages of seven and 15. The average length of the school year varies from 177 days for elementary schools to 181 days for high schools. An effort has been made to eliminate illiteracy through evening schools and adult classes. Maine provides for the training of teachers in six normal schools, which in 1939–40 had an enrolment of 1,122 students. Two normal schools offer four-year courses leading to B.S. degrees. Commercial teacher-training is given by accredited commercial schools, several of which are affiliated with the University of Maine school of education. The University of Maine is at Orono, to which is attached an agricultural experiment station. Among the important institutions of learning which have no official connection with the state are Bowdoin college, at Brunswick; Colby college, at Waterville; Bates college, at Lewiston and Bangor Theological seminary (Congregational), at Bangor.

Charities and Corrections.—The state's welfare activities were co-ordinated in 1931 by an act establishing the department of health and welfare. The department was composed of three bureaus: health, welfare and institutional service, having authority over the state's welfare program. In 1939 the legislature removed control of state institutions from health and welfare to a new department of institutional service. The penal and reformatory institutions consist of the state prison, at Thomaston; the reformatory for men, at South Windham; the reformatory for women, at Skowhegan; the state (reform) school for boys, at South Portland; and the state (reform) school for girls, at Hallowell. The schools are not places of punishment, but reformatories for delinquent boys from eight to 16 years of age and girls from six to 16 years of age who have been committed by the courts for violations of law, or, in the case of girls, who, by force of circumstances or association, are "in manifest danger of becoming outcasts of society." The inmates in the state schools get instruction in various trades and occupations so as to be able to earn a living when discharged. Paupers were formerly cared for chiefly by towns and cities, those wholly dependent being placed in almshouses and those only partially dependent receiving aid in their homes. Federal-state old-age assistance funds are administered by the department of health and welfare. The charitable institutions maintained by the state are: the Augusta State hospital, at Augusta; Bangor State hospital, at Bangor; Central Maine sanatorium, at Fairfield; Northern Maine sanatorium, at Presque Isle; Western Maine sanatorium, at Greenwood Mountain; Pownal State school for the feeble-minded, at West Pownal; Bath Military and Naval Orphan asylum, at Bath, and the Maine school for the deaf, at Portland.

Agriculture, Forests and Fisheries.—It is estimated that about one-third of the people living in Maine are engaged in, or are supported by agriculture, but over one-half of the foodstuffs come from outside the borders of the state. The total number of farms declined from 60,016 in 1910 to 41,907 in 1935. The number of acres in farms showed a corresponding drop, decreasing from 6,296,859 ac. in 1910 to 4,721,842 ac. in 1935. The total value of farm property increased, between 1910 and 1930, from $199,271,998 to $248,696,000. Approximately 93% of the total number of farms are operated by their owners. Numerous co-operative associations have been organized in the interest of specialized producers, but they have not met with complete success, one notable failure being the collapse of the Maine potato growers' exchange in 1925. The total value of all farm products, in 1935, was estimated at $59,100,000. The state ranks first in the union in the production of potatoes. In 1940, the 165,000 ac. planted in potatoes produced 44,000,000 bu., worth more than one-half the total value of all farm crops. The agricultural product second in value was hay, with a production, in 1939, of 918,000 tons and an estimated value of $7,362,360. The only cereal produced on an economic scale was oats. Other crops of economic value are sweet corn for canning, apples, blueberries, dry beans and buckwheat. In 1938 there were 1,615,000 hens on the farms of Maine, and poultry products aggregating $7,008,000 were sold from them. By 1940 the number of hens was 1,873,000. During 1934 66,791,000 gal. of milk and 6,720,000 lb. of butter were produced. The livestock raised on Maine farms, in 1935, included 52,000 horses, worth $4,005,560; 245,000 cattle, worth $4,780,850; 59,000 sheep, worth $254,880; and 44,000 swine, worth $260,480.

The total land area of Maine is given as 19,865,000 ac., of which 16,269,464 ac. is forest land. From this forest land is cut annually 225,000,000 bd.ft. of lumber, 700,000 cords of pulpwood, and 500,000 cords of fuel wood. The men employed in these three industries alone receive $7,000,000 yearly in wages, and over 40% of the total railroad freight tonnage originating in Maine is composed of forest products.

Fishing is still an important industry along the coast of Maine. The catching and canning of young herring under the trade name of "sardines" is the chief product of the fisheries. The sardine production in 1937 was 1,680,241 standard cases, worth $4,998,373, this production being exceeded only by California. In 1938 the pack dropped to 659,584 cases, rising to 2,171,667 cases in 1939. The lobster catch is second in importance to the sardine industry, its value being between $1,000,000 and $2,000,000 per year. Other fishery products are: Cod, herring, haddock, clams, smelts, hake, sword-fish and mackerel.

Minerals and Manufactures.—In 1938 stone, sand, cement, clay products and slate led. Maine formerly ranked high as a producer of lime, building granite and slate, but production in these fields has fallen far below previous records. Granite and slate production have partly revived. Granite abounds all along the coast east of the Kennebec and on the adjacent islands, and is found farther inland, especially about the Rangeley lakes in Franklin and Oxford counties, and near Mt. Katahdin in Penobscot and Piscataquis counties. The huge monolithic columns 51.5 to 54 ft. long and 6 ft. in diameter for the cathedral of St. John the Divine in New York city were quarried on Vinalhaven island. Mineral products with their value in 1938 were: clay products worth $210,814; feldspar, 13,764 long tons, worth $68,047; and sand

and gravel, 3,802,704 short tons, worth $968,766. The total mineral production of the state in 1938 was valued at $3,548,638. Maine has no coal and has only a small amount of iron ore within her borders for the encouragement of manufacturing, yet the abundance of timber, the numerous coves, bays, navigable streams and water-power sites have helped to overcome the handicap. Shipbuilding was the leading industry until about the middle of the 19th century, when wooden ships began to be supplanted by ships of iron and steel. The first cotton mill was built at Brunswick, on the Androscoggin, about 1809; woollen mills followed; and late in the century some of the largest paper and pulp mills in the Union were erected, which are run by water power from the rivers. Maine had, in 1935, according to the census of manufactures, 1,223 industrial establishments, which gave employment to 69,764 wage earners, and had a product worth $371,-849,483. The seven leading industries were as follows: Paper, $53,499,-799; woollen and worsted goods, $41,554,605; boots and shoes, $39,227,671; wood pulp, $22,759,007; cotton goods, $20,152,963; canned vegetables, $8,061,257; and lumber products, $6,165,544. There is still much undeveloped water power; the Public Utilities Commission credits Maine with a potential maximum of 1,383,000 h.p. of which 702,000 are undeveloped.

Transportation.—The S.W. part of the state, with the manufacturing, the quarrying and much of the older agricultural district, always has had fairly satisfactory means of transportation, either by water or by rail. The coast has many excellent harbours, the Kennebec river is navigable for coast vessels to Augusta, and the Penobscot to Bangor. It was not until the last decade of the 19th century that the forests, the farming lands and the summer resorts of Aroostook county were reached by a railway, the Bangor and Aroostook. The total railway mileage in 1938 was 1,932. This shows a decrease of 381 mi. since 1920. The principal railway systems are the Maine Central, which enters every county but one, the Boston and Maine, the Bangor and Aroostook, the Canadian Pacific and the Canadian National. Steamboat lines formerly ran between Maine ports and several Canadian and American ports, but by 1941 most of the steamboats had disappeared. Several air lines connect the state with other states. Plane and auto transport have largely replaced ships and reduced electric and steam railroad traffic. The state highway system at the end of 1935 consisted of 8,060 mi., 6,639 of the total being surfaced. During the year 1936, 48.2 mi. of new surfacing were placed.

History.—Historical scholars are not agreed upon the date at which a history of Maine should begin. If the accounts of explorations by Norsemen be taken into consideration, it is possible that Maine was first sighted by these hardy seamen and explorers about A.D. 1000, when, it is supposed, Leif Ericsson discovered Vinland. The lack of any definite evidence of their explorations passes the credit of discovering Maine to others. John Cabot, while on his second voyage to the New World in 1498, probably saw the rugged coast of Maine. During the 16th century and the early part of the 17th the coast of Maine attracted various explorers, among them Giovanni da Verrazano (1524); Estéban Gomez (1525); Simon Ferdinando (1597); John Walker (1598); Bartholomew Gosnold and Bartholomew Gilbert (1602); Martin Pring (1603); Pierre du Guast, Sieur de Monts (1604); George Weymouth (1605); and John Smith (1614), who explored and mapped the coast and gave to the country the name New England. Gosnold and Gilbert had brought a small band of colonists with them in 1602 but made no attempt at colonization, because of the many savages seen along the shore. In 1603 De Monts received from Henry IV. of France a charter for all the region between 40° and 46° N., or a territory extending from about the present city of Philadelphia to Newfoundland, under the name of Acadie or Acadia, and in 1604 he built a fort on Neutral or St. Croix island at the mouth of the St. Croix river. A severe winter and scurvy reduced the colony by almost half before spring; when relief came it was decided to remove to Port Royal. In 1605 George Weymouth explored the south-west coast, kidnapped five Indians and carried them to England, where three of them lived for a time in the family of Sir Ferdinando Gorges, who soon became the leader in founding Maine. In 1607 the Plymouth company, of which he was an influential member, and which had received a grant of this region from James I. of England in the preceding year, sent out a colony numbering 120 under George Popham (*c.* 1550–1608), brother of Sir John Popham, and Raleigh Gilbert, son of Sir Humphrey Gilbert. The colony established itself at the mouth of the Kennebec river in August, but, finding its supplies insufficient, about three-fifths of its number returned to England in December. Popham died during the winter and Gilbert presided over the council.

The next spring James Davis arrived, bringing with him news of the death of Chief Justice Popham and of Sir John Gilbert, Raleigh Gilbert's brother. The death of two of the colony's chief sponsors and the hardships of the past winter caused the colonists to abandon the settlement and return to England. In 1609 the French Jesuits, Biard and Massé, established a fortified mission station on the island of Mount Desert; and although this, as well as the remnant of De Monts' settlement at the mouth of the St. Croix, was taken in 1613 by Sir Samuel Argall (d. 1626), acting under the instructions of the English at Jamestown, Va., some of these colonists returned later. In 1620 the Council for New England, the successor of the Plymouth company, obtained a grant of the country between 40° and 48° N., extending from sea to sea; and two years later Gorges and John Mason (1586–1635) received from the council a grant of the territory between the Merrimac and the Kennebec rivers for 60m. inland, under the name of the "Province of Maine." In 1629 they divided their possession, Gorges taking the portion between the Piscataqua and the Kennebec. Numerous grants of land in this vicinity followed within a few years; and permanent settlements at York, Saco, Biddeford, Cape Elizabeth, Falmouth (now Portland) and Scarborough were established in rapid succession. The Council for New England surrendered its charter in 1635. In the division of its territory Gorges retained the portion previously granted to him. The region between the Kennebec and the St. Croix north to the St. Lawrence, though still claimed by the French as part of Acadia, was conveyed to Sir William Alexander (1567?–1640); and in 1664, to the Duke of York, afterwards King James II.

Gorges named his tract the "County of New Somersetshire," and immediately began the administration of government, setting up in 1635 or 1636 a court at Saco under the direction of his kinsman, William Gorges. In 1639 he procured for his province a royal charter modelled on that of Maryland, which invested him with the feudal tenure of a county palatine and vice-regal powers of government. But east of the Piscataqua his charter was in conflict with the other (mutually conflicting) grants of the Council for New England; and Gorges and his agents met with a determined opposition, led by George Cleeve, the deputy-president of the Lygonia or "Plough" patent. This patent extended along the coast from Cape Porpoise to Casco and had been granted governmental as well as territorial rights. Moreover, Puritan Massachusetts, which was naturally hostile to the Anglicanism of Gorges and his followers, interpreted her charter so as to make her northern boundary run east and west from a point 3m. north of the source of the Merrimac river, and on this basis laid claim to practically the whole of Maine then settled. The factional quarrels there and with the Commonwealth Government in England made it easy for Massachusetts to enforce this claim at the time, and between 1652 and 1658 Maine was gradually annexed to Massachusetts. In 1672 Massachusetts extended her boundary eastward as far as Penobscot bay. Ferdinando Gorges, a grandson of the original proprietor, brought before parliament his claim to Maine, and in 1664 a committee of that body decided in his favour; but Massachusetts successfully resisted until 1677, when the king in council decided against her. She then quietly purchased the Gorges claim for £1,250 and held the province as a proprietor until 1691, when, by the new Massachusetts charter, Maine was extended to the Saint Croix river and was made an integral part of Massachusetts.

The French still claimed all territory east of the Penobscot, and so Maine was not only an exposed frontier but a battleground during the long struggle of the English against the Indians and the French. Its citizens also bore a conspicuous part in the expeditions beyond its borders. Port Royal was taken in May 1690 by Sir William Phipps, and Louisburg in June 1745 by Sir William Pepperell, both these commanders being from Maine. These expeditions were such a drain on Maine's population that Massachusetts was called upon to send men to garrison the little forts that protected the homes left defenceless by men who had gone to the front. During the War of Independence the town of Falmouth (now Portland), which had ardently resisted the claims of the British, was bombarded and burned, in 1775.

In the same year Benedict Arnold followed the course of the Kennebec and Dead rivers on his expedition to Quebec; and from 1779 to 1783 a British force was established at Castine. The embargo and non-intercourse laws from 1807 to 1812 were a severe blow to Maine's shipping, and in the war of 1812, Eastport, Castine, Hampden, Bangor and Machias fell to the British.

Maine, as a part of Massachusetts, was in general well governed, but a geographical separation, a desire to be rid of the burden of a large State debt, and a difference of economic interests as well as of politics (Maine was largely Democratic and Massachusetts was largely Federalist) created a desire for an independent commonwealth. This was felt before the close of the War of Independence, and in 1785–87 conventions were held at Falmouth (Portland) to consider the matter, but the opposition prevailed. The want of protection during the war of 1812 revived the question, and in 1816 the general court, in response to a great number of petitions, submitted to a vote in the towns and plantations of the district the question: "Shall the legislature be requested to give its consent to the separation of the District of Maine from Massachusetts, and the erection of said District into a separate State?" The returns showed 10,393 yeas to 6,501 nays, but they also showed that less than one-half the full vote had been cast. Acting upon these returns the legislature passed a bill prescribing the terms of separation, and directed another vote of the towns and plantations upon the question of separation and the election of delegates to a convention at Brunswick which should proceed to frame a Constitution, in case the second popular vote gave a majority of five to four for separation; but as that vote was only 11,969 yeas to 10,347 nays, the advocates of separation were unsuccessful. A large source of opposition to separation was removed in 1819 when Congress rearranged the customs districts so that coasting vessels from Maine, as a separate State, would not have to enter and clear on every trip to or from Boston. As a consequence, the separation measures were carried by large majorities that year, a Constitution was framed by a convention which met at Portland in October, and ratified by town meetings in December, and Maine applied for admission into the Union. Owing to the peculiar situation in Congress at the time, arising from the contest over the admission of Missouri, the question of the admission of Maine became an important one in national politics. By an act of March 3, 1820, Maine was finally admitted into the Union as a separate State, her admission being a part of the Missouri Compromise (*q.v.*).

The boundary on the north had not yet been ascertained and had long been a subject of dispute between the United States and Great Britain. The treaty of 1783 (Article II.) had defined the north-east boundary of the United States as extending along the middle of the river St. Croix "from its mouth in the Bay of Fundy to its source" and "due north from the source of St. Croix river to the highlands; along the said highlands which divide those rivers that empty themselves into the river St. Lawrence from those which fall into the Atlantic ocean, to the north-westernmost head of Connecticut river, thence down along the middle of that river to the forty-fifth degree of north latitude." Great Britain claimed that the due north line was 40m. long and ran to Mars Hill in Aroostook county, and that the highlands ran thence westerly 115m. to the source of the Chaudière. The United States, on the other hand, claimed that the northerly line was 140m. long, running to the highlands dividing the Restigouche and the tributaries of the Metis; and there was a further disagreement with regard to the side of the highlands on which the boundary should be, and as to what stream was the "north-westernmost head of Connecticut river." The 5th Article of the Jay treaty of 1794 provided for a commission to decide what the St. Croix river actually was, and this commission in 1798 defined the St. Croix, saying that its mouth was in Passamaquoddy bay and that the boundary ran up this river and the Cheputratecook to a marked monument. The Treaty of Ghent in 1814 (Article IV.) referred the question of the ownership of the islands in Passamaquoddy bay to a commission, which gave Moose, Dudley and Frederick islands to the United States, and (Article V.) provided for the survey (which was made in 1817–18) of a part of the disputed territory, and for a general commission. The general commissioners met at St. Andrews, N.B., in 1816, and in New York city in 1822, only to disagree; and when the king of the Netherlands, chosen as arbitrator in 1829 (under the convention of 1827), rendered in 1831 a decision against which the State of Maine protested, the Federal senate withheld its assent to his decision. In 1838–39 the territory in dispute between New Brunswick and Maine became the scene of a border disturbance, known as the "Aroostook War"; Maine erected forts along the line she claimed, Congress authorized the president to resist any attempt of Great Britain to enforce exclusive jurisdiction over the disputed territory, and an armed conflict seemed imminent. Gen. Winfield Scott was sent to take command on the Maine frontier, and on March 21, 1839, he arranged a truce and a joint occupancy of the territory in dispute until a satisfactory settlement should be reached by the United States and Great Britain. The Webster-Ashburton treaty of 1842 was a compromise which allowed Maine about 5,500 sq.m. less than she had claimed, and allowed Great Britain about as much less than her claim. All grants of land previously made by either party within the limits of the territory which by this treaty fell within the dominions of the other party were to be "held valid, ratified and confirmed to the persons in possession under such grants, to the same extent as if such territory . . . fallen within the dominions of the party by whom such grants were made." The government of the United States agreed to pay to Maine and Massachusetts "in equal moieties" the sum of $300,000 as compensation for the lands which they had claimed, and which under the treaty they were called upon to surrender. In 1853 Maine acquired from Massachusetts for $362,500 the latter's claim to all land in the disputed area. The "North-East Boundary Dispute," was settled in 1910.

The Democratic majority in the district of Maine effected the separation from Massachusetts, and from the date of that separation until 1853 Maine was classed as a Democratic State, although it elected a Whig governor in 1838 and in 1840, and cast its electoral vote for John Quincy Adams in 1824 and in 1828, and for W. H. Harrison in 1840. Maine was a pioneer in laws regulating the liquor business. In 1846 the first prohibitory law was passed; but, owing to its many weaknesses, a new and stricter law became effective in 1851. As a result of the prohibition and slavery questions, there was a party disintegration between 1850 and 1855, followed by the supremacy of the Republican Party from 1856 to 1878. In 1878 the electorate failed to select a governor, as no candidate received a majority of the votes as required by the Constitution. A Democratic-National fusion in the legislature resulted in the election of Alonzo Garcelon (1813–1906), the Democratic candidate. Again there was no election by popular vote in 1879, and Garcelon and his council secured a fusion majority in the legislature. On Jan. 3, 1880, the Supreme Court declared the governor and council in error in counting in a fusion majority, but on Jan. 7 the governor swore in a legislature with 78 fusion and only two Republican members, and, the governor's term having expired, the president of the senate, James D. Lamson, became governor ex officio. On Jan. 12 the Republicans, whose organized legislature was declared legal by the Supreme Court, seized the legislative chambers and chose as governor Daniel Franklin Davis (1843–97). On Jan. 17, Joshua L. Chamberlain, to whom the peaceful solution of the difficulty had largely been due, retired from the task assigned him by Garcelon on Jan. 5 "to protect the public property and institutions of the State" until Garcelon's successor should be duly qualified. In 1880 the Democrats and Greenbackers united and elected their candidate, but after 1883 Maine was strongly Republican until 1910.

Maine's position as a favourite resort for summer vacationists dates from about 1870, when camps, summer hotels and boarding houses began to multiply throughout the State. The needs of this summer population gave a new turn to certain types of agriculture, and the demand for souvenirs revived among the Indians basket-weaving, moccasin-making and such crafts. In 1875 a compulsory education act was passed. The law prohibiting the manufacture or sale of intoxicating liquor was made a part of the Constitution in 1884 by an overwhelming majority of the votes cast. In 1914 the Public Utilities commission was created by an act of the legislature; in the year following, a workmen's compensation law was adopted. Some of the administrative functions of the state were reorganized in 1931 into five departments.

The Republicans have generally controlled Maine since the early eighties, although the Democrats elected a governor in 1910 and won the state's vote for Wilson in 1912. Two decades later the Democrats again elected a governor, Louis J. Brann, thus providing a good omen for the party's national triumph two months later. Roosevelt failed to carry Maine at that time, but Brann was reëlected in 1934. The state's vote for repeal of the 18th amendment in 1933 and for the repeal of its own constitutional provision for prohibition in 1934 further revealed its break from historic traditions. The long contemplated Passamaquoddy Bay hydro-electric project was endorsed in 1934 as a New Deal public works project in order to relieve unemployment and to harness the natural energy of the tides, but was discontinued in June 1936 with the failure of congress to appropriate funds. The Republican party carried Maine in state and national elections in 1936, 1938 and 1940. National defence in Maine in 1941 began with an army air base under construction, airports projected, and a shipbuilding boom under way.

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MAINE DE BIRAN, FRANÇOIS-PIERRE-GONTHIER (1766–1824), French philosopher, was born at Bergerac, on Nov. 29, 1766. The name Maine he assumed (some time before 1787) from an estate called Le Maine, near Mouleydier. After studying under the *doctrinaires* of Périgueux, he entered the king's life-guards, and was present at Versailles on the memorable Oct. 5 and 6, 1789. He then retired to his estate at Grateloup, near Bergerac, where his retired life preserved him from the horrors of the Revolution. It was at this period that, to use his own words, he "passed *per saltum* from frivolity to philosophy." After the Reign of Terror Maine de Biran took part in political affairs. He was excluded from the council of the Five Hundred on suspicion of royalism, but took part with his friend Lainé in the commission of 1813, which expressed for the first time direct opposition to Napoleon. After the Restoration he was treasurer to the chamber of deputies. He died in July 1824.

Maine de Biran's most important works were not published during his lifetime. An incomplete collection, by Victor Cousin, appeared in 1834 and 1841. But the publication (in 1859) by E. Naville (from mss. placed at his father's disposal by Biran's son) of the *Oeuvres inédites de Maine de Biran*, in three volumes first rendered possible a connected view of his philosophical development. At first a sensualist, like Condillac and Locke, next an intellectualist, he finally shows himself a mystical theosophist. The *Essai sur les fondements de la psychologie* represents the second or completest stage of his philosophy, the fragments of the *Nouveaux essais d'anthropologie* the third.

Biran's work presents a very remarkable specimen of deep metaphysical thinking directed by preference to the psychological aspect of experience.

The *Oeuvres inédites* of Maine de Biran by E. Naville contain an introductory study; in 1887 appeared *Science et psychologie: nouvelles oeuvres inédites*, with introduction by A. Bertrand. *See* also O. Merton, *Etude critique sur Maine de Biran* (1865); E. Naville, *Maine de Biran, sa vie et ses pensées* (1874); J. Gérard, *Maine de Biran, essai sur sa philosophie* (1876); Mayonade, *Pensées et pages inédites de Maine de Biran* (Périgueux, 1896); G. Allievo, "Maine de Biran e la sua dottrina antropologica" (Turin, 1896, in *Memorie dell' accademia delle scienze*, 2nd ser., xlv., pt. 2); A. Lang, *Maine de Biran und die neuere Philosophie* (Cologne, 1901); monographs by A. Kühtmann (Bremen, 1901) and M. Couailhac (1905); N. E. Truman in *Cornell Studies in Philosophy*, No. 5 (1904) on Maine de Biran's Philosophy of Will.

MAINE-ET-LOIRE, a department of western France, formed in 1790 for the most part out of the southern portion of the former province of Anjou, and bounded N. by the departments of Mayenne and Sarthe, E. by Indre-et-Loire, S.E. by Vienne, S. by Deux-Sèvres and Vendée, W. by Loire-Inférieure, and N.W. by Ille-et-Vilaine. Area, 2,787 sq. miles. Pop. (1936) 477,690. The department includes the course of the Authion and the lower course of the Maine, with its feeders, the Loir, Sarthe, Mayenne and Oudon, on the right bank of the Loire; as well as those of the Layon, Evre and Divatte on the left. The Val d'Anjou, followed by the Loire, forms a zone of rich meadows, market gardens and orchards from east to west. The west of the department is floored by Palaeozoic rocks and granites of the Armorican system, but east of the line of the Sarthe the rocks are chiefly cretaceous, with tertiary capping on the somewhat higher ground between the rivers. The name Val d'Anjou belongs strictly to the eastern part of the Loire valley in the department. The climate is very mild. The mean annual temperature of Angers is about 54°; the rainfall is between 23 and 24 in. annually. The frequent fogs, combined with the peculiar nature of the soil in the south-east of the department, are highly favourable to meadow growths. The winter colds are never severe, and readily permit the cultivation of certain trees which cannot be reared in the adjoining departments.

The chief cereals grown are wheat, oats and barley, and potatoes and mangels also give good returns. Much hemp is grown in the valley of the Loire, and the vegetables, melons and other fruits of that region are of the finest quality. Good wine is produced at Serrant and other places near Angers, and on the right bank of the Layon and near Saumur, famous for its sparkling white wine. Cider apples, and fruit generally, are produced. Woodland, chiefly of oak and beech, covers large tracts. The fattening of cattle is an important industry round Cholet, and horses are reared. There are important slate quarries near Angers, tufa is worked in the river valleys, and freestone and other stone, iron and coal are also found. The manufactures are linen and woollen stuffs, ticking, gingham, etc., umbrellas, calicoes, handkerchiefs, etc. The department is served by the railways of the State and of the Orléans company. The Mayenne, the Sarthe and the Loire, together with some of the lesser rivers, provide about 130 m. of navigable waterway. In the south-east the canal of the Dive covers some 10 m. in the department.

There are four arrondissements—Angers, Cholet, Saumur and Segré, with 34 cantons and 381 communes. Maine-et-Loire belongs to the académie (educational division) of Rennes, to the region of the IX. army corps (Tours) and to the ecclesiastical province of Tours. Angers (*q.v.*), the capital, is the seat of a bishopric and of a court of appeal. Other important places are Cholet, Saumur and Fontevrault. For architectural interest there may also be mentioned the châteaux of Brissac (17th century), Serrant (15th and 16th centuries), Montreuil-Bellay (14th and 15th centuries), and Ecueillé (15th century), and the churches of Puy-Notre-Dame (13th century) and St. Florent-le-Vieil (13th, 17th and 19th centuries), the last containing the fine monument to Charles Bonchamps, the Vendean leader, by David d'Angers. Gennes has remains of a theatre and other Roman remains, as well as two churches dating in part from the 10th century. Ponts-de-Cé, an interesting old town built partly on islands in the Loire, is important, because till the Revolution its bridges formed the only way across the Loire between Saumur and Nantes.

MAINPURI, a town and district of British India, in the Agra division of the United Provinces. The town (pop. [1941], 19,261) consists of two separate portions, Mainpuri proper and Mukhamganj. Holkar plundered and burned part of the town in 1804, but was repulsed by the local militia. Since the British occupation the population has rapidly increased and many improvements have been carried out. The Agra branch of the Grand Trunk road runs through the town, forming a wide street lined on both sides by shops, which constitute the principal bazaar. Mainpuri has a speciality in the production of carved wooden articles inlaid with brass wire. The American Presbyterian mission manages a high school.

The District of Mainpuri lies in the central Doab. Area, 1,679 sq.mi. Pop. (1941) 872,601. It consists of an almost unbroken plain wooded throughout with mango groves, and isolated clumps of *bábul* trees occasionally relieve the bareness of its saline *usar* plains. On the south-western boundary the Jumna flows in a deep alluvial bed, sometimes sweeping close to the high banks which overhang its valley, and elsewhere leaving room for a narrow strip of fertile soil between the river and the upland plain. The district is watered by two branches of the Ganges canal.

Mainpuri anciently formed part of the great kingdom of Kanauj, and after the fall of that famous state it was divided into a number of petty principalities, of which Rapri and Bhongaon were the chief. In 1194 Rapri was made the seat of a Muslim governor. Mainpuri fell to the Moguls on Baber's invasion in 1526, passed, towards the end of the 18th century, into the power of the Mahrattas, and finally became a portion of the province of Oudh. When this part of the country was ceded to the British, in 1801, Mainpuri town became the headquarters of the extensive district of Etawah, which was in 1856 reduced by the formation of Etah and Mainpuri into separate collectorates.

MAINTAINED PRICE: *see* Price Maintenance.

MAINTENANCE AND CHAMPERTY. In English law maintenance is the maintaining or assisting a party, with money or otherwise, to prosecute or defend an action in which the maintainer has no legitimate interest. The law allows a master to assist his servant, near relations to support each other, the charitable to assist the poor, and persons having an interest even contingent in the subject matter or principle involved in a suit to assist a party to it. Other maintenance is a criminal offence and a civil cause of action. In theory, even if the maintained action succeeds so that a party is assisted only to secure his legal due, the unsuccessful party can sue the maintainer if he can prove that he has suffered damage (*Neville* v. *London Express Newspaper Ltd.*, 1919, A.C. 368), but this is seldom if ever possible since the damages and costs which he is compelled to pay flow from his own wrong and not from the maintenance. If the maintainer is to be rewarded by receiving some part of the subject matter of or some profit from the suit the bargain is the criminal offence of Champerty. (X.)

United States.—Maintenance and champerty as defined by the common law are still generally criminal in the United States. The criminal aspect of maintenance and champerty has now little significance, but the concepts retain their vigour in rendering unethical the conduct of a particular attorney or illegal contracts between attorneys and clients concerning remuneration for services rendered in the prosecuting of a suit. The charging of legal fees contingent upon success is technically champerty, but the strict definition has relaxed as the social necessity of such a practice has become increasingly apparent. The common law doctrines that made illegal all champertous agreements have consequently been greatly modified by judicial decision. A few States follow the so-called Massachusetts rule which makes illegal an agreement by an attorney that he shall receive a specific share in the proceeds of the suit but considers an agreement legal which merely provides for a larger fee in the event of success. The majority of States follow the rule that champerty of itself does not make the agreement illegal unless it is accompanied either by maintenance in the form of an agreement that the attorney will bear the expenses of the suit, or by a provision binding the client not to compromise or release the claim without the consent of the attorney. The fact that such rules consider the form and not the substance of the agreement has led to the modern view held by a few States, namely that neither technical champerty nor maintenance invalidates the contract but its validity is to be determined by a consideration of whether the particular agreement induced the litigation and revealed an overreaching of the client by the attorney. Many States unfortunately have allowed an attorney whose agreement for fees is invalid because of champerty or maintenance to recover reasonable fees from his client, thus permitting him to charge any fees that he may desire in the first instance and in the unusual event of litigation assuring him no matter what the final outcome a reasonable compensation. The champertous character of an agreement between attorney and client can be availed of only by the parties to it, and no defendant can successfully defend the claim against him by proving that the plaintiff is prosecuting it under a champertous agreement.

The ease with which the practices of champerty, maintenance and barratry or the stirring up of vexatious litigation have eluded both the criminal law and the restraining influence of doctrines rendering contracts between lawyers and clients illegal, has led in the large American cities to the practice of "ambulance chasing." Unscrupulous attorneys eager to solicit business in negligence cases employ runners who keep track of accidents with the aid of police, newspaper reporters, doctors, etc., and by appearing on the scene shortly after the accident manage to inveigle the victims into engaging them to prosecute their claims. Needless litigation over minor and often spurious injuries is thus aroused. In Minnesota by virtue of a statute which has since been declared unconstitutional (*Davis* v. *Farmers' Co-op. Equity Co.*, 262 U.S. 312 [1923]), attorneys sought to bring within the jurisdiction of Minnesota courts claims for injuries arising out of railroad transportation which may have occurred a thousand or more miles from the place of trial merely on the ground that the railroad maintained a freight and passenger agent in the State although it operated no trackage within the State, nor was the plaintiff a resident of the State. Similar attempts have been made by other States to facilitate the trial of accident cases remote from the place of their occurrence so as to harass the defendent into a settlement irrespective of the merits of the plaintiff's claim by the prospect of the costs that he would incur in bringing his witnesses to the place of trial. The seriousness of the evil of ambulance chasing is also attested to by recent investigations initiated by the bar and conducted by the courts of New York, Ohio and Wisconsin into the practice in the hope of devising means for its correction. As a result of the investigation conducted by the supreme court of New York in 1928 in the city of New York disbarment proceedings and criminal prosecutions were begun against more than 70 New York lawyers. Though ambulance-chasing is in part the reaction of some of the legal profession to the unscrupulous methods of claim agents for defendant corporations in securing releases from injured parties for nominal sums before the consequences of the injury could be rationally ascertained, its sway can be attributed to the want of sufficiently high moral and intellectual standards for admission to the practice of law.

(J. M. La.)

MAINTENON, FRANÇOISE D'AUBIGNÉ, Marquise de (1635–1719), the second wife of Louis XIV., was born in a prison at Niort, on Nov. 27, 1635. Her father, Constant d'Aubigné, was the son of Agrippa d'Aubigné, the friend and general of Henry IV., and had been imprisoned as a Huguenot malcontent, but her mother had the child christened a Catholic. After the release of d'Aubigné the family went to Martinique. There the father died. Mother and child returned to France, where Françoise was surrendered to a Protestant relative who is said to have converted her to Protestantism. She was removed by an order of state to Catholic guardianship, and reconverted. She and her mother were penniless, and the girl married (1652) Scarron, the famous wit, to whom she was more nurse than wife. He died in 1660. Anne of Austria continued his pension to his widow, and even increased it to 2,000 livres a year, which enabled her to entertain and frequent literary society. After Anne's death the pension was continued by the king on the intercession of his mistress, Madame de Montespan, who put her in charge of the children whom she bore to Louis. In 1674 the king determined to have his children at court, and their governess who had now made sufficient fortune to buy the estate of Maintenon, accompanied them. In 1678 her estate at Maintenon was raised to a marquisate. Mme. de Montespan's jealousy was aroused by these favours, and Mme. de Maintenon's position was almost unendurable until Mme. de Montespan left the court. Madame de Maintenon now became the king's mistress "en titre." The queen declared she had never been so well treated as at this time, and eventually died in Mme. de Maintenon's arms in 1683. In 1684 Mme. de Maintenon was made first lady in waiting to the dauphiness, and in the winter of 1685–1686 she was privately married to the king by Harlay, archbishop of Paris, in the presence, it is believed, of Père la Chaise, the king's confessor, the marquis de Montchevreuil, the chevalier de Forbin, the marquis de Louvois and the valet, Bontemps. No written proof of the marriage is extant, but that it took place is nevertheless certain. Her life during the next 30 years can be fully studied in her letters.

Her political influence has probably been exaggerated, but it was supreme in matters of detail. The ministers of the day used to discuss and arrange all the business to be done with the king beforehand with her, and it was all done in her cabinet and in her presence, but the king in more important matters often chose not to consult her. Such mistakes as, for instance, the replacing of Catinet by Villeroi may be attributed to her, but not whole policies—notably, according to Saint-Simon, not the policy with regard to the Spanish succession. Even the revocation of the edict of Nantes and the dragonnades have been unjustly laid to her charge. Her influence was on the whole a moderating and prudent force. Her social influence was always exercised on the side of decency and morality. Side by side with this public life, she passed a happier existence as the foundress of St. Cyr. Mme. de Maintenon was a born teacher; and she had always wished to establish a home for poor girls of good family placed in such straits as she herself had experienced.

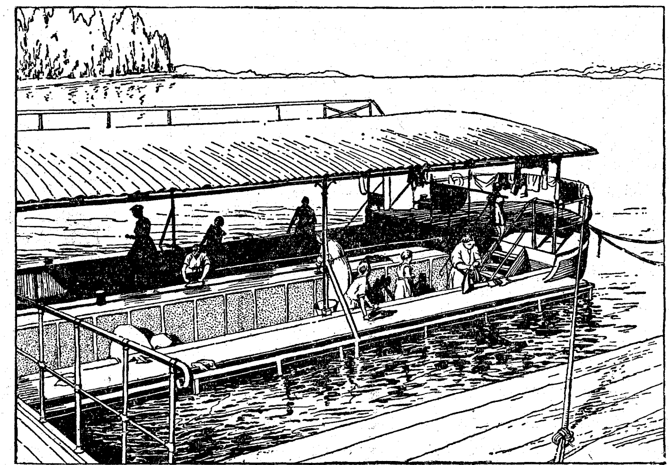
As soon as her fortunes began to mend she started a small home for poor girls at Ruil, which she afterwards moved to Noisy, and which was the nucleus of the splendid institution of St. Cyr, which the king endowed in 1686, out of the funds of the abbey of St. Denis. For her "little sisters" at St. Cyr Racine wrote his *Esther* and his *Athalie*.

The later years of her power were marked by the promotion of her old pupils, the children of the king and Mme. de Montespan, to high dignity between the blood royal and the peers of the realm, and it was doubtless under the influence of her dislike for the duke of Orleans that the king drew up his will, leaving the personal care of his successor to the duke of Maine, and hampering the duke of Orleans by a council of regency, an arrangement which was overthrown by the parlement after the king's death. The regent Orleans visited her at St. Cyr and continued her pension of 48,000 livres. On April 15, 1719, she died, and was buried in the choir at St. Cyr.

Her *Lettres historiques et édifiantes* (7 vols.) and her *Correspondance générale* (4 vols., 1888), were edited by Th. Lavallée. Saint-Simon's account of the court in her day is contained in vol. xii of his *Mémoires*. *See* also Mademoiselle d'Aumale's *Souvenirs sur Madame de Maintenon,* ed. Comte d'Haussonville and G. Hanotaux (3 vols., 1902–04); A. Geffroy, *Madame de Maintenon d'après sa correspondance authentique* (Paris, 2 vols., 1887); A. de Boislisle, *Paul Scarron et Françoise d'Aubigné d'après des documents nouveaux* (1894); É. Pilastre, *Vie et caractère de Madame de Maintenon d'après les oeuvres du duc de Saint-Simon et des documents anciens ou récents* (1907); A. Rosset, *Madame de Maintenon et la révocation de l'édit de Nantes* (1897); Mme. Saint-René Taillandier, *Madame de Maintenon* (1920; Eng. trans. 1922); H. C. Barnard, *Madame de Maintenon and Saint-Cyr* (1934); Maud Cruttwell, *Madame de Maintenon* (1930).

MAINZ (Fr. Mayence), a city and episcopal see of Germany, on the left bank of the Rhine, almost opposite the influx of the Main, in the *Land* of Hesse, and at the junction of the important main lines of railway from Cologne to Mannheim and Frankfort-on-Main, 25 mi. W. of the latter. Pop. (1933) 142,428; (1939) 158,971, of whom two-thirds are Roman Catholic.

History.—Mainz was a pre-Roman settlement, at which, about 13 B.C. Drusus, the step-son of Augustus, erected a fortified camp; the *castellum Mattiacorum* (the modern Castel) on the opposite bank was afterwards added to it, the two being connected with a bridge at the opening of the Christian era. The earlier name became latinized as *Maguntiacum,* or *Moguntiacum,* and a town gradually arose around the camp, which became the capital



BY COURTESY OF H. A. FRANCKS

A FLOATING LAUNDRY ON THE RHINE, JUST BELOW WHERE THE MAIN JOINS IT

of Germania Superior. During the Völkerwanderung Mainz suffered severely, being destroyed on different occasions by the Alamanni, the Vandals and the Huns. Christianity seems to have been introduced into the town at a very early period, and in the 6th century a new Mainz was founded by Bishop Sidonius. In the middle of the 8th century under Boniface it became an archbishopric, and to this the primacy of Germany was soon annexed. Charlemagne, who had a palace in the neighbourhood, gave privileges to Mainz, which rose rapidly in wealth and importance, becoming a free city in 1118. In 1160 the citizens revolted against Archbishop Arnold, and in 1163 the walls of the city were pulled down by order of the emperor Frederick I.

In 1244 certain rights of self-government were given to the citizens; and in 1254 Mainz was the centre and mainspring of a powerful league of Rhenish towns. In 1462 there was warfare between two rival archbishops. The citizens espoused the losing cause and were deprived of their privileges. Many of the inhabitants were driven into exile, and these carried into other lands a knowledge of the art of printing, which had been invented at Mainz by Johann Gutenberg in 1450. During the Thirty Years' War Mainz was occupied by the Swedes and by the French. In 1792 the citizens welcomed the ideas of the French Revolution; they expelled their archbishop, and opened their gates to the French troops. Mainz was ceded to France by the treaty of Campo Formio in 1797, and again by the Treaty of Lunéville in 1801. In 1814 it was restored to Germany and in 1816 it was handed over to the grand duke of Hesse. After World War I it was occupied by Allied troops. During World War II it was bombed by the British.

Architecture and Trade.—The cathedral is a Romanesque edifice with numerous Gothic additions and details. It was originally erected between 975 and 1009, but has since been repeatedly burned down and rebuilt, and in its present form dates chiefly from the 12th, 13th and 14th centuries. The whole building was restored by order of Napoleon in 1814, and another thorough renovation was made more recently. The most noteworthy of the other churches are those of St. Ignatius, with a finely painted ceiling, of St. Stephen, built 1257–1328, and restored after an explosion in 1857, and of St. Peter. The old electoral palace (1627–1678), a large building of red sandstone, now contains a valuable collection of Roman and Germanic antiquities. Among the other principal buildings are the former palace of the grand duke of Hesse, built in 1731–1739 as a lodge of the Teutonic order, and the government buildings. A statue of Gutenberg, by Thorwaldsen, was erected at Mainz in 1837. Mainz still retains many relics of the Roman period, the most important of which is the Eigelstein, a monument believed to have been erected by the Roman legions in honour of Drusus. It stands within the citadel, which occupies the site of the Roman castrum. A little to the south-west of the town are the remains of a large Roman aqueduct, of which upwards of sixty pillars are still standing. The university of Mainz, founded in 1477, was suppressed by the French in 1798.

The site of Mainz would seem to mark it out naturally as a great centre of trade, but the illiberal rule of the archbishops and its military importance seriously hampered its commercial and industrial development, and prevented it from rivalling its neighbour Frankfort. It is now, however, the chief emporium of the Rhenish wine traffic, and also carries on an extensive transit trade in grain, timber, flour, petroleum, paper and vegetables. The principal manufactures are leather goods, furniture, carriages, chemicals, musical instruments, cement and boots. Other industries include brewing, ship-building and printing. Mainz is the administrative and judicial capital of the province of Rhein-Hessen.

The Archbishopric of Mainz, dating from 747, was one of the seven electorates of the Holy Roman Empire, and became a powerful state during the middle ages, retaining some of its importance until the dissolution of the empire in 1806. Its archbishop was president of the electoral college, arch-chancellor of the empire and primate of Germany. The lands of the electorate lay around Mainz, and were on both banks of the Rhine; their area at the time of the French Revolution was about 3,200 sq.m. The archbishopric was secularized in 1803, two years after the lands on the left bank of the Rhine had been seized by France. Some of those on the right bank of the river were given to Prussia and to Hesse; others were formed into a grand duchy for Dalberg. The archbishopric itself was transferred to Regensburg.

MAIR, ALEXANDER WILLIAM (1875–1928), Scottish classical scholar, was born on June 9, 1875, at Deerhill, Banff. After a distinguished career at Aberdeen and Cambridge he was appointed (1899) assistant professor and (1903) professor of Greek at Edinburgh university. He was an unusually able and meticulous scholar of the Cambridge school, and a highly successful teacher. His chief works were his editions and translations of Hesiod, Callimachus, Lycophron and Oppian (the last-named being unpublished at his death). He also wrote the biographies of PLINY, LUCIAN, EPICURUS and several other articles for the present edition of this *Encyclopædia.* He was burned to death by an accident in his study on Nov. 12, 1928.

MAIRET, JEAN DE (1604–1686), French dramatist, was born at Besançon, and died there on Jan. 31, 1686. His own statement that he was born in 1610 has been disproved. He went to Paris to study at the Collège des Grassins about 1625, in which year he produced his first piece *Chriséide et Arimand,* followed in 1626 by *Sylvie,* a "pastoral tragi-comedy." In 1634 appeared his masterpiece, *Sophonisbe,* which marks, in its observance of the rules, the beginning of the "regular" tragedies. Mairet was one of the bitterest assailants of Corneille in the controversy over *The Cid.* It was perhaps his jealousy of Corneille that made him give up writing for the stage. He was appointed in 1648 official representative of the Franche-Comté in Paris, but in 1653 he was exiled for a short time by Mazarin. His other plays include *Silvanire ou la Morte-vive,* published in 1631 with a preface on the observance of the unities, *Les Galanteries du duc d'Orsonne* (1632), *Virginie* (1633), *Marc-Antoine* (1635) and *Le Grand et dernier Solyman* (1637).

See G. Bizos, *Etude sur la vie et les oeuvres de Jean de Mairet* (1877). *Sophonisbe* was edited by K. Vollmöller (Heilbronn, 1888), and *Silvanire* by R. Otto (Bamberg, 1890).

MAIRONIS (1862–1932), Lithuanian poet, whose real name is Jonas Mačiulis, was born at Pasandvaris, in the Kaunas (Kovno) district. In 1909, Maironis was appointed rector of the Kaunas seminary and in 1922 became a professor and deacon of the theological faculty of the Kaunas University which he helped to found. His songs are sung all over Lithuania. His famous poem *Young Lithuania* describes the national rebirth; *Our Sufferings* is a poem descriptive of the Lithuanian national ripening and conquest of independence; his *Magdalen of Raseiniai* castigates the national vices, while his Polish poem *Znad Biruty* appeals to the Polonised Lithuanian nobility. His dramatic works include *Where is Salvation? The Death of Kestutis,* and *Vytautas with the Crusaders,* the two last being historical plays of the 14th century. Maironis also translated the *Rigveda* into Lithuanian.

MAISTRE, JOSEPH DE (1754–1821), French diplomatist and polemical writer, was born at Chambéry on April 1, 1754. His family was an ancient and noble one, and is said to have been of Languedocian extraction. The father of Joseph was president of the senate of Savoy, and held other important offices. Joseph himself, after studying at Turin, entered the civil service of Savoy, finally becoming a member of the senate. In 1786 he married Françoise de Morand. The invasion and annexation of Savoy by the French Republicans made him an exile. He betook himself to the neutral territory of Lausanne. There, in 1796, he published his *Considérations sur la France.* In this he developed his Legitimist views, based on his religious convictions. The philosophism of his day was his lifelong aversion.

Charles Emmanuel now summoned de Maistre to Turin; he followed the king to Sardinia, and in 1802 he was appointed envoy extraordinary and minister plenipotentiary at St. Petersburg. During these years he only published a single treatise, on the *Principe générateur des Constitutions;* but he wrote his best and most famous works, *Du Pape* (written in 1817) and its continuation, *De L'église gallicane* and the *Soirées de St. Pétersbourg,* the last of which was never finished. *Du Pape,* written from the standpoint of papal absolutism, is a treatise on the relations of the sovereign pontiff to the Church, to temporal sovereigns, to civilization generally, and to schismatics, especially Anglicans and the Greek Church. The *Soirées de St. Pétersbourg* deals with the fortunes of virtue and vice in this world. It contains two of De Maistre's most famous pieces, his panegyric on the executioner as the foundation of social order, and his acrimonious, and in part unfair, but also in part very damaging, attack on Locke. Besides these works he wrote an examination of the philosophy of Bacon, some letters on the Inquisition, and, earlier than any of these, a translation of Plutarch's "Essay on the Delay of Divine Justice," with somewhat copious notes. After 1815 he returned to Savoy, and was appointed to high office. He died on Feb. 26, 1821, at Turin. Most of the works mentioned were posthumous, and it was not till 1851 that a collection of *Lettres et opuscules* appeared.

Joseph de Maistre was one of the most powerful, and by far the ablest, of the leaders of the neo-Catholic and anti-revolutionary movement. He regarded the temporal monarchy as an institution of altogether inferior importance to the spiritual primacy of the pope. He was by no means a political absolutist, except in so far as he regarded obedience as the first of political virtues, and he seldom loses an opportunity of stipulating for a tempered monarchy. But the pope's power is not to be tempered at all, either by councils or by the temporal power or by national churches, least of all by private judgment. The absolute necessity of order was, doubtless, the first principle of this thinker, who will invite comparison with Hobbes. The anarchic tendencies of the Revolution in politics and religion offended him. Moreover, he was profoundly and accurately learned in history and philosophy and the superficial blunders of the *philosophes* irritated him as much as their doctrines. To Voltaire he shows no mercy.

Of the two works named as his masterpieces, *Du Pape* and the *Soirées de St. Pétersbourg,* editions are extremely numerous. No complete edition of his works appeared till 1884–87, when one was published at Lyons in 14 volumes. This had been preceded, and has been followed, by numerous biographies and discussions: C. Barthélemy, *L'Ésprit de Joseph de Maistre* (1859); R. de Sézeval, *Joseph de Maistre* (1865); L. I. Moreau, *Joseph de Maistre* (1879); F. Paulhan, *Joseph de Maistre et sa philosophie* (1893); L. Cogordan, "Joseph de Maistre" in the *Grands écrivains français* (1894); F. Descostes, *Joseph de Maistre avant la révolution* (1896), and other works by the same writer; J. Mandoul, *Un Homme d'état italien: Joseph de Maistre et la politique de la maison de Savoie* (1900); E. Grasset, *Joseph de Maistre* (1901); L. Arnould, *La Providence et le Bonheur d'après Bossuet et Joseph de Maistre* (1916); C. Besse, *Le paradox celebre de J. de Maistre sur la guerre* (1916); M. Jugie, *J. de Maistre et l'église Gréco-Russe* (1922); and F. Vermale, *Notes sur J. de Maistre inconnu* (Chambéry, 1921).

MAISTRE, XAVIER DE (1763–1852), younger brother of Joseph de Maistre, was born at Chambéry on Nov. 8, 1763. He served in the Piedmontese army, and wrote his delightful fantasy, *Voyage autour de ma chambre* (published 1794) when he was under arrest at Turin in consequence of a duel. On the annexation of Savoy to France, he left the service, and took a commission in the Russian army. He served under Suvarov in his victorious Austro-Russian campaign and accompanied the marshal to Russia. He shared the disgrace of his general, and supported himself for some time in St. Petersburg by miniature painting. But on his brother's arrival in St. Petersburg he was introduced to the minister of marine. He was appointed to several posts in the capital, but also saw active service, was wounded in the Caucasus, and attained the rank of major-general. He died at St. Petersburg on June 12, 1852. Besides the *Voyage* already mentioned, Xavier de Maistre's works (all of which are of very modest dimensions) are *Le Lépreux de la cité d'Aoste* (1811); *Les Prisonniers du Caucase* (1825), *La Jeune Sibérienne* (1825) and the *Expédition nocturne*, a sequel to the *Voyage autour de ma chambre* (1825).

His works, with the exception of some brief chemical tractates, are included in the collections of Charpentier, Garnier, etc. and his *Oeuvres inédites* (2 vols., 1877). *See* Sainte-Beuve's *Portraits contemporains*, vol. iii. A. Berthier, *Xavier de Maistre* (Lyon, 1920) C. de Bultet, *Aperçu de la vie de Xavier de Maistre* (Grenoble, 1919).

MAITLAND, EDWARD (1824–1897), English humanitarian writer, was born at Ipswich on Oct. 27, 1824, and was educated at Caius college, Cambridge. With Anna Kingsford (1846–88), the supporter of vegetarianism and anti-vivisectionism, he brought out *Keys of the Creeds* (1875), *The Perfect Way: or the Finding of Christ* (1882), and founded the Hermetic Society in 1884. After her death he founded the Esoteric Christian Union in 1891, and wrote her *Life and Letters*. He died on Oct 2, 1897.

MAITLAND, FREDERIC WILLIAM (1850–1906), English jurist and historian, son of John Gorham Maitland, was born on May 28, 1850, and educated at Eton and Trinity, Cambridge. He was called to the bar (Lincoln's Inn) in 1876, and made himself a thoroughly competent equity lawyer and conveyancer, but finally devoted himself to comparative jurisprudence and especially the history of English law. In 1884 he was appointed reader in English law at Cambridge, and in 1888 became Downing professor of the laws of England. Though handicapped in his later years by delicate health, his intellectual grasp and wide knowledge and research gradually made him famous as a jurist and historian. He edited numerous volumes for the Selden Society, including *Select Pleas for the Crown, 1200–1225*, *Select Pleas in Manorial Courts* and *The Court Baron*; and among his principal works were *Gloucester Pleas* (1884), *Justice and Police* (1885), *Bracton's Note-Book* (1887), *History of English Law* (with Sir F. Pollock, 1895; new ed. 1898); *Domesday Book and Beyond* (1897), *Township and Borough* (1898), *Canon Law in England* (1898), *English Law and the Renaissance* (1901), the *Life of Leslie Stephen* (1906). His writings are marked by vigour and vitality of style, as well as by the highest qualities of the historian who recreates the past from the original sources; he had no sympathy with either legal or historical pedantry. He died at Grand Canary on Dec. 19, 1906.

See P. Vinogradoff's article on Maitland in the *English Historical Review* (1907); Sir F. Pollock's in the *Quarterly Review* (1907); G. T. Lapsley's in *The Green Bag* (Boston, Mass., 1907); A. L. Smith, *F. W. Maitland* (1908); H. A. L. Fisher, *F. W. Maitland* (1910).

MAITLAND, SIR RICHARD (LORD LETHINGTON) (1496–1586), Scottish lawyer, poet and collector of Scottish verse, son of Sir William Maitland of Lethington and Thirlestane, who fell at Flodden, studied law at the university of St. Andrews, and afterwards in Paris. His castle at Lethington was burnt by the English in 1549. He was in 1552 one of the commissioners to settle matters with the English about the debatable lands. About 1561 he seems to have lost his sight, but he continued to attend to public business, and was the same year admitted an ordinary lord of session with the title of Lord Lethington, and a member of the privy council. In 1562 he was appointed keeper of the Great Seal, resigning in 1567, in favour of John, prior of Coldingham, his second son. He sat on the bench until his eighty-eighth year. He died on March 20, 1586.

The poems of Sir Richard Maitland are for the most part satirical, and are principally directed against the social and political abuses of his time. He collected and preserved many pieces of Scots poetry. These were copied into two large volumes, one in folio, written by himself, and another in quarto, written by his daughter. These volumes were purchased at the sale of the Lauderdale library by Samuel Pepys, and have since been preserved in the Pepysian library, Magdalene college, Cambridge. They lay there unnoticed for many years till Bishop Percy published one of the poems in his *Reliques of English Poetry*. Several were included by John Pinkerton, in *Ancient Scottish Poems* (2 vols., 1786).

For an account of the Maitland Folio MS. *see* Gregory Smith's *Specimens of Middle Scots*, 1902 (p. lxxiii.). Maitland's own poems were reprinted by Sibbald in his *Chronicle of Scottish Poetry* (1802), and in 1830 by the Maitland Club, named after him, and founded for the purpose of continuing his efforts to preserve the remains of early Scots literature. Sir Richard left in manuscript a history of the family of Seton, and a volume of legal decisions collected by him between the years 1550 and 1565. Both are preserved in the Advocates' Library, Edinburgh; the former was published by the Maitland Club, in 1829. The Scottish Text Society published *The Maitland Folio Manuscript* (ed. W. A. Craigie, 1919, etc.) and the *Maitland Quarto Manuscript* (ed. W. A. Craigie, 1920, etc.).

MAITLAND (MAITLAND OF LETHINGTON), **WILLIAM** (*c.* 1528–1573), Scottish statesman, eldest son of Sir Richard Maitland (1496–1586) (*q.v.*) was educated at St. Andrews, and in 1558 became secretary of State to the regent, Mary of Lorraine. In 1559, however, he threw in his lot with the lords of the congregation. He was sent to Elizabeth for assistance and worked consistently for a union between the two crowns. In 1561 he was appointed secretary of State, and for about six years he directed the policy of Scotland and enjoyed the confidence of Mary Queen of Scots. John Knox was consistently antagonistic to him, and their encounter in the general assembly of 1564 is famous. Maitland was doubtless concerned in the conspiracy against David Rizzio, and after Rizzio's murder was obliged to leave the court and was himself in danger of assassination. In 1567 he was again at Mary's side. He was a consenting party to the murder of Darnley, although he had favoured his marriage with Mary, but the enmity between Bothwell and himself was one of the reasons which drove him into the arms of the queen's enemies, among whom he figured at Langside.

He was one of the Scots who met Elizabeth's representatives at York at 1568; here he showed a desire to exculpate Mary and to marry her to the duke of Norfolk, but he was arrested in Sept. 1569 on account of his share in the Darnley murder. He was delivered from his captors by a ruse on the part of his friend, Sir William Kirkcaldy of Grange. Maitland now became the leader of the remnant which stood by the cause of the imprisoned queen, and with Kirkcaldy held Edinburgh castle against the regent Morton. The castle surrendered in May 1573 and on June 7 or 9 1573 Maitland died at Leith.

"Secretary Maitland" was a man of great learning with a ready wit and a caustic tongue. He placed his country above the claims of either the Roman Catholic or the Protestant religions. Among the testimonies to his abilities are those of Queen Elizabeth, of William Cecil and of Knox.

See J. Skelton, *Maitland of Lethington* (1894); A. Lang, *History of Scotland*, vol. ii. (1902).

MAITLAND, WEST AND EAST (with **CESSNOCK**), adjoining towns of New South Wales, Australia, situated in the lower valley of the Hunter River, 20 miles N.W. of Newcastle. Maitland West lies on low ground and was subject to disastrous floods until strong embankments were built. East Maitland lies higher and is mainly residential. In the rich areas adjoining, mixed farming is practised intensively—lucerne largely on the river flats (6–9 crops a year), maize and vegetables—but dairying (fresh milk and butter), along with bee-keeping, is increasingly replacing other forms. (Av. ann. temps., 75°–53° F; av. ann. rainfall, 33 in.) The Maitlands were formerly market and business centres for extensive agricultural areas reaching up the Hunter River and West Maitland is noted still for its great horse and cattle market. They are well-built towns, and West Maitland has a certain amount of industrial activity. Pop. (1933) East Maitland 4,138; West Maitland 8,191; Cessnock 14,385. Cessnock (17 mi. S.W.) has recently curtailed Maitland's sphere and is superseding it as a market centre. The South Maitland coalfield (*c.* 100 sq.mi.; *c.* 1,400,000 tons reserves) extends some 23 mi. southwards from Maitland and is now the leading coal-producing area in Australia. The coal is that of the "Greta" seam and is of good all-round quality (gas-making, railways, export); the normal annual output is about 10,000,000 tons. Cessnock, the centre for a dairying and agricultural district, is now a substantial town with excellent buildings and has mainly a mining population of about 14,000. (*See* also SINGLETON.)

MAITREYA, the name of the bodhisattva who is to be the next future Buddha. In accordance with the Hindu theory of recurrent cycles of the universe, Buddhism held that its truths have been repeatedly taught by Buddhas, who arise in succession, and that the doctrine after its decay and disappearance will be again realized and taught by other Buddhas in the future. A cycle in which no Buddha appears is called empty, but in this cycle there are to be five, or according to some schools 1,000. Four have already appeared, and the fifth is to be Maitreya (Pāli, *Metteyya*).

The theory of recurrent Buddhas may not be primitive, but it certainly arose before the close of the Pāli Canon, as Metteyya is twice mentioned there (*Dīgha-nikāya,* No. 26, *Buddhavamsa,* ch. 27), and the belief became established in all schools. According to the *Lalita-vistara* Maitreya was appointed vicegerent in the Tushita heaven when Gotama left it to become Buddha. He is sometimes represented in Mahāyāna sūtras as being present as a bodhisattva at the Buddha's discourses.

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MAITTAIRE, MICHEL (1668–1747), English bibliographer, was born in France but went to England with his parents, who were Huguenots, after the revocation of the Edict of Nantes in 1685. He was educated at Westminster school and at Christ Church college, Oxford, after which he taught at Westminster (1695–99) and at a school of his own. For a time he was also tutor to Philip Stanhope, Lord Chesterfield's natural son.

His chief work is *Annales Typographici ab Artis inventae origine ad annum* 1557 *cum appendice ad annum* 1664 (1719–41), a list of all books published before the year 1664, which is still consulted by bibliographers and scholars. He was also responsible for a number of works important to classical scholars, including *Graecae Linguae Dialecti* (1706) and *Latin Classics,* and for a history of typography (1717). He died in London, Sept. 7, 1747.

MAITZ-DE-GOIMPY, LOUIS EDMÉ GABRIEL, COMTE DU (1729–*c.* 1790), French naval officer, was born Feb. 8, 1729, near St. Léger, Eure-et-Loir. He joined the French navy in 1746 and remained in it until his retirement in 1785, by which time he had risen to the rank of commodore. During the American Revolutionary war, he commanded the ship "Destin" and participated in three important naval actions off the American coast, one under de Guichen and two under de Grasse, in the first of which he was wounded.

In addition to his achievements as a naval officer, Maitz-de-Goimpy helped to found the Académie de Marine (1752) and was the author of books on astronomy and on naval matters. He died at Billancourt.

MAIWAND, a village of Afghanistan, 50 mi. northwest of Kandahar. It is chiefly notable for the defeat inflicted on a British brigade under General Burrows by Ayub Khan on July 27, 1880, during the second Afghan War (*see* AFGHANISTAN). Ayub Khan, Shere Ali's younger son, who had been holding Herat during the British operations at Kabul and Kandahar, set out towards Kandahar with a small army in June 1880, and a brigade under General Burrows was detached from Kandahar to oppose him. Burrows advanced to the Helmund, opposite Girishk, but was there deserted by Shere Ali, the wali of Kandahar, and had to retreat to Kushk-i-Nakhud. In order to prevent Ayub passing to Ghazni, Burrows advanced to Maiwand on July 27 and attacked Ayub, who had already seized that place. The Afghans, who numbered 25,000, out-flanked the British, the artillery expended their ammunition, and the native portion of the brigade got out of hand and pressed back on the British battalion. The brigade was completely routed and had to thank the apathy of the Afghans for escaping total annihilation. Of the 2,476 British troops engaged, 934 were killed and 175 wounded or missing. This defeat necessitated Sir Frederick Roberts' famous march from Kabul to Kandahar.

See Lord Roberts, *Forty-one Years in India* (1896).

MAIZE or INDIAN CORN, *Zea Mays,* a plant of the tribe Maydeae of the grass family (Gramineae). The word "maize," derived from the Arawak *má-hiz,* is preferred in international usage since "corn," the term by which the plant is known in the United States, is in many countries synonymous with "grain" and may be applied to any cereal.

Origin and History.—Maize is undoubtedly a plant of American origin, since it was unknown in other parts of the world before the discovery of America. Its modern history begins Nov. 5, 1492, when two Spaniards whom Columbus had delegated to explore the interior of Cuba returned with a report of "a sort of grain they call maiz which was well tasted, bak'd, dry'd and made into flour." Later explorers to the new world found maize being grown by the Indians in all parts of America where agriculture was practised, from Canada to Chile. There is little question that maize had been, for many centuries before the discovery of America, the chief cereal and the basic food plant of the pre-Columbian American civilizations and advanced cultures including the Inca of Peru, the Maya and Aztec of middle America and the cliff-dweller of the southwest. Well-preserved ears of maize and funeral vases ornamented with figures of maize are among the objects frequently encountered in prehistoric graves of Peru, Bolivia and Ecuador. Stone carvings of the maize deity are numerous among the archaeological remains of middle America.

Maize was, in a sense, the bridge over which European civilization travelled to a foothold in the new world. To many of the early colonists, who learned its culture from the Indians, it became the daily bread by which they were nourished. Modern American agriculture is founded to a large extent upon an elaborate cultural complex taken from the American Indians, for not only did the European colonist adopt the maize plant; he also embraced the methods of culture, harvesting and utilization which the Indian had developed through generations of trial and error. The planting of maize in hills, its interplanting with beans and squashes, the use of husking pins in harvesting, the storing of the ears in ventilated cribs, the use of green corn for roasting ears, the removal of the hull with lye to make hominy are but a part of the Indian inventions adopted with only slight changes by the white man.

Introduced into Europe by Columbus and into Africa by the Portuguese, maize spread rapidly throughout the old world. Within one generation after the discovery of America it was known over most of Europe. Within two generations it had spread through Africa, India, Tibet and China, and when European ships began to reach the Chinese coast, maize was already being extensively grown there and was being taxed by the emperor. The first references to maize in literature appear early in the 16th century. The first botanical illustration of the plant occurs in the herbal of Leonard Fuchs, in 1542. The earliest Chinese illustration is found in the *Pên ts'ao kang mu* of Li Shih-Chên, which is dated at 1573. Of all of the manifold products of the new world, maize spread the most rapidly, even more rapidly than tobacco.

The botanical origin of maize is less clear than its geographical origin. Earlier botanists were virtually unanimous in the opinion that maize had originated from pod corn, a primitive type in which the grains are enclosed individually in glumes (Fig. 2). In 1875, however, Ascherson showed that teosinte (*Euchlaena mexicana*), a plant growing in the wild in Guatemala, and as a weed in the cornfields in parts of Mexico, is closely related to maize. Harshberger in 1896 gave final proof of this relationship by demonstrating that maize and teosinte can be hybridized to produce highly-fertile hybrids. For the next half-century, the majority of botanists held the opinion that maize had been derived in some manner from teosinte, either by mutation or by hybridization, and that its centre of origin was in Mexico or Guatemala. In 1939, Mangelsdorf and Reeves, as the result of historical research and extensive hybridization experiments with maize, teosinte and Tripsacum, a third American genus of the tribe Maydeae, concluded: (1) that maize originated from a wild form of pod corn which was once, and perhaps still is, indigenous to the lowlands of South America; (2) that teosinte, the closest relative of maize, is a recent product of the natural hybridization of maize and Tripsacum, which occurred after cultivated maize had been introduced by man into Central America; (3) that the great diversity now displayed by maize is due in part to the inevitable development of numerous new varieties following such hybridization.

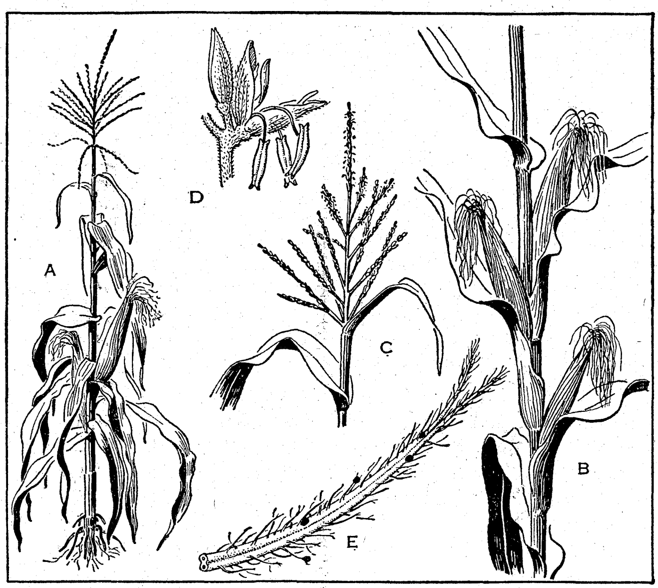

FIG. 1.—A. ENTIRE MAIZE PLANT; B. STALK SHOWING FEMALE OR PISTILLATE INFLORESCENCES; C. THE MALE OR STAMINATE INFLORESCENCE; D. STAMINATE SPIKELET, SHOWING ANTHERS; E. PORTION OF STYLE OR "SILK" MAGNIFIED SHOWING BIFID END AND POLLEN GRAINS CAUGHT IN HAIRS

Botanical Characteristics.—The maize plant is a tall, annual, monoecious grass with a stout, erect, solid stem, a fibrous root system and large narrow leaves with wavy margins, spaced alternately on opposite sides of the stem (Fig. 1A).

The male or staminate flowers are borne on the tassel, a panicle which terminates the main axis of the stem (Fig. 1C). As in all grasses, the flowers occur in spikelets, usually arranged in pairs, one sessile, the other pediceled (Fig. 1D). Each floret contains three anthers (Fig. 1D); each anther, approximately 2500 pollen grains. A single tassel may shed several million pollen grains. These are barely visible to the naked eye, approximately 1/250 inch in length and are ovoid in shape. They are light and easily carried by the wind and this accounts for the fact that maize is naturally cross-pollinated.

The female or pistillate inflorescence, the forerunner of the "ear," is a unique structure among the grasses. Botanically, it is a spike on whose thickened axis, the "cob," the paired spikelets are borne in longitudinal rows. Each row of paired spikelets normally gives rise to two rows of grain; hence the number of rows of grain on the ear is always an even number: 8, 10, 12 and higher even numbers up to 36.

The pistillate inflorescence is enclosed by "shucks" or "husks" which are modified leaves (Fig. 1B). The familiar "silks" which emerge in a pendulous mass from the end of the ear shoot are the styles attached to the ovaries (Fig. 1E). There is a single silk for each potential seed, and the number of seeds on the ear may equal but can never exceed the number of silks which have emerged. Pollination occurs when wind-borne pollen falling upon the fine hairs of the silks germinates and sends its pollen tube down the tissues of the long styles.

Principal Types.—The diversity in maize is enormous and probably exceeds that of any other cultivated plant. There are early maturing varieties, Gaspé Flint from the Gaspé peninsula of Canada and Cinquantino from the Pyrenees mountains of Spain, which mature in 60–70 days; there are very late varieties in Colombia which require 11 months to reach maturity. The number of leaves on a single plant varies from 8 to 48; the number of tillers or suckers from none to 12. Height of stalk may vary from less than 2 ft. to more than 20. The number of rows of grain on the ear may range from 4 to 36, and the size of the ear varies from the diminutive ears of popcorn varieties, some of which are smaller than a man's thumb, to the gigantic corn grown in the Jala valley of Mexico which produces ears up to 2 ft. in length.

Accompanying the variation in vegetative characteristics is a corresponding array of distinct colours. Stalks, leaves and shucks may be green, red, purple, brown, golden or striped. The silks may be green, salmon or various shades of red. The grain may be yellow, white, various shades of red, blue, and brown or variegated.

Superimposed upon the diversity in form and colour is a variation in the texture or the covering of the kernel which serves as the basis for classifying the varieties of maize into the six principal types usually recognized (Fig. 2):

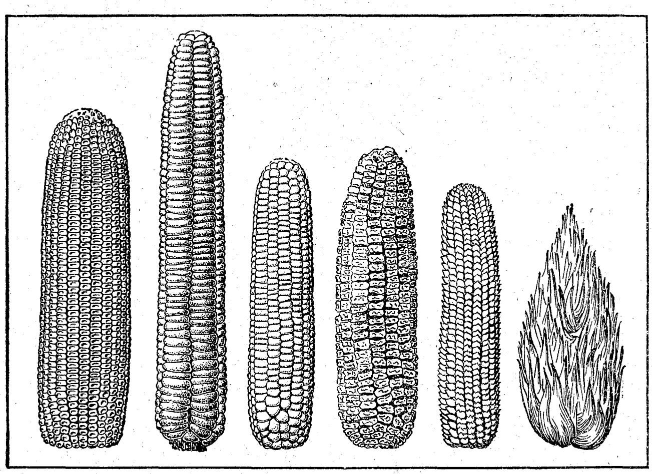

FIG. 2.—THE PRINCIPAL TYPES OF MAIZE FROM LEFT TO RIGHT: DENT, FLINT, FLOUR, SWEET, POP AND POD

1. *Dent corn* is characterized by a depression or indentation in the crown of the kernel, which may vary from a dimple to a rough crease, and which is caused by the unequal drying of the hard and soft starch of which the kernel is composed. Dent corn is the principal type grown commercially in the United States, especially in the corn belt. Although dent corn may occur in any of the known grain colours, the majority of commercial varieties are either yellow or white. Before 1920, yellow corn was preferred in the north, white corn in the south, but with the discovery that yellow corn is richer than white in carotene, a precursor of Vitamin A, and hence frequently more valuable as a feed, there was a decided trend toward yellow varieties. White dent is still preferred for many industrial purposes, especially the manufacture of hominy.

2. *Flint corn* differs from dent corn in containing little soft starch, hence it does not become indented upon drying. The early-maturing flints are extensively grown in the northern United States and Canada, since they germinate more readily in cold soils than dent corn. The tropical flints, because of their resistance to damage by weevils, are the preferred type in tropical lowlands.

3. *Flour corn,* also known as "soft" or "squaw" corn, is usually similar to flint corn in vegetative characteristics, but differs

from it in the texture of the kernels, which are composed largely of soft starch. Because of its soft and mealy kernels, which are easily ground or chewed, flour corn is preferred by Indian tribes wherever it can be grown. It is of little commercial importance in the United States, but is the predominating type in the Andean region of Peru, Bolivia and Ecuador, where many large-seeded varieties, some with kernels an inch in length and almost equally broad, are known.

4. *Sweet corn* is distinguished by its wrinkled, translucent seeds, a condition resulting from the fact that the sugar manufactured by the plant is not converted to starch as it is in other types. Sweet corn is used almost exclusively for human consumption as green corn or roasting ears and as canned or frozen corn.

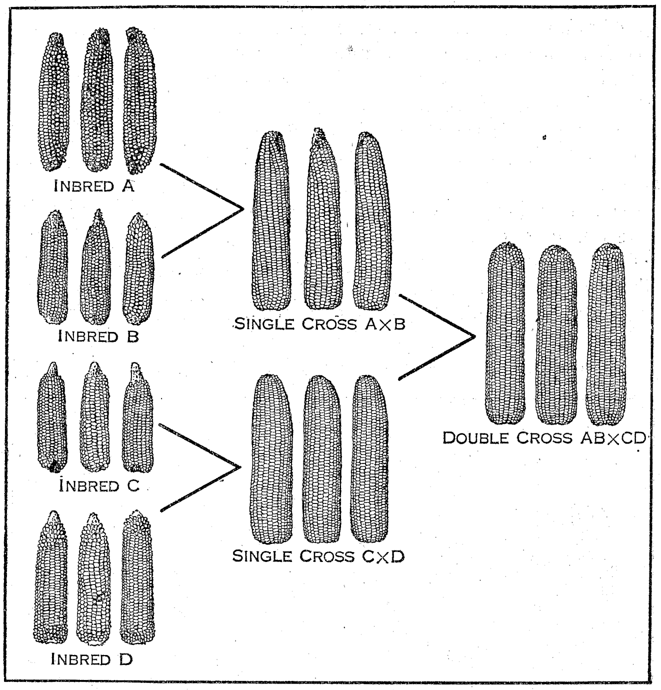

FIG. 3.—HYBRID CORN: INBRED STRAINS A AND B ARE CROSSED TO PRODUCE A SINGLE-CROSS, INBREDS C AND D ARE CROSSED TO PRODUCE A SECOND SINGLE-CROSS. SINGLE-CROSSES AB AND CD ARE CROSSED TO PRODUCE THE COMMERCIAL DOUBLE-CROSS

5. *Popcorn* is actually an extreme type of flint corn, and is included with the latter by some authorities. It is characterized by small hard kernels, completely devoid of soft starch. When heated, the moisture in the cells expands, finally causing the kernels to explode or pop. Popcorn is used extensively in the U.S. confectionery industry. Most of the commercial crop is grown in several counties in Iowa and Nebraska.

6. *Pod corn* is a peculiar type in which each kernel is individually enclosed in husk-like structures, the glumes. It has no commercial importance, but is sometimes grown as a horticultural novelty. It is of considerable botanical interest in representing a primitive condition, probably characteristic of the original wild corn.

Hybrid Maize.—Numerous attempts have been made to improve the uniformity, productiveness and other characteristics of maize through breeding. Earlier attempts to accomplish this met with little success, but beginning about 1920, a new method of corn improvement involving the production of hybrid corn (Fig. 3) was widely adopted and became extremely effective. The method is based upon discoveries in genetics made by E. M. East and D. F. Jones of the Connecticut Agricultural Experiment station and by G. H. Shull of Princeton university.

The first step in the production of hybrid corn is the isolation of superior inbred strains. This is accomplished by artificial self-pollination under bags, which represents a form of inbreeding approximately three times as intense as brother and sister mating in livestock. Inbreeding reduces vigour and productiveness, but results in great uniformity within the strain. The second step involves the crossing of inbred strains by pairs (A x B, C x D, etc.) to produce single-crosses. Single-crosses are exactly as uniform as the parental inbred strains, but because of the phenomenon of hybrid vigour, much more productive. Single-crossed seed of sweet corn is extensively used in the production of green corn for commercial canneries where uniformity in size and shape of the ears is important. Single-crossed seed is usually too expensive, however, for general farm use. A third step is necessary to reduce seed costs. This third step, the production of double-crossed seed, involves the crossing of two single crosses (AB x CD). Double-crosses are slightly less uniform than single-crosses, but almost equally productive.

Hybrid corn does not breed true; but once a satisfactory combination of inbred strains has been identified, the hybrid seed can be produced anew each year from the true-breeding parental inbred strains. Crossing is readily accomplished by growing two stocks in alternate strips in the same field and removing all tassels from the plants of one before pollen is shed. Hybrid corn has proved so productive that by 1943, in spite of the expense involved in producing the seed, more than 50,000,000 ac. were being planted annually to hybrid corn, and an extensive industry devoted to the production of hybrid seed had developed.

World Distribution.—Although pre-eminently an American crop, maize is one of the most widely distributed of the world's food plants. It is grown from 58° N. lat. in Canada and Russia to 40° S. lat. in South America. It is cultivated below sea level in the Caspian plain, and at altitudes exceeding 12,000 ft. in the Peruvian Andes. It thrives almost equally well in the short summer of Canada and the perpetual summer of tropical Colombia. A crop of maize matures somewhere in the world every month of the year.

From the standpoint of acreage planted, maize ranks second among the world's crop plants, being exceeded only by wheat. In the United States, which produces more than half the world's crop, it is by all odds the most important crop, being grown in every state and on approximately three-fourths of all farms. It reaches its maximum importance in the corn belt, a region of fertile, well-drained soils comprising Iowa and parts of Illinois, Indiana, Ohio, Missouri, Kansas, Nebraska, South Dakota and Minnesota. In this region, maize occupies approximately one-half the cultivated land.

Argentina ranks second to the United States in maize production, and is the chief exporting country. In Europe, maize is of greatest importance in the Danube basin and of considerable secondary importance in Italy, Spain and southern France. Both India and south Africa produce considerable quantities of maize, largely for domestic consumption.

Utilization of Maize.—Maize is utilized in three principal ways: (1) as a feed for livestock; (2) as a human food; (3) as a raw material in industry.

In the United States, almost 90% of the maize produced is fed to livestock; approximately half of this amount to hogs, the remainder to beef and dairy cattle, horses and mules and poultry. It requires 10–12 lbs. of corn to produce 1 lb. of beef, 6–8 lbs. to produce 1 lb. of pork. For feeding cattle, the entire plant is frequently harvested and used as ensilage.

As a human food, maize is inferior to other cereals. It contains no gluten and makes a heavy, crumbly bread. It is deficient in niacin, and diets containing excessive amounts of maize usually result in pellagra. Nevertheless, maize was used exclusively for human food in prehistoric times, and is still used extensively for this purpose in Latin-American countries, in parts of Europe and the United States and in south Africa and India. The *tortilla,* a thin flat cake of maize, is the daily bread of Mexico, and maize constitutes 75% to 85% of the diet of the Maya Indians of Guatemala. In the United States, maize is of greatest importance as a human food in the south, but is used to some extent in all parts of the country in the form of corn bread, hominy, mush or polenta, griddle-cakes, scrapple, popcorn, confections and numerous manufactured cereal preparations. Sweet corn, harvested when the grain is in the "milk" stage, is an important American vegetable, consumed fresh, canned or frozen.

Chief among the industrial uses of maize is the manufacture of corn starch and its derivatives and by-products, corn sugar or dextrose, corn syrup, dextrins, corn oil and industrial alcohol. The grain is used in making various alcoholic beverages. The stalk is manufactured into paper and wallboard. Husks are used as filling material. Cobs are used for fuel, for the making of charcoal and the preparation of industrial solvents. Corncob pipes are manufactured from a large-cobbed variety grown in Missouri. During World War II, considerable quantities of maize, converted into alcohol, were used in the manufacture of synthetic rubber. A special type of corn with waxy endosperm has been employed as a substitute for imported cassava starch in the manufacture of tapioca and adhesives.

Production Statistics.—World production of maize in 1940 was slightly more than 5,000,000,000 bu., distributed as follows: United States, 2,500,000,000; Europe, 770,000,000; South America, 712,000,000; Asia, 590,000,000; Africa, 249,000,000. The principal exporting countries for the five-year period, 1930–34, were Argentina, 252,000,000 bu.; Rumania, 44,000,000; Yugoslavia, 17,000,000; Union of South Africa, 13,000,000; United States, 6,000,000. Principal importing countries for the same period were the United Kingdom, 102,000,000 bu.; the Netherlands, 52,000,000; France, 35,000,000; Belgium, 30,000,000; Denmark, 21,000,000.

The acreage of maize harvested in the United States in 1940 was approximately 86,738,000 ac., of which 76,796,000 ac. were harvested as grain, 4,671,000 ac. harvested as silage and 5,271,000 ac. harvested as forage or used for hogging down. The consumption of maize in the United States in 1940 was 2,509,680,000 bu., distributed approximately as follows: starch and derivative products, 141,000,000; alcoholic beverages, 34,000,000; breakfast foods, 9,000,000; farm household use, 31,000,000; seed, 16,000,000; feed and waste, 2,250,000,000; exports, 14,000,000.

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(P. C. MF.)

MAJANO (or MAIANO), **BENEDETTO DA** (1442–1497), Italian sculptor and architect, was born at Majano, Venetia. Little is known of his early life except that it is likely that he studied under his brother, Giuliano, and that he learned stonemasonry in his youth. For a time inlaid wood was his favourite medium, but he gave up this technique when some of his carefully worked pieces were warped by moisture and ruined. He decided to devote himself to a medium less susceptible to damage and turned to marble. The first piece of sculpture which can definitely be attributed to him is a bust of Pietro Mellini (1474).

Mellini then commissioned him to execute a pulpit for Santa Croce in Florence, and this work is generally regarded as his masterpiece. In five panels, it shows bas-relief scenes from the history of the Franciscan order. It has been said of Benedetto's work on it that "he painted in marble as Ghiberti painted in bronze."

His next important patron was Filippo Strozzi, for whom he built a palace at Florence and of whom he sculptured one of his best busts. Other important works of Benedetto's include the altar in San Savino in Faenza and the ciborium in San Domenico in Siena.

During the last years of his life, he lived in San Gimignano. He died May 27, 1497. Majano is generally considered to be one of the great sculptors of his century.

MAJESTY, dignity, greatness, a term especially used to express the dignity and power of a sovereign. This application is to be traced to the use of *maiestas* in Latin to express the supreme sovereign dignity of the Roman state, the *maiestas republicae* or *populi Romani*, hence *maiestatem laedere* or *minuere*, was to commit high treason, *crimen maiestatis*. (For the modern law and usage of *laesa maiestas see* TREASON.) From the republic *maiestas* was transferred to the emperors, and the *maiestas populi Romani* became the *maiestas imperii*, and *augustalis maiestas* is used as a term to express the sovereign person of the emperor. Honorius and Theodosius speak of themselves in the first person as *nostra maiestas*. The term "majesty" was strictly confined in the middle ages to the successors of the Roman emperors in the west, and at the treaty of Cambrai (1529) it is reserved for the emperor Charles V. Later the word is used of kings also, and the distinction is made between imperial majesty (*caesareana maiestas*) and kingly or royal majesty.

From the 16th century dates the application of "Most Christian and Catholic Majesty" to the kings of France, of "Catholic Majesty" to the kings of Spain, of "Most Faithful Majesty" to the kings of Portugal, and "Apostolic Majesty" to the kings of Hungary. In England the use is generally assigned to the reign of Henry VIII, but it is found, though not in general usage, earlier; thus the *New English Dictionary* quotes from an *Address of the Kings Clerks to Henry II* in 1171, where the king is styled *vestra majestas*, and Selden finds many early uses in letters to Edward I, etc.

The fullest form in English usage is "His Most Gracious Majesty"; another form is "The King's Most Excellent Majesty," as in the English Prayer-book. "His Sacred Majesty" was common in the 17th century; and of this form Selden says: "It is true, I think, that in our memory or the memory of our fathers, the use of it first began in England." "His Majesty," abbreviated H.M., is now the universal European use in speaking of any reigning king, and "His Imperial Majesty," H.I.M., of any reigning emperor. From early times, the word has been applied to the Deity.

MAJLÁTH, JÁNOS or JOHN, COUNT (1786–1855), Hungarian historian and poet, was born at Budapest on Oct. 5, 1786. First educated at home, he subsequently studied philosophy at Eger (Erlau) and law at Györ (Raab), his father, Count Joseph Majláth, an Austrian minister of state, eventually obtaining for him an appointment in the public service. Majláth devoted himself to historical research and the translation into German of Magyar folk-tales and of selections from the works of the best of his country's native poets. Moreover, as an original lyrical writer and as an editor and adapter of old German poems, Majláth showed considerable talent. During the greater part of his life he resided either at Budapest or Vienna, but a few years before his death he moved to Munich, where he fell into a state of destitution and extreme despondency. Seized at last by a terrible infatuation, he and his daughter, Henriette, who had long been his constant companion and amanuensis, drowned themselves in the Lake of Starnberg, a few miles southwest of Munich, Jan. 3, 1855.

Of his historical works the most important are the *Geschichte der Magyaren* (Vienna, 1828–31, 5 vols.; 2nd ed., Ratisbon, 1852–53) and his *Geschichte des österreichischen Kaiserstaats* (Hamburg, 1834–50, 5 vols.). Specially noteworthy among his metrical translations from the Hungarian are the *Magyarische Gedichte* (Stuttgart and Tübingen, 1825) and *Himfy's auserlesene Liebeslieder* (Budapest, 1829; 2nd ed., 1831). A valuable contribution to folk-lore appeared in the *Magyarische Sagen, Märchen und Erzählungen* (Brünn, 1825; 2nd ed., Stuttgart and Tübingen, 1837, 2 vols.).

MAJOLICA, a name properly applied to a species of Italian ware in which the body is coated with a tin-enamel, on which is laid and fired a painted decoration. It is also applied to similar wares made in imitation of the Italian ware in other countries. The word in Italian is *maiolica*. Du Cange quotes from a chronicle of Verona of 1368, in which the form *majolica* occurs for the more usual Latin form, *majorica*.

It has usually been supposed that this type of pottery was first made in the island of Majorca, but it is more probable that the name was given by the Italians to the lustred Spanish ware imported by ships hailing from the Balearic Islands. (*See* POTTERY AND PORCELAIN.)

MAJOR (or MAIR), **JOHN** (1470–1550), Scottish theological and historical writer, was born at Gleghornie, near North Berwick. He was educated at the school of Haddington, where John Knox was later a pupil. After a short period spent at Cambridge (at God's house, afterward Christ's college) he entered the University of Paris in 1493, studying successively at the colleges of St. Barbe, Montaigu and Navarre, and graduating as master of arts in 1496. Promoted to the doctorate in 1505, he lectured on philosophy at Montaigu college and on theology at Navarre.

He visited Scotland in 1515 and returned in 1518, when he was appointed principal regent in the University of Glasgow, John Knox being one of those who attended his lectures there. In 1522 he removed to St. Andrew's university, where in 1525 George Buchanan was one of his pupils. He returned to the college of Montaigu in 1525 but was once more at St. Andrew's in 1531, where he was head of St. Salvator's college from 1534 until his death in 1550.

Major's voluminous writings may be grouped under (*a*) logic and philosophy, (*b*) Scripture commentary and (*c*) history. All are in Latin, all appeared between 1503 and 1530 and all were printed at Paris. The first group includes his *Exponabilia* (1503), his commentary on Petrus Hispanus (1505–1506), his *Inclitarum artium libri* (1506, etc.), his commentary on Joannes Dorp (1504, etc.), his *Insolubilia* (1516, etc.), his introduction to Aristotle's logic (1521, etc.), his commentary on the ethics (1530) and, chief of all, his commentary on Peter Lombard's *Sentences* (1509, etc.); the second consists of a commentary on Matthew (1518) and another on the Four Gospels (1529); the last is represented by his famous *Historia Majoris Britanniae tam Angliae quam Scotiae per J.M.* (1521). In political philosophy he maintained the Scotist position that civil authority was derived from the popular will, but in theology he was a scholastic conservative, though he never failed to show his approbation of Gallicanism and its plea for the reform of ecclesiastical abuses. He hoped to reconcile realism and nominalism in the interests of theological peace. He claimed that the historian's chief duty is to write truthfully, and he was careful to show that a theologian might fulfil this condition.

The *History,* on which his fame now rests, was reprinted by Freebairn (Edinburgh, 1740) and was translated in 1892 by Archibald Constable for the Scottish History society. The latter volume contains a full account of the author by Aeneas J. G. Mackay and a bibliography by Thomas Graves Law.

MAJOR, RICHARD HENRY (1818–1891), English historian and geographer, was born in London, Oct. 3, 1818. He held several positions with the British museum, including that of curator of the department of printed maps and plans, which position he was the first to occupy. He also served the Hakluyt society and the Royal Geographical society in a number of executive capacities. He was particularly interested in the explorations of the Italians and the Portuguese in the 15th and 16th centuries, and for his work in this field he was decorated by the Brazilian, Italian and Portuguese governments.

Major's best-known work is a *Life of Prince Henry of Portugal, surnamed the Navigator* (1868), to which he later published a sequel, *The Discoveries of Prince Henry the Navigator and their Results* (1877).

He died in Kensington, June 25, 1891.

MAJOR (Lat. for "greater"), a word used, both as a substantive and adjective, for that which is greater than another in size, quality, degree, importance, etc.; often opposed correlatively to that which is "minor" in the same connotation. In the categorical syllogism in logic, the "major term" is the term which forms the predicate of the conclusion, the "major premise" is that which contains the major term. *Major* as part of an official title in mediaeval Latin has given the Spanish *mayor,* French *maire* and English mayor (*q.v.*). In English the unadapted form "major" is the title of a military officer now ranking between a captain and a lieutenant-colonel.

Originally, the military term was used adjectivally in the title sergeant-major, the "third principal officer in a regiment" (Ward 1639), now the major. In the 16th and 17th centuries there was a similarity between the duties of the sergeant, sergeant-major and sergeant-major-general, in that they attended to the drill and administration of a company, a regiment and an army, respectively. In conversation sergeant-major was abbreviated to major and sergeant-major-general to major-general, whence the modern titles of major and major-general derive. In the case of sergeant-major the "sergeant" was dropped generally about 1660, although in some quarters it lingered for some years later.

Up to about the beginning of the 18th century majors, in common with other field-officers, had companies, the executive command being in the hands of a lieutenant. Majors have now displaced lieutenant-colonels as seconds-in-command of units, though junior majors now command companies, squadrons and batteries. In those armies where the regiment corresponds to a brigade (of three or four battalions), majors command battalions, while the regiment is commanded by a colonel. In the 17th century the duties of a major were a combination of those now performed by the major (second-in-command) and sergeant-major, but on the introduction of adjutants he was relieved of much of the routine work and assumed the more important duties of second-in-command.

The brigade-major corresponds in a higher sphere to the adjutant of a battalion. Such expressions as "town-major" and "fort-major" indicate the purpose of the appointment.

Drum-major was an ancient title in the British service, until it was abolished in 1881 to be substituted by sergeant-drummer, which in turn was abolished in 1928 on the re-introduction of drum-major. The title sergeant-major was introduced as a non-commissioned rank in the British service early in the 18th century and was elevated to warrant rank in 1881. The equivalent term in the Household cavalry is corporal-major.

In music, the term major (*i.e.,* greater) is opposed to minor (*i.e.,* smaller) as defining the size of intervals, a minor interval containing a semitone less than a major. Thus a major third (*e.g.,* C to E) contains four semitones; and a minor third (C to E flat), three. A major scale in turn is one with a major third, as distinguished from a minor scale in which the third is minor, these two different scales constituting the major and minor modes respectively. (*See* HARMONY.)

MAJORCA, the largest of the group of Spanish islands in the Mediterranean sea known as the Balearic Islands (*q.v.*). Pop. (1940) 327,120; area, 1,405 sq.mi. On the northwest the coast is precipitous, but on the other sides it is low and sloping. On the northeast the chief bays are those of Alcudia and Pollensa; while on the southwest is the still more important bay of Palma. In the northwest a chain of mountains runs parallel with the coast and attains its highest elevation in Silla de Torrellas (5,154 ft.). Majorca has typical limestone scenery. Some of the valleys, such as those of Valldemosa and Sóller, have luxuriant vegetation. There are marble quarries, those near Santañy being celebrated; while lead, iron and cinnabar have also been obtained. Coal is found at Benisalem, Selva, Santa Maria and elsewhere.

The inhabitants are principally engaged in agriculture. Old pine woods have in many places given way to the olive, the vine and the almond tree, to fields of wheat and flax or to orchards of figs and oranges.

Inca is the centre of the oil district. The wines are light but excellent, especially the Muscatel and Montona. Brandy is made and exported; woollen and linen cloths are woven; the silkworm is reared and its produce manufactured; and canvas, rope and cord are largely made.

The four principal roads are those from Alcudia, Manacor, Sóller and Andraitx to Palma, the capital. The main railway line runs from Palma to Manacor and Alcudia. There is regular communication with Barcelona and Alicante.

The principal towns include—besides Palma (97,009), Felanitx (7,403) and Manacor (13,585), which are described in separate articles—Andraitx (3,301), Inca (10,799), Lluchmayor (9,347), Pollensa (5,722), Santañy (3,757), Sóller (7,146) and La Puebla (10,080).

MAJORIAN (IULIUS VALERIUS MAIORIANUS), emperor of the west from 457 to 461. After the deposition of Avitus Majorian was declared emperor by the regent, Ricimer. After repelling an attack by the Vandals upon Campania (458), he prepared a large force to invade Africa. Having defeated and concluded an alliance with Theodoric the Visigoth, at the beginning of 460 he crossed the Pyrenees for the purpose of joining the powerful fleet which he had collected at Carthagena. The Vandal king Gaiseric, however, succeeded through the treachery of certain officers in destroying the Roman fleet. Majorian thereupon made peace. But his ill-success had destroyed his military reputation. A mutiny inspired by Ricimer broke out in Lombardy, and on the 2nd of August 461 Majorian was forced to resign. He died five days afterwards, either of dysentery or by violence. Majorian was the author of a number of laws, appended to the Theodosian Code. Of these the most interesting is that forbidding the use of ancient monuments as quarries for building material.

See Sidonius Apollinaris, *Panegyric of Majorian* (*Chronica Minora*, ed. Mommsen, vols. 1, 2 and 3); Gibbon, *Decline and Fall*, ch. xxxvi. (where an outline of the "novels" of Majorian is given); J. B. Bury, *Later Roman Empire*, ch. iii.

MAJORITY: *see* INFANT; AGE.

MAJUBA (properly AMAJUBA, Zulu for "the hill of doves"), a mountain in the Drakenberg, of northern Natal, rising about 7,000 ft. above the sea and over 2,000 ft. above the level of the surrounding country. It overlooks the pass over the Drakenberg known as Laing's Nek, is 8 m. S. of the Transvaal border and 18 m. N. of the town of Newcastle. The railway from Durban to Johannesburg skirts the base of the mountain. During the Boer War of 1880–81 Majuba was occupied on the night of the 26th of February 1881 by some 600 British troops under Sir George Pomeroy Colley. On the following morning the hill was stormed by the Boers under Piet Joubert and the British routed, Colley being among the slain.

MAKAH, the Indians of Cape Flattery, Washington, the only group of Nutka affiliation in the United States. Bold canoemen, they paddle far out on the ocean to harpoon whales. Their culture, of general North Pacific coast type, has closest resemblance to that of the Quileute and Nutka. Of an original 2,000, some 400 remain.

See J. G. Swan, *Indians of Cape Flattery* (1870).

MAKALAKA, a general designation used by the Bechuana, Matabele and kindred peoples, for conquered or slave tribes. The name is more frequently used to designate the Makalanga, one of the tribes now classed as Mashonas conquered by the Matabele.

MAKARAKA ("Cannibals"), a negroid people of Central Africa, related to the powerful Azande or Niam-Niam race, occupying the Bahr-el-Ghazal west of Lado. They came originally from the country of the Kibas, north of the Welle. They are a reddish-black, with nose less flat and cheek-bones less prominent than the ordinary negroes, and they do not extract the incisors. Their long silky hair is built up in the most fantastic form by means of vegetable substances. They are well-known for strength and staying power.

See W. Junker, *Travels in Africa* (1890–92).

MAKARSKA (Ital. *Macarsca*), the chief town of an administrative district in Dalmatia, Yugoslavia. Pop. (1931) 11,685, chiefly Serbo-Croatian. Makarska is a steamship station and has a brisk trade in wine, grain and fruit. Under the name of Mocrum, Makarska was a thriving Roman city, and a bishopric until 639, when the town was destroyed by the Avars. Its bishopric was revived in 1320, but merged in that of Split (Spalato) in 1830.

MAKART, HANS (1840–1884), Austrian painter, born at Salzburg on May 27, 1840, was the son of an inspector of the imperial castle. He has been aptly called the first German *painter* of the 19th century. When he entered the Vienna Academy, German art was under the rule of Cornelius's cold classicism and was entirely intellectual and academic. Makart, poor draughtsman to the very last, with a passionate and sensual love of colour was forced to leave the Vienna Academy. He went to Munich, and after two years of independent study attracted the attention of Piloty, under whom he made astonishing progress. Gradually he came to sacrifice everything to the decorative quality of his work. His "Romeo and Juliet" was bought by the Austrian emperor for the Vienna Museum, and Makart was invited to come to Vienna, where a large studio was placed at his disposal. In Vienna he became the acknowledged leader of the artistic life of the city. The obvious appeal of his huge compositions in their glowing richness of colour, in which he tried to emulate Rubens, made him appear a very giant to his contemporaries in Vienna, and indeed in all Austria and Germany. He reached the zenith of his fame when, in 1879, he designed, single-handed, the costumes, scenic setting, and triumphal cars of the grand pageant with which the citizens of Vienna celebrated the silver wedding of their rulers, all dressed in the costumes of the Rubens and Rembrandt period.

Unfortunately Makart used such villainous pigments and mediums that the majority of his large paintings have practically perished. The paint has cracked, and in some instances crumbled away, and this loss of their chief quality has accentuated their weakness of drawing and execution, and the prevalence of glaring anachronism in his work. He died in Vienna on Oct. 3, 1884.

Important examples of his work are to be found at the galleries of Vienna, Berlin, Hamburg and Stuttgart. For the Vienna Museum he also executed a series of decorative lunettes. His great historical pictures include "Catherina Cornaro," "Diana's Hunt," "The Entry of Charles V. into Antwerp," "Abundantia," "Spring," "Summer," "The Death of Cleopatra," and the "Five Senses."

MAKE-UP. As long as dramatic exposition has existed it has presumably been accompanied by some form of masquerade for the purpose of transforming the actor into the part he portrays. History reveals its employment far into antiquity.

Primitive Make-up.—A suggestion of the simplicity and crudeness of the earliest devices of make-up may be found in the religious rites of primitive races in modern times. The Patagonians, whose only form of dramatic movement was the swaying of their bodies and a monotonous mumbling of incantations, made up for the occasion by smearing their faces with chalk. Among the Australian aborigines, who rank somewhat higher in the ethnological scale, ritual ceremonies are enhanced by bodily adornments of wreaths, flowers and feathers worn over greased bodies and faces daubed with white clay.

The Aleutian Indians use painted wooden masks representing demons and sea animals for their mystic rites, while the natives of the South Sea islands dress their heads with helmet-like structures, into which are built masks of wood, reeds, tortoise shell and human skulls, sometimes decorated with vegetable substances to represent hair. Some of these islanders, like the Areoi, discard the mask and impress their spectators by painting their faces red and their bodies black. The Red Indians of North America, besides decorating their bodies and faces with variously hued war paints, were accustomed to behold their medicine man dressed for their rituals in the complete skin and head of elk, bear, wolf or panther.

The Chinese and Siamese theatre of to-day not only hands down its old tradition of masks, but makes use of grotesquely painted faces of blue, green, ochre, vermillion and ghastly white for demons and spirits. For the official ceremonies of the ancient Egyptians wigs were worn by kings and priests. Persian warriors wove strands of jute into their marcelled beards.

In the procession of Dionysus, out of which grew the Greek drama, the god was represented with long hair and beard, two small horns projecting from his forehead, while the reeling Bacchantes appeared with faces smeared with wine dregs or mulberry juice. Some of the followers in the train portrayed dead souls clad in shrouds with their faces covered in white lead.

Development.—For the miracle plays of the 14th century and onward actors made up with startling realism for animals, devils, saints and angels. Much ingenuity in facial disguise was used in a mediaeval play called *The Acts of the Apostles,* wherein the spectators saw the eyes of St. Matthew drawn out of his head and Simon Magus change his face several times. In an early English Passion play, Christ and the Apostles wore gilt wigs and the evil spirits appeared with bodies painted a reptile-like green, huge horns of oxen and rams ornamenting their heads.

The stage directions of a French morality play, *Bien Avisé et Mal Avisé,* call for a double face for Fortune—one smiling and the other terrible. In a modern production of an old secular play, *Noah's Flood,* at the New Theatre, New York, God was supplied with a gilded face.

A favourite farce actor in Paris during the reign of Henry IV. was known as Gros Guillaume. His face make-up consisted of a thick coating of flour which, at comic moments, he sent flying into the eyes of his fellow actors by puffing out his fat cheeks; on his chin he wore a piece of white lamb's skin, representing a beard. The popular *Commedia dell' Arte* (*q.v.*) of the Italian theatre of the 16th and 17th centuries was performed by actors masked always in the typical grotesquerie of Pierrot, Harlequin, Pantaloon, Scaramouche, Capitano, etc. The white face of the modern circus clown is a direct inheritance from the Pierrot, who in the 18th century discarded the mask and powdered his face with flour. The Italian Pulcinello and the French Polichinelle were represented as deformed old men with white hair and moustaches and huge hooked red noses.

The English stage of Elizabeth did away with the mask as a means of facial make-up. Instead of the set expressions of the disguised Harlequins and Pantaloons, actors were seen as human beings with their natural faces or appropriately painted, bearded and wigged as the character called for. Cosmetics were applied simply and obviously as there was no artificial lighting to soften disguise deficiencies. The theatre of Molière encountered few make-up difficulties. The customary long ringlets of the Court were worn whatever the period of the play, whether Roman or Contemporary and the only beard necessary was the partly shaved moustache of the prevailing mode.

The ignoring of archaeological verity in make-up was characteristic of the English stage until after the time of David Garrick who, for nearly every character, wore the white court wig of George III. and as Romeo appeared as a British gentleman of his day. The art of make-up was but little studied before the beginning of the 19th century. Costume was clumsy and incorrect, wigs and beards for character parts of crude material and the faces of old men, villains and clowns inartistically painted. The early method of acting Shylock was as a comedy part that roused audiences to laughter. Doggett, a celebrated Shylock, wore a ridiculous red wig and beard for the part. The first actor to redeem the character from buffoonery was Macklin, who presented him sinister and black-bearded. Since Macklin, actors have varied the aspect of Shylock according to their fancy. A well-remembered portrait was that of Henry Irving whose Jew was the picture of an elderly aristocrat.

The stage lighting of the period was dim and ineffectual, first by candles, later by smoking oil lamps, and in its twilight crudity passed unnoticed. As illuminating gas and calcium lights were introduced the necessity arose for greater circumspection in appearance. Make-up material, however, was still somewhat elemental and natural appearing heads and complexions a rarity. The electrical lighting in theatres today would make sorry work of some of these old stagers. Wigs were constructed of any workable material resembling human hair, sheep and goat fleeces, yak and horse hair. Sometimes for rough and tousled heads jute was used. Human hair, nevertheless, was employed when available and gradually superseded the coarser material. Llama hair is often used in white wigs.

Modern Make-up.—The art of the wig-maker has kept pace with the general perfection of theatrical devices. The old man's bald or semi-bald pates were formerly constructed of light felt or soft buckskin and coloured with dry chalk, ochre and vermillion until a flesh-like hue was obtained. The up-to-date peruquier builds his bald wigs on blocks that shape the article to the real proportions of the head and with hard, shell-like pates. Wax and papier mâché were used at first, later celluloid of a natural flesh colour. Through this the hair is sewn shred by shred with a needle formed like a fish hook. In the case of full wigs for younger characters a soft flexible cap of silk gauze or bolting cloth is fitted to the head and the hair sewn through. For the purpose of quick disguise a composite wig consisting of pate, forehead, eyebrows, nose and moustache is a device that has been found effective but the disadvantage it possesses is that it takes away all expression of the face. It resembles the mask of the *Commedia dell' arte*. There have been odd experiments in make-up such as in Granville Barker's production of *Midsummer Night's Dream* (London, 1914) wherein the fairies' faces and wigs were bright gold.

Beards made on wire frames and hung over the ears, and moustaches pinched into the nostrils by wire have been replaced by natural looking appendages sewn on gauze and attached to the face by spirit gum—a compound of rosin, mastic and alcohol. The most artistic result, however, is accomplished by the use of crêpe hair, a vegetable fibre that is braided into long ropes and cut off, combed out and pasted to the face piecemeal. Sheep wool dyed was formerly used.

Grease paint, a valuable invention of over a half-century ago, is a composition of oil, spermaceti and wax, suited to any complexion, ruddy, sallow, Moorish or fair, and runs in colour scheme from white to black. (*See* COSMETICS.) Mascara for tinting the hair is made in various hues of pressed gum and colour and applied with a wet brush. Face powder is of talc tinted with lake colours. Minstrel black is a compound of burnt cork and glycerine. This was used for the stage negro until brown grease paint showed the wiser way. Even Othello was at one time blackened with charred cork. Clown white has a basis of zinc oxide. Formerly white lead was employed but this was found to possess dangerous qualities. Its use caused the death of the most famous of American clowns, George L. Fox. Rice starch is the usual material for whitening the hair. There is little difference between the preparation of the face for the stage and for the screen. The latter requires a more minute method and must allow for the colour prohibitions of the camera. (*See* MOTION PICTURES: *Make-up.*)

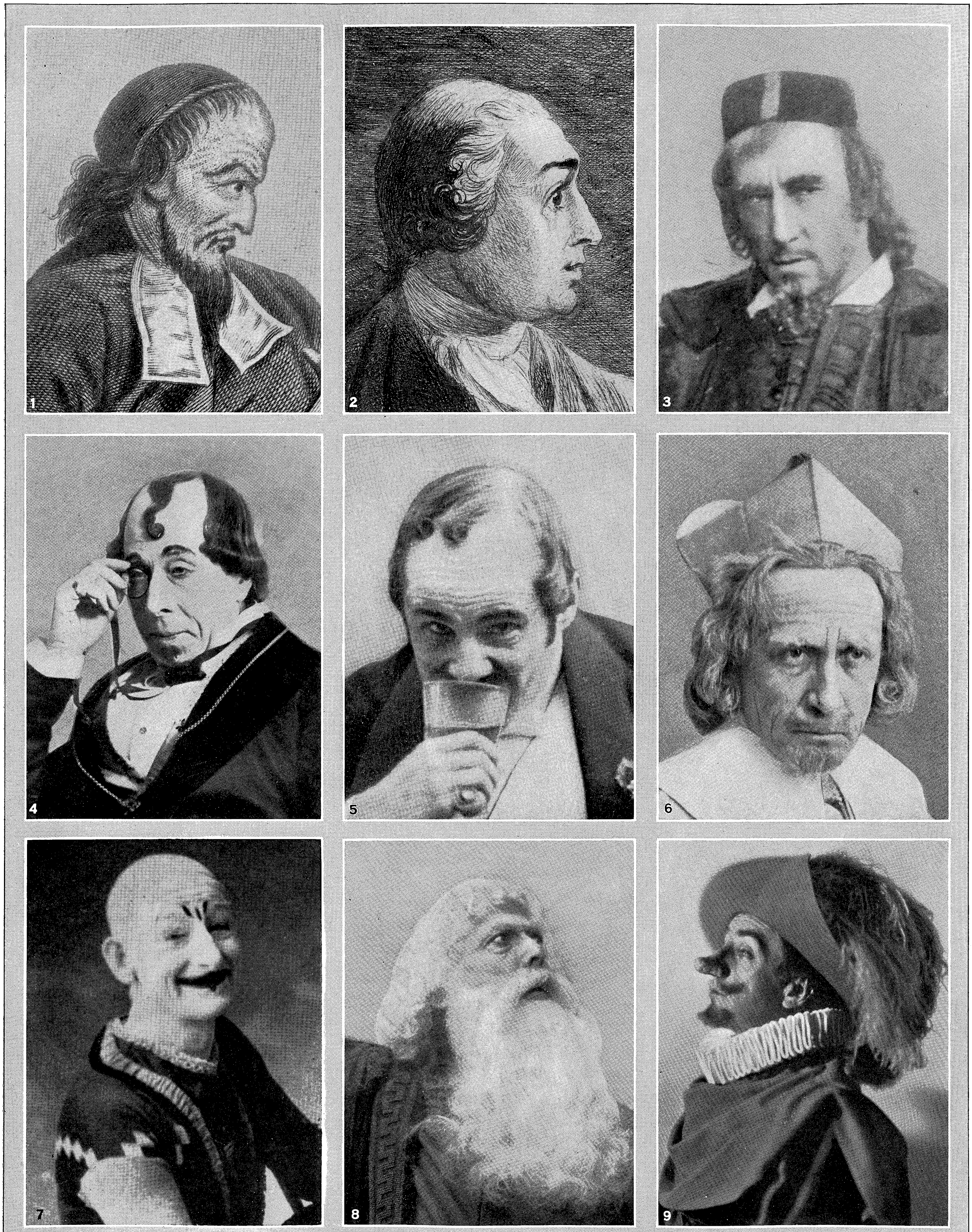
With the newer possibilities of make-up the actor should be chary of its use in the theatre. It is often quite unnecessary. Too great an overlay of paint hides expression and inhibits the play of facial muscles. The subtle changes of emotion are often hidden and lessen the effect of the actor's work upon his audience. Many artists of the theatre use practically none at all. The Italian actress, Eleanora Duse, discarded it entirely. Modern stage lighting which strikes the actor's features from many angles is so searching that it reveals paint instead of complexion unless colour is sparingly put on. It must not be forgotten that a great part of an actor's charm lies in his unconcealed personality. The deadly white skin, the over-rouged cheek, the flaming mouth and the heavily lined eyelid all make for unappealing grotesquerie.

(O. SK.)

MAKING-UP PRICE. A term used in the London and other British stock exchanges to denote the price at which speculative bargains are carried over from one account to the next. The carrying over of a "bull" position in Eries, for example, implies a sale for cash and a simultaneous repurchase for the new account, both bargains being done at the making-up price. This is fixed at noon on carry-over day, in accordance with the market price then current (*see* STOCK EXCHANGE). The term is also used in New York, where the making-up prices are fixed at the end of a day's business, in accordance with the American system of daily settlements.

MAKÓ, the capital of Csanád county, Hungary, a typical market town of the Hungarian plain situated near the right bank of the Maros. Cereal cultivation and stock raising are important activities on its fertile communal lands and there are several flour mills in the town, but its chief specialisation is the growth of vegetables, particularly onions for which it is famous. Pop. (1930) 35,824.

MAKONNEN, RAS TAFARI (1891–), king of Abyssinia, "King of the Kings of Ethiopia, Lion of Judah, the Elect of God," born July 17, 1891, was great-grandson of Haile Melekot, King of Shoa, and son of a distinguished soldier and diplomat. He was educated by the French mission at Harrar. In 1912 he married Waizero Manin, granddaughter of Ras Michael, his eldest son being born July 27, 1916. When on Sept. 27, 1916, the dissolute Lej Yasu was dethroned and his aunt, Zauditu, proclaimed empress, Tafari, her cousin, was appointed regent, heir to the throne, and Ras (prince) of Rases. Ras Michael, Yasu's father, was defeated on Oct. 27. Yasu rallied his father's army, but it surrendered at Magdala in Dec. 1917. Yasu was incarcerated in 1921. An indefatigable worker, widely read, possessing personality, ability and enthusiasm for reform, Tafari



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ENGLISH AND AMERICAN ACTORS IN CHARACTER MAKE-UP

1. Charles Macklin (1697–1797), as Shylock. 2. David Garrick (1717–79), as Romeo, in 18th century costume. 3. Sir Henry Irving (1838–1905), as Shylock. 4. George Arliss (1868–1946), as Disraeli. 5. Richard Mansfield (1857–1907), as Baron Chevrial in "A Parisian Romance." 6. Edwin Booth (1833–93), as Cardinal Richelieu. 7. George L. Fox (1825–77), celebrated American clown, in character of Humpty Dumpty. 8. Robert Mantell (1854–1928), as King Lear. 9. Walter Hampden (1879–), as Cyrano de Bergerac

MAKE-UP

PHOTOGRAPHS, (1) THE J. C. STRAUSS STUDIO, (3, 6, 8) THE WHITE STUDIO, (5) PIRIE MACDONALD, (7) SARONY, (9) CHAS. H. DAVIS.

OTIS SKINNER (1858–1942) IN VARIOUS RÔLES ILLUSTRATING CONTRASTS IN MAKE-UP

1. As Charles Surface in "The School for Scandal"
2. Portraying Hajj in "Kismet"
3. As Sancho Panza in Cervantes' "Don Quixote"
4. As Falstaff in "Henry IV."
5. Otis Skinner without make-up
6. As he appeared in "Mister Antonio"
7. As Denis Roulette in "Sire"
8. As Falstaff in "Merry Wives of Windsor"
9. As Philippe Bridau in "The Honor of the Family"

gradually increased his power. In order to gain authority independently of the Empress Zauditu, Ras had himself proclaimed king, Nov. 7, 1928. After Zauditu's death he formally mounted the throne on Nov. 2, 1930, as Emperor Haile Selassie I. He continued his work of modernization, secured the admission of Abyssinia to the League of Nations in 1923, and made a dramatic tour of European capitals in 1924. Difficulties with England over control of the Nile waters were soon overshadowed by disputes with Italy. In spite of the arbitration agreement of 1928 and the action of the League of Nations, hostilities broke out late in 1935 with Italy, ending in the flight of the emperor from Addis Ababa, May 1, 1936, occupation of the capital by the Italians, May 5, and the proclaiming of King Victor Emmanuel as emperor of Abyssinia. In May 1941 Haile Selassie returned to Addis Ababa. (J. Sw.)

MAKRAN or **MEKRAN,** a province of Baluchistan, India, fringing the Arabian sea from Persia almost to Sind for 200 mi. It is subject to the khan of Kalat under British supervision. Total area, 23,269 sq.mi.; pop. (1941), 86,651. The lateral valley of Kej is associated with Makran in early geographical records. The Kej-Macoran of Marco Polo is the Makran of today.

The long stretch of sandy foreshore is broken on the coast-line by the magnificent cliffs of Malan, the headlands of Ormarah and Gwadar, and the precipitous cliffs of Jebel Zarain, near Pasni. Within them lies the usual frontier band of parallel ridges, alternating with narrow valleys. The normal conformation of the Baluchistan frontier is somewhat emphasized in Makran. Here the volcanic action, which preceded the general upheaval of recent strata and the folding of the edges of the interior highlands, is still in evidence in occasional boiling mud volcanoes on the coast-line. Evidence of extinct mud volcanoes exists through a very wide area in Baluchistan and Seistan. The coast is indented by several harbours. Ormarah, Khor Kalmat, Pasni and Gwadar are all somewhat difficult of approach by reason of a sand-bar which appears to extend along the whole coast-line, and which is very possibly the last evidence of a submerged ridge; and they are all subject to a very lively surf under certain conditions of wind. Of these the port of Gwadar (which belongs to Muscat) is the most important. They all are stations of the Indo-Persian telegraph system which unites Karachi with Bushire. With the exception of the Kej valley, and that of the Bolida, which is an affluent of the Kej, there are no considerable spaces of cultivation in Makran. These two valleys seem to concentrate the whole agricultural wealth of the country. They are picturesque, with thick groves of date palms at intervals, and are filled with crops and orchards, yet the surrounding waste of hills is chiefly a barren repetition of sun-cracked crags and ridges with parched and withered valleys intersecting them. Makran is the home of remnants of an innumerable company of mixed people gathered from the four corners of Asia and eastern Africa. The ancient Dravidians, of whom the Brahui is typical, still exist in many of the districts which are assigned to them in Herodotus. Amongst them there is always a prominent Arab element, for the Arabs held Makran even before they conquered Sind. There are negroes on the coast, bred from imported slaves. The Meds of the Indus valley still form the greater part of the fishing population, representing the Ichthyophagi of Arrian. The old Tajik element of Persia is not so evident in Makran as it is farther north; and the Karak pirates whose depredations led to the invasion of India and the conquest of Sind, seem to have disappeared altogether. The fourth section includes the valleys formed by the Rakshān and Mashkel, which, sweeping downwards from the Kalat highlands and the Persian border east and west, unite to break through the intervening chain of hills northward to form the Mashkel swamps, and define the northern limits of Makran. In these valleys are narrow strips of very advanced cultivation, especially dates. The great Mashkel swamp and the Kharan desert to the east of it, mark the flat phase of southern Baluchistan topography. It is geologically part of an ancient inland lake or sea which included the present swamp regions of the Helmund. The latter is separated from the higher central depression of the Lora by a long transverse band of serrated hills. Here and there these jagged peaks appear as if half overwhelmed by an advancing sea of sand. They are treeless and barren, with occasional water at the edges of their foot-hills. The Koh-i-Sultan, at the western extremity of the northern group of these hills, is over 6,000 ft. above sea-level, but the general level of the surrounding deserts is only about 2,000 ft., sinking to 1,500 ft. in the Mashkel Hamun and the Gaod-i-Zirreh.

The whole of this country has been surveyed and the boundary between Persian and British Baluchistan demarcated by a commission in 1895–1896. In 1898 a British force was sent to Makran by sea, owing to a rebellion against the authority of the khan of Kalat, and an attack made by some Makran chiefs on a British survey party. A brief campaign terminated with the capture of the Kej citadel. Another similar expedition was required in 1901 to storm the fort at Nodiz.

See *Baluchistan District Gazetteer*.

MAKSOORA, in Mohammedan architecture, the sanctuary or praying-chamber in a mosque, sometimes enclosed with a lattice screen; the word is occasionally used for a similar enclosure round a tomb.

MAKUAN, a group of little-known tribes of South American Indians, constituting an independent linguistic stock. The Maku tribes are scattered over a considerable area in the region about the equator between the Rio Negro and Yapura rivers. They are a short, rather ugly and light-skinned folk, shy and usually of quite primitive culture. Many of them are slaves of the adjacent Arawakan and other tribes. They are regarded as the shattered remnants of a once widely spread primitive population, which has been in large measure destroyed or absorbed by the Arawakan and other tribes who have penetrated and overrun the region. The wilder tribes have no agriculture, pottery or textiles, and live as nomad hunters with flimsy temporary shelters.

See T. Koch-Gruneberg, *Die Maku* (Anthropos, vol. i. pp. 877–906); *Zwei Jahre unter den Indianern* (Berlin, 1909).

MALABAR, a district of British India, in the Madras Presidency. Geographically the name is sometimes extended to the entire western coast of the peninsula. Properly it should apply to the strip below the Ghats, which is inhabited by people speaking the Malayalam language, a branch of the Dravidian stock, who form a peculiar race, with castes, customs and traditions of their own. It would thus be coextensive with the old kingdom of Chera, including the modern states of Travancore and Cochin, and part of Kanara. In 1931 the total number of persons speaking Malayalam in the Presidency was 3,727,254.

The district of Malabar extends for 145 mi. along the coast, running inland to the Ghats with a breadth varying from 70 to 25 mi. The administrative headquarters are at Calicut. Area, 5,790 sq.mi. Malabar is much diversified in its configuration; from the eastward, the great range of the Western Ghats, only interrupted by the Palghat gap, looks down on a country broken by spurs, ravines, forests and jungle. To the westward, gentler slopes and downs, and gradually widening valleys, closely cultivated, succeed the forest uplands, till, nearer the seaboard, the low laterite tablelands shelve into rice plains and backwaters fringed with coco-nut palms. The coast runs in a south-easterly direction, and forms a few headlands and small bays, with a natural harbour in the south at Cochin. In the south there is considerable extent of table-land. The mountains of the Western Ghats, from 3,000 to 7,000 ft. high, run almost parallel to the coast, and along the coast is an almost continuous chain of lagoons or backwaters which have been formed by the action of the waves and shore currents in obstructing the waters of the rivers. Connected by artificial canals, they form a cheap means of transit for a large local trade. Fishing and fishcuring is an important industry, coir is manufactured, and there are saw-mills, soap and tile works. The forests are extensive and of great value. The population in 1941 was 3,929,425.

The staple crop is rice, the next most important products being coco-nuts, fruits, and pepper. Coffee is grown chiefly in the upland tract known as the Wynaad. The Madras railway crosses the district and runs along the coast from Calicut to Mangalore. The principal seaports are Calicut, Tellicherry, Cannanore and Cochin. The principal exports are coffee, coco-nut products and pepper.

MALABARI, BEHRAMJI (1853–1912), Indian journalist and social reformer, was born in 1853 at Baroda, the son of a poor Parsi in the employment of the state. He was educated in a mission school, but he never obtained an academical degree. Coming to Bombay, he fell under the influence of Dr. John Wilson, principal of the Scottish College. He published a volume of poems in Gujarati (1875), and *The Indian Muse in English Garb* (1877), which attracted attention in England. In 1880 he acquired the *Indian Spectator,* which he edited for twenty years until it was merged in the *Voice of India.* In 1901 he became editor of *East and West.* He was an ardent and indefatigable advocate of social reform in India, especially as regards child marriage and the remarriage of widows. It was largely by his efforts, in the press and in tours through the country, that the Age of Consent Act was passed in 1891. He died at Bandora, near Bombay, on July 12, 1912.

He also wrote *Gujarat and the Gujarati's* (1883), and *The Indian Eye on English Life* (1893).

See R. P. Karkaria, *India, Forty Years of Progress and Reform* (London, 1896).

MALABON, a municipality (with 21 *barrios* or districts) of the province of Rizal, Luzon, Philippine Islands, one mile inland from Manila bay and three miles north of Manila, with which it is connected by a street-car line. Pop. (1939) 33,285; 22 whites. Malabon is noted for its fish ponds and fisheries and for the manufacture of perfume from the flowers of ilang-ilang trees (*Cananga odorata*). Other leading industries are sugar refining, cigar making and the weaving of jusi cloth. Tagalog is the vernacular. Of the inhabitants aged 6 to 19 inclusive, 39·6% were reported in 1939 as attending school, while 75·2% of the population 10 years old and over was reported as literate. Malabon was formerly known as Tambóbong.

MALACCA, a town on the west coast of the Malay peninsula, which with the adjoining territory forms one of the Straits Settlements, and gives its name to the straits that divide Sumatra from the Malay peninsula. Malacca was administered by a resident councillor, responsible to the governor of the Straits Settlements, and by district officers and other officials under his direction. The population of the town of Malacca in 1939 was about 44,000. In 1941 the population of the territory was estimated at 233,930, of whom Malays numbered 110,673, Chinese 91,099, Indians 28,416 and Europeans 588 (*see* also STRAITS SETTLEMENTS). The trade of this once flourishing port has declined, most of the vessels being coasting craft. This is due to the shallowness of the harbour, and to the fact that Penang and Singapore, at either entrance to the straits, draw all the trade and shipping. The area of the territory is 637 sq.mi. The settlement is wholly agricultural. Much of the land has been in the hands of natives, but there is ordinarily a large acreage under rubber (*hevea*). The settlement is well opened up by roads; and a railway, which is part of the Federated Malay States railway system, was constructed from the town of Malacca to Tampin in the Negri Sembilan. There is a good rest-house at Malacca and a comfortable seaside bungalow at Tanjong Kling, seven miles from the town. Malacca is 118 mi. by sea from Singapore and 50 mi. by rail from Seremban, the capital of the Negri Sembilan. In World War II it was occupied by Japan.

History.—Malacca, visited by few ships, was the least important of the three British settlements on the Straits which gave their name to the colony. It has, however, a remarkable history (*see* MALAY PENINSULA: *History*). The precise date of its foundation cannot be ascertained, but there is reason to believe that this event took place in the 14th century. The Roman youth Ludovigo Barthema is thought to have been the first European to visit it, some time before 1503; and in 1508 Diogo Lopez de Siqueira sailed from Portugal for the purpose of exploiting Malacca. He was hospitably received, but disagreements with the natives ensued and word was brought to Siqueira that a treacherous attack was about to be made upon his ships. Siqueira sent a native man and woman ashore "with an arrow passed through their skulls" to the sultan, "who was thus informed," says de Barros, "through his subjects that unless he kept a good watch the treason which he had perpetrated would be punished with fire and sword." The sultan retaliated by arresting Ruy de Araujo, the factor, and twenty other men who were ashore collecting cargo. Siqueira immediately burned one of his vessels and sailed for Portugal. In 1511 d'Albuquerque captured the town. Malacca became a Portuguese possession for 130 years, and was the base of their commercial explorations in south-eastern Asia while they enjoyed, and later while they sought to hold, their monopoly in the East. It was from Malacca, immediately after its conquest, that d'Albuquerque sent d'Abreu on his voyage of discovery to the Moluccas, or Spice islands, which later were the objective of Magellan's voyage of circumnavigation. Under the Portuguese government St. Francis Xavier started a mission in Malacca, the first Christian mission in Malayan lands.

The Dutch held Malacca from 1641 till 1795, when it was taken from them by Great Britain, and the Dutch system of monopoly in the straits was abolished. The colony was restored to the Dutch in 1818, but six years later it came finally into the hands of Great Britain, being exchanged by a treaty with Holland for the East India Company's settlement of Bengkulen and a few other unimportant places on the west of Sumatra. By this treaty the Dutch were precluded from interference in the affairs of the Malay peninsula, and Great Britain from similar action in regard to the States of Sumatra, with the exception of Achin, the right to protect that state being maintained by Great Britain until in 1872 it was finally abandoned by a treaty concluded with Holland. It was not until 1833 that the whole territory was brought under British control. It fell to the Japanese in Jan. 1942.

BIBLIOGRAPHY.—*The Commentaries of d'Albuquerque* (Hakluyt Society); *The Voyages and Adventures of Fernand Mendez Pinto* (1653); Captain A. Hamilton, *An Account of the East Indies* (Edinburgh, 1727); Valentyn's *History of Malacca,* translated by Dudley Hervey; *Journal of the Straits* (now *Malayan*) *Branch of the Royal Asiatic Society;* "Our Tropical Possessions in Malayan India," *ibid.;* Hugh Clifford, *Further India* (1904); Sir F. Swettenham, *British Malaya* (1906); *Malaya,* ed. R. O. Winstedt (1923). *See* also articles on MALAY PENINSULA, and STRAITS SETTLEMENTS. (H. CL.)

MALACHI, the name assigned to the last book of the Old Testament in English (the last of the "prophets" in the Hebrew Bible), which according to the title (Mal. i. 1) contains the "word of Yahweh to Israel by the hand of Malachi." In form the word means "my messenger." It could be explained as a contraction of Malachiah, "messenger of Yahweh"; but the Septuagint is probably right in not regarding it as a proper name ("by the hand of His messenger"). Not only do we know nothing from internal or external evidence of the existence of a prophet of this name, but the occurrence of the word in the title is naturally explained as derived from iii. 1: "Behold, I send my messenger" (*cf.* ii. 7). The prophecy must, therefore, be regarded as anonymous; the title was added by the compiler who wrote similar editorial titles to the anonymous prophecies beginning Zech. ix. 1, xii. 1. (Note the use of "burden").

The contents of the prophecy fall into a series of clearly marked sections, as in the paragraph division of the Revised Version. These apply, in various ways, the truth emphasized at the outset: Yahweh's love for Israel in contrast with his treatment of Edom (i. 2–5). Israel's response should be a proper regard for the ritual of His worship; yet any offering, however imperfect, is thought good enough for Yahweh's altar (i. 6–14). Let the priests, who are responsible, take warning, and return to their ancient ideals (ii. 1–9). Again, the common Fatherhood of God should inspire a right relation among fellow Israelites, not such conduct as the divorce of Israelite wives in order to marry non-Israelite women (ii. 10–16). The prevalence of wrong-doing has provoked scepticism as to righteous judgment; but the messenger of Yahweh is at hand to purge away indifferentism from worship and immorality from conduct (ii. 17–iii. 6). The payment of tithes now withheld will be followed by the return of prosperity (iii. 7–12). Religion may seem useless, but Yahweh remembers His own, and will soon in open judgment distinguish them from the irreligious (iii. 13–iv. 3). The book closes with an appeal to observe the law of Moses, and with a promise that Elijah shall come before the threatened judgment—probably a later addition.

The topics noticed clearly relate the prophecy to the period of Ezra and Nehemiah, when the Temple had been rebuilt (i. 10; iii. 1, 10), the province of Judah was under a Persian governor (i. 8), and there had been time enough for the loss of earlier enthusiasm. The majority of modern scholars are agreed that the prophet prepares for the work of those reformers (Ezra, 458 *c.;* Nehemiah, 444, 432 B.C.). The priests have fallen into contempt (ii. 9) and have neglected what is still one of their chief trusts, the oral law (ii. 6 *seq.*). The priestly code of written law, in its present form, was not promulgated until 444 B.C. (Neh. viii.–x.) and it is not presupposed by "Malachi" who writes under the influence of the earlier Code of Deuteronomy only, and must therefore belong to a date prior to 444. The independent character of the attack on current abuses (marriage with foreign women, ii. 11; non-payment of sacred dues, iii. 8) suggests priority to the work of Ezra. The prophecy affords an interesting and valuable glimpse of the post-exilic community, with its various currents of thought and life. The completion of the second Temple (516 B.C.) has been followed by disillusionment as to the anticipated prosperity, by indifference to worship, scepticism as to providence, and moral laxity. In view of these conditions, the prophet's message is to reassert the true relation of Israel to Yahweh, and to call for a corresponding holiness, especially in regard to questions of ritual and of marriage.

The book is a significant landmark in the religious history of Israel. Its emphasis on the observance of ritual finds fullest development in the Priestly Code, subsequently promulgated; its protest against foreign marriages is made effective through the reforms of Ezra and Nehemiah; the influence of its closing words on later expectation is familiar to every reader of the new Testament (Matt. xvii. 3, 4, 10–13; xxvii. 47, 49; John i. 21, 25).

BIBLIOGRAPHY.—The chief commentaries in German are those by Nowack (1897, 1904), Wellhausen (1898), Marti (1904), Sellin (1922); there is one in French by A. van Hoonacker (1908). Those recommended in English are by G. A. Smith (1898, 1927), S. R. Driver (*Century Bible,* 1906), J. M. P. Smith (*International Critical Commentary,* 1912, W. E. Barnes (*Cambridge Bible,* 1917).

(H. W. R.)

MALACHITE, a bright green mineral, consisting of a basic copper carbonate, $CuCO_3Cu(OH)_2$. It belongs to the monoclinic system, but rarely forms good crystals, occurring mostly as nodular, botryoidal or reniform masses, with pronounced radial and concentric structure, successive layers often varying much in colour. It may also be quite compact or earthy and often forms thin films or mere stains on rocks. It is very commonly associated with the deep blue azurite (*q.v.*). The density is about 4 and the hardness 3·5–4·0. It is soluble in acids with effervescence.

Malachite is one of the commonest ores of copper and perhaps the most conspicuous, being a useful guide in prospecting. It is found in the upper oxidized portions of copper deposits, and is formed by the action of water, air and carbon dioxide on primary copper sulphides, especially where calcium carbonate is present. The soluble copper salts set free by oxidation of the sulphides react with limestone or other carbonates and precipitate the insoluble malachite. The mineral is found in nearly all copper-mining districts: specially fine specimens have come from various mines in Russia, where it has often been used as a polished ornamental stone, though the colour is rather crude. Other well-known localities for good specimens are the Copper Queen mine, Bisbee, Arizona, and the old Burra Burra mines, Kooringa, South Australia. (*See* also DYES, SYNTHETIC.) (R. H. RA.)

MALACHOWSKI, STANISLAW (1736–1809), Polish statesman, the younger son of Stanislaw Malachowski, palatine of Posen. He was first elected a deputy to the Diet of 1764, and the Four Years' Diet unanimously elected him its speaker (1788). Malachowski worked tirelessly for reform and to save the republic. He was one of the framers of the constitution of May 3, 1791, exceeding in liberality all his colleagues and advocating the extension of the franchise to the towns and the emancipation of the serfs. In 1807 Malachowski was placed at the head of the executive committee appointed at Warsaw after its evacuation by the Prussians, and when the grand duchy of Warsaw was created Malachowski became president of the senate. In the negotiations with the Austrian government concerning the Galician salt-mines Malachowski assisted the treasury by hypothecating all his estates as an additional guarantee. In 1809 he died at Warsaw.

MALACHY, ST. (*c.* 1094–1148), otherwise known as Maol-Maodhog (or Maelmaedhog) Ua Morgair, archbishop of Armagh and papal legate in Ireland, was born at Armagh. His father, an Irish clergyman, the *Fearleighlinn,* or *lector,* at the university, was said to have been of noble family. He was vicar of Archbishop Celsus or Ceallach of Armagh, and carried out many reforms ending to increase conformity with the usage of the Church of Rome. He spent four years with Malchus, bishop of Lismore (in Munster), a strong advocate of Romanism. On his return from Lismore, Malachy undertook the government of the decayed monastery of Bangor (in Co. Down), but very soon afterwards he was elected bishop of Connor (now a small village near Ballymena). After the sack of that place by the king of Ulster he withdrew into Munster; here he was kindly received by Cormac MacCarthy, with whose assistance he built the monastery of Ibrach (in Kerry). Meanwhile he had been designated by Celsus to succeed him in the archbishopric but eventually returned, at his own desire, to the smaller and poorer portion of it, the bishopric of Down. In 1139, Malachy set out from Ireland with the purpose of soliciting from the pope the pallium for the archbishop of Armagh. On his way to Rome he visited Clairvaux, and thus began his friendship with St. Bernard. Malachy was received by Innocent II with great honour, and made papal legate in Ireland, though the pope refused to grant the pallium until it had been unanimously applied for "by a general council of the bishops, clergy and nobles." Nine years later (1148), at a synod of bishops and clergy held at Inis-Patrick (St. Patrick's island, near Skerries, Co. Dublin), Malachy was commissioned to return to Rome and make fresh application for the pallium; he did not, however, get beyond Clairvaux, where he died in the arms of St. Bernard, on Nov. 2, 1148. The object of his life was realized four years afterwards, in 1152, during the legateship of his successor. Malachy was canonized by Clement III in 1190. Malachy reformed and reorganized the Irish Church and brought it into subjection to Rome; like Boniface, he was a zealous reformer and a promoter of monasticism. He opened the first Cistercian monastery in Ireland, five more being soon afterwards established. Several works are attributed to him, but are all probably spurious.

St. Bernard's *Life* of Malachy, and two sermons on his death will be found in J. P. Migne, *Patrologia Latina,* clxxxii, clxxxiii; *see* also the ecclesiastical histories of Ireland by J. Lanigan (1829) and W. D. Killen (1875); A. Bellesheim, *Geschichte der katholischen Kirche in Irland,* Bd. I. (Mainz, 1890); G. T. Stokes, *Ireland and the Celtic Church* (6th ed., 1907); J. O'Hanlon, *Life of Saint Malachy* (Dublin, 1859); articles in *Dict. Nat. Biog.* and Herzog-Hauck's *Realencyklopädie für protestantische Theologie.*

MALACOSTRACA, the largest subclass of the Crustacea (*q.v.*), including the lobsters, crawfish, crabs, shrimps, prawns, beach fleas, sow bugs and various other crustaceans. They may be briefly defined as Crustacea having the body composed of nineteen somites, all, typically, bearing appendages, the trunk-limbs differentiated into two series, a thoracic of eight and an abdominal of six pairs; and the genital openings of the female on the sixth, those of the male on the eighth thoracic somite. A study of the comparative morphology of the Malacostraca permits us to draw up a scheme for the probable course of evolution of the group which is, at least, not contradicted by our scanty knowledge of its fossil representatives. According to this scheme, the earliest Malacostraca exhibited what has been called the "caridoid facies"; that is to say, they were shrimplike in general form, with a carapace enveloping, but not coalesced with, the thoracic somites, with stalked eyes, biramous antennules, and a scale-like exopodite on the antenna, with the thoracic limbs forming walking-legs with swimming exopodites and branchial epipodites and with a tendency for one or more of the anterior pairs to be assimilated to the mouth-parts as maxillipeds; with the abdominal appendages forming biramous swimmerets, except the last pair which are large, lamellar, and form with the telson a "tail-fan."

The earliest fossils that can be definitely referred to the Malacostraca occur in the Carboniferous rocks and present, with little modification, the caridoid facies described above. Some of them (*Pygocephalus*) have a brood-pouch formed by overlapping plates (*oostegites*) from the bases of the thoracic legs and appear, therefore, to be referable, to the Mysidacea. From the caridoid Mysidacea a series can be traced in which the carapace is progressively reduced, the thoracic exopodites are lost and the eyes become sessile. Although palaeontology gives no help, the steps of this series are indicated by the specialized offshoots which have given the Cumacea, Thermosbaenacea, Tanaidacea and Isopoda. The Amphipoda belong to the same series but their precise place in it is less clear. The other orders of Malacostraca have no brood-pouch and appear to have diverged very early from the primitive stock. Already in Carboniferous times the Syncarida had lost the carapace and had much the same general structure as the recent *Anaspides* and its allies. Another series in which the carapace coalesced with the thoracic somites gave rise to the great group of the Decapoda, from which the Euphausiacea are perhaps an offshoot. The Decapoda, beginning with caridoid forms, have, in several independent lines, assumed the crablike or "carcinoid facies" by reduction of the abdominal region (Brachyura or true crabs, and crablike Anomura). The Stomatopoda had assumed nearly their typical structure in Jurassic times but their earlier history is unknown.

In the scheme of phylogeny thus outlined no mention has been made of the Phyllocarida, which, in most systems of classification, are ranked as the most primitive Malacostraca, forming a link with the Branchiopoda. They differ from the other Malacostraca in having an additional somite in the abdomen, the telson terminating in a "caudal fork," and a bivalve carapace provided with an adductor muscle. The thoracic limbs are more or less flattened and leaflike and have a general resemblance to the trunk-limbs of the Branchiopoda though a close comparison is difficult. The existing genera, *Nebalia* and its allies, are believed to show affinity with the fossil *Ceratiocaridae,* the earliest of which appear in Cambrian rocks and are thus vastly more ancient than any other Malacostraca. Recent work, however, tends to diminish the significance of the differences between Phyllocarida and other Malacostraca, and, in particular, the recognition of a vestigial seventh abdominal somite in certain primitive Mysidacea suggests that the Phyllocarida may, after all, be mose closely related to the Peracaridan series than has been supposed.

The orders composing the Malacostraca may be grouped in the following five divisions, briefly characterized below:

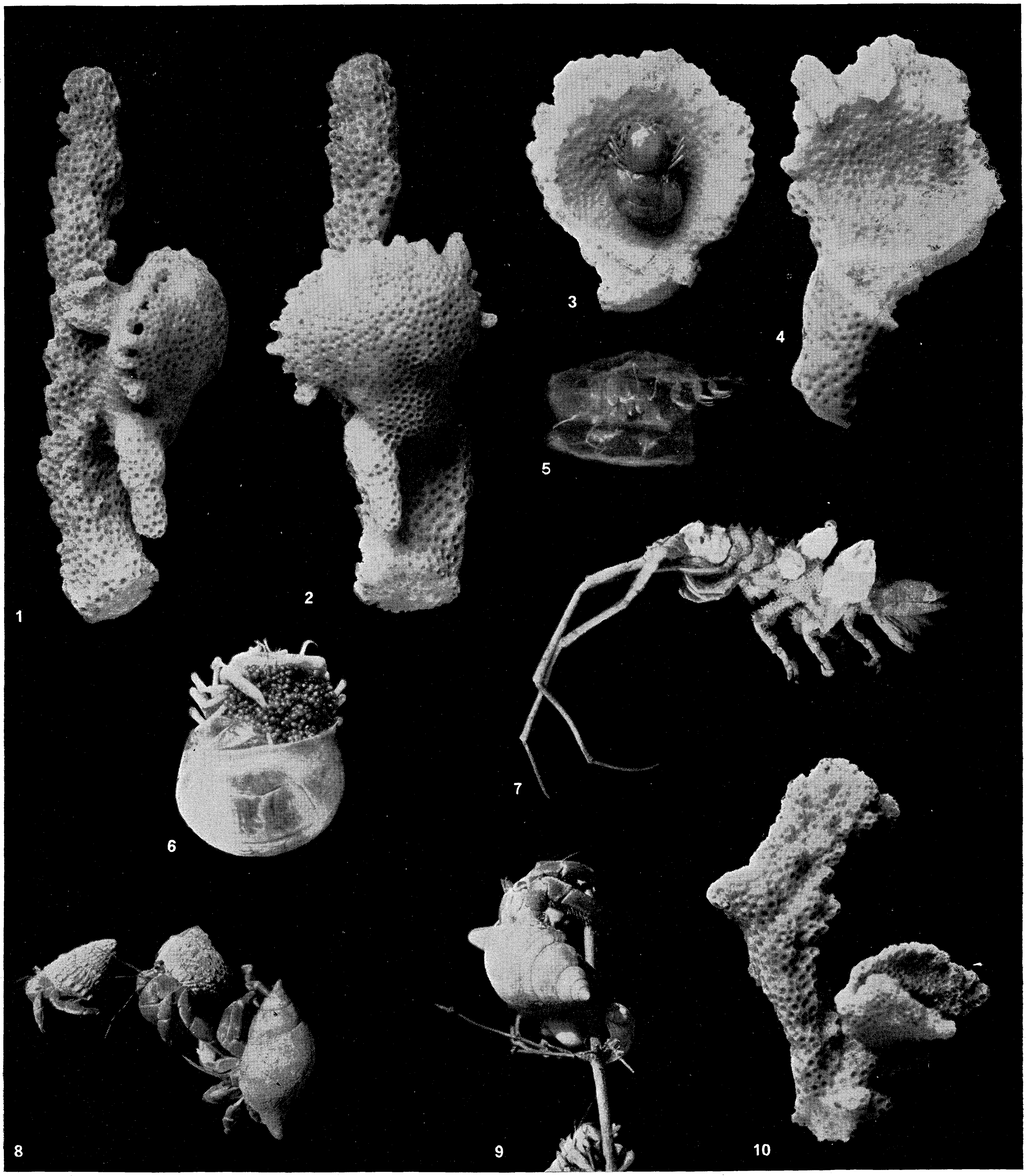
1. *Peracarida.* A carapace, if present, not fused with more than four thoracic somites; eyes, when present, stalked (Mysidacea, stalks movable; Tanaidacea, stalks fixed) or sessile (Cumacea, Isopoda, Amphipoda). The Mysidacea comprise generally small shrimplike swimming forms, nearly all marine. They are called "opossum" shrimps because of the brood pouch formed of oöstegites or plates attached to the coxae of the thoracic legs, in which the young undergo their entire metamorphosis after hatching out as nauplii. Their size range is considerable, running from the tiny *Anchialus pusillus,* $\frac{1}{8}$ in. long, to *Gnathophausia ingens,* which exceeds 6 in. in length. Probably all serve as the food of other animals. Several species occur in fresh-water. One of these is *Mysis relicta,* a widely distributed lacustrine form in the northern hemisphere. Thermosbaenacea includes only the minute, blind, creeping *Thermosbaena,* found in a hot spring in Tunis. Cumacea are marine mud-burrowers but the males are, to some extent, free swimming. Tanaidacea are also part of the micro-fauna of the sea bottom, less natatory than the Cumacea. Isopoda are a very varied and successful group, creeping, mud-burrowing and sometimes actively swimming in the sea and a few in fresh water. The destructive wood-boring crustaceans are principally isopods. The most widely distributed of them in both Atlantic and Pacific oceans, *Limnoria lignorum,* the "Gribble," is often accompanied by a boring amphipod, *Chelura terebrans.* Next to the molluscan shipworms, the tiny Gribble ($\frac{1}{8}$ to $\frac{1}{6}$ in. long) is the worst known destroyer of submerged timbers. Infested piling may carry 300–400 individuals to the square inch of surface in favoured localities. An untreated test piece of Oregon fir 5 ft. long by 3 in. square, set in Port Jackson, Australia, was 60% destroyed in six months by a combined attack by *Limnoria* and *Chelura.* By the time nine months had elapsed, it was so utterly riddled with the assistance of shipworms, which had by this time invaded the timber, that insufficient material remained to support further ravages by the borers present. Several species of *Sphaeroma,* though larger ($\frac{3}{8}$ in. long, more or less), also attack wood, but not so generally as *Limnoria,* and less in American than in Australian waters. *Sphaeroma quoyana* is reported to have honeycombed claystone or "papa rock" used in harbour works in New Zealand to such an extent that blocks of concrete overlaying it sank several feet. Parasitism appears in many different families and leads to extremes of specialization and degeneration. One suborder, Oniscoidea, consists of the terrestrial, air-breathing wood lice. Creeping and swimming forms of Amphipoda, another varied and successful group, abound in fresh water and in the sea. A few sand-hoppers or "beach fleas" may become wholly terrestrial. The vast majority of amphipods belong to one suborder (Gammaridea), which includes both free-living and parasitic forms; members of a smaller suborder (Hyperiidea) are planktonic, occur at times in vast swarms, and are consumed in great quantities by seals, cetaceans and other marine animals; a third suborder (Caprellidea) contains the exclusively parasitic family *Cyamidae* or whale lice.

2. *Phyllocarida.* Sometimes referred to as *Leptostraca,* this order is characterized in part by a large carapace which is not fused with any of the thoracic somites, stalked eyes and abdomen of seven segments (six in all other Malacostraca). The single order, Nebaliacea, includes only three or four living genera, all marine mud-burrowers, in part scavengers. They are widely distributed in all seas, usually occurring at moderate depths. Some, such as the large *Nebaliopsis typica,* which attains a length of more than $1\frac{1}{2}$ in., live at depths exceeding 1,000 fathoms. The doubtful affinities of the Phyllocarida are mentioned above.

3. *Syncarida.* This group possesses stalked eyes but no carapace. A small fresh-water group of limited distribution, to which belong the mountain shrimp (*Anaspides*) of Tasmania and a few allies in the Australian region, and also the Bathynellidae of central Europe, minute, blind, degenerate, subterranean forms. They appear to be survivors of a group widely distributed in Carboniferous and Permian times.

4. *Eucarida.* This group is recognized by its stalked eyes and carapace fused dorsally with all thoracic somites. The Euphausiacea are a small group of planktonic, phosphorescent shrimps except for a few living in the deep sea at 1,000 fathoms or more. The pelagic species are of importance as food of whalebone whales. The Decapoda, on the other hand, form the most extensive and diversified of all the orders of Crustacea. It includes the largest representatives of the class and, indeed, of living Arthropoda, and, since many of them are used for food, they are more generally familiar and more thoroughly studied than any other Crustacea. They are classified into two suborders: —Natantia, comprising the shrimps and prawns; and Reptantia, subdivided into four sections, spiny lobsters and their relatives, (Palinura), true lobsters and crayfish (Astacura), hermit and lithodid crabs and their allies (Anomura) and the true crabs (Brachyura). The headquarters of the group is in the sea but many of its members have invaded fresh waters (river prawns and river crabs in the tropics and crayfishes in temperate regions) and although a few are so far terrestrial as to deserve the name of land crabs, and may even climb lofty trees like the Coconut Crab, they pass their young stages in salt or fresh water.

5. *Hoplocarida.* These differ from all other Malacostraca in having the first antennae and the stalked eyes attached to movably articulated segments of the head. The carapace is small and shallow, fused with two or three thoracic somites, leaving four well-developed somites free. The members of the single order Stomatopoda are sometimes known as "mantis shrimps" from the resemblance of their large prehensile claws to those of the mantis insect. They are exclusively marine, burrowing in sand or lurking



COURTESY OF U.S. NATIONAL MUSEUM

VARIOUS CRUSTACEA MALACOSTRACA

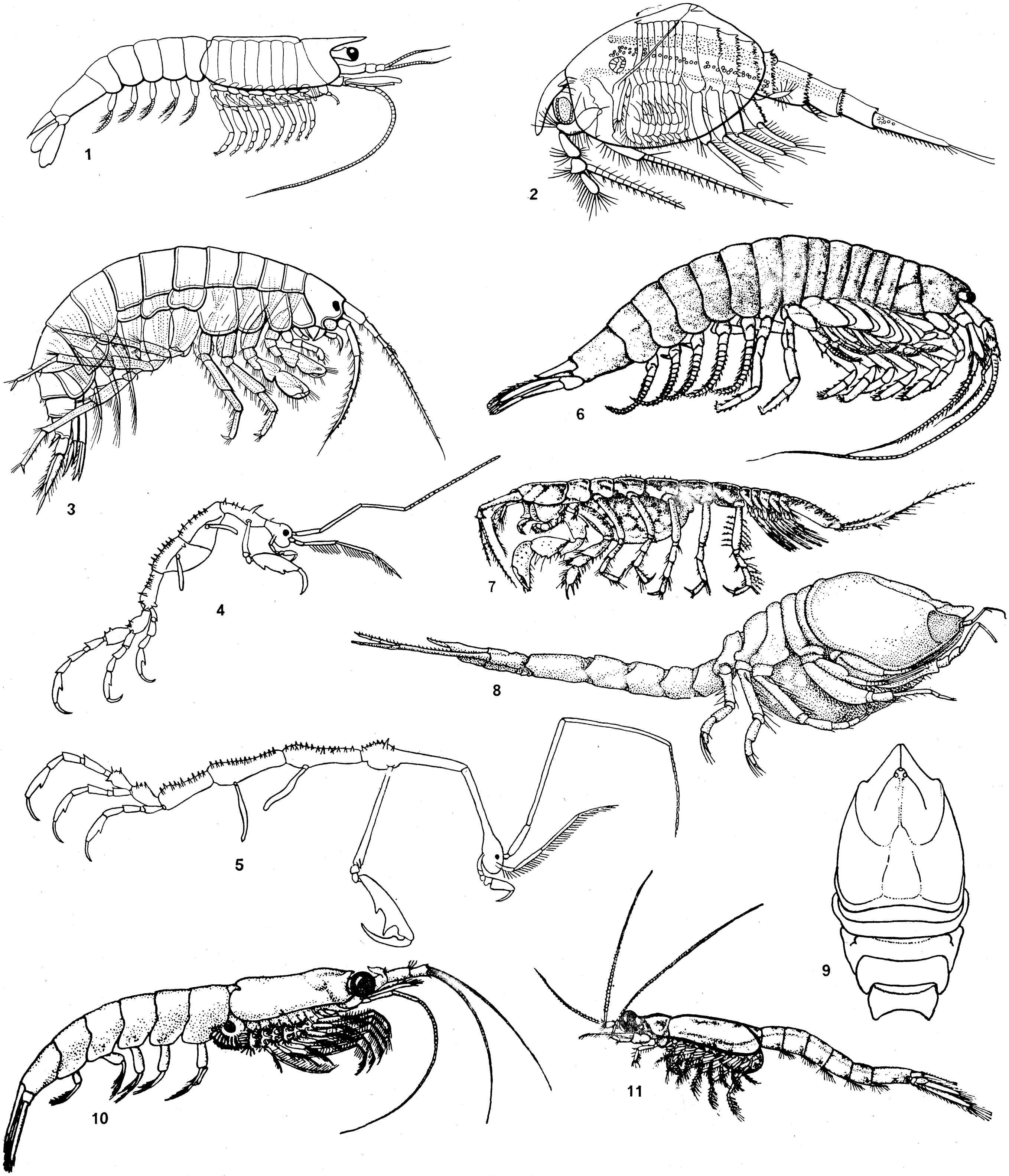
1, 2, 3, 4, 6, 10. Coral gall crab, *Hapalocarcinus marsupialis* (Eucarida, Order Decapoda, Section Brachyura) and "house" formed by coral, *Pocillopora* species. This crab occurs in the Indo-Pacific and in South America, on the west coast of Colombia and in the Secas Islands, Panama; specimens photographed are from Port Utria, Colombia. 1. Shows the breathing holes kept open by respiratory streams of water. 3. Opened gall with female. Figs. 1-4 about x 2. 5. Young, partially formed gall. 6. Female x 4 showing egg mass and abdominal "pouch" from which the crab derives its specific name

5. *Phronima* (Peracarida, Order Amphipoda, Suborder Hyperiidea) by reflected light, compare with Plate fig. 2, Crustacea. Natural size

7. *Arcturus baffini* (Peracarida, Order Isopoda), a North American Arctic species. The female usually carries her young around on her long antennae. The figured specimen is an old "granny" which has not moulted for a long time, as it carries several barnacles, *Balanus* species (Cirripedia, Order Thoracica), attached to its back. Natural size

8, 9. Land hermits, *Coenobita clypeatus* (Eucarida, Order Decapoda, Reptantia, Section Anomura), common in Florida and the Caribbean region; under favourable circumstances grow to be three or four times the size of the specimens shown here. About x ½

MALACOSTRACA



COURTESY OF (8, 9) U.S. NATIONAL MUSEUM, (1) FROM LANKESTER, "TREATISE ON ZOOLOGY" (A. & C. BLACK), (2) FROM C. CLAUS, "LEHRBUCH" (JULIUS SPRINGER), (3) FROM SARS, "CRUSTACEA OF NORWAY" (BERGEN MUSEUM), (4-5) FROM MAYER, "CAPRELLIDEN," (6-7, 10-11) FROM CALMAN, IN "A TREATISE ON ZOOLOGY" (A. & C. BLACK)

VARIOUS CRUSTACEA MALACOSTRACA

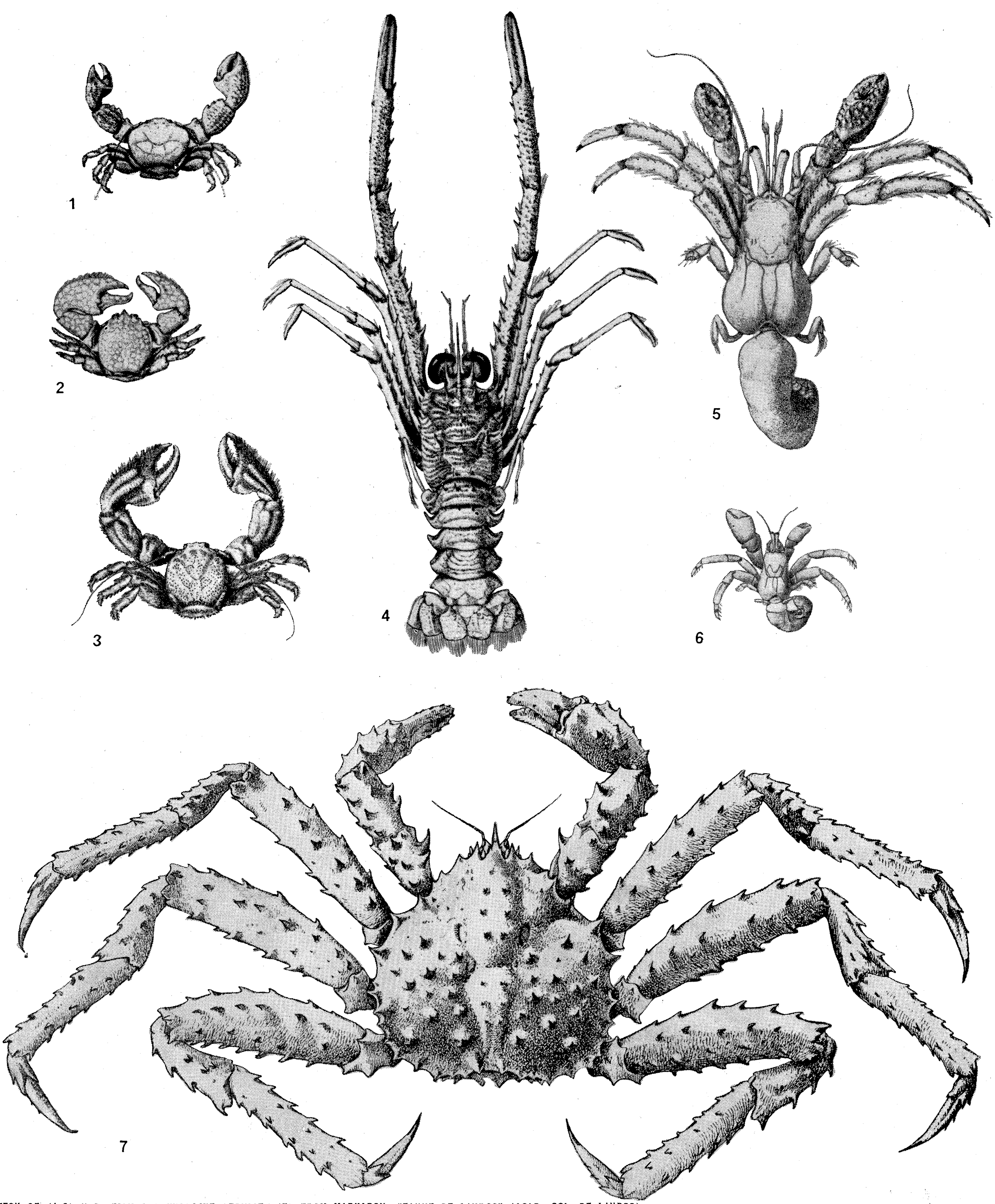
1. Diagram of a generalized malacostracan, showing the "caridoid facies"
2. *Nebalia bipes* (Phyllocarida, Order Nebaliacea). Appendages show through the transparent shell or carapace. *Nebalia* is widely distributed in both the Atlantic and Pacific oceans. About x 12
3. Freshwater amphipod, *Gammarus pulex* (Peracarida, Order Amphipoda, Suborder Gammaridea), by some called freshwater "shrimp." A widely distributed Palaearctic species ranging from England to Japan and found in some parts of North Africa; does not occur in North America

4, 5. "Skeleton shrimp," *Caprella eximia* (Peracarida, Order Amphipoda, Suborder Caprellidea); female (fig. 4) and male (fig. 5) from the Pacific shores of Asia. Enlarged x 3

6. *Anaspides tasmaniae* (Syncarida, Order Anaspidacea), found only in rocky pools at high elevations in the mountains of Tasmania the figure here given
7. *Apseudes spinosus* (Peracarida, Order Tanaidacea), female with eggs in "brood pouch" or marsupium. Primarily a Norwegian species, it has been taken off the Irish coast in 725 fathoms

8, 9. *Diastylus planifrons* (Peracarida, Order Cumacea). 8. Female with eggs in "brood pouch" from the Straits of Magellan. About x 7. 9. Same, dorsal view of cephalothorax

10. *Meganyctiphanes norvegica* (Eucarida, Order Euphausiacea), male, common in the cooler parts of the north Atlantic; in immense swarms or schools, called "krill" by Norwegian fishermen and whalers, serves as food of whales. About x 2
11. Opossum shrimp, *Mysis relicta* (Peracarida, Order Mysidacea), female with brood pouch. A circumpolar species found in the larger freshwater lakes of North America, Europe and Asia



COURTESY OF (1-6) U.S. FISH AND WILDLIFE SERVICE, (7) FROM MARKAROV, "FAUNE DE L'URSS" (ACAD. SCI. DE L'URSS)

VARIOUS CRUSTACEA MALACOSTRACA
(EUCARIDA, ORDER DECAPODA, REPTANTIA, SECTION ANOMURA)

1, 2, 3. Porcellanid "crabs." **1.** *Pachycheles rugimanus,* ranging from North Carolina through the West Indies. About x 2. **2.** *Porcellana sayana,* ranging from North Carolina through the Caribbean area to Panamá; generally found commensal with hermit crabs in gastropod mollusk shells. About natural size. **3.** *Megalobrachium poeyi,* ranging from the Bahamas through the West Indies to Colombia. About x 2

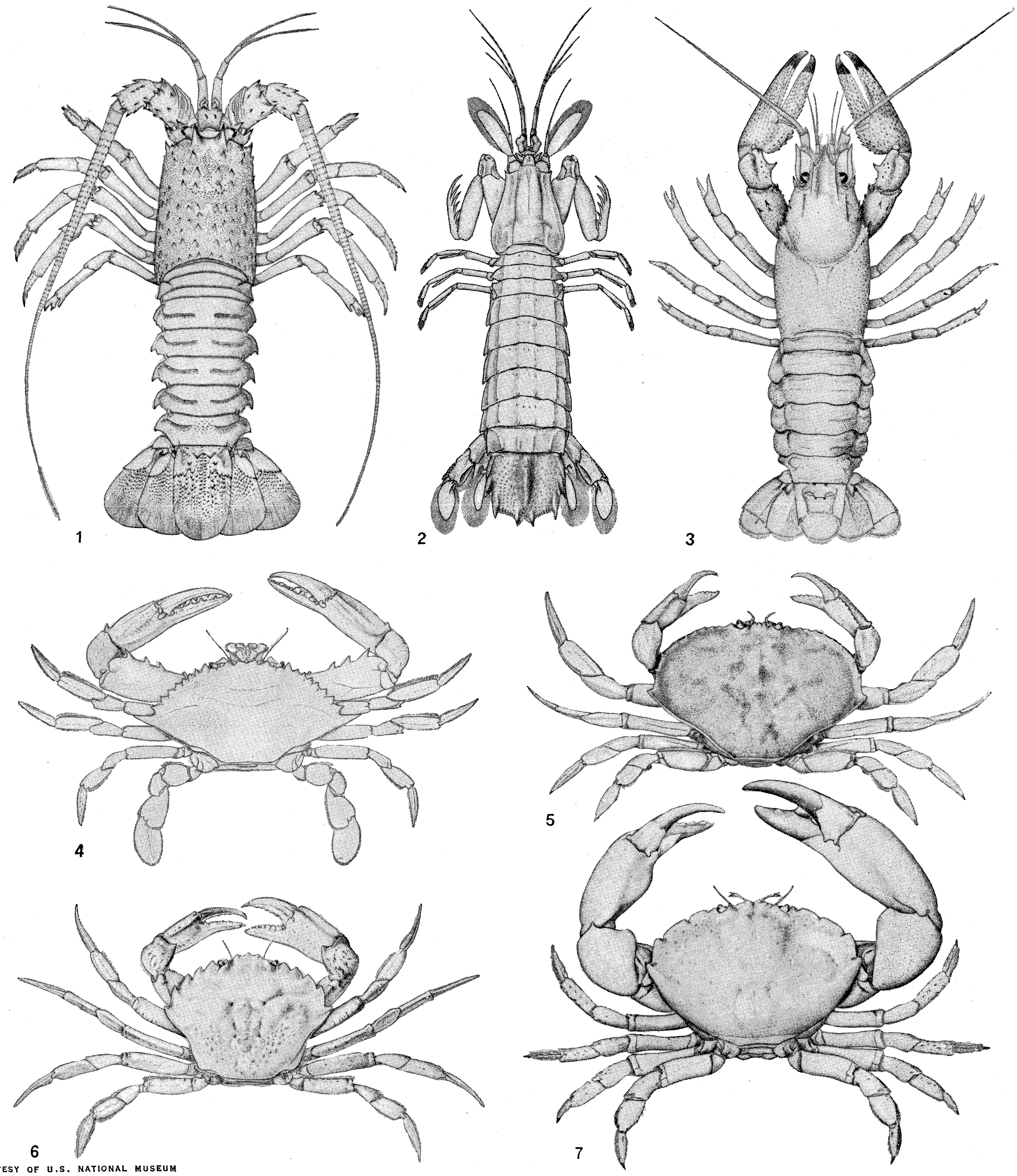
4. "Munida" or squat lobster, *Munida evermanni,* known only from deep water (220-225 fathoms) off Puerto Rico. About x 1½

5, 6. Hermit crabs without their usually carried gastropod shells. 5. *Clibanarius tricolor,* found in Bermuda and ranging from Florida through the West Indies to Barbados, a common species. About x 6. 6. *Calcinus tibicen,* more widely distributed than the preceding species, ranging from Florida to Brazil. About natural size

7. *Paralithodes camtschatica,* Alaskan king crab. Related species are called rock crabs in Europe. Occurring in the north Pacific ocean and the Bering sea, from the shores of Japan and Kamtschatka northward to Bering strait and south to southeastern Alaska. Males are larger than the females, attaining an over-all spread of 4 or 5 ft., with shell or carapace measuring nearly 12 in. in length; weight up to 22 lb.

It is to be noticed in the Anomura that the fifth pair of legs, counting the pincer legs or chelipeds, are much reduced in size and are often hidden under the shell or carapace, as in the king crab, fig. 7. In the hermit crabs the fourth pair of legs, as well, are reduced in size

MALACOSTRACA



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CRUSTACEA MALACOSTRACA

1. Spiny or rock lobster of the Pacific coast of North America, *Panulirus interruptus* (Eucarida, Order Decapoda, Reptantia, Section Palinura). The Florida counterpart, *Panulirus argus,* as well as the South African spiny lobster, attains a body length of 18 in. A California spiny lobster weighing 17 lb. has been recorded. About one-fifth natural size
2. Mantis shrimp, *Squilla empusa* (Hoplocarida, Order Stomatopoda) from Woods Hole, Mass. Not quite one-half natural size
3. River crayfish, *Cambarus affinis* (Eucarida, Order Decapoda, Reptantia, Section Astacura), from Havre de Grace, Md. About one-half natural size
4. Blue crab of the east coast of the United States, *Callinectes sapidus* (Eucarida, Order Decapoda, Reptantia, Section Brachyura), about three-tenths natural size; fully grown males may attain a shell width of as much as 8¾ in.
5. Edible crab of Pacific coast of North America, also known as the Dungeness crab, *Cancer magister* (Eucarida, Order Decapoda, Reptantia, Section Brachyura); attains a shell or carapace width of approximately 8 in.
6. Green crab, or "Joe Rocker," common shore crab of Europe, *Carcinides maenas* (Eucarida, Order Decapoda, Reptantia, Section Brachyura), occurring on north Atlantic coast of the United States, Pernambuco, Brazil, Bay of Panama, coasts of Europe and North Africa, Suez Canal, Red Sea, Ceylon, Australia and Hawaiian Islands. About one-third natural size.
7. Stone crab, *Menippe mercenaria* (Eucarida, Order Decapoda, Reptantia, Section Brachyura); southern Atlantic and Gulf coasts of United States and Mexico. Attains a width of shell or carapace of 5 in. Like the blue crab, the stone crab is much relished for food in the eastern and southern U.S.

in crevices in the shallow waters of all the warmer seas. A few go into brackish water. Many species are rare, known only from a few specimens, yet others are found in greater abundance, such as *Squilla investigatoris,* of which 500 were taken in a single haul from 110 fathoms in the Indian ocean. Despite their vicious claws, they have numerous enemies among the fish and octopuses. They are much used fresh or fried for food in the Mediterranean region, in the Philippines, Malaya and elsewhere. In Japan they are cheaper than other edible crustacea. One of the largest stomatopods on record is a Philippine specimen of *Lysiosquilla maculata,* whose body measured slightly more than 15 in. in length.

See CRAB; CRAYFISH; HERMIT CRAB; LOBSTER; SHRIMP; WOOD LOUSE. For terminology, *see* ZOOLOGY. (W. T. C.; W. L. ST.)

MÁLAGA, a maritime province of Spain, one of the eight modern subdivisions of Andalusia; bounded on the west by Cadiz, north by Seville and Cordova, east by Granada, and south by the Mediterranean sea. Pop. (1940), 677,474; area, 2,813 square miles. The northern half of Málaga belongs to the Andalusian plain watered by the Guadalquivir, the southern is mountainous, and rises steeply from the coast. Of the numerous sierras is that of Alhama, separating the province from Granada, rising above 7,000 ft.; its westward continuation in the Sierra de Abdalajis and the Axarquia between Antequera and Málaga; and not far from the Cadiz boundary the Sierras de Ronda, de Mijas, de Tolox and Bermeja, converging and culminating in a summit of nearly 6,500 ft. The principal river is the Guadalhorce, which rises in the Sierra de Alhama. After a westerly course past Antequera it bends through the defile of Peñarrubia and the *Vega* or Vale of Málaga, falling into the sea near that city. The only other considerable stream is the Guadiaro or Guadalevín, which has the greater part of its course within the province and flows past Ronda. There is an extensive salt lagoon near the northern boundary. The mountains are rich in lead and iron. There are warm sulphurous springs and baths at Carratraca. Large quantities of grapes and raisins, oranges and lemons, figs and almonds, are exported. The oil and wines of Málaga are also esteemed. After 1870 the manufacture of beet and cane sugar developed into an important industry. The fisheries are important. The province is traversed by the Cordova-Málaga railway. The nationalists occupied the province during the civil war of 1936–39.

Málaga, the capital (pop. 1940, 208,344), Antequera (23,218), Vélez-Málaga (10,813), Ronda (15,813), Coín (9,631) and Alora (5,614), are described in separate articles.

MÁLAGA, capital of Málaga province, an episcopal see, and, next to Barcelona, the most important seaport of Spain, situated on the Mediterranean coast, at the southern base of the Axarquia hills and at the eastern extremity of the fertile Málaga plain in 36° 43′ N. and 4° 25′ W. Pop. (1940), 208,344 (mun., 238,085). The climate is mild and equable, the mean annual temperature being 66.7°. The principal railway inland gives access through Bobadilla to all parts of Spain, with a branch line along the coast to Vélez-Málaga. Málaga is the Μάλακα of Strabo (iii. 156) and Ptolemy (ii. 4, 7) and the *Malaca foederatorum* of Pliny (iii. 3). The place seems to have been of some importance even during the Carthaginian period; under the Romans it became a municipium, and under the Visigoths an episcopal see. In 711 it passed into the possession of the Moors, and soon came to be regarded as one of the most important cities of Andalusia. It was attached to the caliphate of Cordova, but on the fall of the Omayyad dynasty it became for a short time the capital of an independent kingdom; afterwards it was dependent on Granada. In 1487 it was taken by Ferdinand and Isabella after a protracted siege. In 1810 it was sacked by the French. It was captured Feb. 8, 1937 by the nationalist general Queipo de Llano. Málaga lies principally on the left bank of the Guadalmedina ("river of the city"); the streets near the sea are comparatively modern, and well-built suburbs have spread into the rich and pleasant country which surrounds the city. The Plaza de Riego, the Plaza de la Constitucion, and the Paseo de la Alameda are important. The cathedral, on the site of an ancient mosque, was begun about 1528; after its construction had been twice interrupted, it was completed to its present state in the 18th century. The castle of Gibralfaro, on a rock to the N.E., dates from the 13th century.

New harbour works were undertaken in 1880, and all vessels can load or discharge at the quays, which are connected with the main railway system by a branch line. Iron, lead, wine, olive oil, brandy, almonds, fresh and dried fruit, hats and canary seed are exported in large quantities. Imports include petroleum, grain, codfish, fuel, chemicals, iron and steel, machinery and manures. There are large cotton mills, iron foundries, smelting works and engineering works. The industries include tanning, distilling and the manufacture of sugar, chocolate, soap, candles, artificial ice, chemical products, white lead and pianos.

MALAKAND PASS, a mountain pass in the North-West Province of India connecting the British district of Peshawar with the Swat valley. It is now a military post and the headquarters of a political agency. It came into prominence for the first time in 1895 during the Chitral campaign, when 7,000 Pathans held it against Sir Robert Low's advance but were easily routed. After the campaign was over a fortified camp was formed on the Malakand to guard the road to Chitral. During the frontier risings of 1897 the Swatis made a determined attack on the Malakand, where 700 were killed, and on the adjacent post of Chakdara, where 2,000 were killed. A military force was hurried to the relief and took part in the prolonged frontier operations of 1897–98. (*See* SWAT.)

MALALAS (or MALELAS) (Syriac for "orator"), **JOHN** (*c.* 491–578), Byzantine chronicler, was born at Antioch. He wrote a chronicle beginning with the creation and ending with the death of Justinian (565). It possesses little historical value; it is, however, important as the first specimen of a chronicle written not for the learned but for the instruction of the monks and the common people, in the language of the vulgar, with an admixture of Latin and Oriental words. It is preserved in an abridged form in a single ms. now at Oxford.

For a full discussion *see* Krumbacher, *Geschichte der byzantinischen Litteratur* (1897), p. 332–334, and the *editio princeps,* by E. Chilmead (Oxford 1691), containing Bentley's well-known letter to Mill.

MALAN, SOLOMON CAESAR (1812–1894), British divine and orientalist, was born at Geneva on April 22, 1812. His father, Dr. H. A. C. Malan, a Protestant divine, came of an exiled French family. In 1830 he became tutor in the marquis of Tweeddale's family, in Scotland, and in 1833 he matriculated at St. Edmund hall, Oxford, where he gained several scholarships. From 1837 to 1840 he held the post of classical lecturer at Bishop's college, Calcutta. After serving various curacies, he was presented to the living of Broadwindsor, Dorset, which he held from 1845 until 1886. In addition to many European languages, he was familiar with Tibetan, Chinese, Armenian and Georgian, and his translations were numerous. He opposed Westcott and Hort's text of the New Testament, and the transliteration of oriental languages. He died at Bournemouth on Nov. 25, 1894. His life was written by his son.

MALANGE: *see* ANGOLA.

MÄLAR, a lake of Sweden, extending 73 m. westward from Stockholm, which lies at its junction with the Saltsjö, an arm of the Baltic Sea. The height of the lake normally only reaches 2 ft. above sea-level, and its outflow is sometimes reversed. The area is 449 sq.m., and the deepest sounding is 210 feet. It contains numerous islands and its outline is very irregular, the mean breadth being about 15 m. but an arm extends northward for 30 m. nearly to the city of Uppsala. The lake is connected by navigable channels with lake Hjelmar, to the south-west, and the Baltic to the south, by the Södertelge canal and by two channels at Stockholm. The more important towns, besides Stockholm, are Vesterås on the north, Södertelge and Eskilstuna near the south shore. Many of the business men of Stockholm have residences on the shores of the lake. On Drottningholm is a palace built by Nicodemus Tessin in the 17th century on the site of one built by John III. in the 16th century. At Mariefred on the south shore there is the castle of Gripsholm (1537), with four towers built by Gustavus Vasa, containing a large collection of portraits. On the northward arm of the lake is the palace of Rosenberg, now a school of gunnery. On the same arm is Sigtuna, whose ruined churches are a memorial of its former rank among the principal towns of Sweden. On Björkö, an island in the eastern part of the lake, there was a large settlement of earlier importance than Sigtuna. Here a cross commemorates the preaching of Christianity by St. Ansgar in 829. On the northern arm about 10 m. south of Uppsala, there is the château of Skokloster, occupying the site of a monastery.

MALARIA (syn. ague, intermittent [and remittent] fever, marsh fever, jungle fever, hill fever), a disease caused by the presence of special micro-parasites in the blood, conveyed to man by anopheline mosquitoes and characterized by exacerbations at regular intervals, the so-called "ague fit." The ague fit begins with chilliness, increasing until the whole body shivers and the teeth chatter with cold; the face is pale or livid, the fingers dead white, the nails blue. During this stage the cutaneous vessels are constricted and the surface is cold to touch, but rectal temperature rises. There is a copious flow of clear, watery urine. The second stage is that of dry heat, the skin is burning and flushed. The urine now is scanty and high coloured. The third stage is that of sweating, which is profuse, and may be drenching. The urine is scanty and deposits a thick brick-red sediment of urates on cooling. The three stages together will probably last six to 12 hours and after a period of 24 hours (quotidian), 48 hours (tertian) or 72 hours (quartan) from the commencement of the ague fit, according to the type of infecting parasite, the cycle of symptoms will be repeated. Between attacks the patient is generally in fair health except for that general undermining which the repetition of attacks brings about in time.

Malaria had long been recognized as a disease of world-wide incidence and the cause of a higher sickness and death-rate than any other disease. The finding of malarial parasites in the blood cell by Laveran at Constantine in 1880, the demonstration of the life cycles of the quartan and tertian species of parasite by Golgi in 1885, and of the subtertian fever species by Marchiafava and Celli, and the discovery that the disease is transmitted through the agency of mosquitoes first from bird to bird, by Ronald Ross in India 1897–99, and later from man to man, in conjunction with the investigations and teachings of Patrick Manson and other pioneers, were important factors in a great stimulus to the study of tropical diseases, both of men and of animals in general, and the whole of tropical sanitation was powerfully affected.

Parasites.—Malaria is due to small Protozoa (*q.v.*) or animal parasites which pass an asexual stage in man, living and developing in the red blood cells, dividing into young forms or fresh broods in two or three days' time and producing some male and female forms (gametocytes), which are drawn with the blood into the stomach of the female mosquito, and there conjugate and complete a sexual cycle. An oöcyst forms from the female gamete and in this a swarm of young sporozoites develop and, becoming free in the body cavity, pass to the salivary glands, whence they are injected at the bite of the mosquito and begin again the asexual stage in man. (*See* PARASITIC DISEASES.)

Malaria parasites are of three species: *Plasmodium falciparum, P. vivax* and *P. malariae,* the causal organisms of "subtertian," tertian and quartan fevers respectively. Following the teaching of Laveran, a small body of workers believed that there was but one species, a theory of unity, and on the other hand certain investigators, because of minute differences between examples of the same species, concluded there were even further species and gave names to them. However, as Prof. Marchoux pointed out in a thorough review of the question at the First International Malaria Congress held at Rome in Oct. 1924, experimental research tended to support the idea of plurality and existence of the three species above named. This was supported by the difference and practically constant periods of evolution of each, the transmission of the same species to healthy subjects, the specificity of culture of the parasites of each of the three species *in vitro,* and by epidemiological studies.

In malaria symptomology nothing of fundamental importance has been discovered in recent years. There has been advance on our knowledge of the cause and treatment of blackwater fever (*q.v.*) or haemoglobinuria, the serious nature of which has called forth many investigations, especially in the particular and heavily infected regions where it occurs. Some investigators hold that this condition may arise not only in infections with *P. falciparum,* but occasionally with *P. vivax* and exceptionally with *P. malariae.* The association of an unknown virus with the malarial parasite has been considered as the cause. J. Thomson's work in Rhodesia in 1923–24 gave strong evidence in favour of *P. falciparum* as the causal organism of all local cases and possibly elsewhere. He showed that *P. falciparum* can almost always be found in the blood; and that cases had been living in a district heavily infected by *P. falciparum.* He found one case after five months and another after 40 years' residence; he noted its occurrence only in people who had had attacks of malaria, though possibly unrecognized as such at the time, and had taken their quinine inadequately in amount and over an insufficient period of time. A similar observation was made in the cases which developed blackwater fever on their way home, or after they had left an endemic area even for some time. The finding of the other species of parasite, both of which tend more to chronicity and are readily found in the blood stream, may, when present, be, in Thomson's view, but an indication of a mixed infection.

Diagnosis.—In the diagnosis of malaria in endemic localities the estimate of inhabitants infected is based on the percentage rate of an enlarged spleen or of a positive blood finding amongst a proportion of the population. For the latter, the examinations of a thick and a thin film of blood are made. In the absence of the parasite an estimate of the relative number of large mononuclear (endothelial) cells to other white cells in the blood may be made in certain cases, but the evidence obtained is not conclusive. An increase above the basic figure of 15% endothelial cells of the total white cells was taken by Stevens and Christopher as indicative of actual or recent malaria in Europeans living in the tropics. Blood cell counts made at some time prior and subsequent to the finding of the malarial parasite did not show the presence of a constant relative increase of endothelial cells, nor was this a constant factor in latent malaria, even when the clinical diagnosis was obvious and the most reliable factor, an enlarged spleen, present. With regard to the finding of the parasite in the blood in these cases of "latent malaria in England" it must be remembered that but a small drop is taken and that parasites are not easily found except at the period of a relapse. The clinical signs of latent malaria most commonly found are, in order of frequency, an enlarged spleen, anaemia, functional disorders of the heart and enlargement of the liver. The tendency to chronicity and febrile relapses in malarial infections is very marked.

Distribution.—Malaria is a world-wide disease with endemic foci in all countries. It is most prevalent and extremely common in the tropics with the native population and high infection rate, constant heat, moisture and water for the breeding of the anopheline mosquito and requisite temperature for the development of the sexual stage of the parasite therein. As the poles are approached, the foci of endemicity gradually become less. For the development of the parasite in the mosquito an adequate temperature is necessary. On an average the three forms, *P. malariae, P. vivax* and *P. falciparum,* take 14, 11 and six days, respectively, the time varying with the temperature. In subtropical countries, malarial outbreaks follow the rainy seasons, when opportunities arise for the breeding of the mosquitoes. Norway and Sweden are examples of countries wherein *Anopheles* are present but malaria absent.

In Great Britain malaria was formerly not uncommon, but became rare until the return of many infected troops. Related to the presence of these carriers there were 235 indigenous cases in England in 1917, the number falling to four in 1924, thus corresponding with the cure of the malarial carriers. There exist in England three species of *Anophelinae* in which the parasites may develop and be transmitted from man to man, but with treatment of infected cases from abroad there is now practically an absence of the human carrier of the parasites, or at least of parasites with sufficiently numerous sexual forms in the blood, a minimum of 12 per cu.mm. of blood being considered necessary for development in the mosquito. Climatic conditions, particularly temperature and humidity, influence the endemic prevalence of malaria. A mean daily temperature exceeding 60° F is necessary for its propagation for the full development of the parasite in the mosquito, *P. falciparum* requiring a very high temperature; *P. malariae* completing its cycle at a low one, and *P. vivax* over a wide range of low to high. This explains the seasonal incidence of the three types of malaria, the relatively high incidence of *P. falciparum,* the most malignant parasite, and the large number of infected inhabitants and high death-rate in the tropics and subtropics, and its rarity in indigenous cases in temperate climes, the presence of the endemic foci of *P. malariae* in the cooler hill country in the tropics and subtropics and the universal distribution of *P. vivax.*

Though *P. falciparum* is the most malignant and spreads most rapidly when anophelism is intense, because of its greater output of gametes in the blood, it does not tend to such chronicity in the absence of reinfection as do the other two forms. In the absence of reinfection *P. malariae,* by far the rarest form, is, however, the most resistant and *P. vivax* holds an intermediate place. Of 28,270 blood examinations made in England at one laboratory on cases of malaria contracted during the World War, 777 were found positive, and of these *P. vivax* numbered 759, *P. falciparum* 14, *P. malariae* four. There was a marked falling off as the time in England lengthened, and it was rare to find the parasite after the quarterly period of 12 to 15 months. Seven cases were found after 30 months all with *P. vivax,* one in a double infection with *P. malariae* after 39 months, and one case after 51, and another after 59 months; *P. falciparum* was found after three months in a double infection with *P. vivax* at the 11th month, once alone at the 12th month, and once in a triple infection at the 14th month. The third of the four cases of *P. malariae* had also been home a long time, namely, 16 months. In none of this extensive series was the parasite ever found after five years at home. It is not uncommon to hear a person settled in a non-infective country for many years accusing a temporary febrile attack or period of lassitude as a return of malaria which he once contracted abroad. Proof of this seems wanting. Though malaria has been transferred directly from man to man, the parasites infecting man have not been made to infect any animal. Entomologists have furthered their investigations into the bionomics and classification of mosquitoes and the determination of the species of anopheles that carry malarial parasites.

S. P. James and Dale have reported that quinine, quinidine and cinchonine possess the same curative properties for all forms of malaria, and without difference in their toxicity save for the greater cardiac depressant action of quinidine. Fletcher at Kuala Lumpur has made a careful series of observations on this point.

Prophylaxis and Treatment.—The treatment of malaria is intimately bound up with prophylaxis. Particular reference may, however, be made to the recent therapeutic use of horse serum in the treatment of that severe form of malaria, blackwater fever, wherein this serum appears to inhibit the action of an auto-haemolysin and its destruction of red blood cells in the body.

Many clinicians strongly advocate in tropical regions intramuscular and intravenous injections of the bihydrochloride of quinine in serious cases, and injections do act quickly in severe, malignant, remittent and comatose cases, but in ordinary cases oral administration of the sulphate has been satisfactory. In acute attacks it must be borne in mind that 24 hours or more may elapse before the good effects of quinine become manifest.

The classical successes in the reduction of malaria at Ismailia, Hongkong, Havana and elsewhere have encouraged similar work in other localities, but there are few such examples as the long continued labours of M. Watson in the Federated Malay States and the brilliant sanitary victory of Gen. Gorgas and the Americans over both malaria and yellow fever at Panama. The work of Darling, Bass and others in southern United States and in the islands must also be mentioned. The method of mosquito reduction against malaria, first suggested and tried under Ross in Freetown, Sierra Leone, in 1899, has not been followed as widely as anticipated, and local authorities too often dislike spending money on sanitation and hamper practical efforts of sanitarians by the attitude that it is better to prevent malaria by quinine or by the use of mosquito-nets, measures impractical in an uneducated native community. Local conditions must always determine the most suitable mode of prophylaxis, and it is important, as É. Sergent points out, to have several methods of control which may well be combined and include with specific measures an educational propaganda. Obviously there must be action to eliminate infection from all carriers of the parasite; in other words, to prevent the mosquito becoming infected, to destroy the species of Anopheles in which the parasite may develop, and to prevent their biting and inoculating the parasite into the blood of man. Good results have attended well-applied efforts of this kind. Better health results and there are real economic returns for expenditure. The native must be looked after and enjoined to adopt some sanitary methods until he is taught to share in systematized efforts to protect and cure himself of malaria as of other endemic diseases.

Measures to rid carriers of the parasite are most difficult to put into practice. There is no settled or fixed dosage, or time of administration, of the specific remedy, quinine or other of the cinchona bark extracts. Acute attacks respond readily to quinine; each dose makes a reduction in the number of parasites, and this reduction occurs every day, until finally none of the parasites is left. Treatment must be continued for a long time. Empirically three months appear to be enough, but there are obstinate cases.

Standard Treatment.—For some years a standard line of treatment to procure disinfestation has been adopted by Bass in America and by Ronald Ross and his colleagues in Great Britain, and the former has been recently introduced by J. Thomson in Rhodesia. The two former vary slightly. Ross gives 30 grains of quinine daily during the attack and for three days after, followed by ten grains daily, just before or after breakfast, for three months; Bass ceases after two months. Success has attended these standard treatments, and it is well for administrative purposes that a standard be adopted in each country. It will not cure all cases, but the exceptions appear rare and when detected can be specially treated. Stevens found arsenic, after initial doses of quinine, of great value in helping to eradicate the parasite. Together with quinine or other drug therapy, the important factor of building up and maintaining the general health, so as to assist the natural forces of the body to eliminate the malarial parasite, must not be forgotten.

Regarding the value of quinine prophylaxis amongst carriers, the results obtained at the malaria centres and camps during the war showed that any dosage under a total of 60 grains weekly proved insufficient for an adult male. Other salts of quinine, of hydrochloride and bihydrochloride, affect the digestion less and seem to be as satisfactory. The tannate has been much used in Italy, especially for prophylaxis among children. The daily small dose is more easily, and therefore more certainly, taken by patients (out of hospital) than larger occasional doses which cause some dyspepsia and headache and are therefore frequently postponed. Children can be given a larger proportion by body-weight than adults, say, twice as much. Ross has always felt that, to be effective, quinine should be continued in ten-grain doses daily for three months after a subject has left a malarial country.

Quinine prophylaxis has been of value on particular occasions, such as in tiding a body of troops over a critical period of fighting or passing through a heavily infected area, in that it has kept off attacks of malaria during that time. Bodies of troops in Salonika who were given quinine daily remained free as long as they were taking it, but went down with malaria as soon as they stopped it, showing they were infected in spite of it.

Not all people bear quinine continued over a long period well, and they may show symptoms of quininism. Occasionally an individual is hypersensitive to quinine and may show symptoms even following an initial dose. On the first appearance of quininism the drug should be stopped for a time, or arsenical treatment substituted. In the hypersensitive case some begin with very small doses to desensitise the patient. Certain investigators in the Tropics consider that it is more difficult to eliminate the parasite by quinine therapy in cases that have been taking quinine consistently and have become infected in spite of it. The cost of quinine and of its supervised administration has frequently rendered quinine prophylaxis impracticable in certain endemic areas.

Quinine prophylaxis should be supported by measures to prevent mosquito bites as far as practicable. In endemic areas and where there are many carriers the infection rate of the mosquito may be very high and frequent reinfection may occur.

The second measure of prophylaxis, *i.e.,* the reduction of anopheline mosquitoes and the prevention of bites, has received more general application. This is difficult and costly, but it results in a lessened sickness and death-rate from malaria, and in profit from the expenditure incurred.

In subtropical regions or where mosquitoes hibernate in dark places in rooms of homes, cellars, stables, outhouses and such places, often attaching themselves to cobwebs, they should systematically be killed directly or by fumigation. The breeding place of the mosquitoes is any still water on which they lay their eggs, and to kill the larvae and pupal forms through which they pass in development is the object in view. Much can be done by the filling in of small pools, cattle foot-marks, draining of marshes, clearing out of long grass and reeds from the sides of streams, the conversion of still to running water when in large masses, the clearing away of all cans and unnecessary water containers and the covering by gauze of cisterns and tanks and the like around the homes. A female mosquito lays about 250 eggs at one time and seven to ten days bring them to maturity. The young aquatic forms may be destroyed by larvicides such as kerosene, waste oil, cresol or "paris green," which, when mixed with 100 parts of dust (1 c.c. of the mixture to 10sq. metres of water) and blown on to the water, distributed by the winds or dropped from aeroplanes, kills the anopheline larva forms and does not injure the fish or the animals that drink therefrom. Valuable agents against larvae and pupae are the surface-feeding minnows, gambusia, stickleback and perch.

Anopheline mosquitoes do not attack until sunset, when one may remain as far as possible indoors in houses, bungalows and huts protected by close-mesh wire or netted windows and double doors; a bed or head net should cover any exposed part of the body during sleep. In the early evening the wearing of puttees by men and a paper lining under the stockings of women prevents bites on the legs. Coolie lines should be placed, when possible, a mile from the breeding places of Anopheles, though this does not mean that the mosquitoes cannot fly much farther. There is little danger to be anticipated from breeding places over a mile distant, if the mosquitoes have opportunities of feeding close at hand (*i.e.,* from other mammals), and if the intervening space be raised, wind-swept and clear of all shrubs and trees. The knowledge that the mosquito will attack man or animal in its thirst for blood has raised certain questions regarding the preservation of game, but up to the present no practical studies on any extensive scale have been made.

Use in Psychiatry.—Following the observation of W. Jauregg in Vienna in 1917, that certain chronic conditions showed improvement after malarial attacks, the therapeutic use of malaria in psychiatry has been extensively applied in many countries. Many cases of general paralysis have benefited, some sufficiently to be able to return to family and social life. Time must be given to determine the permanency or otherwise of the amelioration. Its use in other cases of cerebrospinal syphilis and also in such mental diseases as *dementia praecox,* confusional insanity and *encephalitis lethargica* is under consideration. The parasite used is *P. vivax* and it appears more satisfactory to inoculate the patient by an experimentally infected mosquito than by infection with blood from a case of malaria. Thereby all risks of other infection are avoided, a wise precaution, especially in an endemic region where other species of the parasite occur. Infected cases are allowed to have six to ten febrile attacks of malaria and are then given quinine which in these experimental cases readily cures the attacks.

War Malaria.—The following were the British War Office figures of the number of cases admitted to hospital in four of the fighting areas during the war: Mesopotamia, 1916, 680; 1917, 744; 1918, 10,202. Salonika, 1916, 31,059; 1917, 71,413; 1918, 59,087. East Africa, 1917, 58,236; 1918, 20,015. Egypt, 1916, 1,423, 1917, 8,480; 1918, 30,241.

Until the war spread to the Eastern fronts British armies suffered little from tropical diseases. In the summer of 1916 an epidemic of malaria occurred among the troops on the Salonika front, and continued until the end of the war.

Following the outbreak of malaria at Salonika, Sir Alfred Keogh, the director-general, Army Medical Services, early in 1917 appointed a special malaria hospital in each command in the United Kingdom, for the express purpose of finding a permanent cure if possible, and of treating the thousands of men who were being returned home sick with malaria from the Eastern fronts, Sir Ronald Ross being also appointed consultant in malaria at the War Office. The fact that moderate doses of quinine will control actual attacks within a few days was fully verified, with very few exceptions. Almost every form of treatment that had ever been suggested—enormous doses of quinine reaching 100 grains *per diem,* smaller doses continued for three weeks or more, additional medication with arsenic and other drugs, continuous doses lasting for a month, and various kinds of interrupted dosage—all proved uncertain. Thirty gains of quinine, continued every day for three weeks, proved a failure. Intramuscular injections and even intravenous injections did no better. Men who were presumed to be cured relapsed again after returning to duty; a large proportion of those infected with malaria became almost useless for further service. Numerous nostrums advocated for malaria proved valueless, the only exceptions being one or two arsenical preparations, which, however, were *no better* than ordinary quinine.

In all these attempts, treatment had seldom been continued for more than one month and rarely or never for more than two months—owing, of course, to military exigencies. It was decided to deal with the large numbers of discharged soldiers by a longer period of treatment. In 1918 two whole divisions, full of malaria, had been brought from Salonika to France and were there subjected to a longer course of treatment preparatory to their being sent again into the firing-line. The regiments arrived in an extremely bad condition, were all placed in camps in the Dieppe region, and the men were given 15 grains of quinine in solution once daily for a fortnight, followed by ten grains of quinine in solution daily for two and one-half months more. The course, designed and carried out by Col. J. Dalrymple, had marvellous results, almost the whole of the two divisions being found fit for the front at the end of three months. About the same time large malaria concentration-camps were established in England, where cases were given similar treatment, but for shorter periods; and it was found generally that (1) doses of less than ten grains daily did not suffice to prevent relapses even while they were being taken; (2) doses of ten grains daily did so suffice, except in about 6% of the cases, most of whom, however, relapsed during the first days of the treatment; (3) 15 grains a day reduced the relapses still further, but only to about 4% or 5%.

The long-continued treatment of malaria was now proved to be satisfactory, and was extended to pensioners also. In one London clinic alone nearly 30,000 pensioners have been treated in this way. The results have been admirable, and probably few who have taken the treatment properly have returned. But the ten grains of quinine must be taken religiously every day, and it is well to associate this with or follow it by a course of arsenic. Quinidine replaced the quinine in a small number of these cases. Empirically, three months appear to be enough, but in obstinate cases four months might be better. Even long courses of treatment will not necessarily cure people who are subject to reinfection during treatment; and it is even possible that they are not so effective during the first six months or the first year of infection as they are later. The results described above were obtained among returned cases in Britain.

The prevention of malaria on the battle-front was always difficult and sometime impossible. Mosquito-reduction in the face of enemy fire is impracticable; quinine prophylaxis was under such conditions disappointing; and the armies were obliged to fall back upon mosquito-nets and mosquito-proof tents and bivouac shelters, carefully designed by the British War Office. Better results were obtained at the bases of operations, especially in Palestine; and a very successful campaign of mosquito reduction was carried out by Col. J. C. Robertson at Taranto in southern Italy.

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(Ro. Rs.; W. B.-A.)

MALATYA (MALATIEH or ASPUZU), the chief town of a vilayet in Turkey, on the Samsun-Sivas-Diarbekr road, altitude 2,900 ft., situated about 10 mi. S.W. of the junction of the Tokhma Su (med. Kubakīb) with the Euphrates, near the south end of a fertile plain, and at the northern foot of the Taurus. Pop. (1940) 36,292. It was rebuilt after the earthquake of 1893, and is noted for its fruit orchards. Eskishehr or Old Malatya (*Melitene*), 5 mi. N.E. and 3 mi. from the mediaeval bridge (Kirkgeuz) over the Tokhma Su, has large gardens and many ruined mosques, baths, etc., relics of Mansur's city. The earliest site was possibly Arslan Tepe about 2 mi. south of Eskishehr where two "Hittite" stelae, representing hunting scenes, were found.

Under Titus, Melitene was the seat of the 12th legion; Trajan raised it to a city. Lying in a very fertile country at the focus of important routes, it grew in size and importance, and was the capital of Armenia Minor or Secunda. Justinian, who completed the walls commenced by Anastasius, made it the capital of Armenia Tertia; it was then a great place (Procop., *De aed.*, iii. 4). The town was burned by Chosroes after his defeat there in 577. Taken by the Saracens, retaken and destroyed by Constantine Copronymus, it was recovered to Islam, and rebuilt under Mansur (A.D. 756). It again changed hands more than once, being reckoned among the frontier towns of Syria (Iṣtakhry, pp. 55, 62). At length the Greeks recovered it in 934, and Nicephorus II., finding the district much wasted, encouraged the Jacobites to settle in it. A convent of the Virgin, and the church which bears his name, were erected by bishop Ignatius. Malatya became a great seat of the Jacobites, and was the birthplace of their famous maphrian Barhebraeus (or Abulfaragius). At the time of the first crusade, the city, being hard pressed by the Turks, was relieved by Baldwin. The city returned to the Turks in 1102 and subsequently became part of the realm of Kilij Arslan, sultan of Iconium.

MALAYALAM, a language of the Dravidian family, spoken on the west coast of southern India. It is believed to have developed out of Tamil as recently as the 9th century. It possesses a large literature, in which words borrowed from Sanskrit are conspicuous. The literary language is closely connected with Tamil. In general it differs from Tamil in the absence of personal terminations to verbs.

See Bibliography in *Linguistic Survey of India*, vol. iv. (1906).

MALAY ARCHIPELAGO, the largest group of islands in the world, lying southeast of Asia and north and northwest of Australia. It includes the Sunda Islands, the Moluccas, New Guinea and the Philippine Islands, but excludes the Andaman-Nicobar group. The equator passes through the middle of the archipelago; it successively cuts Sumatra, Borneo, Celebes and Halmahera, four of the most important islands.

	Area	Estimated population
	Sq.mi.	
Sunda Islands	646,385	61,127,108
Moluccas	30,168	543,030
New Guinea	312,329	1,312,013
Philippine Islands	115,600	16,000,303

The islands of the archipelago nearly all present bold and picturesque profiles against the horizon, and at the same time the character of the scenery varies from island to island and even from district to district. Volcanoes running southeast through Sumatra, east through Java and the southern islands to Timor, curving north through the Moluccas, and again north, from the end of Celebes through the whole line of the Philippines, follow a line roughly resembling a horseshoe narrowed toward the point. A disastrous eruption occurred in Aug. 1928 from Mt. Rokatinda, in the island of Palu Wai, north of Flores. The loftiest mountain in the archipelago would appear to be Kinabalu in Borneo (13,451 ft.). An important fact in the physical geography of the archipelago is that Java, Bali, Sumatra and Borneo, and the lesser islands between them and the Asiatic mainland, all rest on a great submerged bank, nowhere more than 100 fathoms below sea level and seldom exceeding 50 fathoms, which may be considered a continuation of the continent; while to the east the depth of the sea has been found at various places to be from 1,000 to 3,557 fathoms. As the value of this fact was particularly emphasized by Wallace, the limit of the shallow water, which is found in the narrow but deep channel between Bali and Lombok, and strikes north to the east of Borneo, has received the name of "Wallace's Line." The Philippines on the other hand, "are almost surrounded by deep sea, but are connected with Borneo by means of two narrow submarine banks" (A. R. Wallace, *Island Life*). The archipelago, in effect, is divided between two great regions, the Asiatic and the Australian, and the fact is evident in various branches of its geography—zoological, botanical, and even human. It is believed that there was a land connection between Asia and Australia in the later part of the Secondary epoch, and that the Australian continent, when separated, became divided into islands before the southeastern part of the Asiatic.

The most notable fact in the geological history of the archipelago was the discovery in Java of the fossil remains of *Pithecanthropus erectus* and *Homo Modjokertensis*. The strata in which they were found belong to the middle Pleistocene. Among the rocks of economic importance may be mentioned granite of numerous kinds, syenite, serpentine, porphyry, marble, sandstones and marls. Coal is worked in Sumatra and Borneo; china clay in Java. Diamonds are obtained in Borneo, garnets in Sumatra, Bachian and Timor, and topazes in Bachian, antimony in Borneo and the Philippines; lead in Sumatra, Borneo, Celebes and the Philippines; copper and malachite in the Philippines, Celebes, Timor, Borneo and Sumatra; nickel in Celebes and, most important of all, tin in Banka, Billiton and Singkep. Iron is pretty frequent in various forms, occurring in Celebes and particularly in southeast Borneo. Wolframite is known, and manganese is mined in Java. Chromium, manganese and gold are mined in the Philippines. Gold exists in Sumatra and other islands; silver is found in Java and Sumatra. Platinum and quicksilver are found in Borneo. Petroleum is a valuable product of Sumatra and many parts of British and Dutch Borneo. Saltpetre is found in Sumatra and Flores, and sulphur, naphtha, alum, lignite and magnetite in Sumatra, and asphalt in Buton (Celebes).

Climate, Flora, Fauna.—The most striking general fact as regards climate in the archipelago is that wherever that part of the southeast monsoon which has passed over Australia strikes, the climate is comparatively dry, and the vegetation is less luxuriant. The east end of Java has less rainfall than the west; the distribution of the rain on the north coast is quite different from that on the south, and a similar difference is observed between the east and west of Celebes. The northwest monsoon, beginning in October and lasting till March, brings the principal rainy season in the archipelago.

Most of the islands of the archipelago belong to the great equatorial forest belt. In its economical aspect the vegetation, whether natural or cultivated, is of prime interest. The list of fruits is very extensive, though few of them are widely known. These, however, include the orange, mango, mangosteen, shaddock, guava and the durian. The variety of food plants is equally notable. Not only are rice and maize, sugar and coffee, among the widely cultivated crops, but the coconut, the bread-fruit, the banana and plantain, the sugar palm, the tea plant, the sago palm, the cacao tree, the ground-nut, the yam, the cassava and others besides are of practical importance. The cultivation of sugar, rubber, kapok, palm oil and coffee owed its development mainly to the Dutch; and to them also was due the introduction of tea and cinchona (quinine). They greatly encouraged the cultivation of the coconut among the natives, and it flourishes, especially in the coast districts, in almost every island in their territory. The oil is largely employed in native cookery. Pepper, nutmegs and cloves were long the objects of the most important branch of Dutch commerce; and gutta percha, camphor, dammar, benzoin and other forest products have a place among the exports. (For details concerning flora and fauna, *see* separate articles, especially JAVA.)

Inhabitants.—The majority of the native inhabitants of the Malay archipelago belong to two races, the Malays and the Melanesians (Papuans). As regards the present racial distribution, the view accepted by many anthropologists, following A. H. Keane, is that the Negritos, still found in the Philippines, are the true aborigines of Indo-China and western Malaysia, while the Melanesians, probably their kinsmen, were the earliest occupants of eastern Malaysia and western Polynesia. At some date long anterior to history it is supposed that Indo-China was occupied first by a fair Caucasian people and later by a yellow Mongolian race. From these two have come all the peoples—other than Negrito or Papuan—found today from the Malay peninsula to the farthest islands of Polynesia. A rather recent Hindu strain is evident in Java, strongly in parts of Bali, in some districts in Sumatra, and others of the western islands. There are many Arab and Indian settlers, and slight intermarriage exists between these and the Malayans. The Chinese form, from an economical point of view, one of the most important sections of the community in many of the more civilized districts. Chinese have been established in the archipelago from a very early date: the first Dutch invaders found them settled at Jacatra; and many of them, as, for instance, the colony of Ternate, have taken so kindly to their new home that they have acquired Malay to the disuse of their native tongue.

There is a vast field for philological explorations in the archipelago. Of the great number of distinct languages known to exist, few have been studied scientifically. The most widely distributed is the Malay, which has not only been diffused by the Malays themselves throughout the coast regions of the various islands, but has also been adopted by the government of the Dutch East Indies as a *lingua fianca.* The most cultivated of the native tongues is the Javanese, and it is spoken by a greater number of people than any of the others. Among the other languages which have been reduced to writing and grammatically analyzed are the Balinese, closely connected with the Javanese, the Sasak (Lombok) and allied Sumbawanese, Sumbanese, Rottinese and Timorese languages. The commercial activity of the Buginese causes their language to be fairly widely spoken. (K.G.J.; E.E.L.; X.)

HISTORY

The Hindu and Moslem Periods.—Indians, both merchants and political refugees, arrived in the East Indies early in the Christian era. The immigration continued for seven centuries; but the number that came was never large. The new arrivals intermarried with the Indonesian aristocracy, and their descendants formed the governing class. The immigrants deeply affected government and religion, although the lower class remained purely Indonesian. The Indians exerted their greatest influence in Java and Sumatra, and from there the new culture spread to Bali and the Moluccas. Traces of Indian civilization have also been found in Borneo and Celebes. While the majority of the immigrants were Hindus, there were also some Buddhists; and the two religions co-existed without persecution. India likewise provided the models for architecture and sculpture. Chinese traders arrived in the Malay archipelago about the same time as the Indians; but the Indonesians were not influenced by their civilization.

The two most powerful kingdoms between the 5th and 9th centuries were Shrivijaya and Shailendra. The former, with its capital at Palembang in Sumatra, included part of Sumatra and the Malay peninsula, and was a commercial and naval power. The Shailendra dynasty ruled in central Java during the 8th and 9th centuries, and under it Indian art reached its highest development, *e.g.,* the Buddhist temple at Borobudur. The kingdom of Shailendra came under the control of eastern Java about A.D. 870. About 1025 the kingdom of Shrivijaya was greatly weakened by an Indian invasion, although it survived until the latter part of the 13th century. Eastern Java became the most powerful kingdom, and in the late 13th century, King Kertanagara conquered part of Sumatra and Borneo as well as Bali and several islands of the Moluccas. After a brief interlude of civil war and the ephemeral intervention of a Chinese fleet and army sent by Kublai Khan, Vijaya became king in 1294. He greatly extended Kertanagara's conquests and founded the empire of Madjapahit. Its strength rested upon sea power and control of the spice trade; and the petty kings in the islands became tributary vassals. The empire began to decline about 1389, and finally collapsed in the late 15th or early 16th century.

The decay of the Hindu empire of Madjapahit was hastened by the spread of the Moslem religion, which was brought to the East Indies by traders. In 1292 Marco Polo visited the islands, and noted that the inhabitants of the little town of Perlak on the northern tip of Sumatra had been converted to Islam. From here it spread gradually through the islands and the Malay peninsula, until Hinduism survived only in Bali. The process of conversion was still in progress when the Portuguese arrived, and their efforts to substitute Christianity for Islam had little effect. They were more successful in conquering or weakening the new Moslem kingdoms which were beginning to arise out of the ruins of Madjapahit.

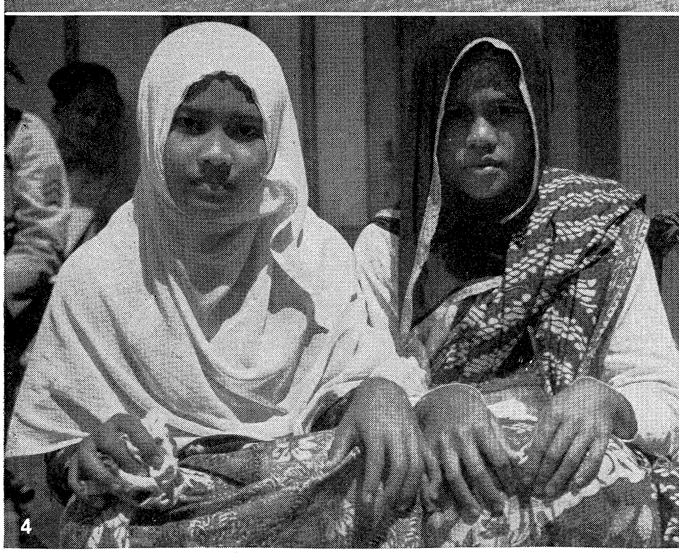
The Portuguese and Spanish.—In 1511 Alphonso d'Albuquerque occupied Malacca, and in November of that year an expedition under Antonio d'Abreu was despatched to find a route to the Moluccas and Banda Islands, then famous for their cloves and nutmegs. The explorers reached Amboina and Ternate, after gaining some knowledge of Java, Madura, Sumbawa and other islands, possibly including New Guinea. In 1514 a second Portuguese fleet arrived at Ternate, which during the next five years became the centre of Portuguese enterprise in the archipelago.

Spain sought to secure the Moluccas and in Aug. 1519 an expedition commanded by Ferdinand Magellan (*q.v.*) sailed from Seville to seek a westward passage to the archipelago. After losing the commander in the Philippines and discovering Borneo, the two surviving ships reached the Moluccas late in 1520. One vessel returned to Seville by the cape route, thus completing the first voyage round the world. Reinforcements from Spain arrived in 1525 and 1528; but in 1529 a treaty was concluded between the emperor Charles V and John III of Portugal by which, in return for 350,000 gold ducats, the Spanish claim to the Moluccas was withdrawn. The boundary between the Spanish and Portuguese spheres was fixed at 17° E. of the Moluccas, but the Philippines were included within the Spanish sphere.

Though the Portuguese traders frequented the coast of Java and Sumatra and established a trading post in Sumatra, they annexed no territory in either; but farther east they founded numerous forts and factories, notably in Amboina, the Banda Islands, Celebes and Halmahera. Ternate remained the seat of the governor of the Moluccas, who was the highest official in the archipelago, though subordinate to the viceroy or governor of Portuguese India. The first attempt to enter into relations with the states of Borneo was made by D. Jorge de Menezes, who visited Brunei in 1526, and in 1528 sent an unsuccessful envoy to its rajah.

In 1536, after a period of war and anarchy caused by the tyrannical rule of Menezes, Antonio Galvão, the historian, was appointed governor of the Moluccas. He crushed the rebellion and won the affection of the natives by his just and enlightened administration, which had no parallel in the annals of Portuguese rule in the archipelago. He returned to Europe in 1540 (*see* PORTUGUESE LITERATURE), after inaugurating an active missionary movement, which was revived in 1546–1547 by Francisco de Xavier (*q.v.*). At this period the Portuguese power in the east was already beginning to wane; in the archipelago it was weakened by administrative corruption and by incessant war with native states, notably Bintang and Achin; bitter hostility was aroused by the attempts of Portuguese to establish a commercial monopoly and to convert their subjects and allies (*see* PORTUGAL: *History*).

The English and Dutch, 1595–1674.—Pirates from Dieppe

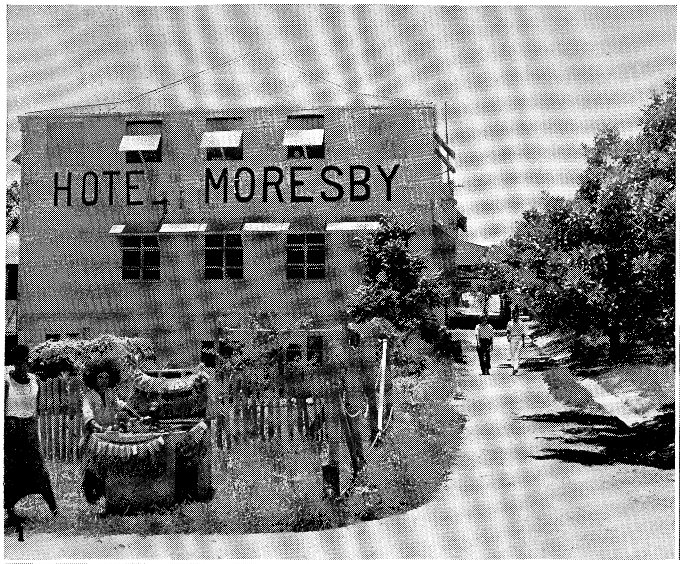


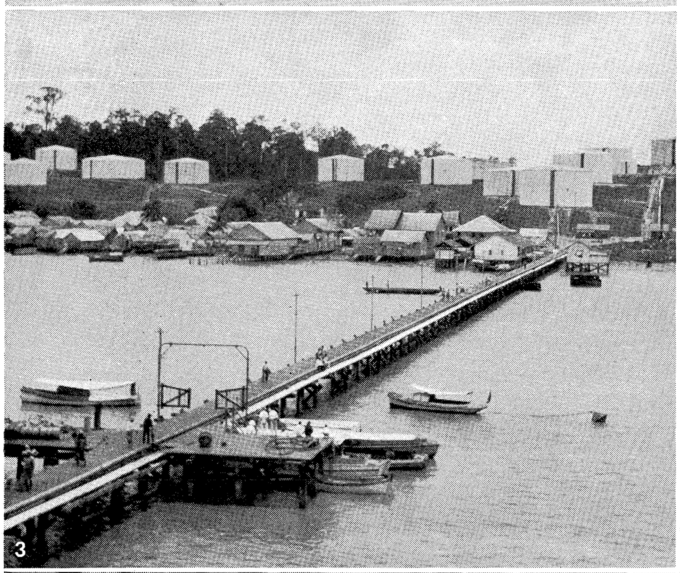
PHOTOGRAPHS, (1, 2) RATHENAU-PIX, (3, 4) DEANE DICKASON FROM EWING GALLOWAY, (5) EWING GALLOWAY

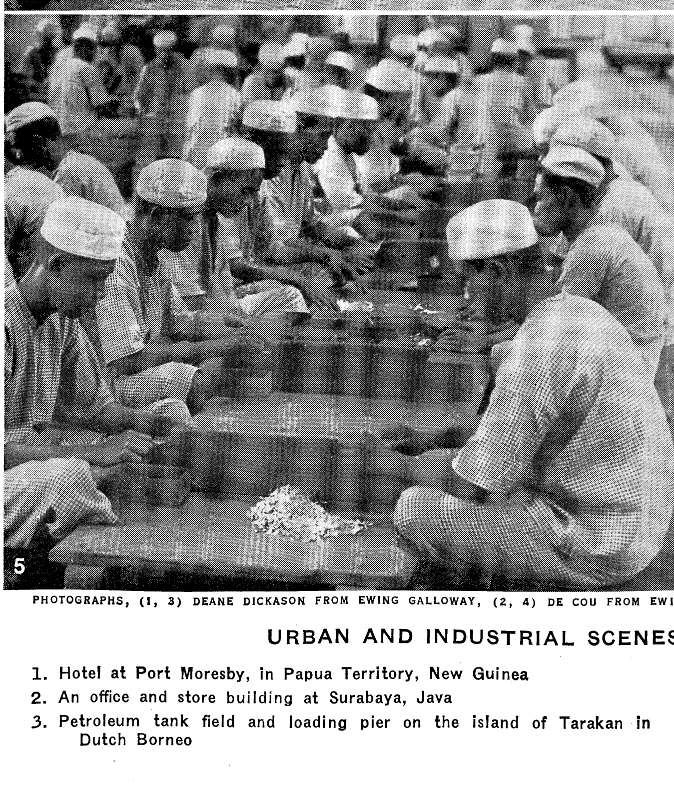
PEOPLES OF THE MALAY ARCHIPELAGO

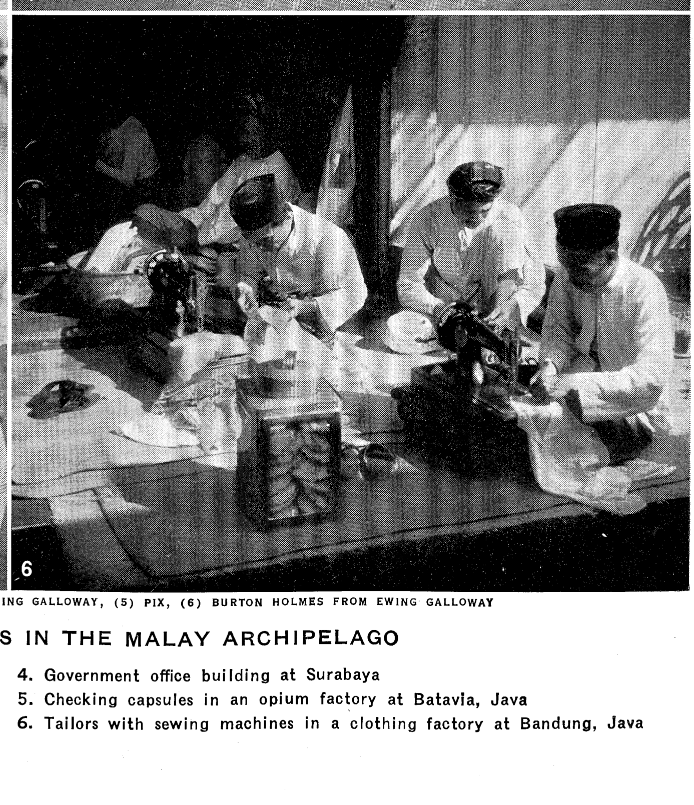
1. Javanese women washing clothes on rafts, near Batavia
2. Native boy riding a water buffalo near Macassar, Celebes
3. Gathering of tribesmen on the constabulary parade ground at Port Moresby, Papua Territory, New Guinea
4. Girls of the Menangkabau tribe, the most civilized Malays of Sumatra
5. A Batta bridal party on Toba lake in Sumatra

MALAY ARCHIPELAGO









PHOTOGRAPHS, (1, 3) DEANE DICKASON FROM EWING GALLOWAY, (2, 4) DE COU FROM EWING GALLOWAY, (5) PIX, (6) BURTON HOLMES FROM EWING GALLOWAY

URBAN AND INDUSTRIAL SCENES IN THE MALAY ARCHIPELAGO

1. Hotel at Port Moresby, in Papua Territory, New Guinea
2. An office and store building at Surabaya, Java
3. Petroleum tank field and loading pier on the island of Tarakan in Dutch Borneo
4. Government office building at Surabaya
5. Checking capsules in an opium factory at Batavia, Java
6. Tailors with sewing machines in a clothing factory at Bandung, Java

visited the archipelago between 1527 and 1539. It is possible that they reached Australia; but their cruise had no political significance, and the Spaniards and Portuguese remained without European competitors until the appearance of Sir Francis Drake in 1579. Sir James Lancaster was active in these seas at the end of the century and visited Achin in 1602. An expedition under Sir Henry Middleton traded in the archipelago in 1604. The English were simple traders or explorers; far more formidable were the Dutch, who came to the east partly to avenge the injuries inflicted on their country by the Spaniards, partly to break the commercial monopoly of the peninsula states. As middlemen they already possessed a large interest in the spice trade, for the Portuguese, having no direct access to the principal European markets, had made a practice of sending cargo to the Netherlands for distribution by way of the Scheldt and Rhine. The Dutch now sought to monopolize not only the distribution but the production of spices—an enterprise facilitated by the co-operation of many exiled Portuguese Jews who had settled in Holland.

The first Dutch fleet sailed from Texel, under the command of Cornelius Houtman, on April 2, 1595, and reached Sumatra on Jan. 1, 1596. It visited Madura, and though not a commercial success, demonstrated the weakness of the Portuguese. In 1602 the Dutch East India company (*q.v.*) was incorporated, and for nearly two centuries this organization played the chief part in the history of the archipelago. By 1604 the Dutch could already claim to be the stronger power at sea. They had attacked the Portuguese in Ceylon (1601), established friendly relations with Achin (1602), and defeated a powerful fleet off Banda (1602). In 1606 they concluded a treaty of alliance with the sultan of Johor, and in 1608 they forced the Portuguese to assent to an armistice for 12 years. On Nov. 29, 1609, Pieter Both was chosen by the states-general, on the nomination of the Dutch East India company, as first governor-general of Netherlands India. In 1611, the headquarters of the Dutch was changed from Bantam to Jakatra, which in 1619 was renamed Batavia and was thenceforward the Dutch capital. Meanwhile the English East India company, chartered in 1600, had also extended its operations to the archipelago. After 1611 the commercial rivalry between the Dutch and British became acute, and in 1613, 1615 and 1618 commissioners met in London to discuss the matters in dispute. The result of their deliberations was the treaty of defense, signed on June 2, 1619 and modified on Jan. 24, 1620, which arranged for co-operation between the Dutch and British companies, and especially for the maintenance of a joint fleet. But neither company could restrain its agents in the east from aggressive action, and many fresh causes of dispute arose, the chief being the failure of the British to provide the naval forces required for service against the Portuguese, and the so-called massacre of Amboina (*q.v.*) in 1623. The treaty of defense lapsed in 1637. The Dutch company opened up trade with Japan and China, and prosecuted the war against Portugal with great vigour, invading Portuguese India and capturing Point de Galle in 1640, Malacca in 1641, Cochin and Cannanore in 1663.

Rebellions in Java (1629) and the Moluccas (1650) were suppressed with great severity, but in 1662 the company suffered a heavy reverse in Formosa, all its colonists being expelled from the island. A new war between Great Britain and Holland broke out in 1672 and was terminated by the treaty of Westminster (Feb. 17, 1674). Thenceforward the British company devoted its energies chiefly to the development of its Indian possessions, while the Dutch were left supreme in the archipelago.

Dutch Ascendancy, 1674–1749.—The weakness of Spain and Portugal and the withdrawal of the British left the Dutch company free to develop its vast colonial and commercial interests. In 1627 the so-called Dutch colonial system had been inaugurated by the fourth governor-general, Jan Pieterszoon Coen (*q.v.*). Under this system, which was intended to provide Netherlands India with a fixed population of European descent, Dutch girls were sent to the archipelago to be married to white settlers, and subsequently marriages between Dutchmen and captive native women were encouraged. As early as 1624 vast fortunes had been acquired by traders. The system of practical slavery enforced on the native races provoked an insurrection throughout Java, in which the Chinese settlers participated; but the Dutch maintained naval and military forces strong enough to crush all resistance, and a treaty between the company and the Susuhunan in Nov. 1749 made them practically supreme in Java.

Decline of Dutch Power, 1749–1811.—In the second half of the 18th century there was a rapid decline in the revenue from sugar, coffee and opium, while the competition of the British East India company, which now exported spices, indigo, etc., from India to Europe, was severely felt. The administration was corrupt, largely because of the vast powers given to officials, who were invariably underpaid; and the financial methods of the company precipitated its ruin, large dividends being paid out of borrowed money. The burden of defense could no longer be sustained; piracy and smuggling became so common that the company was compelled to appeal to the states-general for aid. In 1798 it was abolished and its authority vested in a Council of the Asiatic Possessions. In 1803 a commission met to consider the state of the Dutch colonies, and advocated drastic administrative and commercial reforms, notably freedom of trade in all commodities except firearms, opium, rice and wood—with coffee, pepper and spices, which were state monopolies. Some of these reforms were carried out by H. W. Daendels (1808–1811), who was sent out as governor-general by Louis Bonaparte, after the French conquest of Holland. In 1811 Daendels was recalled and J. W. Janssens became governor-general.

British Occupation, 1811–1816.—Netherlands India was at this time regarded as a part of the Napoleonic empire, with which Great Britain was at war. A British naval squadron arrived in Moluccas in February 1810 and captured Amboina, Banda, Ternate and other islands. In 1811 a strong fleet equipped by Lord Minto, then governor-general of India, captured Java. Raffles (*q.v.*) was appointed lieutenant-governor and he introduced many important changes in the departments of revenue, commerce and judicature. He was succeeded by John Fendal, who in 1816 carried out the retrocession of Netherlands India to the Dutch, in accordance with the treaty of Vienna (1814).

Restoration and Reform of Dutch Power, 1816–1910.—The whole history of the archipelago was changed by Raffles' occupation of Singapore in 1819, as a means of preventing the Dutch from acquiring a monopoly of trade throughout Malaya and with China. Questions at issue between Great Britain and the Netherlands were settled by treaty in 1824. The Dutch were given almost entire freedom of action in Sumatra, while the Malay peninsula was recognized as within the British sphere of influence.

The reform movement inaugurated by the commission of 1803 was resumed in 1830, when Johannes van den Bosch was appointed governor-general (*see* JAVA). The reform movement was aided by the publication in 1860 of *Max Havelaar,* a romance by E. Douwes Dekker (*q.v.*), which contained a scathing indictment of the colonial system.

The extension of Dutch political power—notably in Java, Sumatra, Celebes, the Moluccas, Borneo, the Lesser Sunda Islands and New Guinea—proceeded simultaneously with the reform movement, and from time to time involved war with various native states. A large expedition was sent to Lombok in 1894, and almost the whole of that island was incorporated in the Dutch dominions. A 30-years' war with Achin (*see* SUMATRA) began in 1873.

While the Dutch were consolidating their authority, other countries were acquiring new commercial or colonial interests in the archipelago. Immigration from China and Japan steadily increased, especially toward the end of the period 1816–1910. The enterprise of Sir James Brooke (*q.v.*) led, after 1838, to the establishment of British sovereignty in northwest Borneo; in 1895 New Guinea was divided between Great Britain, Germany and the Netherlands; the Spanish-American War of 1898 resulted in the cession of the Philippines, Sulu Island and the largest of the Mariana Islands to the United States, and the sale of the Caroline group to Germany. Australian and Japanese trade in the archipelago was stimulated by the establishment of the Australian commonwealth (1901) and the Russo-Japanese War (1904–05).

The effect of World War I was to deprive Germany of the Caroline Islands and the northern part of New Guinea, which is now administered under mandate by the Commonwealth of Australia. The division of Timor (the Portuguese portion of which was formerly joined up with Macao for administrative purposes but is now independent of that island) between Portugal and Holland was reminiscent of the struggles of past centuries. The Dutch Portuguese treaty of 1859, modified by the convention of 1908, settled all outstanding questions.

Apart from the Philippines, the Malay archipelago was before World War II almost wholly in the hands of the British and the Dutch. (*See* also EAST INDIES.)

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(K. G. J.; C. H.; E. S.; X.)

MALAY LANGUAGE. Having been the common medium of intercourse in the Malay archipelago for more than four centuries past, Malay is for practical purposes the most important of the Indonesian languages. But it is not the most typical one, for its morphological system has been much simplified, making it serve as an easy *lingua franca*.

We must distinguish between (1) the Malay of the Malays themselves, including (*a*) the language of literature, which is fairly uniform everywhere, having undergone but little change since the 16th century, and the more modernized styles of journalism and letter writing; (*b*) the speech of educated Malays, based on the common colloquial of the south of the peninsula, the islands of the Riau-Lingga groups and part of the east coast of Sumatra; a special variety of it, the court language, only differing by adding a few terms exclusively appropriate to princely personages; (*c*) the local peasant dialects, which in the north of the peninsula differ very much, especially in pronunciation, from (*b*) and (2) the various versions of Malay, often mere jargons, spoken by all sorts of foreigners. In this last class fall the Malay of the Straits-born Chinese and the Malay current in Java, adopted by the Dutch throughout their eastern possessions.

Scripts.—Since the 14th century Malay has been written in the Arabic alphabet augmented by five letters. Thus written, it is sometimes styled Jawi, an Arabic term derived from "Java the Less," an old name for Sumatra. The oldest surviving Malay manuscripts date from about A.D. 1600. Till the 14th century the language was written in Sumatra in an alphabet of south Indian origin; but old inscriptions are rare and full of Sanskrit words. In some parts of southern Sumatra Malay is still written in a modernized form of this script. The Arabic character, being deficient in vowel symbols and sparing in their use, is ill adapted to Malay, which has many unrelated words differentiated only by vowels. The Dutch and British have transcribed it into the Roman alphabet, the Dutch with Dutch values, the British on the Hunterian system, with (roughly) Italian values for the vowels and English ones for the consonants.

Sounds and Words.—Neglecting the specially Semitic sounds found in Arabic loanwords and often assimilated in speech to the nearest Malay sound, the English Romanized Malay has the following vowels *a, e, i, o, u,* and a neutral vowel written *ĕ;* diphthongs, *ai, au,* consonants, *k, g, ng, ch, j, ny, t, d, n, p, b, m, y, r, l, w, s, h.* The glottal stop is symbolized at the end of a word after a vowel by *k* when the Arabic script has *kof* or *kaf,* by an apostrophe when it has *hamzah.* In some parts of the Malay region (*e.g.* Borneo) final *k* is still a *k.* Normally, vowels in closed syllables are short, in open ones short or long (except *ĕ,* which is always short and often suppressed entirely). Two consonants cannot begin or end a word.

Words are simple, compound or derivative. Simple words, which are mostly of two syllables, are the shortest forms occurring in actual use, compound ones are made by reduplication (complete, partial or with variation of one or more sounds) or by junction, of simple words; derivatives by adding to a simple or compound word one or more syllables, incapable of separate existence, which are prefixed, suffixed or infixed after the initial consonant. Syllabic stress, which is weak, is normally on the penultimate, unless this contains the neutral vowel followed by one consonant only, in which case the stress is on the final.

Morphology.—The infixes, *ĕm, ĕr, ĕl,* are mere survivals. The prefixes and suffixes are living formative factors. The chief prefixes are: *mĕng* (with variants *mĕny, mĕn, mĕm, mĕ,* according to the initial of the simple word), prefixed in certain syntactical relations and forming verbs of action, mostly transitive, *pĕng* (with similar changes), nouns denoting agent or instrument, *bĕr,* verbs middle and reflexive, denoting action of the subject on or for itself (or, with a plural subject, reciprocal), intransitive action, state and, in particular, use, production or possession, and adjectives of similar import; *tĕr,* the accomplished event and, in negative or interrogative phrases, possibility, *di,* the passive. The suffixes *i* and *kan* make transitive, *kan* also causative, verbs; *an,* nouns, both by itself and when accompanied by one of the prefixes *pĕng, pĕr,* and *kĕ;* the last combination is also a passive. Number, gender, case, person, tense, mood and degrees of comparison can be indicated by the addition of separate words; but the language is terse and prefers an impersonal form of expression and tolerates indeterminateness. Reduplication is often used to express indefinite variety, plurality, degree of quality, frequency and reciprocity.

Syntax.—The leading idea comes first and anything in intimate relation to and qualifying it comes next. Thus the genitive, attributive adjective and demonstrative follow the substantive. There is no copula, and in simple sentences either predicate or subject may come first. Where subject, verb and object appear, they occur normally in that order; but an emphatic object can precede the subject. With a passive verb the order subject, verb, agent, can be varied if the agent is the enclitic third personal pronoun *nya,* or if a preposition is used before the subject, agent or both. In speech, sentences are usually shorter than in the written language.

Numerals.—The elements of the system are the integers 1 to 9 (of which 1 has two forms, *satu,* the normal, and *sa,* proclitic before certain words), *puloh,* which by prefixing *sa* and the other integers to it forms 10 and its multiples to 90, *bĕlas,* similarly forming 11 to 19, *ratus,* hundreds, *ribu,* thousands and likewise three words of Sanskrit origin for 10,000, 100,000 and 1,000,000. In enumerating concrete units it is usual to add to the numeral an auxiliary word (like "head" in "three head of cattle," for which Malay substitutes "tail").

Vocabulary.—The language is rich in specific expressions for minutely differentiated kinds of objects and actions (*e.g.,* various modes of carrying, striking, etc.). The vocabulary is very mixed, but native Malay words largely preponderate. The loanwords are mostly terms denoting abstract ideas or else things of foreign origin. In the middle ages many were borrowed from Sanskrit and since the 14th century many more from Arabic. A fair number of Tamil, Persian, Hindustani, Javanese, Chinese, Portuguese, Dutch and English words have also been adopted; and the last two classes (like the Arabic) are still growing. The influx of Dutch (and also Javanese) words into the Malay of the Dutch possessions is widening the gap between it and the language of British Malaya. (C. O. B.)

Literature.—Their most characteristic literature is to be found, not in their writings, but in the folk-tales which are transmitted orally from generation to generation and repeated by the wandering minstrels called by the people *Pĕng-līpor Lāra, i.e.* "Soothers of Care." Some specimens of these are to be found in the *Journal of the Straits Branch of the Asiatic Society* (Singapore). The collections of *Malay Proverbs* made by Klinkert, Maxwell and Clifford also give a good idea of the literary methods of the Malays. Their verse is of a very primitive description. There are rhymed fairy tales. The best Malay books are the *Hikāyat Hang Tūak, Bĕstāmam* and the *Hikāyat Abdullah.* The latter is a diary of events kept during Sir Stamford Raffles' administration by his Malay scribe.

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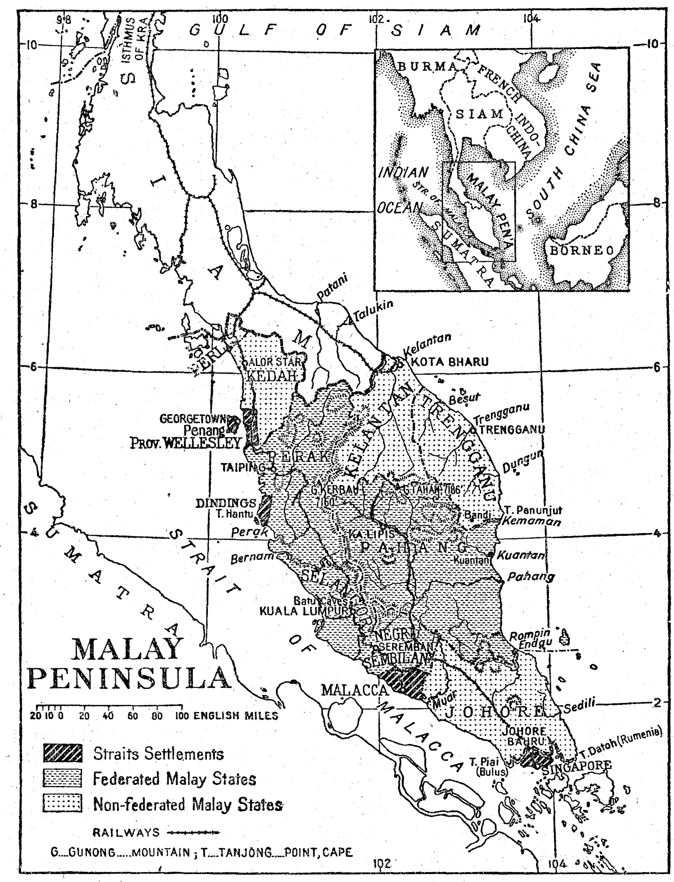
MALAY PENINSULA (called by Malays *Tanah Malayu, i.e.,* Malay Land), projects into the China sea, and forms the most southerly portion of the continent of Asia. Geographically, it begins at the isthmus of Kra, 10° N., at which point it is only between 60 and 70 m. wide, and the distance from sea to sea is further diminished by a large irregular salt-water inlet. Politically and anthropologically, this upper portion must be regarded as a



continuation of Thailand rather than a section of Malaya. From the isthmus of Kra the peninsula extends south with a general inclination towards the east, the most southerly point being Tanjong Bulus in 1° 16½′ N. A line drawn diagonally down the centre from the isthmus of Kra to Cape Rumenia (E. of Singapore) gives the length at about 750 miles. The breadth at the widest point, from Tanjong Penunjut in Trengganu to Tanjong Hantu in the Dindings, is about 200 miles. Area under British influence was about 52,500 sq.mi. The peninsula is bounded on the north by Thailand, on the south by the island and strait of Singapore, on the east by the China sea, and on the west by the Strait of Malacca.

Physical Characteristics.—A range of granite mountains forms a backbone which divides the peninsula into two unequal portions, the larger of which lies to the east and the smaller to the west. Smaller ranges run parallel to the main chain in many places, and there are numerous isolated spurs. A characteristic feature is limestone bluffs that stand up in the plains both on the eastern and the western slopes. The descent from the summits of the range into the plain is somewhat less abrupt on the west than it is on the east, and between the foot of the mountains and the Strait of Malacca the largest alluvial deposits of tin are situated. On the eastern side of the range, after a steep descent, the granite formation gives place to a broad quartzite outcrop, to the east of which there is evidence of tin-bearing granite intrusions. The highest known peak in the main range is Gunong Kerbau (7,160 ft.). The highest mountain is Gunong Tahan (7,186 ft.), which forms part of a quartzite range on the eastern side, between Pahang and Kelantan. The west coast is covered to a depth of some miles with mangrove swamps, with only a few isolated stretches of sandy beach. On the east coast the force of the north-east monsoon, which beats upon the shores of the China sea from November to February, has kept the land for the most part free from mangroves, and the sands, broken here and there by rocky headlands thickly wooded, and fringed by *casuarina* trees, stretch for miles. On both coasts islands are numerous. The peninsula may be described as one vast forest, intersected by countless streams and rivers which form the most lavish water-system in the world; 72% of Malaya is still forest. Only a fraction of these forests has been visited by human beings, the Malays and even some of the aboriginal tribes having their homes on the banks of the rivers, and never, until the first modern road-system was started, leaving the banks of a stream except for a short time when passing from one river-system to another.

The principal rivers on the west are the Perak, the Bernam and the Muar. The first is far finer than its fellows, and is navigable for steamers for about 40 m. from its mouth, and for native craft for over 250 miles. It is shallow and not of much importance as a waterway. The Bernam runs through swampy country for the greater part of its course, and steam-launches can penetrate over 100 m. from its mouth; it is therefore probably the deepest river. The Muar waters a fertile valley, and is navigable for native boats for over 150 miles. On the east coast the principal streams are the Patani, Talukin, Kelantan, Besut, Trengganu, Dungun, Kemaman, Kuantan, Pahang, Rompin, Endau and Sedili, all guarded by difficult bars at their mouths, and dangerous during the north-east monsoon. The deepest rivers are the Kuantan and Rompin; the largest are the Kelantan and the Pahang, both of which are navigable for native boats for over 250 miles. The Trengganu river is obstructed by impassable rapids about 30 m. from its mouth. The rivers on the east coast are still practically the only highways, the Malays travelling by boat in preference to walking, but they serve their purpose indifferently, and beauty is their chief claim to distinction. Magnificent limestone caves are found on both slopes of the peninsula, those at Batu in Selangor being the finest on the west coast, while those of Chadu and Kota Glanggi in Pahang are the most extensive on the east. So far as is known, the Malay peninsula consists of an axial zone of crystalline rocks, flanked on each side by an incomplete band of sedimentary deposits. Granite is the most widely spread of the crystalline rocks; but dykes of various kinds occur, and gneiss, schist and marble are met. These rocks form the greater part of the central range, and they are often—especially the granite—decomposed and rotten to a considerable depth The sedimentary deposits include slate, limestone and sandstone. Coal is mined at Rawang in Selangor. The limestone has yielded *Proetus, Chonetes* and other fossils, and is believed to be of Carboniferous age. In the sandstone Myophoria and other Triassic fossils have been found, and it appears to belong to the Rhaetic or Upper Trias. The minerals produced are tin, gold, iron, galena and others, in insignificant quantities

Tin occurs in the form of cassiterite, and is found always close to granite. In limestone it occurs in pipes and veins. Particularly in clays over the limestone very rich deposits are found. The most important lode-mines in the peninsula are at Sungai Lembing near Kuantan: they are among the world's greatest deep tin-mines. The Malay states produce 30% of the world's output of tin. Gold is worked in Pahang, and has been exploited from time immemorial by the natives of that State and of Kelantan. Small quantities have been found in Perak.

It was formerly the custom to speak of the Malay peninsula as unhealthy, and even to compare it with the west coast of Africa. It is now generally admitted that, though hot, it compares favourably with Burma. The chief complaint which Europeans make is of the extreme humidity, which causes the heat to be more oppressive than where the air is dry. The thermometer, even at Singapore on the southern coast, which is the hottest portion of the peninsula, seldom rises above 93° in the shade, while the mean for the year at that place is generally below 80°. On the mainland, and especially on the eastern slope, the temperature is cooler, the thermometer falling at night below 70°. On an average day in this part of the peninsula the temperature in a European house ranges from 88° to 68°. The number of rainy days throughout the Malay peninsula varies from 160 to over 200 in each year. Violent gusts of wind, called "Sumatras," accompanied by a heavy downpour of short duration are common between the monsoons.

The rainfall on the west coast varies from 64 to 115 in. per annum, and that of the east coast, where the northeast monsoon breaks with all its fury, is usually about 122 inches. The development of health stations at Fraser Hill and Cameron Highlands did much to improve the health of Europeans. In parts of the country malaria is rife, but much has been done to combat the conditions that produce the malaria-carrying mosquito. The Malays formerly suffered severely from smallpox epidemics, but under British rule vaccination was introduced, and the ravages of the disease no longer assume serious dimensions. Occasional small outbreaks of cholera occur in a few localities. After 1925 Singapore was the health hub of the far east, when it became the centre of the Far Eastern Health bureau of the League of Nations. As a whole, the Malays are a remarkably healthy people, and deformity and hereditary diseases are rare. There is little leprosy, but there is a leper hospital near Penang on Pulau Jerjak and another at Pangkor for lepers from the Federated Malay States.

Flora and Fauna.—The soil of the peninsula is fertile. In the vast forests the decay of vegetable matter during countless ages has enriched the soil to the depth of many feet, and from it springs the most marvellous tangle of huge trees, shrubs, bushes, underwood, creepers, climbing plants and trailing vines, the whole hung with ferns, mosses and parasitic growths, and bound together by rattans and huge rope-like trailers. In most places the jungle is so dense that it is impossible to force a way through it without a woodknife, and even the wild beasts use well-worn game tracks through the forest. In the interior brakes of bamboos are found, many of which spread for miles along the river banks. Some good hardwood timber is found, the best being *merbau, rĕsak* and *chĕngal*. Orchids abound. The principal fruit trees are the *durian,* mangosteen, custard apple, pomegranate, *rambutan, pulasan, langsat, rambai,* jack fruit, coconut, areca-nut, sugar palm, and banana. Coffee, sugar cane, rice, pepper, gambier, cotton and sago are grown with success. Rubber is the most important form of cultivation. The principal jungle products are gutta and rubber of several varieties, and many kinds of rattan. The mangrove grows on the west coast in profusion. Agilawood, the camphor tree and ebony are found in small quantities.

The fauna of the peninsula is varied and no less profuse than the vegetable life. The Asiatic elephant; the *seladang,* a bison of a larger type than the Indian gaur; two varieties of rhinoceros; the honey bear (*bruang*), the tapir, the sambhur (*rusa*); the speckled deer (*kijang*), two species of mouse deer (*napoh plandok* or *kanchil*); the gibbon (*ungka* or *wawa'*), the *siamang,* another species of anthropoid ape, the crab-eating macaque (*kra*), the *brok* or coconut monkey, so called because it is trained by the Malays to gather nuts from the coconut trees, and four species of leaf monkey (*lotong*); the bear cat (*arctictis binturong*), the lemur; the Asiatic tiger, the black panther, the leopard, the clouded leopard, several varieties of jungle cat; the wild boar, the wild dog; the flying squirrel, the flying fox; the python, the cobra, and many other varieties of snake, including the hamadryad; the crocodile, the otter and the gavial, as well as many kinds of squirrel, rat, etc., are found throughout the jungles. On the east coast peafowl are found. The argus pheasant, the fire-backed pheasant, the blue partridge, the adjutant bird, several kinds of heron and crane, snipe, wood pigeon, green pigeon, swifts, swallows, pied robins, hornbills, parakeets, flycatchers, nightjars, and many other kinds of bird are met with frequently. Members of the duck tribe are rare: only the tree duck and cotton teal are likely to be met. The forests swarm with insects, from *cicadae* to beautiful butterflies, and from stick and leaf insects to endless varieties of ants. The scorpion and the centipede are common. The profusion and variety of insects probably surpass those to be met with anywhere else in the world.

Political Divisions and Population.—The Malay Peninsula in 1941 was divided into three sections: the colony of the Straits Settlements, and the Federated and Unfederated Malay States. The colony of the Straits Settlements consisted of the islands of Singapore and Penang, the territory of Province Wellesley on the mainland opposite to Penang, and the town and territory of Malacca. The Federated Malay States under British protection consisted of the sultanates of Perak, Selangor and the Negri Sembilan on the west coast, and the sultanate of Pahang on the east coast. The Unfederated States under British protection: Johore, Kelantan, Trengganu, Kedah and Perlis. The population of the peninsula numbers about 5,504,000, of whom 1,420,841 inhabit the colony of the Straits Settlements, 2,193,605 the Federated Malay States and 1,889,648 the Unfederated States.

The population of the peninsula includes 2,358,335 Chinese, mostly immigrants or descendants of immigrants from the southern provinces of China, of whom 915,384 reside in the colony of the Straits Settlements, 978,208 in the Federated, and the remainder in the Unfederated Malay States. The Malay population of the peninsula, including immigrants from the eastern archipelago, number 2,286,459, while Tamils and other natives of India number about 748,829, the aboriginal natives of the peninsula about 33,000, Europeans and Americans 31,197 and Eurasians 19,204.

Excluding the Thai, or Siamese, who are recent arrivals from the north, there are three races which for an extended period of time have had their home in the Malay peninsula. These are the Semang or Pangan, the Sakai and the proto- and civilized Malays. The Semang, as they are most usually called by the Malays, are Negritos—a small, very dark people, with features of the negroid type, prognathous, and with short, woolly hair clinging to the scalp in tiny crisp curls. These people belong to the race which would seem to be the aboriginal stock of southern Asia. They appear to be related to the Aetas of the Philippines and the Andamanese. (*See* ANDAMANESE and NEGRITOS.) The state of civilization to which they have attained is very low. They neither plant nor have they any manufactures except their rude bamboo and rattan vessels, the fish and game traps which they set with much skill, and the bows, blowpipes and bamboo spears with which they are armed. They are skilful hunters, catch fish by ingeniously constructed traps, and live almost entirely on jungle-roots and the produce of their hunting and fishing. The most civilized element of these people is found in Upper Perak, and the members of this clan have some knowledge of the art of planting. To include the Sakai in the category of Malayan races is also incorrect. The Sakai still inhabit in greatest numbers the country which forms the interior of Pahang, the Plus and Kinta districts of Perak, and the valley of Nenggiri in Kelantan. Representatives of their race are scattered among Malay villages throughout the country, and also along the coast, but these have mixed with Malays, and acquired so many customs, etc., from their more civilized neighbours, that they can no longer be regarded as typical of the race to which they belong. The pure Sakai in the interior have a good knowledge of planting rice, tapioca, etc., fashion vessels from bamboos, which they decorate with patterns traced by the aid of fire, make loincloths (their only garment) from the bark of the *trap* and *ipoh* trees; are musical, using a rude lute of bamboo, and a nose-flute, and singing in chorus melodiously; and altogether have attained to a higher degree of civilization than have the Semang. They are about as tall as the average Malay, are slimly built, light of colour, and have wavy fine hair. In their own language they usually have only three numerals, viz., *na-nun,* one; *nar,* two; and *ne',* three, or variants of these; all higher arithmetical ideas being expressed by the word *kerpn,* which means "many." A few cases have been recorded, however, of tribes who can count in their own tongue up to four and five. Among the more civilized, the Malay numerals up to ten are adopted. An examination of their language seems to indicate that it belongs to the Mon-Khmer group of languages, and anthropological information points to the conclusion that they may be related to the Veddas of Ceylon. Though they now use metal tools imported by the Malays, the names they give to those weapons which most closely resemble the stone implements found all over the peninsula are native names wholly unconnected with their Malay equivalents. It has been suggested that in a forgotten past the Sakai were the fashioners or importers of the stone implements. The presence of the Sakai in the interior of the peninsula has been considered as one of many proofs that the Malays intruded from the south and approached the peninsula by means of a sea route, since had they swept down from the north, driven thence by the people of a stronger breed, it might be expected that the fringe of country dividing the two contending races would be inhabited by men of the more feeble stock. Instead, we find the Sakai occupying this position. It is remarkable that the Negritos never pierced the Sakai belt: though more primitive, they may have come to Malaya later, thus indicating that they have been driven northward by the Malays (*q.v.*).

Archaeology.—Stone celts of various types have been unearthed in caves, mines and rice fields, throughout the Federated Malay States. Cord-marked and other pottery occurs in the upper layers of palaeo-protoneolithic culture and with late neoliths. In Batang Padang, Perak, have been found graves, built of large granite slabs; cists, closely related to the dolmen. Rough pottery, iron tools with small sockets for handles, cornelian beads, cross-hatched stone-pounders, and bronze implements of various types reveal the culture of the people who built these graves. At Kenaboi, in Negri Sembilan, stone quoits, stone bark-pounders and tiny socketed bronze celts were found associated. These may be relics of the Mon-Khmers. It may have been they, who at Selinsing, Pahang, and elsewhere sunk circular pits (termed "Siamese mines" by the Malays) as deep as 120 ft. and sometimes no more than 2 ft. apart and connected at the base by galleries.

In Province Wellesley and Kedah Buddhist remains with the script of southern India *c.* A.D. 400 have been found. Clay tablets in the Nagari script of North India of the 10th or perhaps 7th century A.D. were dug up in a Kedah cave. A granite statue of Devi, the wife of Shiva, and other Hindu remains were also discovered recently in Kedah. In Malacca, a stone *Makara* (or fabulous sea-animal) of a type found in Java, may be a relic of Hindu days or a later import. A stone with a 14th century Javanese inscription existed formerly at Singapore.

The most interesting Muslim relic is a stele from Trengganu, now in Raffles' museum, Singapore, erected by a Sri Paduka Tuan, bearing the oldest (14th century A.D.) Malay text in Arabic script known, and exhorting rulers, styled Mandalika, to uphold Islam. At Pengkalan Kempas, in Negri Sembilan, there are a Muslim tombstone of the 15th century and carved monoliths, one of which is of Sumatran type, resembling the gravestone of prince Aditiawarman at Kubor Raja (A.D. 1378). In Malacca are some Muslim, Portuguese and Dutch remains.

History.—As early as the 9th century A.D. Ibn Khordadzbeh and other Arab writers speak of the great Buddhist Palembang kingdom, Soi Vijaya, and references have perhaps been identified in their works to Kedah and Singapore. Lately in Trengganu a stone has been discovered showing that Islam reached the peninsula in the 14th century. Islam destroyed the Hindu and Buddhist kingdoms of Java and Sumatra. In 1292 Marco Polo found it in the little Sumatran port of Perlak. Ibn Batuta also visited Sumatra. Until the rise of Malacca the more frequent ports of call in the Straits of Malacca were in Sumatra.

The importance of the Malay peninsula consisted in its fitness to be the distributing centre of the spices brought from the Moluccas *en route* for India and Europe. As early as the 3rd century B.C. Megasthenes mentions spices brought to the Ganges from "the southern parts of India," and the trade was probably one of the most ancient in the world. So long as India held the monopoly of the clove, the Malay peninsula was ignored, the Hindus spreading their influence through the archipelago and leaving traces thereof even to this day. Mohammedan traders from Coromandel and Malabar, following the routes which had been prepared for them by their forebears, broke down the Hindu monopoly and ousted the earlier exploiters so that by the beginning of the 16th century the spice trade was almost exclusively in their hands. These traders were also missionaries of their religion, as is every Muslim, and to them is due the conversion of the Malays from animism, tinctured by Hindu and Buddhist beliefs, to the Mohammedan creed. The desire to obtain the monopoly of the spice trade has been a potent force in the fashioning of Asiatic history. The Moluccas were, from the first, the objective of the Portuguese, and no sooner had they found their way round the Cape of Good Hope and established themselves successively upon the coast of East Africa, in the neighbourhood of the Gulf of Aden and the Malabar coast, than Malacca, then the chief trading centre of the Malayan archipelago, became the object of their desire.

The first Portuguese expedition sent to capture it was under Diogo Lopez de Siqueira and sailed from Portugal in 1508. At Cochin Siqueira took on board certain adherents of Alffonso d' Alboquerque who were in bad odour with his rival d'Almeida, among them being Magellan, the future circumnavigator of the world, and Francisco Serrão, the first European who ever lived in the Spice islands. Siqueira's expedition ended in failure, owing partly to the aggressive attitude of the Portuguese, partly to the justifiable suspicions of the Malays, and he was forced to destroy one of his vessels, leave a number of his men in captivity, and sail direct for Portugal. In 1510 a second expedition was sent from Portugal under Diogo Mendez de Vasconcellos, but d'Alboquerque retained it at Cochin to aid him in the retaking of Goa, and it was not until 1511 that the great viceroy could spare time to turn his attention to the scene of Siqueira's failure. After futile negotiations for the recovery of the Portuguese captives, the Portuguese made a successful assault upon Malacca.

The Portuguese were satisfied with the possession of Malacca and did not seek to extend their empire in Malaya. Instead they used every endeavour to establish friendly relations with the rulers of neighbouring kingdoms, and before d'Alboquerque returned to India he despatched embassies to China, Siam and several kingdoms of Sumatra, and sent a small fleet, with orders to assume a conciliatory attitude toward all natives, in search of the Moluccas. Very soon the spice trade had become a Portuguese monopoly, and Malacca was the headquarters of the trade. Magellan's famous expedition had for its object not the barren feat of circumnavigation but the breaking down of this monopoly, without violating the papal bull which gave to Spain the conquest of the west, to Portugal the possession of the east. In 1528 a French expedition sailed from Dieppe, penetrated as far as Achin in Sumatra, but returned without reaching the Malay peninsula. It was the first attempt made to defy the papal bull. In 1591, three years after the defeat of the Armada, Raymond and Lancaster rounded the cape, and after cruising off Penang, decided to winter in Achin. They hid among the Pulau Sembilan near the mouth of the Perak river, and captured a large Portuguese vessel which was sailing from Malacca in company with two Burmese ships. In 1595 a Dutch expedition confined its operations to Java and the neighbouring islands.

During this period Achin developed a determined enmity to the Portuguese, and more than one attempt was made to drive the strangers from Malacca. Eventually, in 1641, a joint attack was made by the Achinese and the Dutch, and the latter became the owners of the coveted port. Malacca was taken from the Dutch by the British in 1795; was restored to the latter in 1818; but in 1824 was exchanged for Benkulen and a few more unimportant places in Sumatra. The first British factory in the peninsula was established in the native state of Patani on the east coast in 1613, the place having been used by the Portuguese in the 16th century for a similar purpose; but the enterprise came to an untimely end in 1620 when Captain Jourdain, the first president, was killed in a naval engagement in Patani Roads by the Dutch. Penang was purchased from Kedah in 1786, and Singapore from Johore in 1819. The Straits Settlements—Singapore, Malacca and Penang—were ruled from India until 1867, when they were erected into a crown colony under the charge of the colonial office. In 1874 the Malay state of Perak was placed under British protection by a treaty entered into with its sultan; and this led to the inclusion in a British protectorate of the neighbouring states of Selangor, Negri Sembilan and Pahang, which later formed the Federated Malay States. In 1902 the northern Malay states of the peninsula were admitted to lie within the Siamese sphere of influence, but in 1909 Siam ceded her suzerain rights over Kelantan, Trengganu, Kedah and Perlis to Britain.

During World War II, the Japanese effected a landing in Kelantan on Dec. 8, 1941, and proceeded down both sides of the peninsula. By Jan. 31, 1942 they had completed the conquest of the peninsula, and on Feb. 15 Singapore fell after a two weeks' siege. The British were not prepared for an overland invasion of the supposedly impenetrable peninsula or an attack from the north on the naval base on which 20 years of labour and $400,000,000 had been expended.

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(H. Cl.; X.)

MALAYS, the name given by Europeans to the people calling themselves *Orang Malayu, i.e.,* Malayan folk, who are the dominant race of the Malay Peninsula and the Malay Archipelago, and to the brown races which inhabit the portion of Asia south of Siam and Indo-China, and the islands from the Philippines to Java, and from Sumatra to Timor, except the Sakai and Semang in the Malay Peninsula, the Bataks in Sumatra, and the Muruts in Borneo. The name of Orang Malayu is given to those who speak the Malayan language, and represent the dominant people of the area. The Proto-Malays originated from Sumatra in the 12th century. They were generally short in stature, round headed, with broad faces, short noses with broadish nostrils, slightly prominent jaws and cheekbones. The eyes are often oblique with epicentric fold. They belong to the Southern Mongoloid group. (*See* A. C. Haddon, *Races of Man,* and L. H. Dudley Buxton, *Peoples of Asia.*)

The Malays had attained to a certain stage of civilization before they set foot in Malaya. The semi-wild tribes, ethnologically Malayan and distinct from the aboriginal Semang and Sakai, are met with almost invariably in the neighbourhood of the coast and must have reached the peninsula by a sea route, a fact which explains their amphibian habits. Many tribes hold to a pristine paganism. There were possibly several streams of movement for in some instances the earlier Malay immigrants were driven by the later invaders back down the coast and sought refuge in the far interior.

Social and Political Structure.—The Menangkabau Malays of Sumatra are divided into matrilineal, matrilocal clans. The patrilineal patrilocal clan is found elsewhere, but generally the Malays have advanced to a social order from which the clan system is absent. Their political organisation into aristocratic and lower classes—with hereditary rulers, has attained a high level. There are customs, here and there in this extensive area, relating to succession and inheritance which are clearly related to the matrilineal system found in Sumatra. (*See* Dr. G. A. Wilken and C. O. Blagden, *Malayan Sociology,* 1921.)

Religion and Superstitions.—Most Malays to-day are Sunni Mohammedans of the school of Shafi'i, and use the terms *Orang Malayu, i.e.,* a Malay, and *Orang Islam, i.e.,* a Mohammedan, as synonymous expressions. Their conversion from paganism took place between the 13th and 15th centuries, A.D. The raja of Achin, in northern Sumatra, is said to have been converted as early as 1206, while the Bugis in Celebes did not become Mohammedans until 1495. Their conversion was slow, gradual, and is even now in some respects imperfect. Upon the bulk of the Malayan peoples their religion sits but lightly. Prior to their conversion to Islam the Malays were subjected to a considerable Hindu influence, from traders who visited the archipelago from India. In Bali and Lombok the people still profess a form of Hinduism, and Hindu remains are found in many other parts of the archipelago. Throughout, the superstitions of the Malays show this Hindu influence, and many of the demons whom their medicine-men invoke in their magic practices are borrowed from the pantheon of India. A substratum of superstitious beliefs, from the days when the Malays professed only their natural religion, is firmly rooted in the minds of the people. (*See* W. W. Skeat, *Malay Magic,* 1900.)

Mode of Life.—The Malays of the coast are a maritime people, and were long famous for their piracy. They are now peaceable fisher-folk. Inland the Malays live by preference on the banks of rivers, build houses on piles some feet from the ground, and plant groves of coco-nut, betel-nut, sugar-palm and fruit-trees around their dwellings. Rice, the staple food of the people, is the principal article of agriculture among them. Sugar-cane, maize, tapioca and other similar products are grown in smaller quantities. In planting rice three methods are in use: the cultivation of swamp-rice in irrigated fields; the planting of ploughed areas; and the planting of hill-rice by sowing each grain separately in holes bored for the purpose. In the irrigated fields the rice plants are first grown in nurseries and are subsequently transplanted when they have reached a certain stage of development. The Malays also work jungle produce such as gutta, rattans, agila wood, camphor wood, and the beautiful *kamuning* wood which is used by the natives for the hilts of their weapons. The principal manufactures of the Malays are cotton and silk cloths, earthenware and silver vessels, mats and native weapons. The best cotton cloths are those manufactured by the Bugis people in Celebes, and the *batek* cloths which come from Java and are stamped with patterns. The best silks are produced by the natives of Pahang, Kĕlantan and Johor in the Malay Peninsula. The silver ware from Malaya was pronounced the most artistic of any exhibited at the Colonial Exhibition in London in 1886. The pottery of the Malays is rude. The Malays made gunpowder and forged cannon before Europeans arrived. For the writing of Malay itself the Arabic character has been adopted for some hundreds of years. At an earlier time the script used was based upon forms borrowed from Indian sources. The Malays are excellent boat-builders.

Disposition.—In ordinary circumstances, the Malay is not treacherous, and in many instances men of this race have risked their own lives on behalf of Europeans who chanced to be their friends. They are courteous and self-respecting. Their code of manners is minute and strict, and they observe its provisions faithfully. The Malays are indolent, pleasure-loving, improvident, fond of bright clothing, of comfort, of ease, and dislike toil exceedingly. They have no idea of the value of money, and little notion of honesty where money is concerned. They borrow rather than earn money. They frequently refuse to work for a wage though in sore need of cash, and yet at the invitation of one who is their friend they will toil unremittingly without any thought of reward. They are addicted to gambling, and formerly were much given to fighting, but their courage on the whole is not high if judged by European standards. The sexual morality of the Malays is very lax, but prostitution is not common. Polygamy, though allowed by their religion, is practised for the most part among the wealthy classes only. The Malays show a marvellous loyalty to their rajas and chiefs.

Acts of homicidal mania called amuck (*amok*), which word in the vernacular means to attack, can in some cases certainly be traced to madness *pur et simple,* but the typical *amok* is usually the result of circumstances which render a Malay desperate. The motive is often inadequate from the point of view of a European, but to the Malay it is sufficient to make him weary of life and anxious to court death. Briefly, where a man of another race might not improbably commit suicide, a Malay runs *amok,* killing all whom he may meet until he himself is slain.

The nervous affliction called *latah,* to which many Malays are subject, is also a curious trait. The victims lose for the time all self-control and all sense of their own identity, imitating the actions of any person who chances to rivet their attention.

Costume and Weapons.—The Malays wear a loose coat and trousers, and a cap or head-kerchief, but the characteristic item of their costume is the *sarong,* a silk or cotton cloth about two yards long by a yard and a quarter wide, the ends of which are sewn together, forming a kind of skirt. This is worn round the waist folded in a knot, the women allowing it to fall to the ankle, the men, when properly dressed in accordance with ancient custom, folding it over the hilt of their waist-weapon, and draping it around them so that it reaches nearly to the knee. In the hall of a raja on state occasions a head-kerchief twisted into a peak is worn, and the coat is furnished with a high collar extending round the back of the neck only. This coat is open in front, leaving the chest bare. The trousers are short and of a peculiar cut and material, being coloured many hues in parallel horizontal lines. The *sarong* is of Celebes manufacture and made of cotton, to the surface of which a high polish is imparted by friction with a shell. The typical fighting costume of the Malay is a sleeveless jacket with texts from the Koran written upon it, short tight drawers reaching to the middle of the thigh, and the *sarong* is then bound tightly around the waist, leaving the hilt of the dagger worn in the girdle exposed to view.

The principal weapon of the Malays is the *kris,* a short dagger with a small wooden or ivory handle, of which there are many varieties. The blade of a *kris* may either be wavy or straight, but if wavy the number of waves must always be uneven in number. The *kris* most prized by the Malays are those of Bugis (Celebes) manufacture, and of these the kind called *tuasek* are of the greatest value. Besides the short *kris,* the Malays use long straight *kris* with very narrow blades, shorter straight *kris* of the same form, short broad swords called *sundang,* long swords of ordinary pattern called *pedang,* somewhat shorter swords curved like scimitars with curiously carved handles called *chenangkas,* and short stabbing daggers called *tumbok lada.* The principal tools of the Malays are the *parang* or *gôlok,* a heavy knife used in the jungle, without which no peasant ever stirs abroad from his house, the *beliong* or native axe, and the *pisau raut,* which is used for scraping rattan. Their implements consist of a plough fashioned from a fork of a tree, and a rude harrow. Reaping is usually performed by the aid of a curious little knife which severs each ear of grain separately. The fisherfolk use many kinds of nets, which they manufacture themselves. Sails, paddles, oars and punting-poles are all in use. (H. Cl.)

Bibliography.—*See* H. Schurtz, *Indonesien* (1913); R. O. Winstedt, *Malaya* (1923) and *Shaman, Saiva and Sufi* (1925); I. H. N. Evans, *Papers on the Ethnology and Archaeology of the Malay Peninsula* (1927); L. R. Wheeler, *The Modern Malay* (1928). *See* also many volumes of *Papers on Malay Subjects* (Singapore, periodically).

MALAY STATES (British). The native states of the Malay peninsula under British protection, divided into two groups: (1) federated, and (2) unfederated. (For information concerning the botany, geology, etc., of the Malay states, *see* Malay Peninsula. For the ethnology *see* Malays.)

I. FEDERATED STATES

The federated states (area 27,506 sq.mi.), under the protection of Great Britain until Jan. 1942, but not British possessions, were Perak, Selangor, and the confederation of small states known as the Negri Sembilan (*i.e.,* Nine States) on the west coast, and Pahang on the east coast. Each state was under the rule of a sultan, assisted by a state council, upon which the resident, and in some cases the secretary to the resident, had a seat, and which was composed of native chiefs and of representatives of the European, Chinese and sometimes Indian communities, nominated by the sultan with the advice and consent of the resident. The council, in addition to dealing with the appointment of headmen and religious matters revised all sentences of capital punishment. The administrative work of each state was carried on by the resident and his staff of European officials. The sultan of each state was bound by treaty with the British government to accept the advice of the resident; British officials were pledged not to interfere with the religious affairs of the Mohammedan community. In the administration of the Malay population use was made of the native aristocratic system, the peasants being governed largely by their own chiefs, headmen and village elders, under the supervision of British district officers. To the work of development of their country the Malays contributed little, sound administration having been secured by the British officials, enterprise and capital having been supplied mainly by the Chinese, and the labour employed being almost entirely Chinese or Tamil. Meanwhile the Malays lived principally on reservations, raising just enough food for themselves and having virtually no contact with the Chinese and Indian immigrants. Only during the decade prior to the Japanese invasion had a handful of Malay nationalists claimed for their compatriots a share in the tin and rubber industries, in whose development and prosperity they had had very little part. They also asked for more participation in the administration, previously confined to the raja class, and for the restriction of Indian and Chinese immigration.

Each principal department of the administration had its federal head, and all the residents corresponded with and were controlled by the chief secretary, who, in his turn, was responsible to the high commissioner, the governor of the Straits Settlements.

All matters of administrative interest to the federation were settled by the federal council, a body created in 1909. The council consisted of the high commissioner (president), the chief secretary to the government, the four British residents, the legal adviser, the treasurer, the heads of the medical, education and public works departments, the controller of labour and certain nominated unofficial members, European, Malay, Chinese and Indian; it met generally three times a year and all federal legislation was passed by it.

A centralized bureaucracy developed at Kuala Lumpur (the federal capital), which administered the federation efficiently in the interests of the British and Chinese mine-owners and rubber planters. The Malay sultans were so completely relegated, albeit politely, to the background that their colleagues in the unfederated states perennially refused to be assimilated to the federation. The later politico-economic issues of Malay included preference of natives (to Chinese and Indians) for administrative posts, an all-Malayan Customs union, and the struggle for power between Singapore and Kuala Lumpur. These issues respected the treaty rights of the sultans but left the bulk of the peninsula's inhabitants uninterested and untouched in their fairly water-tight social and economic compartments.

Population.—The growth of the population was the yardstick of the states' prosperity. According to the census of 1921, the population was 1,324,890, having increased since 1911 by 27·7%; it continued to rise rapidly, and was estimated at the end of June 1932 to be 1,622,903. In March 1941 there were estimated to be 713,679 Malays; 978,208 Chinese; 468,029 Indians and 11,019 Europeans. The increase among Malays, especially in Selangor, was largely due to the influx of foreign Malays who settled in the coast districts to plant rubber; the increase in the Indian population also synchronized with the development of the rubber industry. Total population (1941) 2,193,605.

Commerce and Industry.—The 19th century trade of the Malay peninsula was so long hampered by the anarchy growing in the sultanates that Singapore successfully agitated for the extension of British sovereignty there. The 20th century brought such a phenomenal development of the peninsula's tin and rubber industries that food crops were neglected and Malaya came to import approximately two-thirds of its food requirements. The depression of 1930–32 proved that over-concentration on tin and rubber had made Malaya's commercial history a fever-chart of prosperity alternating with poverty. The fluctuations were caused by world market conditions (notably in the United States, the best customer) and were almost wholly beyond local control. Wages declined, the immigrant labourers left Malaya, and state revenues—dependent as they were on the two major industries—declined seriously for the second time (the first crisis occurred in 1921) in the country's generally prosperous history. Thanks to international restriction agreements for tin and rubber, prosperity began returning to the peninsula in 1934. Quotas were imposed on Japanese imports, which had been flooding the country, and tariffs were generally raised in accordance with the London-inspired policy of imperial preference, accepted with varying degrees of reluctance by the Malay states. World War II gave a tremendous fillip to tin and rubber exports until 1942 but virtually ruined the younger (and almost wholly Asiatic-controlled) copra and pineapple industries.

In the 1920s, dredging revolutionized the tin industry technically and also altered the nationality of its control. In the late 1930s about 40 British companies, with a capital of £8,000,000–9,000,000, were engaged in tin dredging in the federation: at this period Chinese output accounted for only about 36% of the ore produced, exactly reversing the position in 1920, when they controlled about 63% of the industry. In 1940 Malaya's tin producers established a record export of 85,384 tons, valued at over £21,000,000, despite curtailed prospecting of new lands, increased freight and insurance charges, inequitable assessment of mines, and the failure of some London-registered companies to produce at capacity because of what they termed excessive taxation. That same year Malaya shipped 549,327 tons of rubber at a value of $(Str.)449,780,904—almost double the value of exports for the preceding year. This was accomplished in the face of such obstacles as increased production costs, higher taxation, the withdrawal of some of the European estate staff, and above all, labour strikes and shortages.

Ores other than tin include gold, coal, iron and bauxite. The Raub gold mine in Pahang was the only gold mine working in these states in the years prior to 1942, but alluvial gold was recovered in various places. Coal was mined by the Malayan collieries in Selangor; the output (averaging 350,000–400,000 tons annually) was absorbed wholly by local industries. The iron ores of the east coast states were prospected and exploited by the Japanese, and were shipped in a crude state to Japan, where they were of great importance to the steel industry. One of the Japanese iron mines of Trengganu was also an important producer of low-grade manganese with an average export, during the 1934–38 period, of about 30,000 tons annually. The existence of bauxite in Johore was discovered in 1936; almost all the deposits were prospected and worked by the Japanese. In 1939, 66,700 tons were exported to Japan.

Agriculture.—*Rice.*—The depression of 1930 and the start of World War II aroused the federal government to the danger of continued disparity between the production and consumption of rice—the main food item for 99% of the population. By 1940, a threat to permit the Chinese to break the monopoly of rice-growing traditionally exercised by the Malays, the Malay colonization of newly irrigated lands, and finally an indirect official subsidy to paddy farmers had succeeded in increasing rice cultivation in the peninsula by 27%. But even then the acreage under rice totalled only 740,000; the federated states were producing only a fourth of their rice requirements (more than half of which was grown in Kedah and Kelantan), and the country was still importing about one-half million tons of rice, chiefly from Thailand. Emergency stocks had been built up by the government on the eve of the war; and as hostilities progressed, rice imports were first licensed, then monopolized, and a rice pool for distribution was formed.

Other food crops were officially encouraged during both world wars and the depression. The agriculture department, notably at its experimental farm in Serdang, was deflected from rubber research to crop studies, after the Rubber institute was founded in 1924. Little permanent increase in food production, however, was registered until 1939–40, because rubber and tin production were more remunerative. Transport and marketing facilities were lacking particularly in Pahang, which had the largest available cultivable areas. But by the end of 1940 the area under food crops other than rice (chiefly maize, colocasia, sweet potatoes, tapioca and yams) was 117,883 ac., as compared with 91,782 ac. in 1939. Despite this rise in production, accompanied by far larger returns to the cultivator, vegetables were increasingly imported into Malaya. In 1940 such imports amounted to 69,012 tons, marking an increase over 1939, itself a record year.

Tobacco production was greatly stimulated by World War II, and the Chinese in 1940 opened 13 new factories in the peninsula. Tobacco imports in that year amounted to the usual annual average of 12,500,000 lbs. The area under coffee was only 16,522 ac. in 1940; interest was taken in its cultivation only during rubber slumps. Sugar, formerly important, had almost disappeared by 1938, when there were only 330 acres under cane in the peninsula. In spite of sporadic attempts to stimulate local fruit production and the large acreage under fruit trees (approximately 190,000), this industry experienced only a mild commercial development, owing to inadequate marketing arrangements and the existence of only one canning factory in Penang. Pineapples were the only fruit crop developed for the export market, chiefly Great Britain and Canada. In 1939, more than 50,000 of the 61,280 ac. planted to pineapples as a sole crop were located in Johore; there were 20 canning factories, principally in Singapore. This industry was a Chinese enterprise but was under government organization and supervision. Pineapple growers and coconut producers were especially hard hit by the war's closure of markets after 1939. Even the large vegetable oil producers, owning about 100,000 ac. and £3,000,000 in capital, were producing at a loss. Tea, areca nuts, and derris root were cultivated in the federation, partly for the domestic market and partly for export. At the end of 1940, Malaya had almost 9,000 ac. under tea, of which about half were in Pahang. Areca nuts were exported chiefly to India. Their production expanded both during the depression and World War II. Derris exports, about half of which were sold to the American market, were well maintained in 1940; at that time there were about 10,000 ac. under this crop.

Natural Resources.—*Livestock.*—Improved pig-breeding and cattle-raising figured heavily on the official war program after 1939, but too late to remedy appreciably the peninsula's chronic shortage of livestock.

Fisheries.—Malay fishermen enjoyed a major share of the east coast production, but the financing and marketing of fish were wholly in non-Malay hands. No regulations governed the catch of Malaya's diminishing supply of river fish. In spite of the undeveloped state of this industry, Malaya's fish resources provided considerable revenues to the poorer peninsular states, and also the most important protein element in the local diet. In 1939 total production was estimated at 89,902 tons.

Forests.—Nearly 77% of Malaya's total area was classified as forest land, chiefly on the east coast. About one-fifth of this area was in reserved forests. The more accessible lowland timber suffered severely from agricultural and mining enterprises. Malaya's annual timber consumption, some 40,000,000 cu.ft., ran about 44% over current production. The forestry department fostered a nascent sawmill industry by means of a license system and by developing an export trade to Great Britain. Exports of Malaya's hardwoods were reported to be dangerously stimulated by war demands.

Revenues.—The principal sources were export duties on tin and rubber and, far behind, railway receipts, land and forest revenue, excise, import duties, and the opium monopoly. During 1939–42, tin and rubber exports were subjected to special taxation, and a nominal income tax was levied despite strong local opposition. From 1909 to 1914 the federation's revenues almost doubled; the two world depressions forced retrenchments in the public works program and official emoluments; and prosperous budgets did not reappear until the mid-1930s. Expenditures likewise rose rapidly, so while the tin and rubber booms brought revenues to $(Str.)70,200,000 in 1939, expenditures came to $77,100,000. The following year the position was reversed: revenues soared to $98,500,000 while expenditures totalled $78,500,000, including a gift of $10,000,000 to the imperial government. The chief revenue items were the export taxes on tin ($23,300,000) and on rubber ($7,300,000).

Railways.—Communications in the Federated Malay States kept pace with the growing requirements of the tin and rubber industries. There were in 1940 3,108 mi. of metalled and 198 mi. of unmetalled roads. The total length of line open to traffic under the Federated Malay States railway administration was 1,068 mi. in 1931, after which time there was virtually no new construction.

This includes the Johore state railway, which at Gemas branches into the west coast line to Prai and to the Siamese frontier; and the east coast line, which runs northward toward Tumpat. The Kelantan section was extended southward to the east coast line (total length 328 mi.) to provide direct communication between Kelantan and Singapore. Through traffic, over the west coast line, with the Siamese state railways was opened in 1918, and between the Federated Malay States and Kelantan via the Siamese railway in 1921. The Johore causeway, connecting Singapore with the peninsula, was opened in 1924 and destroyed by the British in 1942. The causeway carried two lines of rails and a roadway; total length, 3,465 ft.; average headway at low tide, 47 ft.

Education.—Important movements for the extension of education were set on foot after World War I, despite difficulties encountered in increasing the number of teachers and the improvement of the teaching staff. A few scholarships were given to Raffles college. The Malay college at Kuala Kangsar for Malays of good birth had an enrolment of 149 boys in 1939. Malay vernacular teachers were trained at the Sultan Idris college. There were trade schools at Kuala Lumpur, Ipoh and Bagan Serai, and a central technical institute in the federal capital. In 1940 the federation spent £437,796 on the education provided in 49 English schools with 19,505 pupils; 582 Malay schools with 63,638 pupils; 572 registered Chinese schools with 58,227 pupils; 17 official and 463 aided Tamil schools. There were, in addition, 100 non-aided schools with 23,527 pupils.

Although increasing allocations of funds were made, free education was dispensed exclusively to Malays, and only grants-in-aid were given to private schools run by Chinese, Indians and missionaries. Higher education was, with the exception of some scholarships, restricted to the few who could pay for it. The government required rubber estate managers to open schools for their coolies' children, but the quality of such education was admittedly low. The education department was trying, prior to 1942, to introduce a more practical vocational program in its curriculum, and to decrease the white-collar unemployment especially conspicuous during the depression, as well as to foster agricultural training in Malay schools. The McLean Commission report, published at the end of 1939, outlined important departures in policy which, however, the war did not permit to materialize.

Perak.—Perak is situated between the parallels of 3° 37′ and 6° 5′ N. and 100° 3′ to 101° 51′ E. on the western side of the Malay peninsula. It is bounded on the north by Province Wellesley and the Malay state of Kedah; on the south by Selangor; on the east by Pahang, Kelantan and the Thai state, Patani; and on the west by the Straits of Malacca. The coast-line is about 90 mi. in length. The extreme distance from the most northerly to the most southerly portions of the state is about 172 mi., and the greatest breadth from east to west is about 100 mi. The total area of the country is estimated at 7,800 sq.mi.

The Perak river runs in a southerly direction, almost parallel with the coast for nearly 150 mi. of its course. The Plus, Batang, Padang and Kinta rivers are its principal tributaries, all of them falling into the Perak on its left bank. The other principal rivers of the state are the Krian, Kurau, Larut and Bruas to the north of the mouth of the Perak, and the Bernam to the south. None of these rivers is of importance as a waterway. The mountain ranges, which cover a considerable area, run from the northeast to the southwest. They are all thickly covered with jungle. The ranges are two, the main range and the Bintang range, with the valley of the Perak between them. There are several hill sanatoria at heights which vary from 2,500 to 4,700 ft. above sea-level.

History.—The early history of Perak is obscure. According to Malay accounts a settlement was first made by Malays in Perak at Bruas, and the capital was later moved to the banks of the Perak river. It would appear as if members of the great Bendaharas of Malacca married into the Bruas family and were concerned in the early settlements. When the Malacca sultanate fell, owing to the invasion of the Portuguese in 1511, a member of that royal house is said to have migrated to Perak, and the present dynasty claims descent from him. What is certain is that Perak was twice invaded by the Achinese, and its rulers carried off into captivity, one of them, Sultan Mansur Shah, becoming ruler of Achin. The first European settlement in Perak was made by the Dutch in 1650, under a treaty entered into with the Achinese; but the natives rose against the Dutch again and again, and it was abandoned in 1783, though it was afterwards reoccupied, the Dutch being finally supplanted by the British in 1795. In 1818 the Siamese conquered Perak, but its independence was secured by a treaty between the British and Siamese governments in 1824. From that date until 1874 Perak was ruled by its own sultans, but in that year, owing to internal strife, Sultan Abdullah applied to the then governor of the Straits Settlements, Sir Andrew Clarke, for a British resident. The treaty of Pangkor was concluded on Jan. 20, 1874. The first resident, J. W. W. Birch, however, was murdered on Nov. 2, 1875, and a punitive expedition became necessary; Sultan Abdullah and the other chiefs concerned in the murder were banished; the actual murderers were hanged; Raja Muda Yusuf was declared regent. He died in 1888, and was succeeded by the sultan Idris, G.C.M.G., a most enlightened ruler, who was from the first a strong and intelligent advocate of British methods of administration. Sir Hugh Low was appointed resident, a position which he held until 1889, when he was succeeded by Sir Frank Swettenham. Until the Japanese conquest, the history of Perak was one of peace, prosperity and wealth. Although the federal capital was Kuala Lumpur in Selangor, Perak enjoyed the honour of being the senior and leading state of the federation.

The population in 1941 was estimated at 984,464, of whom 331,209 were Malays, 445,266 Chinese, 196,945 Indians, 4,069 Europeans, 1,570 Eurasians.

In 1940 imports were valued at £3,310,333, and exports at £6,925,188. Exports were chiefly tin and rubber.

A line of railway connects the port of Teluk Anson with the great mining district of Kinta, whence the line runs, crossing the Perak river at Enggor, to Kuala Kangsar, the residence of the sultan, thence to Taiping, and via Krian to a point opposite the island of Penang. A second line runs south from Perak to Singapore. Perak also possesses some 880 mi. of excellent metalled cart-road.

For administrative purposes the state was divided into six districts: Upper Perak, Kuala Kangsar and Lower Perak, on the Perak River; Kinta; Batang Padang, Larut and Krian. Of these, Larut and Kinta are the principal mining centres, while Krian is a rice-growing district. The districts on the Perak river are mostly peopled by Malays. The administrative capital was Ipoh.

Selangor.—Selangor is situated between the parallels 2° 32′ and 3° 37′ N. and 100° 38′ and 102° E., on the western side of the Malay peninsula. It is bounded on the north by Perak, on the south by Negri Sembilan, on the east by Pahang and Negri Sembilan, and on the west by the Straits of Malacca. The coast-line is about 100 mi. in length, greatest length about 104 mi., and greatest breadth about 48 mi., total area estimated at about 3,000 sq.mi.

The state consists of a narrow strip of land between the mountain range which forms the backbone of the peninsula and the Straits of Malacca. Compared with other states in the peninsula, Selangor is poorly watered. The principal rivers are the Selangor, the Klang and the Langat. The principal port is Port Swettenham, situated at the mouth of the Klang river, and is connected with Kuala Lumpur by a railway. The state has valuable deposits of alluvial tin; mining and rubber-planting are chief industries. Kuala Lumpur was the federal capital of the Malay states.

According to native tradition, the ruling house of Selangor is descended from a Bugis raja, who, with two of his brothers, settled in the state in 1718, the son of the youngest brother by a Johore princess becoming ruler of the country. In 1783 the then sultan of Selangor joined with the Yang-di-per-Tuan Muda of Riau in an unsuccessful attack upon the Dutch who then held Malacca. In retaliation the Dutch, under Admiral Van Braam, invaded Selangor and drove the sultan out of his country. In 1785, aided by the Bendahara of Pahang, Sultan Ibrahim of Selangor reconquered his state; but the Dutch blockaded his ports, and eventually forced him to enter into a treaty whereby he consented to acknowledge their sovereignty. The earliest British political communication with Selangor began in 1818, when a commercial treaty was concluded with the governor of Penang. From 1867 till 1873 there was civil war in the state. In 1874 an atrocious act of piracy off the mouth of the Langat river led to the governor, Sir Andrew Clarke, appointing, at the request of the sultan, a British resident.

In 1941 the total population was estimated at 696,173, of whom 150,604 were Malays, 335,661 Chinese, 194,291 Indians, 4,913 Europeans and 2,625 Eurasians. In 1940 the value of imports was £10,194,343 and of exports £18,580,338.

The main trunk line of the Federated Malay States railways passes through Selangor. It enters the state at Tanjong Malim on the Perak boundary, runs southward through Kuala Lumpur and so into the Negri Sembilan. It runs for 81 mi. in Selangor territory. A branch line 27 mi. long connects Kuala Lumpur with Port Swettenham on the Klang straits where there are extensive wharves, capable of accommodating ocean-going vessels. A second branch line, measuring rather more than 4 mi. in length, connects the caves at Batu with Kuala Lumpur. Frequent communication has been maintained by steamer between Port Swettenham and Singapore, and by coasting vessels between the former port and those on the shores of the Straits of Malacca. All the principal places in the state are connected with one another by telegraph and telephone.

For administrative purposes Selangor was divided into six districts: Kuala Lumpur, in which the capital was situated; Ulu Selangor, which is a prosperous mining district; Kuala Selangor, which is agricultural, and poorly populated by Malays; Ulu Langat, mining and agricultural; Kuala Langat, agricultural; and Klang, the only port of the state. Much money has been expended upon Kuala Lumpur, which possessed large public buildings, waterworks, etc., and where a house for the high commissioner and the residence of the chief secretary was situated. In some sort Kuala Lumpur was the capital not only of Selangor, but also of the whole federation. Its scenery is attractive.

Negri Sembilan.—Negri Sembilan (the Nine States) is a federation of small native states which is now treated as a single entity, being under the control of a British resident, and is situated between parallels 2° 28′ and 3° 18′ N. and 101° 45′ and 102° 45′ E., on the western side of the Malay peninsula. It is bounded on the north by Pahang, on the south by Malacca, on the east by Pahang and Johore, and on the west by the Straits of Malacca. The coast-line is about 28 mi. in length, and the extreme distance from north to south is 55 mi., and that from east to west about 65 mi. The estimated area is about 3,000 sq.mi. Port Dickson, or Arang-Arang, is the only port. It is connected with the capital, Seremban, by a railway 24 mi. in length. Most of the state depends for its prosperity upon agriculture, but in some of the districts tin has been worked with good results.

In the 14th century A.D. Sungai Ujong is mentioned as tributary to the Javanese kingdom, Majapahit; in the 15th it was ruled by the Bendaharas of Malacca; in the 16th came Minangkabau immigrants with matriarchal notions that made their descendants claim aboriginal ancestresses. In the 18th century a raja from Minangkabau was brought from Sumatra to arbitrate between the small states, each of which continued to be governed in all local affairs by its own chief and by the village and tribal councils sanctioned by ancient custom. The Sumatran raja took the title of Yang-di-per-Tuan of Sri Menanti. Apparently the nine states were originally Klang, Jelebu, Sungai Ujong, Segamat and Pasir Besar (both now in Johore), Rembau, Naning (now in Malacca), Jelai (now Inas) and Ulu Pahang (the region between Ulu Serting and Temerlop). During the last years of the 18th century a Yang-di-per-Tuan Muda ruled Rembau, and the state of Tampin was created to provide for the family of the new chief. In 1887 the governor of the Straits Settlements sent Martin Lister to the Negri Sembilan, which had become disintegrated, and by his influence the ancient federal system was revived under the control of a resident appointed by the governor. Prior to this, in 1873, owing to civil war in Sungai Ujong, Sir Andrew Clarke sent a military force to that state, put an end to the disturbances, and placed the country under the control of a British resident. Jelebu was taken under British protection in 1886, and managed by a magistrate under the orders of the resident of Sungai Ujong. In 1896, when the federation of all the Malay states under British control was effected, Sungai Ujong and Jelebu were reunited to the confederation of small states from which they had so long been separated and the whole, under the old name of the Negri Sembilan, or Nine States, was placed under one resident. Later the federation consisted of Sungai Ujong, Jelebu, Johol and Rembau and the smaller states of Ulu Nuar, Jempul, Terachi, Gunong Pasir and Inas.

In 1941 the total population was estimated at 293,510, of whom 104,701 were Malays, 124,418 Chinese, 59,472 Indians, 1,416 Europeans and 855 Eurasians. In 1940 exports were valued at £6,152,723 and imports at £1,305,978, with rubber the leading item of export.

Seremban, the administrative capital of Negri Sembilan, is connected with Port Dickson by a railway 24½ mi. in length. It is situated on the trunk line of the Federated Malay States, and is thus joined by rail to Selangor on the north and to Malacca and Singapore on the south. Frequent steam communication has been maintained between Port Dickson and the ports on the Straits of Malacca and with Singapore.

For administrative purposes Negri Sembilan was divided into five districts, viz., the Seremban district, the Coast district, Jelebu, Kuala Pilah and Tampin. Each of these was under the charge of a European district officer responsible to the resident. The Yang-di-per-Tuan lives at Kuala Pilah. The hereditary chiefs of the various states aided in the government of their districts, and had seats upon the state council over which the Yang-di-per-Tuan presided. Port Dickson was a favourite pleasure resort.

Pahang.—Pahang, on the east coast of the peninsula, is situated between parallels 2° 28′ and 3° 45′ N. and 101° 30′ and 103° 30′ E. It is bounded on the north by Kelantan and Trengganu; on the south by Negri Sembilan and Johore; on the east by the China sea; and on the west by Perak and Selangor. The coast-line is about 112 mi. in length; the greatest length is about 210 mi., and greatest breadth about 130 mi. The state is the largest in the peninsula, its area being estimated at 14,000 sq.mi. The ports on the coast are the mouths of the Endau, Rompin, Pahang and Kuantan rivers, but during the northeast monsoon the coast is not easy of approach, and the rivers, all of which are guarded by difficult bars, are impossible of access except at high tides. Kuantan is the principal port, always accessible at high water, but hampered by monsoon influences which cause the river to silt up.

The principal river of the state is the Pahang; 180 mi. from the coast this river is formed by two others named the Jelai and the Tembeling. The former is joined 20 mi. farther upstream by the Lipis, which has its rise in the mountains that form the boundary with Perak. The Jelai has its rise in a more northerly portion of this range, while its two principal tributaries above the mouth of the Lipis, the Telom and the Serau, rise, the one in the plateau which divides Perak from Pahang, the other in the hills which separate Pahang from Kelantan. The Tembeling has its rise in the hills which divide Pahang from Kelantan, but some of its tributaries rise on the Trengganu frontier, while the largest of its confluents comes from the hills in which the Kuantan river takes its rise. The Pahang is navigable for large boats as far as Kuala Lipis, 200 mi. from the mouth, and light-draught launches can get up to that point. Smaller boats can be taken some 80 mi. higher up the Jelai and Telom. The river, however, as a waterway is of little use, since it is uniformly shallow. The Rompin and Kuantan rivers are somewhat more easily navigated for the first 30 mi. of their course. But the waterways of Pahang are of little value. Gunong Tahan (7,184 ft.) is situated on the boundary between Pahang and Kelantan. Pahang is covered almost entirely by forest, but in the Lipis valley, which formerly was thickly populated, there is an expanse of open grass plain unlike anything to be seen on the western seaboard. The coast is a sandy beach fringed with *casuarina* trees and there are only a few patches of mangrove-swamp.

In the 13th century Pahang was claimed as subject to Buddhist Palembang, in the 14th it (and Tiomen) as subject to Majapahit. Later came the modern Tai or Siamese influence. In the 15th century a sultan of Malacca captured its ruler and married his daughter. The captives could not speak Malay. After the capture of Malacca by the Portuguese its royal house provided rulers for Pahang until its last member was murdered in 1699. Thereafter Pahang fell under the suzerainty of the later rulers of Johore, who left a Dato' Bendahara in charge. An old court name for its capital was Indrapura. The title of the ruler of Pahang was Bendahara until 1882, when Wan Ahmad assumed the title of sultan. Up to that time the Bendahara had been installed by the sultan of Riau, and held office by virtue of that chief's authority. About 1855 the father of Wan Ahmad died at Pekan, and his elder son Bendahara Korish, who succeeded him, drove Wan Ahmad from the country. After making three unsuccessful attempts to dethrone his brother, Wan Ahmad succeeded in 1865 in invading the state and wresting the throne from his nephew, who had succeeded Bendahara Korish some years earlier. In spite of two attempts to shake his power by invasions from Selangor which were undertaken by his nephews Wan Aman and Wan Da, Bendahara Ahmad ruled with a rod of iron. In 1887 he consented to enter into a treaty with the governor of the Straits by which he accepted a consular agent at his court. This treaty was signed on Oct. 8, 1887. In the following year a Chinese British subject was murdered at Pekan in circumstances which pointed to the responsibility of the sultan, and in Oct. 1888 a resident was appointed to assist the sultan in the administration of his country, that being, in the opinion of the British government, the only guarantee for the life and property of British subjects which it could accept. In Dec. 1891 disturbances broke out, the nominal leaders of which were certain of the sultan's trusted chiefs. The sultan took no part in the outbreak, but undoubtedly it had his sympathy. The rebels were driven to seek safety in flight in Nov. 1892, but in June 1894 they gathered strength for a second disturbance, and raided Pahang from Kelantan, in which state they had been given shelter. This event, added to other raids from across the border, led to an irregular expedition into Trengganu and Kelantan by the resident of Pahang (Mr.—later Sir—Hugh Clifford) in 1895, and this had the desired result. The rebel chiefs were banished to Siam. Pahang joined the Federated Malay States by a treaty signed in 1895, and the sultan and his principal chiefs were present at the federal durbar held at Kuala Kangsar in Perak in 1897.

The long succession of civil wars which racked the land after the death of Bendahara Ali caused thousands of Pahang Malays to fly the country. Today the valley of the Lebir river in Kelantan and the upper portions of several rivers near the Perak and Selangor boundaries are inhabited by Pahang Malays, the descendants of these fugitives. The Pahang natives are almost all engaged in agriculture. The work of the mines, etc., has been performed by foreign labour. In the Lipis valley the descendants of the Rawa Malays (from Sumatra) who at one time possessed the interior in defiance of the Pahang rajahs, still outnumber the people of the land. Total population estimate of 1941 was 219,458, of whom 127,165 were Malays, 72,863 Chinese, 17,321 Indians, 621 Europeans and 176 Eurasians. In 1940 exports were valued at £1,915,474 and imports at £577,565; the chief exports were rubber and tin.

A road over the mountains, 82 mi. long, joins Kuala Lipis, the administrative capital of Pahang, to Kuala Kubu, the nearest railway station in Selangor. Another joins Bentong to Kuala Lumpur and a third, Bentong to Negri Sembilan. Pekan, where the sultan resides, was the capital of Pahang until 1898, when headquarters were transferred to the interior as being more central. None of these towns is of any size. In the Kuantan valley, which lies parallel to the Pahang river, a European company worked one of the world's greatest lode tin-mines. Pahang is fertile and well suited for agriculture. The rainfall is heavy and regular. The climate is cooler than that of the west coast, and the full force of the monsoon is felt from October to February. The state was divided into four districts—Ulu Pahang, in which the capital is situated; Temerloh, which includes 80 odd miles of the Pahang valley and the Semantan river; Pekan, which includes the coast rivers down to Endau; and Kuantan. Each of these was under the charge of a district officer. The boundary with Johore and the Negri Sembilan was rectified by a commission which sat in London in 1897–1898.

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II. UNFEDERATED STATES

By a treaty in 1909, Siam ceded to Great Britain suzerain rights over the four Siamese Malay states: Kelantan, Trengganu, Kedah and Perlis, which for centuries had been more or less nominal dependencies of Siam and all of which, except Trengganu, had been administered by British officers in the service of Siam for some years before the transfer, which was effected without disturbance. The British government put an adviser at the court of each raja and guaranteed administration on the lines laid down by Siam so far as might be compatible with justice and fair treatment for all. The four states lie to the north of the Federated Malay States, two on the east and two on the west side of the peninsula. In 1914 the southern state Johore accepted an adviser. Total pop. of Unfederated States is 1,889,648.

Johore.—The richest and most highly organized of the Unfederated States of British Malaya, situated at the southern end of the peninsula, stretching from 2° 40′ S. to Cape Romania, the most southerly point on the mainland of Asia, and including all small islands adjacent to the coast which lie to the south of parallel 2° 40′ S. It is bounded north and northwest, respectively, by the federated state of Pahang, Negri Sembilan and the territory of Malacca, south by the strait which divides Singapore island from the mainland, east by the China sea, and west by the Straits of Malacca. The district of Muar was placed under Johore by the British as a temporary measure in 1877, and is now an integral part of it. The coast-line measures about 250 mi. The greatest length from N.W. to S.E. is 165 mi., the greatest breadth from E. to W. 100 mi. The area is estimated at 7,500 sq.mi. The principal rivers are the Muar, the most important waterway in the south of the peninsula; the Johore, up which the old capital of the state was situated; the Endau, which marks the boundary with Pahang; and the Batu Pahat and Sedeli, of comparative unimportance. Johore is less mountainous than any other state in the peninsula. The highest peak (4,187 ft.) is Gunong Ledang, called Mt. Ophir by Europeans. The capital is Johore Bharu, situated at the nearest point on the mainland to the island of Singapore. The palace built by the late sultan Abubakar is a feature of the town. The capital of the province of Muar is Bandar Maharani, named after the wife of the late sultan before he had assumed his final title. Other towns are Batu Pahat, Segamat, Kota Tuiggi, Mersing and Jemaluang. The climate is healthy and equable for a country so near the equator; it is cooler than that of Singapore. The shade temperature varies from 98.5° F to 65° F. The rainfall averages 97 in. per annum.

In 1940 there were 929 mi. of metalled road in the state. In 1941 the total population was estimated at 664,472, of whom 296,727 were Malays, 303,338 Chinese, 58,622 Indians, 1,249 Europeans and 349 Eurasians. The revenues in 1940 came to $(Str.)24,737,983. Imports were valued at $57,275,959, foodstuffs, animals and tobacco accounting for almost half of the total. Exports were valued at $138,214,062, of which rubber accounted for $117,424,870 (205,211 tons). Other exports were iron and tin ores, pineapples, copra, tapioca and betel nuts. In 1938 there were 7 English schools with an average enrolment of 1,993 pupils; 134 Malay vernacular boys' schools with 15,907 pupils and 21 girls' schools with 2,236 pupils. Tamil schools, with 8 exceptions, were all estate schools with an average enrolment of 3,632.

History.—The Mohammedan empire of Johore was founded by the sultan of Malacca after his expulsion from his kingdom by the Portuguese in 1511. Like Achin, Johore took an active part in the protracted war between the Portuguese and the Dutch for the possession of Malacca. In 1699 the last of the Malacca royal line was murdered at Kota Tuiggi and the throne passed to the line of the great Malacca chiefs, the Bendaharas. Later we find Johore ruled by an officer of the Bugis rulers of Riouw, bearing the title of Temenggong, and owing feudal allegiance to his master in common with the Bendahara of Pahang. In 1812, the Dutch had driven the Bugis out of Rian and recognized as sultan of Johore a descendant of the Bendahara chiefs of old Malacca. His son, Sultan Husain, ceded the island of Singapore to the East India company in 1819. In 1855 the then sultan, Ali, was deposed, and his principal chief, the Temenggong, was given the supreme rule by the British. His son, Temenggong Abubakar, proved to be a man of exceptional intelligence. He made numerous visits to Europe, took considerable interest in the government and development of his country, and was given by Queen Victoria the title of Maharaja in 1879. In 1885 he entered into a new agreement with the British government, and was allowed to assume the title of Sultan of the State and Territory of Johore. He was succeeded in 1895 by his son, Sultan Ibrahīm. In 1914 an agreement was concluded whereby a general adviser was appointed with powers similar to those exercised by British residents in the Federated Malay States.

Kelantan.—This state on the east coast, bounded north and northeast by the China sea, east by Trengganu, south by Pahang and west by Perak and Ra-nge, lies between 4° 48′ and 6° 20′ N. and 101° 33′ and 102° 45′ E. The greatest length from north to south is 115 mi. and the greatest breadth from east to west 60 mi. The area is 5,870 sq.mi. The northern part of the state is flat and fertile, but the southern district, which comprises more than half the total area, is hilly and broken.

Next to the Pahang, the Kelantan river is the largest on the east coast. It is 120 mi. long and is navigable for shallow-draft launches and big country boats for about 80 mi., and for vessels of 8 ft. draft for about 6 mi. Its principal tributaries are the Galas, Pergau and Lebir. The Golok and Semarak rivers water the west and east parts of the state, falling into the sea a few miles on either side of the mouth of the Kelantan river. The climate of Kelantan is mild and singularly healthy in the open cultivated regions. The population was estimated in 1941 at 404,470, of whom 365,783 were Malays, 23,188 Chinese, 7,680 Indians, 206 Europeans and 40 Eurasians. The Chinese are increasing and natives of different parts of India are resorting to the state for purposes of trade. Kota Bharu (pop. 14,843) is the only town in the state. It lies on the right bank of the river, about six miles from the sea. Since 1904 it has been laid out with metalled roads and many public and private buildings have been erected. The town is the commercial as well as the administrative centre of the state. Tumpat on the coast (pop. 2,406) is the place next in importance after Kota Bharu. A network of creeks renders communication easy in the northern districts, the river and its tributaries afford means of access to all parts of the south; 336 mi. of road have been made. Kelantan has been connected by telegraph with Bangkok and Singapore, and maintains regular postal communication with those places. Rice cultivation has been the principal industry. Rubber, coconuts and betel-nuts rank next. Much livestock is raised. At present there is no mining. Gold, tin and galena have been found in several localities. The Kelantanese are expert fishermen, some 10,000 finding employment in fishing and fish-drying. Silk-weaving is an industry. Revenues came to £455,948 in 1940. Total exports were valued at £1,639,786; imports at £1,037,386. The chief exports were rubber, iron ore, copra, cattle and areca nuts.

By virtue of a mutual agreement made in 1902 Siam appointed a resident commissioner to Kelantan and consented, so long as the advice of that officer should be followed, to leave internal affairs to be conducted locally. Under this arrangement a council of state was appointed, departments of government were organized, penal, civil and revenue laws were passed and enforced, courts were established and a police force was raised. Though formerly of an evil reputation, the people are peaceful and law-abiding, and serious crime is rare. The state was divided into *mukim* or parishes, but the *imam* no longer exercise temporal authority. There were in 1938 62 Malay vernacular boys' schools with an average enrolment of 5,750 pupils. The Ismail English Boys' school had 104 pupils.

Like Trengganu, Kelantan is said to have been subject to Palembang (the great Buddhist kingdom Sri Vijaya) in the 13th and under the Javanese Majapahit in the 14th century. The rulers of old Malacca conquered it, carrying off princesses with non-Malayan titles. Kelantan is found on Portuguese maps and on Dutch. The sites of ancient towns and the remains of gold diggings are visible here and there, but all knowledge of the men who made these marks has been lost. The present ruling family dates from about 1790. Siam was frequently called upon to maintain internal peace and in 1892 a royal prince was sent to reside in Kelantan as commissioner. Complications brought about by the incapacity of the ruler led to the making of the agreement of 1902, to the fixing of a regular tribute in money to Siam, and ultimately to the lifting of the state from chaotic lawlessness into the path of reform. On July 15, 1909 the state came under British suzerainty and the commissioner of Siam was replaced by a British adviser.

The history of Kelantan has been dominated by the economic and political repercussions from litigation with the Duff Development company, which had been granted a vast concession. In consequence the state's debt came to about $5,500,000.

During World War I the sultans of Trengganu and Kelantan joined forces in a brief revolt against British rule.

Trengganu.—This state on the east coast bounded north and northeast by the China sea, south by Pahang and west by Pahang and Kelantan, lies between parallels 4° 4′ and 4° 46′ N. and 102° 30′ and 103° 26′ E. The greatest length from north to south is 120 mi., and the greatest breadth from east to west 50 mi. It has a coast-line of 130 mi. and an estimated area of about 6,000 sq.mi. There are several islands off the coast, some of which are inhabited. The surface is generally mountainous.

Principal rivers are the Besut, Stiu, Trengganu, Dungun and Kemaman, none of which is navigable for any distance. The climate is mild and fairly healthful. In 1941 the population was estimated at 203,253, of whom 184,286 were Malays, 16,750 Chinese, 421 Indians, 53 Europeans and 15 Eurasians. The Malays are concentrated round the mouths and lower reaches of the rivers. The capital is situated at the mouth of the Trengganu river. Difficulty of access by river and by land renders the interior almost uninhabitable. Communication is maintained by boat along the coast. In 1938 the state possessed 218 mi. of main roads and 150 mi. of subsidiary roads. There were six post offices and four telephone exchanges. The telegraph line was used for telephonic communication from Kuala Trengganu to Besut, Dungun and Kemaman. In 1941 a telegraphic service between Kelantan and northern Trengganu was opened.

Most of the people are rice-planters, nearly 10,000 are fishermen. The chief exports are iron, rubber, tin, dried fish, copra, silk sarongs, haematite, wolfram, gambier and areca-nuts. Silk-weaving, carried on by the women, is a considerable industry. The silk is imported raw and is re-exported in the form of Malay clothing (*sarongs*) of patterns and quality which are widely celebrated. The manufacture of native weapons and of brassware was at one time brisk but is declining. Revenues in 1940 came to $(Str.)3,303,006, of which exports were valued at $13,210,895 and imports at $8,378,136. Rice took first place among imports. The more important imports from Singapore are rice, cotton and silk fabrics, tobacco and cigarettes, sugar, tinned milk, petroleum and machinery.

The Buddhist monk, Chao Ju Kua, writing about A.D. 1225 says that like Kedah, Kelantan and Pahang, Trengganu was subject to the Sumatran Buddhist kingdom, Palembang; Javanese records of the 14th century A.D. mention it as conquered by Majapahit. In later centuries Malacca and Siam disputed its possession. An inscribed stone now in Raffles museum, Singapore, shows that Islam had penetrated the state early in the 14th century. The royal house is descended from the father of the non-royal Bendahara who became sultan of Johore after the murder of the last descendant of the old Malacca royal family in 1699. In 1720 the Bugis sacked the capital. Until the acquisition of the state by Great Britain a triennial tribute of gold flowers was irregularly paid to Siam, and this with occasional letters of instructions and advice constituted almost the only evidence of Siamese suzerainty. Of government there was practically none. The revenues were devoured by the rajas. There were no written laws, no courts and no police. Crime was rampant, the peasantry was mercilessly downtrodden, but the land was full of holy men and the cries of the miserable were drowned in the noise of ostentatious prayer. Trengganu presented in 1909 the type of untrammelled Malay rule which had disappeared from every other state in the peninsula. In that year, however, the first British agent arrived in the state, which was shortly afterwards visited by the governor of the Straits Settlements, who discussed with the sultan the changed conditions consequent upon the Anglo-Siamese treaty and laid the foundations of future reform. In 1919 the agent was replaced by an adviser whose advice must be followed in all questions other than those touching the Mohammedan religion. While revenue came chiefly from opium and land taxes, and there was no poll or income tax, imposts were sufficient to be bitterly resented by the natives.

Kedah.—This state, on the west coast of the peninsula, lies between parallels 5° 20′ and 6° 42′ N., and is bounded, north by Palit and Songkla, east by Songkla and Raman, south by Province Wellesley and Perak, and west by the sea. The coast-line is 65 mi. long, the greatest distance from north to south is 115 mi. and the greatest breadth 46 mi. Off the coast lies a group of islands, the largest of which is Langkawi, well peopled and forming a district of the state.

The total area of Kedah is about 4,000 sq.mi. The land is lowlying and swampy near the coast except towards the south where the height known as Kedah peak rises from the shore opposite Penang, flat and fertile farther inland, and mountainous towards the eastern border. The rivers are small, the Sungai Kedah, navigable for a few miles for vessels of 50 tons, and the S. Muda, which forms the boundary with Province Wellesley, being the only streams worthy of notice. The plains are formed of marine deposit, and in the mountains limestone and granite preponderate. In 1941 the population was estimated at 520,719, of whom 337,456 were Malays, 107,223 Chinese, 61,161 Indians, 664 Europeans and 140 Eurasians. There are three towns of importance. Alor Star, the capital, on the Kedah river, 10 miles from the sea, in a flat, fertile locality, is a well laid out town with good streets, many handsome public and private buildings, and good wharfage for small vessels. Only three urban areas had a population of more than 5,000. Of these Alor Star might be classed as a Malay town and Sungai Patani and Kulim as Chinese centres of population. The bulk of the population is scattered over the plains in small villages. A good road runs from Alor Star to Penang and another south to Taiping in Perak. Bangkok and Singapore are now linked up by a railway system through Perlis. There is a good postal service. In 1938 there were 15 post and telegraph offices, and 588 mi. of road, of which 415 mi. were metalled. In addition, 225 mi. of canals were maintained by the administration. The chief industries are rice and rubber cultivation. In north Kedah rice is the main crop, in the south, rubber, coconuts and tapioca. There are many coconut, betel-nut and fruit plantations. The principal exports have been rubber, rice, tapioca and tin-ore. The chief imports have been cotton goods, tobacco and cigarettes, sugar and petroleum. The ruler held the rank of sultan and was assisted in the government by a council and by the British adviser who after the state passed from Siamese to British protection in 1909 replaced the officer formerly appointed by Siam. In 1905 the Siamese government advanced $2,500,000 to Kedah, to pay the debts of the state, which sum was refunded by the British government on assuming the position of protector. The revenue in 1940–41 was £1,124,108. The chief sources were customs, land revenue, the opium monopoly and excise taxes. The state was divided into a number of administrative districts under European and Malay officials. There were English schools at Alor Star and Sungai Patani, and 82 government boys' schools with an average enrolment of 11,733 pupils. There were also 24 royal boys' schools with 1,742 pupils. Secondary education was given at the Sultan Abdul Hamid college (438 enrolment).

In Kedah there have been found Sanskrit inscriptions going back to A.D. 400. An old name for the country was Langkasuka. There are references in Arab voyagers and in inscriptions at Negapatam and Tanjore to Kedah in the 10th and 11th centuries A.D. It seems clear that it was tributary to Buddhist Palembang and was ravaged by her enemies, the Chola kings. When the rise of Malacca shook Siamese authority in the peninsula, Kedah oscillated between them, and on the conquest of Malacca by the Portuguese, fell to Siam, though the capital was raided and burned by the Europeans. The ruler and his people were converted to Islam in the 15th century. In 1619 the king of Achin led into captivity the rulers of Kedah and Perak. In 1768, the

Siamese kingdom being disorganized, the sultan of Kedah entered into political relations with the East India company, leasing Penang to the latter. Further treaties followed in 1791 and 1802, but in 1821 Siam reasserted her control, expelling the rebellious sultan after a sanguinary war. The sultan made several fruitless efforts to recover the state, and at length made full submission, when he was reinstated. In 1868 an agreement between Great Britain and Siam was substituted for the treaties of the East India company with the sultan. In 1905 the Siamese government had to intervene to avert a condition of bankruptcy, adjusting the finances and reorganizing the general administration. Four years later, the state became a British dependency.

Perlis.—This small state, consisting of the left bank drainage area of the Perlis river, lies between Setul and Kedah, which bound it on the north and west and on the east respectively. It touches the sea only round the mouth of the river. Its area is about 316 sq.mi. In 1941 the total population was estimated at 57,289, of whom 45,959 were Malays, 8,147 Chinese, 1,126 Indians, 3 Europeans and 10 Eurasians. Kangar is the administrative headquarters of the state. A good deal of tin is worked; and rice, fish, eggs and poultry, rubber, cattle, copra, guano, betel-nuts and hides are exported. Rice is the main occupation, with 45,000 ac. under paddy as compared with 5,000 ac. under rubber and 3,800 planted to coconuts. In the early part of the 19th century Perlis was a district of Kedah, but during a period of disturbance in the latter state it established itself as a separate chiefdom. In 1897 Siam restored the nominal authority of Kedah. In 1905 the Siamese government advanced a loan of $200,000 to Perlis and appointed an English adviser to assist in the general administration. This money was refunded to Siam and the adviser relieved by a British officer when the state became British in July 1909. In 1940–41 the revenue was $480,000 (U.S.), of which customs provided more than half. At the end of 1940 there was an enrolment in the schools of 2,703 boys and 754 girls. The state had 35 mi. of metalled roads and 89 mi. of canals and rivers. There were two post offices (at Kangar and at Padang-Besar) and telephonic connection with the federation, Johore and Singapore.

Defense.—As a result of a wish frequently expressed by the Malays to have their own regiment replace the Indian battalion stationed at Taiping, an all-Malay unit of 700 men was garrisoned at Fort Dixon in 1932. Six years later a Malay sapper force was formed. In March 1939, the Malay sappers were increased by 1,000 men, so as to release units of the regular British army. Malays were also accepted in the Naval Volunteer reserve formed in September 1939; in 1941, 100 additional volunteers were recruited. While there were about four times as many Malays in the fighting forces in 1941 as there had ever been before, the strength of the Malay navy when war broke out in the Pacific was only about 800 men. A big step forward, however, was marked by the fact that most of their training was carried out by senior Malay ratings.

The Registration Enactment of 1921 theoretically ensured the registration of British manpower in the federal states. Yet in 1938, at the time when the F.M.S. Volunteer forces plan was completed, only a small percentage among the 12,000 European residents had registered. Deficiencies were officially noted in almost all the volunteer units. Two bills of June 7, 1940, were designed to call up batches of European British for intensive training, but they were incompletely carried out. Passive defense likewise suffered from the lack of a central organization and coherent policy.

In the period 1918–39, the federation contributed £2,300,000 towards imperial defense, and during World War II financed 40% of the local defense expenditures. In August 1940 the federal states raised a war loan of $20,000,000. A year later the federal council authorized the raising of an additional $10,000,000. (*See* World War II.)

See Norman, *The Far East* (1895); Skeat and Blagden, *Pagan Races of the Malay Peninsula* (London, 1906); Hart, *Reports on Kedah* (Calcutta, 1907–1909); Graham, *Kelantan, A Handbook* (Glasgow, 1907); L. A. Mills, *British Malaya* (Singapore, 1925); *The Malays in Malaya* (Singapore, 1928); W. J. Hinton, *Government of Pacific Dependencies: British Malaya* (Honolulu, 1929); R. Boulter, *Economic Conditions in British Malaya* (London, 1931); R. Braddell, *The Legal Status of the Malay States* (Singapore, 1931); C. A. Vlieland, *Report on the 1931 Census* (London, 1932); R. Emerson, *Malaysia* (New York, 1937); H. E. Desch, "Malaya's Forests," *Asiatic Review* (October 1938); A. Neelakandha, *Indian Problems in Malaya* (Kuala Lumpur, 1938); Sir L. Fermor, "Malaya's Mineral Resources and the War," *Asiatic Review* (April 1941); C. Brown, *From Suez to Singapore* (1942); L. A. Mills, *British Rule in Eastern Asia* (1942).

(H. Cl.; V. Tn.)

MALAY STATES (Thai or Siamese). After 1909 the border between Malaya and Thailand (Siam) was at about 6° 30′ N. The 20,000 sq.mi. of territory between the border and the isthmus of Kra was inhabited chiefly by Malays and Thai. During the first part of the 20th century these states were semi-autonomous, under their own chieftains. By 1920 the northern states were incorporated into the administrative divisions of Chumpon, Nakhon Srithamarat and Puket. The states of the southern group retained their chieftains, chiefly Malay, till about the time of the 1932 revolution when they too were brought into a unified administration. Palawan, Satun (*q.v.*) and Patani (*q.v.*) were the chief southern states. The whole area was occupied by Japan in Dec. 1941. (*See* World War II.)

This area contains most of Thailand's tin and rubber production. The trend, therefore, similar to that in Malaya, was for the Chinese population to increase at the expense of the Malays. The area has been only partially developed agriculturally.

MALCOLM, the name of four kings of the Scots, two of whom, Malcolm I, king from 943 to 954, and Malcolm II, king from 1005 to 1034, are shadowy personages.

Malcolm III (d. 1093), called Canmore or the "large-headed," was a son of Duncan I, and became king after the defeat of the usurper Macbeth in 1054, being crowned at Scone in 1057. Having married as his second wife (St.) Margaret (*q.v.*), a sister of Edgar Aetheling, who was a fugitive at his court, he invaded England in 1070 to support the claim of Edgar to the English throne, returning to Scotland with many captives after harrying Northumbria. William the Conqueror answered this attack by marching into Scotland in 1072, whereupon Malcolm made peace at Abernathy. However, he ravaged the north of England again and again, until in 1091 William Rufus invaded Scotland and received his submission. Then in 1092 a fresh dispute arose and William summoned Malcolm to his court at Gloucester. The Scot obeyed, and calling at Durham on his southward journey was present at the foundation of Durham cathedral. When he reached Gloucester Rufus refused to receive him unless he did homage for his kingdom. Malcolm declined and almost at once invaded Northumbria. He was killed at a place afterwards called Malcolm's Cross, near Alnwick, Nov. 13, 1093. Four of Malcolm's sons, Duncan II, Edgar, Alexander I and David I, became kings of Scotland, and one of his daughters, Matilda, became the wife of Henry I of England, a marriage which united the Saxon and the Norman royal houses.

Malcolm IV (*c.* 1141–65) was the eldest son of Henry, earl of Huntingdon (d. 1152), son of King David I, and succeeded his grandfather, David, as king of Scotland in 1153. He died unmarried on Dec. 9, 1165.

See E. A. Freeman, *The Norman Conquest*, vols. iv and v (1867–79), and *The Reign of William Rufus* (1882); W. F. Skene, *Celtic Scotland* (1876–80); E. W. Robertson, *Scotland under Her Early Kings* (1862); and A. Lang, *History of Scotland,* vol. i (1900).

MALCOLM, SIR JOHN (1769–1833), Anglo-Indian soldier, diplomatist, administrator and author, was born in Dumfriesshire, Scotland, on May 2, 1769, the son of a farmer. He received a cadetship in the Indian army at the age of 12, and in April 1783 he landed at Madras, shortly afterwards joining his regiment at Vellore. He held various important appointments in India from 1792. In 1799 he became a friend of Lord Wellesley, who sent him as envoy to the Persian court to arrange an alliance with Great Britain. He negotiated favourable treaties at Tehran and returned to Bombay by way of Baghdad in May 1801. He then acted as private secretary to Lord Wellesley and in 1803 was appointed to the Mysore residency. At the close of the Mahratta War, in 1804, and again in 1805, he negotiated important treaties with Sindhia and Holkar, and in 1806, besides seeing the arrangements arising out of these alliances carried out, he directed the difficult work of reducing the immense body of irregular native troops.

In 1808 Malcolm was again sent on a mission to Persia. After his return to England he wrote his *History of Persia* (2 vols., 1815). On his return to India in 1817 he was appointed by Lord Moira his political agent in the Deccan; as brigadier-general under Sir T. Hislop he took a distinguished part in the victory of Mehidpur (Dec. 21, 1817), as also in the subsequent work of settling the country. In 1821 he returned once more to England, where he remained until 1827, when he was appointed governor of Bombay. His influence in this office was directed to the promotion of various economical reforms and useful administrative measures. Leaving India for the last time in 1830, shortly after his arrival in England he entered parliament as member for Launceston and opposed the Reform bill. He died on May 30, 1833.

Besides the work mentioned above, Sir John Malcolm published

Sketch of the Political History of India since . . . 1784 (in 1811 and 1826); *Sketch of the Sikhs* (1812); *Observations on the Disturbances in the Madras Army in 1809* (1812); *Persia, a Poem,* anonymous (1814); *A Memoir of Central India* (2 vol., 1823); and *Sketches of Persia,* anonymous (1827). A posthumous work, *Life of Robert, Lord Clive,* appeared in 1836. See *Life and Correspondence of Sir John Malcolm,* by J. W. Kaye (2 vol., 1856).

MALDA, a district of British India, in the Rajshahi division of Bengal. Area, 2,004 sq.mi.; pop. (1941), 1,232,618. The administrative headquarters are at English Bazar (pop. in 1941, 23,333) near the town of Old Malda. The district is divided into two almost equal parts by the Mahananda river, flowing from north to south. The western tract between the Mahananda and the main stream of the Ganges is an alluvial plain of sandy soil and great fertility. The eastern half is a slightly elevated region, called the Barind. The soil here is a hard red clay; and the whole is sparsely populated. Agricultural prosperity centres on the Mahananda, where mango orchards extend continuously along both banks; the mangoes of Malda have a wide reputation and demand. The principal industry is the production of silk. The weaving of piece goods has declined, but the rearing of silkworms and the export of raw silk and silk thread are carried on upon a large scale. The Godagari-Katihar section of the Eastern Bengal state railway traverses the district and has done much to develop it.

Malda supplied three capitals to the early Mohammedan kings of Bengal. The sites of Gaur and Pandua exhibit the most interesting remains to be found in the lower valley of the Ganges; the site of Tanda, the capital from about 1564 to 1595, was washed away by floods in 1826 and no trace of it remains. (*See* GAUR.) The connection of the East India company with Malda dates from an early period. As early as 1676 there was a factory there, and in 1770 English Bazar was fixed upon for a commercial residency.

MALDEN, a city of Middlesex county, Massachusetts, U.S.A., on the Malden river, 5 mi. N. of Boston. It is served by the Boston and Maine railroad. The population was 58,036 in 1930 (29% foreign-born white, largely from Russia, Canada, Ireland and Italy) and was 58,010 in 1940 by the federal census. It has an area of 4.8 sq.mi., and is almost surrounded by the cities of Melrose, Revere, Everett and Medford, with the Middlesex Fells (a state reservation) closing its boundary on the northwest. Malden is a residential suburb of Boston, with which it is connected by the Boston surface and elevated street railway system; and it has 175 highly diversified manufacturing industries, with an output in 1940 valued at $32,000,000. The city's assessed valuation for 1940 was $68,723,775. When first settled, in 1640, Malden was part of Charlestown and was known as Mystic Side. It was incorporated as the town of Mauldon (named after Maldon, England, the home of some of its founders) in 1649 and was chartered as a city in 1881. Melrose was set off from it in 1850; Everett in 1870. Malden was the birthplace of Adoniram Judson, and Michael Wigglesworth was its minister from 1656 to 1705. It was the first town to petition the colonial government to withdraw allegiance from King George.

MALDEN and COOMBE, a municipal borough in the parliamentary borough of Kingston, Surrey, England, 10 mi. from London on the Southern railway. Pop. (est. 1938) 38,820. Area, 4.94 sq.mi. Walter de Merton, lord chancellor of England, founded a college here in 1264 for the maintenance of 20 scholars at Oxford, where Merton college was founded about two years later. From 1894 to 1936, when they were incorporated as a borough, Malden and Coombe were governed by an urban district council. The district is mainly residential. A borough planning scheme is in force and building is rigidly regulated.

MALDIVE ISLANDS, an archipelago of coral islets in the Indian ocean, forming a chain between 7° 6′ N. and 0° 42′ S. It lies 400 mi. S.W. of Ceylon, and some 300 of the numerous islands in the 17 Maldivian atolls are inhabited. In the extreme south are the isolated atolls of Addu and Fua-Mulaku, separated from Suvadiva by the Equatorial channel, which is itself separated from the main chain of atolls by One-and-a-half-degree channel. Thence the chain continues northward to the Eight-degree channel, beyond which lies Minikoi, 71 mi. from the nearest point of the Maldives and 110 mi. from that of the Laccadives to the north. The main part, north of One-and-a-half-degree channel, consists of a series of banks either surrounded or studded all over with reefs.

After the Portuguese, from about 1518 onward, had attempted many times to establish themselves on the islands by force, and after the Maldivians had endured frequent raids by the Mopla pirates of the Malabar coast, they began to send tokens of homage and claims of protection (the first recorded being in 1645) to the rulers of Ceylon. The Maldive Islands are a dependency of the British colony of Ceylon. The hereditary sultan of the archipelago resides on the island of Malé, 3 mi. in circumference, which is the capital. The entire population of the Maldives (80,000 in 1939) is Mohammedan. The people have been classed in four ethnological divisions. (1) Those of the atolls north of the Kardiva channel. Here the people are more vigorous than their less warlike southern neighbours. They annually visited the coasts of India or Ceylon, and often married Indian wives, thus acquiring distinct racial characters of an approximately Dravidian type. (2) Those of the central division, under the direct rule of the sultan, and more exposed to Arab influences. They formerly traded with Arabia and Malaysia, and many Arabs settled among them, so that they betray a strong strain of Semitic blood in their features. (3 and 4) The natives of the southern clusters, who have had little communication with the Central Malé people, and probably preserve more of the primitive type, approximating in appearance to the Sinhalese villagers of Ceylon. The language is a dialect of Sinhalese, but indicating a separation of ancient date, and many of the Maldivians read Arabic with considerable fluency. They are an intelligent and industrious people. More than half of the men earn their livelihood as fishermen, going to sea in boats of their own building. Coir making is the industry second in importance. The finest quality of coir is found in the Tiladummati atoll. A large number of the people are also engaged in the manufacture of lace. The chief exports of the islands, besides coir, are coco-nuts, copra, millet and fruit.

Minikoi atoll, with the numerous wrecks on its reefs, and its lighthouse, is a familiar sight to seafarers in these waters. The atoll is growing outward on every side, and at one place it rises 19 ft. above sea level. The population, which numbers about 3,000, is divided into five castes, of which the three highest are pure Maldivians, the lower two the same as in the Laccadives. All are centred in a village opposite Mou Rambu Point, on the west or lagoon side; but most of the men are employed with the Lascar crews on large vessels plying in the eastern seas.

See F. W. Hockley, *A Short Account of the People, History and Customs of the Maldive Archipelago* (1935).

MALDON, a market town, municipal borough and port, in the Maldon parliamentary division of Essex, England, on the south side of the Blackwater, 43 mi. E.N.E. from London by the L.N.E.R. Pop. (1938) 9,012. Area 10.4 sq.mi. At Maldon (*Maelduna, Melduna, Mealdon* or *Meaudon*), finds of prehistoric objects indicate early settlement. An earthwork, of which traces exist, may be Saxon or Danish. The Anglo-Saxon Chronicle relates that Edward the Elder established a "burh" there about 921. Maldon was more remarkable for its fortress than for its commercial importance. It remained a royal town up to the reign of Henry I and thus is entered as being on *terra regis* in Domesday. Henry II granted the burgesses their first charter. In 1403 the bishop of London granted further judicial and financial rights. Maldon was incorporated by Philip and Mary in 1554, and in 1768 the incorporation charter was regranted, with modifications in 1810. The church of All Saints dates from 1056. Other public buildings are the grammar school, founded *c.* 1407; the town hall, formerly D'Arcy's tower, built in the reign of Henry VI; and the public hall. There are foundries, an oyster fishery and some shipping. On Osea island there is a farm colony for unemployed. Beeleigh abbey, 1 mi. W., a Premonstratensian house founded in 1180, is a residence in which the beautiful Early English chapter house, the warming house and dormitory are incorporated.

MALEBRANCHE, NICOLAS (1638–1715), French philosopher of the Cartesian school, the youngest child of Nicolas Malebranche, secretary to Louis XIII, and Catherine de Lauzon, sister of a viceroy of Canada, was born at Paris on Aug. 6, 1638.

Deformed and constitutionally feeble, he studied theology at the Sorbonne, and in 1660 he joined the congregation of the Oratory. In 1664 he read Descartes's *Traité de l'homme* (*de homine*). After ten years' study of the works of Descartes he produced the famous *De la recherche de la vérité où l'on traite de la nature, de l'esprit de l'homme et de l'usage qu'il doit faire pour éviter l'erreur dans la science* (1674), followed at intervals by other works, both speculative and controversial. Like most of the great metaphysicians of the 17th century, Malebranche interested himself also in questions of mathematics and natural philosophy, and in 1699 was admitted an honorary member of the Academy of Sciences. During his later years his society was much courted, and he received many visits from foreigners of distinction. He died on Oct. 13, 1715; his end was said to have been hastened by a metaphysical argument into which he had been drawn in the course of an interview with Bishop Berkeley. For a critical account of Malebranche's place in the history of philosophy, *see* CARTESIANISM. His other works include *Conversations métaphysiques et chrétiennes* (1677; Eng. trans., 1695); *Traité de la nature et de la grâce* (Amsterdam, 1680; Eng. trans., 1695); *Méditations chrétiennes et métaphysiques* (1683); *Traité de morale* (Rotterdam, 1684; Eng. trans. by Sir J. Shipton 1699); several polemical works against Arnauld from 1684 to 1688; *Entretiens sur la métaphysique et sur la religion* (1688); *Traité de l'amour de Dieu* (1697); *Entretiens d'un philosophe chrétien et d'un philosophe chinois sur l'existence et la nature de Dieu* (1708); *Réflexions sur la prémotion physique* (1715).

A critical edition of his *Oeuvres* was edited by Jules Simon (4 vols., 1871). This edition omits the *Traité de morale* (ed. H. Joly, 1882). *See* also Mrs. Norman Smith in the *British Journal of Psychology* (Jan. 1905); H. Joly, in the series *Les Grands philosophes* (1901); L. Ollé-Laprune, *La Philosophie de Malebranche* (2 vols., 1870); M. Novaro, *Die Philosophie des Nicolaus Malebranche* (1893); F. Pillon, articles on Malebranche's critics, and his correspondence with Mairan, in *L'Année philosophique* (1894).

MALER KOTLA, an Indian state, within the Punjab, one of the Cis-Sutlej states, under British influence since 1809. The territory lies south of Ludhiana. Area 165 sq.mi. Pop. (1941) 88,109. Estimated gross revenue, £64,875. The town Maler Kotla is 30 mi. S. of Ludhiana; pop. (1941) 29,321. The nawab or chief, is of Afghan descent; his family came from Kabul, and occupied positions of trust in Sirhind under the Mogul emperors. They gradually became independent as the empire decayed in the 18th century. In General Lake's campaign against Holkar in 1805 the nawab of Maler Kotla sided with the British. After the subjugation and flight of Holkar, the English government succeeded to the power of the Mahrattas in the districts between the Sutlej and Jumna; and in 1809 its protection was formally extended to Maler Kotla and other Cis-Sutlej states, against the formidable encroachments of Ranjit Singh. The state contributed handsomely to World War I; its sappers served with distinction in France and Mesopotamia then and in World War II also.

MALESHERBES, CHRETIEN GUILLAUME DE LAMOIGNON DE (1721–1794), known as Lamoignon-Malesherbes, French statesman, was born at Paris on Dec. 6, 1721, of a famous legal family. He studied law, and proved his capabilities as president of the *cour des aides* in the parlement of Paris in 1750, in succession to his father who was made chancellor. The chancellor's duty of controlling the press was entrusted to Malesherbes by his father, and made him known to the public. In 1771 the parlements of France were dissolved, and Maupeou's new method of administering justice substituted. Malesherbes remonstrated against the system, and was banished to his country seat at St. Lucie. He was recalled with the old parlement on the accession of Louis XVI. and made minister of the *maison du roi* in 1775. During his nine months of office he did much to check the practice of issuing *lettres de cachet*. On retiring from the ministry with Turgot in 1776 he travelled through Switzerland, Germany and Holland. In 1787 his essay on Protestant marriages helped to procure their civil recognition in France. He was elected a member of the Académie Française, and turned to scientific and literary pursuits, but the king summoned him back to the ministry in 1787. After a short term of office, he retired again into private life, and, as the troubles increased, went to Switzerland. In Dec. 1792, in spite of his old age and long retirement, he voluntarily undertook, with Tronchet and Desèze, the defence of the king before the Convention, and was required to break the news of his condemnation to the king. He then returned once more to the country, but in Dec. 1793 he was arrested and on April 23, 1794 guillotined, after seeing his daughter, his son-in-law, de Rosambo, and his grand-children executed for their relationship to him.

See *Oeuvres choisies de Malesherbes* (1809); F. A. de Boissy d'Anglas, *Essai sur la vie, les écrits et les opinions de M. de Malesherbes* (2 vols., 1818); de Beaucourt, *Captivité et derniers moments de Louis XVI.* (2 vols., 1892).

MALET, SIR EDWARD BALDWIN, 4th baronet (1837–1908), British diplomatist, 2nd son of Sir Alexander Malet, 2nd baronet, was born at The Hague on Oct. 10, 1837. He was educated at Eton, and entered the diplomatic service in 1854 at the age of 17. He served as attaché to his father at Frankfurt, returning to England to take his degree at Corpus Christi college, Oxford, in 1856. He then held various diplomatic posts at Brussels (1858), Paraná, Argentina (1860), Rio de Janeiro (1861), Washington (1861) and Lisbon (1865). Malet rejoined Lord Lyons, with whom he had worked in Washington, on the latter's transfer to Constantinople (1865). In 1867 he went to Paris, also with Lord Lyons, who sent him, after the battle of Sedan, on a mission to Count Bismarck, which resulted in Jules Favre's interview with Bismarck. For his services from March 19 to June 6, 1871, in charge of the Paris embassy while Lord Lyons was with the French Government at Versailles, Malet was awarded the C.B. He then held appointments as secretary of legation at Peking (1871), Athens, Rome (1875, becoming secretary to embassy in 1876), and Constantinople (1878). Owing to the ill-health of Sir A. H. Layard, Malet was given provisional rank as minister plenipotentiary.

In 1879 Malet became British agent and consul-general in Egypt. He held this post in 1881 during the revolt of the Egyptian army, and recommended intervention by Turkey under European control, or by France and Great Britain. When European diplomatic representatives moved to Alexandria, Malet did his utmost to reassure the Europeans. While engaged on plans for their protection, he was obliged by a sudden illness to return to England. He returned to Egypt on Aug. 10, and after the battle of Tal-el-Kebir (Sept. 13, 1882) obtained the commutation of the death sentence on the defeated Arabi to one of perpetual banishment. After helping Lord Dufferin to draw up and carry out his scheme of reorganization, he was promoted (Sept. 1883) to the post of British envoy at Brussels. In 1884 he was transferred as ambassador to Berlin, where he took part in many important negotiations during his 11 years in office. He was made G.C.M.G. in 1885, and G.C.B. in 1886. After his retirement in 1895 he was appointed (1899) a member of the international court of arbitration at The Hague. He succeeded his brother, Henry Charles Eden, in the baronetcy in 1904. He died at Chorley Wood, Hertfordshire, on June 29, 1908.

Malet published *Shifting Scenes* (1901). The memoir of his service in Egypt was completed from his correspondence after his death and privately circulated in 1909.

MALET, LUCAS, the pen-name of Mary St. Leger Harrison (1852–1931), English novelist, daughter of Charles Kingsley, born at Eversley on June 4, 1852. She studied at the Slade school and at University College, London, and married in 1876 William Harrison, rector of Clovelly. After her husband's death in 1897 she eventually settled in London. Her powerful story, *The Wages of Sin* (1891), attracted great attention, and her *History of Sir Richard Calmady* (1901) had an even greater success.

Her other novels include *Mrs. Lorimer* (1882); *Colonel Enderby's Wife* (1885); *A Counsel of Perfection* (1888); *The Carissima* (1896); *The Gateless Barrier* (1900); *On the Far Horizon* (1906); *Adrian Savage* (1911); *The Tall Villa* (1920); *The Survivors* (1923); *The Days of Want* (1926).

MALHERBE, FRANÇOIS DE (1555–1628), French poet, critic and translator, was born at Caen, the eldest son of another François de Malherbe, *conseiller du roi* in the magistracy of Caen.

He himself was educated at Caen, at Paris, at Heidelberg and at Basle. At the age of 21 he entered the household of Henri d'Angoulême, grand prior of France, the natural son of Henry II. He served this prince as secretary in Provence, and married there in 1581 Madelaine de Coriolis. After his patron's death he lived partly in Provence and partly in Normandy for many years, but very little is known of his life during this period. He was presented by his countryman, the Cardinal Du Perron, to Henry IV., and was at last summoned to court and endowed after one fashion or another. It is said that the pension promised him was not paid till the next reign. His father died in 1606, and he came into his inheritance. From this time forward he lived at court, corresponding affectionately with his wife, but seeing her only twice in some 20 years. His old age was saddened by a great misfortune. His son, Marc Antoine, a young man of promise, fell in a duel in 1626. His father used his utmost influence to have the guilty parties brought to justice, but he died before the suit was decided (it is said in consequence of disease caught at the camp of La Rochelle, whither he had gone to petition the king). Malherbe's first poem *Les Larmes de Saint Pierre* appeared in 1587. His poetical work is scanty in amount. The beautiful *Consolation à Duperier* (*c.* 1599), in which occurs the famous line—

"Et rose, elle a vécu ce que vivent les roses—"

the odes to Marie de' Medici and to Louis XIII., and a few other pieces comprise all that is really worth remembering of him. His prose work is much more abundant, not less remarkable for care as to style and expression, and of greater positive value. It consists of some translations of Livy and Seneca, and of a very large number of interesting and admirably written letters, many of which are addressed to Peiresc, the man of science of whom Gassendi has left a delightful Latin *Life*. It contains also the *Commentaire sur Desportes,* in which Malherbe's minute and carping style of verbal criticism is displayed on the great scale.

The personal character of Malherbe was far from amiable, but he exercised, or at least indicated the exercise of, a great and enduring effect upon French literature, though by no means a wholly beneficial one. The lines of Boileau beginning *Enfin Malherbe vint* are rendered only partially applicable by the extraordinary ignorance of older French poetry which distinguished that peremptory critic. But the good as well as bad side of Malherbe's theory and practice is excellently described by his contemporary and superior Regnier, who was animated against him, not merely by reason of his own devotion to Ronsard but because of Malherbe's discourtesy towards Regnier's uncle P. Desportes, whom the Norman poet had at first distinctly copied. These are the lines:—

Cependant leur savoir ne s'étend nullement
Qu'à régratter un mot douteux au jugement,
Prendre garde qu'un *qui* ne heurte une diphthongue,
Epier si des vers la rime est brève ou longue,
Ou bien si la voyelle à l'autre s'unissant
Ne rend point à l'oreille un vers trop languissant.
. . . .
C'est proser de la rime et rimer de la prose.

This is perfectly true, and from the time of Malherbe dates that great and deplorable falling off of French poetry in its more poetic qualities, which was not made good till 1830. Nevertheless the critical and restraining tendency of Malherbe was not ill in place after the luxuriant importation and innovation of the *Pléiade;* and if he had confined himself to preaching greater technical perfection, and especially greater simplicity and purity in vocabulary and versification, instead of superciliously striking his pen through the great works of his predecessors, he would have deserved wholly well. As it was, his reforms helped to elaborate the kind of verse necessary for the classical tragedy, and that is the most that can be said for him.

Malherbe's works were published two years after his death. He left behind him an unenviable reputation for acerbity in his relations with his contemporaries, but his influence as a critic was great and far reaching. He represents the reaction against the innovations of the Pléiade and the beginning of the strict French classical school.

The chief authorities for the biography of Malherbe are the *Vie de Malherbe* by his friend and pupil Racan, and the long *Historiette* which Tallemant des Réaux has devoted to him. The standard edition is that of Ludovic Lalanne (5 vols., 1862–69).

See A. Gasté, *La Jeunesse de Malherbe* (1890); G. Brunot, *La Doctrine de Malherbe* (1891); V. Bourrienne, *Points obscurs dans la vie normande de Malherbe* (1895); and the duc de Broglie's "Malherbe" in *Les Grands écrivains français.*

MALIBRAN, MARIE FÉLICITÉ (1808–1836), operatic singer, daughter of Manoel Garcia (*q.v.*), was born in Paris on March 24, 1808. Her father was then a member of the company of the Théâtre des Italiens, and she accompanied him to Italy and London. She possessed a soprano voice of unusual beauty and phenomenal compass, which was carefully cultivated by her father. She was only seventeen when she was suddenly asked to take Pasta's place in *The Barber of Seville* at Covent Garden. She was engaged for the remaining six weeks of the season, and then appeared in New York in *Othello, The Barber of Seville, Don Juan, Romeo and Juliet, Tancred.* Her gifts as an actress were on a par with her magnificent voice, and her gaiety made her irresistible in light opera, although her greatest triumphs were obtained in tragic parts. She married a French banker of New York, named Malibran, who was much older than herself. The marriage was an unhappy one, and Mme. Malibran returned alone to Europe in 1828, when she began the series of representations at the Théâtre des Italiens, which excited an enthusiasm in Paris only exceeded by the reception she received in the principal towns of Italy. She was formally divorced from Malibran in 1835, and married the Belgian violinist, Charles de Beriot. She died on Sept. 23, 1836.

See *Memoirs of Mme. Malibran by the comtesse de Merlin and other intimate friends, with a selection from her correspondence* (2 vols., 1840); M. Teneo, *La Malibran, d'après des documents inédits,* in *Sammelbände der internationalen Musik-Gesellschaft* (Leipzig, 1906); L. Héritte de la Tour, *Une famille de grands musiciens mémoires de Louise Héritte Viardot* (1923).

MALIC ACID, widely distributed in the vegetable kingdom in unripe apples (whence its name), in barberries, grapes, mountain ash berries, quinces and sorbapples. Its acid potassium salt is found in rhubarb. It is known in the form of colourless deliquescent needles readily soluble in water or alcohol, and is a hydroxysuccinic acid, $CO_2H{\cdot}CH(OH){\cdot}CH_2{\cdot}CO_2H$; it melts at 100° C and when maintained at 130° C it furnishes fumaric acid alone, but on rapid heating at 180° C maleic anhydride distils away leaving a residue of fumaric acid (*q.v.*).

Since malic acid contains one asymmetric carbon atom (*see* STEREOCHEMISTRY) it should exist in two optically active forms and one inactive racemoid modification. The acid from natural sources is *laevo*-malic acid; the racemoid acid arising in organic syntheses has been resolved into both *laevo-* and *dextro*-forms through the cinchonine salts. Among the simpler syntheses of inactive malic acid are (1) the action of hydrous silver oxide on bromosuccinic acid, (2) the reduction of racemic or tartaric acid (*q.v.*) with hydriodic acid, (3) the hydration of fumaric or malic acid.

MALIGNANT, wicked, of a malicious or wilfully evil disposition. The word was early applied by the Protestants to the Romanists, with an allusion to the "congregation of evil-doers" (Vulgate, *Ecclesiam malignantium*) of Psalm xxvi. 5. In English history, during the Great Rebellion, the name was given to the Royalists by the Parliamentary party. In the Great Remonstrance of 1641 occur the words "the malignant partie, whereof the archbishop (Laud) and the earl of Strafford being heads." The name throughout the period had special reference to the religious differences between the two parties. In medical science, the term "malignant" is applied to a particularly virulent or dangerous form which a disease may take, or to a tumour or growth of rapid growth, extension to the lymphatic glands, and recurrence after operation.

MALIGNITE, a phaneric igneous rock composed principally of orthoclase, aegerine-augite, and biotite, with melanite, nephalite, sphene, etc. It resembles basalts, and was named by Lawson (1896) from the Maligne river, Canada.

MALINES (Flemish, *Mechlin*), an ancient and important city, and the seat since 1559 of the only Belgian archbishopric. Pop. (est. 1939) 62,339. It is on the Dyle in the province of Antwerp, about half-way between Antwerp and Brussels. The archbishop is the primate of the country The archbishop's palace is in a picturesque situation, and dates from the creation of the see. The fine cathedral dedicated to St. Rombaut was begun in the 12th and finished early in the 14th century, and modified in the 15th after a fire. The massive tower of over 300 ft., which is described as unfinished because the original intention was to carry it to 500 ft., is its most striking external feature. The cathedral contains a fine altar-piece by Van Dyck. The old palace of Margaret of Austria, regent for Charles V, has been preserved and is now a court of justice. In the church of Our Lady (16th century) is Rubens' masterpiece "the Miraculous Draught of Fishes," and in that of St. John is a fine triptych by the same master. Malines, although no longer famous for its lace, carries on a large trade in linen, needles, furniture and oil; it is a great junction for the lines Ghent-Liége and Antwerp-Brussels and has large state railway-works.

The lordship of Malines was conferred as a separate fief by Pippin the Short on his kinsman Count Adon in 754. In the 9th century Charles the Bald bestowed the fief on the bishop of Liége, and it passed to Philip the Bold, of Burgundy, in 1384. During the religious troubles of the 16th century Malines suffered greatly, and in 1572 it was sacked by Alva's troops during three days. In the wars of the 17th and 18th centuries it was besieged many times and captured by the French, Dutch and English on several occasions. The French finally removed the fortifications in 1804, since which year it has been an open town.

Malines was bombarded three times during World War I and seriously damaged. The law courts, restored shortly before the war, the school of music, and the picturesque houses round the Yzeren Leeh were ruined, and the south side of the cathedral of St. Rombaut and the chimes badly damaged. The Cloth Hall, also restored before the war, was, afterwards, used as the Town hall. Conferences were held there, 1921–25, between Cardinal Mercier, Archbishop of Malines, and some dignitaries of the Church of England, to further a reunion of the churches.

In World War II, the British expeditionary forces first met the Germans in the vicinity of Malines. The fall of Malines led to the speedy capture of Antwerp and Brussels.

MALINKÉ, the name of a tribe, formerly commonly called Negroid, of west Sudan. Malinké is a general term covering many individual divisions of speech and tribe. The languages spoken are divided into (*a*) Malinké proper (Eastern Malinké), used throughout the length of the Upper Niger above Bamako and between Niger and Bafing; (*b*) Xasonké, usually called Northern Malinké in the Kayes region; (*c*) Western Malinké on the Gambia and (*d*) Southern Malinké on the edge of the dense forests. These languages belong to the Nigero-Senegalese group of tongues, as does the *lingua franca* of the region *Kăgbe* or "white language" (*cf.* Chinese 白話, "white speech," for vernacular). The people and their language are mentioned by El Bakri (11th century), Ibn Batuta (14th century) and by Ibn Khaldun (17th century). For the physical and other characteristics of the Malinké, *see* AFRICA: *Anthropology and Ethnology.*

MALIPIERO, G. FRANCESCO (1882–), Italian composer, was born in Venice on March 18, 1882. He studied under Bossi in Venice, and in 1902 followed him to Bologna. Later he went to Paris, but his strong individuality prevented him from attaching himself to any school. Since 1921 he has been professor of composition at Parma conservatoire. Malipiero is one of the most advanced of Italian composers. One of his aims is to achieve the perfect fusion of music and drama, and his experiments in this direction have aroused great interest and much criticism. In *Pantea,* a symphonic drama for a dancer with invisible chorus and orchestra, the dancer's movements represent, it is claimed, the "moods of the soul." *Sette Canzoni,* perhaps his best achievement so far, is now included with the two dramas *La morte delle maschere* and *Orfeo* in a trilogy under the title *L'Orfeide.* It is divided into episodes, each with a *canzone* as its central feature and mimic action for the setting. But this *canzone* is not a song created for stage requirements but one which has a natural place in scenes of real life. Other dramatic works are: *Ellen e Fuldano, San Francesco d'Assisi, Sogno d'un tramonto d'autunno, Canossa,* and *La mascherata delle principesse.* He has also written four symphonies, *Impressione dal vero* (2 sets, 1911, 1914), *Ditirambo tragico* (1917), *Armenie* (1917), *Per una favola cavalleresca* (1921), *Oriente immaginario,* and *Grottesco* for orchestra; a string quartet: *Rispetti e strambotti* (Coolidge prize 1920); songs, and piano pieces; as well as a number of literary works including the texts of his four operas, a monograph on the Orchestra, and articles on musical subjects in the *Rivista musicale italiana.*

MALLARMÉ, FRANÇOIS RENÉ AUGUSTE (1755–1835), French revolutionary, was born at Nancy on Feb. 25, 1755. He was brought up in his father's profession as a lawyer, and was appointed *procureur-syndic* of the district of Pont-à-Mousson. During the Revolution, he was elected by the department of Meurthe deputy to the Legislative Assembly and the Convention, where he joined the Mountain and voted for the death of Louis XVI. He was made president of the Convention on May 30, 1793, and by his weakness contributed to the fall of the Girondins. In November he was sent to establish the revolutionary government in the departments of Meuse and Moselle. After Robespierre's fall he joined the "Thermidorians," and was sent on a mission to the south of France, where he set free a number of "suspects." On June 1, 1795 he was arrested, but soon set free. He held office both under the directory and the empire. Appointed sub-prefect of Avesnes during the Hundred Days he was imprisoned by the Prussians in revenge for the sentence of death carried out by his orders on some young girls at Verdun who had offered flowers to the Prussians when they entered the town (1793). He lived in exile during the Restoration, returned to France after 1830, and died at Richemont (Seine-Inférieure) on July 25, 1835.

MALLARMÉ, STÉPHANE (1842–1898), French poet and theorist, was born at Paris, on March 18, 1842. His life was simple and without event. His small income as professor of English in a French college was sufficient for his needs, and, with his wife and daughter, he divided the year between a fourth-floor flat in Paris and a cottage on the banks of the Seine. His Tuesday evening receptions, which did so much to form the thought of the more interesting of the younger French men of letters, were almost as important a part of his career as the few carefully elaborated books which he produced at long intervals. *L'Après-midi d'un faune* (1876) and other fragments of his verse and prose had been known to a few people long before the publication of the *Poésies complètes* of 1887, in a facsimile of his clear and elegant handwriting, and of the *Pages* of 1891 and the *Vers et prose* of 1893. His remarkable translation of poems of Poe appeared in 1888, "The Raven" having been published as early as 1875, with illustrations by Manet. *Divagations,* his own final edition of his prose, was published in 1897, and a more or less complete edition of the *Poésies,* posthumously, in 1899. He died at Valvins, Fontainebleau, on Sept. 9, 1898. All his life Mallarmé was in search of a new aesthetic, and his discoveries by the way were often admirable. But he was too critical ever to create freely, and too limited ever to create abundantly. His great achievement remains unfinished, and all that he left towards it is not of equal value. There are a few poems and a few pieces of imaginative prose which have the haunting quality of Gustave Moreau's pictures, with the same jewelled magnificence, mysterious and yet definite. His later work became more and more obscure, as he seemed to himself to have abolished limit after limit which holds back speech from the expression of the absolute. Finally, he abandoned punctuation in verse, and invented a new punctuation, along with a new construction, for prose. Patience in the study of so difficult an author has its reward. No one in our time has vindicated with more pride the self-sufficiency of the artist in his struggle with the material world. To those who knew him only by his writings his conversation was startling in its clearness; it was always, like all his work, at the service of a few dignified and misunderstood ideas. (A. Sy.)

See also Paul Verlaine, *Les Poètes maudits* (1884); J. Lemaître, *Les Contemporains* (5th series, 1891); Albert Moekel, *Stéphane Mallarmé, un héros* (1899); E. W. Gosse, *French Profiles* (1905) and A. Symons, *The Symbolist Movement in Literature* (1900); A. Ellis, *Stéphane Mallarmé in English Verse,* introd. by G. Turquet-Milnes (1927). A bibliography is given in the *Poètes d'aujourd'hui* (1880–1900, 11th ed., 1905) of MM. A. van Bever and P. Léautaud.

MALLAWAN, a town in Hardoi district, the United Provinces, India. Pop. (1941) 11,084. Under native rule the town possessed considerable political importance, and upon the British annexation of Oudh in 1856 it was selected as the headquarters of the district. After the Mutiny, however, it was abandoned in favour of Hardoi, and in recent times its population has shown a steady decrease. Saltpetre and brass utensils are manufactured, and in the town is to be found a branch of the Board of Foreign Missions of the Methodist Episcopal Church of the United States.

MALLEABLE CAST IRON: *see* CAST-IRON.

MALLECO, an inland province of southern Chile, lying between the provinces of Bío-Bío and Cautín. Area 5,512 sq.mi.; pop. (1940) 154,174. It is in the rainy, forested region of southern Chile, inhabited to a considerable extent by Araucanian Indians. Gold placer mining has attracted some attention, but the output is small. Principal industries are cattle and wheat raising and timber-cutting. The State central railway crosses the province, and the capital (Angol) is served by a branch line.

MALLESON, GEORGE BRUCE (1825–1898), Indian officer and author, born at Wimbledon, on May 8, 1825. He obtained a cadetship in the Bengal infantry in 1842, and served through the second Burmese War. He attracted attention by his "Red Pamphlet" (1857), before the outbreak of the mutiny. He retired with the rank of colonel in 1877. He died at Kensington, on March 1, 1898. He continued, and considerably rewrote the *History of the Indian Mutiny* (6 vols., 1878–80), left unfinished by Sir John Kaye. He also wrote: *History of the French in India* (2nd ed., 1893) and *The Decisive Battles of India* (3rd ed., 1888).

MALLET or **MALLOCH, DAVID** (?1705–1765), Scottish poet and dramatist, the son of a farmer, was born in Perthshire, probably in 1705. He went to school in Edinburgh, and in 1720, to Edinburgh university, where he made the friendship of James Thomson, author of *The Seasons.* Short poems by Mallet appeared in the *Edinburgh Miscellany,* and in Allan Ramsay's *Tea Table Miscellany,* in which his ballad "William and Margaret" was published in 1724. In this year he changed his name from Malloch to Mallet. He travelled for some years as private tutor to the duke of Montrose's sons, and in 1742 through Pope's influence was appointed secretary to the prince of Wales. For his services as a pamphleteer for the Tory party, Lord Bute gave him a lucrative sinecure in 1760. He died on April 21, 1765. In 1740, in collaboration with Thomson, Mallet produced the masque *Alfred* (containing the patriotic song "Rule, Britannia"); in 1751 after Thomson's death, he published a new version, claiming that it was almost entirely his own work.

A collection of his *Works* appeared in 1759 (3 vols.). His *Ballads and Songs* were edited by F. Dinsdale, with notes and a biographical memoir, in 1857.

MALLET DU PAN, JACQUES (1749–1800), French journalist, was born near Geneva. Voltaire obtained him a professorship at Cassel, which, however, he soon resigned. He joined Linguet (*q.v.*) in London, in the production of his *Annales politiques* (1778–1780), and during Linguet's imprisonment in the Bastille (1781–83) continued them himself. Linguet resented this, and Mallet du Pan changed the title of his publication to *Mémoires historiques* (1783), which he incorporated with the *Mercure de France* in Paris from 1783. He sided with the Royalists at the Revolution, and was sent by Louis XVI on a mission to the German princes (1791–2). His anti-revolutionary pamphlets, and a violent attack on Bonaparte and the Directory resulted in his exile in Berne (1797). In 1798 he came to London and founded the *Mercure britannique.* He died at Richmond, Surrey, on May 10, 1800. Mallet du Pan was a pioneer of modern political journalism.

Mallet du Pan's *Mémoires et correspondance* was edited by A. Sayous (1851). *See* also B. Mallet, *Mallet du Pan and the French Revolution* (1902).

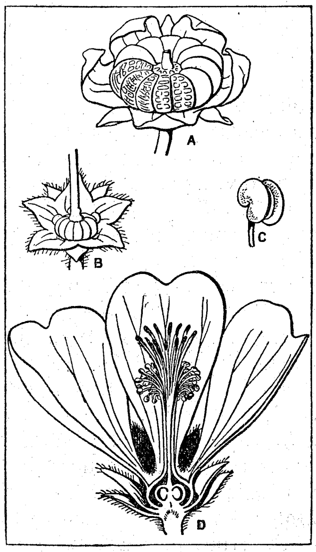
MALLING, EAST and **WEST,** two villages of Kent, England, respectively 5 and 6 mi. W. by N. of Maidstone. Pop. (1931) East Malling, 2,305; West Malling, 2,373. East Malling has large paper mills and there is an important horticultural research station. At West Malling are remains of Malling abbey, a Benedictine nunnery founded in 1090 by Gundulf, bishop of Rochester. The remains, partly incorporated in a modern building, include the Norman west front of the church, the Early English cloisters, the chapter-house and gate-house (the chapel of which is restored to use). About Addington, near West Malling, are considerable prehistoric remains, including mounds, single stones, stone circles and pits in the chalk hills; while at Leybourne are the gateway and other fragments of a mediaeval castle.

MALLOCK, WILLIAM HURRELL (1849–1923), English author, was born at Cockington Court, Devonshire. He was educated privately, and at Balliol college, Oxford. He attracted considerable attention by his satirical story *The New Republic* (2 vols., 1877), in which he introduced characters easily recognized as prominent living men, Mark Pattison, Matthew Arnold, W. K. Clifford and others. In a series of books dealing with religious questions he insisted on dogma as the basis of religion and on the impossibility of founding religion on purely scientific data. In *Is Life Worth Living?* (1879) and *The New Paul and Virginia* (1878) he attacked Positivist theories, and in *Doctrine and Doctrinal Disruption* (1900) he advocated the necessity of a strictly defined creed. Later volumes on similar topics were *Religion as a Credible Doctrine* (1903) and *The Reconstruction of Belief* (1905). Among his anti-socialist works there should be classed his novel, *The Old Order Changes* (1886). His other novels include *A Romance of the Nineteenth Century* (1881), *A Human Document* (1892), *The Heart of Life* (1895) and *The Veil of the Temple* (1904). He published a volume of *Poems* in 1880, and in 1900 *Lucretius on Life and Death* in verse. Mallock died at Wincanton, Somerset, on April 2, 1923.

MALLOW, a town and watering place of co. Cork, Eire, on the Blackwater, 144½ mi. S.W. from Dublin, and 21 N. from Cork by the Great Southern railway. Pop. (1936) 4,948. The town possesses a tepid mineral spring and a spa-house. There are manufactures of mineral water and condensed milk, corn-mills and tanneries. Mallow received a charter of incorporation from James I. Its name was originally Magh Allo, that is, Plain of the Allo (the old name used by Spenser for this part of the river), and the ford was defended by a castle, built by the Desmonds, the ruins of which remain. A bridge connects the town with the suburb of Ballydaheen. Mallow is a centre for salmon fishing on the Blackwater.

MALLOW, any plant of the family Malvaceae, especially of the genera *Hibiscus* (*q.v.*) and *Malva,* the latter embracing about 30 species of annual and perennial herbs, widely distributed throughout the northern hemisphere. The mallows possess the reniform one-celled anthers which specially characterize the Malvaceae (*q.v.*). The petals also are united by their base to the tube formed by the coalesced filaments of the stamens. The special characters which separate the genus *Malva* from others most nearly allied to it are the involucre, consisting of a row of three separate bracts attached to the lower part of the true calyx, and the numerous single-seeded carpels disposed in a circle around a central axis, from which they become detached when ripe. The flowers are mostly white or pinkish, never yellow, the leaves radiate-veined and more or less lobed or cut. Three species are found in Britain. The musk mallow (*Malva moschata*) is a perennial herb with five-partite, deeply cut leaves and large rose-coloured flowers clustered together at the ends of the branched stems and is found growing along hedges and borders of fields, blossoming in July and August. It owes its name to a slight musky odour diffused by the plant in warm dry weather when it is kept in a confined situation. The round-leaved dwarf mallow (*Malva neglecta*) is a creeping perennial growing in waste sandy places, with roundish serrate leaves and small pinkish-white flowers produced in the axils of the leaves from June to September. It is common throughout Europe and the north of Africa, extending to western and northern Asia. The common mallow (*Malva sylvestris*), the *mauve* of the French, is an erect biennial or perennial plant with long-stalked roundish-angular serrate leaves, and conspicuously axillary reddish-purple flowers, blossoming from May to September. Like most plants of the order it abounds in mucilage, and hence forms a favourite domestic remedy for colds and sore throats. The aniline dye called mauve derives its name from its resemblance to the colour of this plant. Besides the foregoing three other species have become naturalized in various parts of North America.

The marsh mallow (*Althaea officinalis*), the *guimauve* of the French, belongs to the same genus as the hollyhock (*q.v.*). (For rose mallow, *see* HIBISCUS.) The mallow of Scripture, Job xxx 4, has sometimes been identified with Jew's mallow (*Corchorus olitorius*), a member of the allied family Tiliaceae, but more plausibly with *Atriplex halimus,* the sea orache of Europe. Once widely used in medicine, mallows are no longer considered of value.



FROM GROOM, "ELEMENTARY BOTANY" (G. BELL & SONS)

MALLOW (MALVA SYLVESTRIS)

A. Fruit. B. Portion of the flower showing calyx, epicalyx and part of style. C. Upper part of stamen, showing opening of anther. D. Vertical section of flower

MALMÉDY, a small town acquired by Belgium from Germany through the treaties after 1918, lying in a wild and deep basin, on the Warche, 20 mi. S. of Aix-la-Chapelle by rail via Eupen. Pop. (est. 1939) 5,913. (*See* EUPEN AND MALMÉDY.)

MALMESBURY, JAMES HARRIS, 1ST EARL OF (1746–1820), English diplomatist, was born at Salisbury on April 21, 1746, who was the son of James Harris, the author of *Hermes.* Educated at Winchester, Oxford and Leyden, he became secretary in 1768 to the British embassy at Madrid, then minister *ad interim,* and in 1772 minister plenipotentiary to the court of Prussia. In 1777 he was transferred to the court of Russia, where he made his reputation, for he managed to get on with Catherine in spite of her predilections for France, and steered adroitly through the accumulated difficulties of the first Armed Neutrality. He was made a knight of the Bath in 1778, but in 1782 returned home owing to ill-health, and was appointed by his friend Fox to be minister at The Hague. He furthered Pitt's policy of maintaining England's influence on the Continent by the arms of her allies, and held the threads of the diplomacy which ended in the king of Prussia's overthrowing the republican party in Holland, which was inclined to France, and re-establishing the prince of Orange. He was created Baron Malmesbury of Malmesbury (Sept. 1788), and permitted by the king of Prussia to bear the Prussian eagle on his arms, and by the prince of Orange to use his motto "Je maintiendrai." He returned to England, and seceded from the Whig party with the duke of Portland in 1793; and in that year he was sent by Pitt, but in vain, to try to keep Prussia true to the first coalition against France. In 1794 he was sent to Brunswick to solicit the hand of the unfortunate Princess Caroline for the prince of Wales. In 1796 and 1797 he was at Paris and Lille vainly negotiating with the French Directory. In 1800 he was created earl of Malmesbury, and Viscount Fitzharris, of Heron Court in the county of Hants. He was now consulted by successive foreign ministers, trusted by men of the most different ideas in political crises, and was above all the confidant, and for a short time after Pitt's death almost the political director, of Canning. Lord Palmerston, who was his ward, derived many of his ideas on foreign policy from him. Malmesbury died on Nov. 21, 1820, and was succeeded as 2nd earl by his son James Edward (1778–1841), under-secretary for foreign affairs under Canning. Malmesbury only published an account of the Dutch revolution, and an edition of his father's works, but his important *Diaries* (1844) and *Letters* (1870) were edited by his grandson.

MALMESBURY, JAMES HOWARD HARRIS, 3RD EARL OF (1807–1889), English statesman, son of the 2nd earl, was born on March 25, 1807, and educated at Eton and Oriel college, Oxford. In 1841 he had only just been elected to the House of Commons as a Conservative when he succeeded to the peerage. His political career attracted a good deal of attention, partly from his being foreign secretary in 1852 and again in 1858–59 (he was also lord privy seal in 1866–68 and in 1874–76), and partly from his influential position as an active Tory of the old school in the House of Lords at a time when Lord Derby and Disraeli were, in their different ways, moulding Conservatism. His *Memoirs of an Ex-Minister,* published in 1884, remain his chief title to remembrance.

MALMESBURY, a market town and municipal borough in the Chippenham parliamentary division of Wiltshire, England, 94½ mi. W. of London by the Great Western railway. Pop. (est. 1938) 2,272. Area, 178 ac. Maildulphus, a Scottish or Irish monk, built a hermitage near the site of the modern Malmesbury (Maildulphi-urbs, Maldelmesburh, Malmesbiri) about 635, and formed the nucleus of the later abbey of which Aldhelm, his pupil, became the first abbot. Aethelstan, who was buried there, rebuilt and endowed the monastery. Round the abbey the town of Malmesbury grew up, and by the time of the Domesday survey it had become one of the only two Wiltshire boroughs. The first charter purports to have been given by Aethelstan. It granted to the burgesses all privileges and free customs such as they held in the time of Edward the Elder, with additional exemptions, in return for help against the Danes. The castle of Henry I gave a further impetus to the growth of the town. In 1645 it was made a free borough under the title of "aldermen and burgesses of the borough of Malmesbury, County Wilts." By this charter it was governed until 1885. The borough returned two members to parliament from 1295 to 1832 and one member from then until 1885. In the middle ages the town possessed a considerable cloth manufacture, and at the Dissolution the abbey was bought by a rich clothier and fitted with looms for weaving. The trade in wool still flourished in 1751.

It lies on a ridge surrounded on all sides except the north-west by the river Avon and a small tributary. The church of St. Peter and St. Paul consists of the greater part of the nave (with aisles) of a Benedictine abbey church. The ruins of the great tower arches now terminate the building eastward. The nave is transitional Norman, with a Decorated superstructure including the clerestory. The south porch is Norman. With the exception of a crypt, the monastic buildings have disappeared. In the market square stands a fine market cross of the 16th century, borne upon an octagonal battlemented basement. Early English fragments of a hospital of St. John of Jerusalem appear in the corporation almshouse. Malmesbury has an agricultural trade, and small manufactures of silk and pillow lace.

MALMGREN, FINN (1895–1928), Swedish meteorologist, was born at Falun. He matriculated at Stockholm at the age of 16, and went to Uppsala university, afterwards becoming assistant to Professor Hamberg at his observatory at Portetjäkko. After a short period at the meteorological institute at Uppsala, Malmgren was appointed assistant professor at Pettersson's hydrographic institute for oceanic studies at Bornö. In 1922 he joined Amundsen in the second stage of his voyage in the North Polar Basin, and acted for three years as meteorologist to the expedition under Dr. H. U. Sverdrup. As a result of his studies during the voyage he took his degrees of Master, and later Doctor, of Science on his return. In 1926 he flew across the North Polar Basin in the airship Norge, and Amundsen's official account of the expedition contains a chapter by him on "Weather and Weather Warnings during the Polar flight." He gave up a post as lecturer and curator at Vastmanlands Dala College to become meteorologist of the Expedition under General Nobile, which sailed in the airship Italia for the North Pole.

After passing over the North Pole on May 24, 1928, the following day the Italia crashed on to the ice, and Malmgren was severely injured. Ten of the party were thrown out on to the ice, and the remainder were carried away in the airship. On May 30, realizing that the injuries of Nobile and Ceccioni made it impossible for them to walk, and believing that a small party would have some chance of reaching Cape North, Malmgren set out with Mariano and Zappi. When they reached Brock island about June 15, Malmgren's legs were frostbitten and he was unable to walk any further. Mariano and Zappi stayed with him for some time, and then, at his own request, dug a trench and left him. He gave his life in order that his two companions might reach Cape North and so obtain provisions for the rest of the expedition. They were picked up by an aeroplane on July 13. A professorship at the university of Uppsala was founded as a memorial to Malmgren.

MALMÖ, a seaport of Sweden, chief town of the district (*län*) of Malmöhus, on a small bay of the Sound, 384 m. S.S.W. of Stockholm by rail. Pop. (1800), 38,054; (1943), 159,708.

Malmö (Malmhauge, Malmey, Malmöye, Malmoughe), sometimes called *Ancona Scanorum* or *Ellenbogen,* first appears in history about the middle of the 13th century. During the Hanseatic period it was the most important commercial town on the Sound, but in the 16th and 17th centuries greatly lost ground owing to the decay of its herring fisheries and the rise of its rival, Copenhagen. It began to revive in the late 18th century.

It is connected with Copenhagen, 17¼ m. W. by N., by steam-ferry, the Sound being kept open in winter by an ice-breaker. It is also the first important station in Sweden on the Berlin–Stockholm route, which crosses the sea between Sassnitz in Rügen and Trelleborg 20 m. S.E. of Malmö. The town formerly had strong fortifications, of which only the citadel (Malmöhus) remains; in it the earl of Bothwell was imprisoned by Frederick II. of Denmark for some time after his departure from Scotland in 1567. The town-hall (1546, largely restored in 1864) contains a handsome chamber, the Knutssal, formerly used by the council of the gild of Canute. The church of St. Peter (*Peterkyrka*) dates in part from 1319. Malmö is second to Stockholm as an industrial centre. There are breweries and large works for the manufacture of machinery, among which are the Kockum mechanical works, with yards for the construction of vessels of war, and others; of cotton and woollen goods, rubber factories, sugar factories, gloves, chocolate, sweetmeats and tobacco. Malmö is a free port. It has a large export trade in grain, timber, cattle, flour, butter, cheese, matches, wood-pulp, etc. The imports are coal, manufactures, cotton, chemicals, iron, herring, manures, grain, etc. The harbourage includes an outer harbour of 22 ft. depth, and two inner basins admitting vessels of 21 ft. draught, with dry dock and patent slip. Malmö returns four members to the second chamber of the Riksdag (parliament).

MALMSEY (mahm'zĭ), a strong sweet wine, originally made at Monemvasia, Napoli di Malvasia, in Greece. The name of the place was corrupted in Med. Lat. into *malmasia,* whence the English form of the word. The corruption malvasia gives the O. Fr. *malvesie,* from which comes the alternative English form "malvoisie." The wine is now made more in Spain and Madeira than in Greece.

MALOCELLO, LANCILOTO ("LANZAROTE, the 'Lancelot Maloisiel' of the French"), leader of the first of modern European oceanic enterprises. This was a Genoese expedition, which about 1270 seems to have sailed into the Atlantic, re-discovered the "Fortunate Islands" or Canaries, and made a settlement in one of the most northerly isles of this archipelago, still known (after the Italian captain) as Lanzarote. "Lancarote" is said to have been killed by the Canarian natives; but the castle built by him was standing in 1402–1404, when it was utilized for the storage of grain by the French conquerors under Gadifer de la Salle. Malocello's enterprise is probably not unconnected with the great Genoese venture of 1291 in search of a waterway to India.

See the *Conosçimiento,* p. 100, as edited by Marcos Jimenez de la Espada in the *Boletin de la sociedad geográfica de Madrid* (February 1877); *Le Canarien* in P. Margry, *Conquête des . . . Canaries,* p. 177; M. A. P. d'Avezac in vol. vi., part ii., of *L'Univers,* pp. 1–41 (*Iles africaines de l'océan atlantique*); C. R. Beazley, *Dawn of Modern Geography,* iii. 411–413, 449, 451.

MALOLOS, a municipality (with administrative centre and 45 *barrios* or districts) and capital of the province of Bulacan, Luzon, Philippine islands, on a branch of the Pampanga river and on the Manila-Dagupan railway. Pop. (1939) 33,384; six whites. During the revolution against the U.S., the insurgent congress met there and framed and proclaimed the "Malolos Constitution." In March 1899 the town was captured by the United States forces. It is a commercial centre of some importance, and palay (rice) is cultivated extensively in the surrounding region. Tagalog is the vernacular. Of the inhabitants aged 6 to 19 inclusive, 46·9% were reported in 1939 as attending school; while 67·4% of the population 10 years old and over was reported as literate.

MALONE, EDMUND (1741–1812), Irish Shakespearian scholar and editor, was born in Dublin, on Oct. 4, 1741, the son of a barrister and a member of the Irish House of Commons. He was educated at Trinity college, Dublin, and was called to the Irish bar in 1767. On the death of his father in 1774 he went to London, where he frequented literary and artistic circles. He frequently visited Dr. Johnson and was of great assistance to Boswell in revising and proof-reading his *Life,* four of the later editions of which he annotated. He was one of Sir Joshua Reynolds's executors, and published a posthumous collection of his works (1798) with a memoir. Horace Walpole, Burke, Canning, Lord Charlemont, and, for a time, George Steevens, were among Malone's friends. Encouraged by the two last he devoted himself to the study of Shakespearian chronology, and the results of his "Attempt to ascertain the Order in which the Plays of Shakespeare were written" (1778) are still largely accepted. This was followed in 1780 by two supplementary volumes to Steevens's version of Dr. Johnson's *Shakespeare;* and this again, in 1783, by an appendix volume. The seven years (1785–92) were devoted to Malone's own edition of Shakespeare in 11 volumes.

Malone published a denial of the claim to antiquity of the Rowley poems (*see* CHATTERTON, THOMAS), and in this (1782) as in his branding (1796) of the Ireland mss. (*see* IRELAND, WILLIAM HENRY) as forgeries, he was among the first to guess and state the truth. His elaborate edition of Dryden's works (1800), with a memoir, was another monument to his industry, accuracy and scholarly care. At the time of his death, on April 25, 1812. Malone was at work on a new octavo edition of Shakespeare, and he left his material to James Boswell the younger; the result was the edition of 1821—generally known as the Third Variorum edition—in 21 volumes.

A memoir of Malone by James Boswell is included in the *Prolegomena* to the edition of 1821. *See* also Sir J. Prior, *Life of Edmond Malone* (1860).

MALONE, a village of northeastern New York, U.S.A., the county seat of Franklin county; on the Salmon river, 10 mi. from the Canadian border, and served by the New York Central and the Rutland railways. Pop. (1920), 7,556 (91% native white); 8,743 in 1940, federal census. It is in the northern foothills of the Adirondacks, at an altitude of 780 ft., and is a centre for excursions into the Great North woods. It has paper, pulp and lumber mills, and other important manufacturing industries. The village (settled about 1805) was at first called Harison and then Ezraville, before adopting its present name in 1812. It was incorporated in 1833. During the War of 1812 it was a point of strategic importance, as it was on the line of communication between Lakes Champlain and Ontario, and later it was twice the rendezvous of Fenians for attacks on Canada.

MALONIC ACID crystallizes in large colourless plates, dissolving readily in water, alcohol or ether, and melts at 135·6° C. Although the sparingly soluble calcium malonate occurs in beetroot, the acid itself, $HO_2C{\cdot}CH_2{\cdot}CO_2H$, is generally produced by laboratory methods, such as the oxidation of malic acid (*q.v.*) or the hydrolysis of cyanoacetic acid, $CN{\cdot}CH_2{\cdot}CO_2H$. When carefully heated at 140–150° C, malonic acid partly decomposes into acetic acid and water, but 10–12% undergoes dehydration with formation of carbon suboxide, C_3O_2.

The outstanding importance of malonic acid in systematic chemistry arises from the varied syntheses which can be effected with its ethyl ester, *diethyl malonate,* or "malonic ester," $CH_2(CO_2C_2H_5)_2$. This ester, usually prepared by passing hydrogen chloride into a solution of cyanoacetic acid (obtained from chloroacetic acid) in absolute alcohol, is a colourless fragrant liquid boiling at 198° C. Its very reactive methylene group, CH_2, is instrumental in effecting syntheses of higher mono- and di-basic acids. (*See* CHEMISTRY: *Organic.*) The replacement of one hydrogen of this methylene group by sodium gives sodiomalonic ester; this on treatment with an alkyl iodide gives the ester of the corresponding alkyl malonic acid. In the presence of sodium ethoxide the esters of malonic acid and diethylmalonic acid undergo condensation with urea to furnish respectively barbituric and diethyl-barbituric acids, the latter being the well-known soporific drug, veronal (*q.v.*). By a similar condensation with urea ethylphenylmalonic ester yields the drug phenobarbital.

MALORY, SIR THOMAS (d. 1471), translator and compiler of the famous English classic, the *Morte d'Arthur.* Previous to the publication of Professor Kittredge's monograph, *Who was Sir Thomas Malory?* the identity of this writer remained an unsolved problem. Of direct evidence we have very little; in the concluding passage of the book the author asks the prayers of the reader for "Syr Thomas Maleore knyght," and states that the book was ended "the ix. yere of the reygne of Kyng Edward the fourth." Caxton, who printed *Morte d'Arthur* after Malory's death, in his preface (1485) says that he printed the book "after a copye unto me delivered whyche copye Syr Thomas Malorye dyd take oute of certeyn bookes of frensshe and reduced it in to Englysshe."

Kittredge identifies Caxton's Malory with Sir Thomas Malory, knight, of Newbold Revell (or Fenny Newbold), M.P. for Warwickshire in 1445. He had served in France, in the retinue of the earl of Warwick. He is almost certainly the "Thomas Malorie, miles," who, on account of his part in the Wars of the Roses was excluded with several others from the operation of a pardon issued by Edward IV. When Sir Thomas Malory's widow died in 1479 she was in possession of his hereditary estates in Northamptonshire and Warwick, so that it seems clear that Sir Thomas must have conveyed them to her in his life-time probably for fear of confiscation.

On two occasions, in 1451 and 1452, Humphrey, duke of Buckingham was commissioned to arrest Thomas Malory, knight, and bring him before the king and council "to answer certain charges," in the first case with respect to the rights of the monks of Axiholme in Kirby Monachorum, the parish which contained Malory's estate of Newbold Revell. (*See* Calendar of Patent Rolls, 1446–52, p. 476, and 1452–61, p. 61.)

Malory's *Morte d'Arthur* is an abridged compilation of the great body of Arthurian romance in its latest form. The *Merlin, Tristan, Lancelot, Queste* and *Mort Artus* are all represented, the only branch omitted is that dealing with the "early history" of the Grail, the *Joseph of Arimathea* and *Grand S. Graal.* But we do not yet know whether Malory himself was responsible for this selection, or whether he found it ready to hand in a ms., the "Frensshe Booke" to which he often refers. Mediaeval copyists, at the instance of their patrons, did make compilations from the various romances within their reach, such as *e.g.,* the enormous codex 112 (*fonds Franç.*) of the Bibliothèque Nationale, which includes large sections of the *Tristan,* the *Lancelot,* and the *Merlin* Suite. Taking into consideration alike what Malory retains and what he omits, it seems most probable that he was in possession, not of complete copies of the romances, but of one or more volumes of compilations from these sources.

The *Morte d'Arthur* represents the Arthurian cycle in the period of its decadence; nor does Malory in any way endeavour to overcome the difficulties caused by the juxtaposition of a number of independent (and often contradictory) versions; but the diversity of sources is harmonized and wrought into a whole by the great charm of Malory's style; simple, direct, idiomatic, yet musical and dignified, it has lent to the relations between Lancelot and Guenevere a character of truth and vitality lacking in his predecessors. Malory took the Arthurian story in its worst and weakest form, and he imparted to it a moral force and elevation which the cycle, even in its earlier and finer stage, had, save in the unique case of Von Eschenbach's *Parzival,* never possessed. *Morte d'Arthur* was the first English prose epic, and formed one of the chief foundations of English prose.

See G. L. Kittredge, "Who was Sir Thomas Malory?" (*Harvard Studies and Notes in Philology and Literature,* vol. v., 1897); and *Sir Thomas Malory* (Barnstable 1925); *Morte d'Arthur,* ed. by Dr. Oskar Sommer (an exact reproduction of the original text in 2 vols.)—vol. iii. a study on *The Sources of Malory.* The sections on *Lancelot* and *Queste* are unfortunately very inadequate; for these cf. *The Legend of Sir Lancelot,* Grimm Library, vol. xii. (J. L. W.; X.)

MALOU, JULES EDOUARD XAVIER (1810–1886), Belgian statesman, one of the leaders of the clerical party, was born at Ypres on Oct. 19, 1810. He was minister of finance in the coalition ministry of J. B. Nothomb in 1844, and formed with B. T. de Theux a Catholic cabinet in 1846, which was overthrown in the Liberal victory of 1847. Malou then became a member of the senate, and his party only regained ascendancy in 1870. The extreme clerical ministry of Baron d'Anethan retired in December 1871 after serious rioting in Brussels, and Malou was the real, though not the nominal, head of the more moderate clerical administrations of de Theux and Aspremont-Lynden (1870–78). After the fall of the ministry in 1878 he adopted a frankly clerical policy, and when he became chief of a new government in June 1884 he proceeded to undo the educational compromise of his predecessors in the Frère-Orban ministry. His legislation in favour of the Catholic schools caused rioting in Brussels, and in October the king demanded the retirement of MM. Jacobs and Woeste, the members of the cabinet against whom popular indignation was chiefly directed. Malou retired, and died at Woluwe Saint Lambert, in Brabant, on July 11, 1886. He was a financier of great experience. A list of his works is given in Koninck's *Bibliographie nationale de Belgique.*

MALOUET, PIERRE VICTOR, BARON (1740–1814), French publicist and politician, was born at Riom (Puy-de-Dôme) on Feb. 11, 1740. He entered the civil service and was employed successively at the French embassy in Lisbon, in the administrative department of the duc de Broglie's army, as commissary in San Domingo (1767–1774), and after his return to France, as commissary-general of the marine. He was sent to carry out plans of colonization in French Guiana in 1776, but superseded in 1779. He became intendant of Toulon, and in 1789 was returned to the states-general. He emigrated to England in Sept. 1792, but later tried and failed to obtain permission to assist in the defence of Louis XVI. In 1801 Napoleon restored him to his position in the civil service, and sent him to Antwerp as commissioner-general and maritime prefect. He entered the council of state in 1810, but offended the emperor by his plain speech, and was disgraced in 1812. Louis XVIII. made him minister of marine at the Restoration, and he died on Sept. 7, 1814.

For accounts of his domestic and colonial policy see *Collection de ses opinions a l'Assemblée Nationale* (3 vols., 1791–92); and *Collection de mémoires et correspondances officielles sur l'administration et notamment sur la Guiane française et hollandaise* (5 vols., 1802).

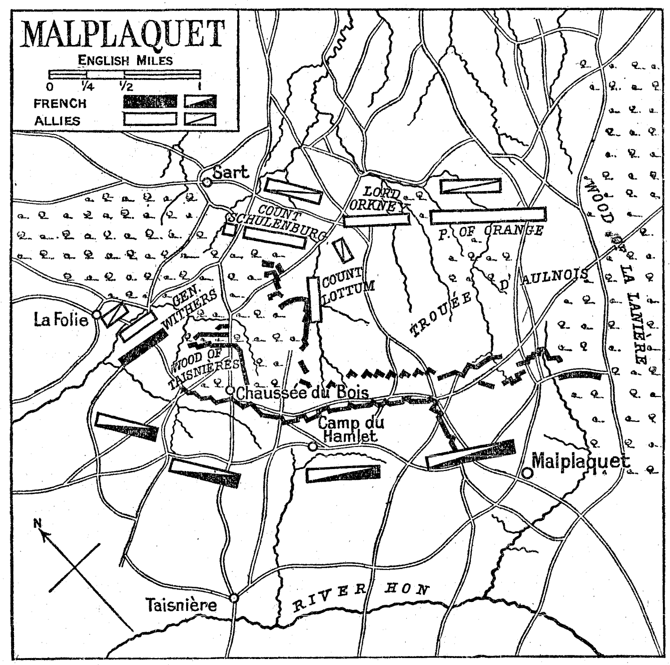
MALPIGHI, MARCELLO (1628–1694), Italian physiologist, was born on March 10, 1628, at Crevalcuore near Bologna, where he graduated in medicine in 1653 and where he became lecturer in 1656. A few months later he was appointed to the chair of theoretical medicine at Pisa, but after four years he returned to Bologna. In 1662 his friend, Borelli, secured his appointment as professor primarius at Messina. After a further four years he again returned to his native university, and spent the next twenty-five years there. In 1691 he removed to Rome as private physician to Innocent XII., and he died there of apoplexy on Nov. 30, 1694. Shortly before his death, he drew up a long account of his academical and scientific labours, correspondence and controversies, and committed it to the charge of the Royal Society of London, which published his autobiography in 1696.

Malpighi was one of the first to apply the microscope to the study of animal and vegetable structure; and his discoveries were so important that he may be considered to be the founder of microscopic anatomy. Although Harvey had correctly inferred the existence of the capillary circulation, he had never seen it; it was reserved for Malpighi in 1661 (four years after Harvey's death) to see for the first time the blood coursing through a network of small tubes on the surface of the lung and of the distended urinary bladder of the frog. This discovery was given to the world in two letters *De Pulmonibus,* addressed to Borelli, published at Bologna in 1661 (often reprinted). These letters contained also the first account of the vesicular structure of the human lung, and they made a theory of respiration for the first time possible. Malpighi's next achievement was a demonstration of the plan of structure of secreting glands. He maintained that the secretion was formed in terminal acini standing in open communication with the ducts. The name of Malpighi is still associated with his discovery of the mucous character of the lower stratum of the epidermis, of the vascular coils in the cortex of the kidney, and of the follicular bodies in the spleen. He was the first to attempt the finer anatomy of the brain, and described the distribution of grey matter and of the fibre-tracts in the cord, with their extensions to the cerebrum and cerebellum with great accuracy; but from his microscopic study of the grey matter he concluded that it was of glandular structure and that it secreted the "vital spirits." At an early period he applied himself to vegetable histology, and became acquainted with the spiral vessels of plants in 1662. His *Anatomia plantarum* published in 1672 included the *Observationes de ovo incubato,* which gave one of the best accounts (with good plates) of the development of the chick. His *Diss. epist. de bombyce* (1669) elaborately described the structure and metamorphosis of the silk-worm.

Malpighi also wrote *Epistolae anatomicae Marc. Malpighii et Car. Fracassati* (Amsterdam, 1662) (on the tongue, brain, skin, omentum, etc.); *De viscerum structura: exercitatio anatomica* (London, 1669); *De structura glandularum conglobatarum* (London, 1689); *Opera posthuma, et vita a seipso scripta* (London, 1697) with preface and additions, was published at Amsterdam in 1700. An edition containing all his works except the last two was published in London in 1686.

MALPLAQUET, a village of France in the department of the Nord, close to the Belgian frontier and about 10 m. S. by E. of Mons, famous as the scene of the battle, September 1709, between the Allies under the duke of Marlborough and Prince Eugène and the French commanded by Marshal Villars, in which the former were victorious. The country to the west and south of Mons is enclosed by a semicircular wall of woods and broken ground, through which there are only two important gaps—that of Jemappes (*q.v.*) (famous in 1792) to the west, and that of Aulnois, in which stands the village of Malplaquet, to the south. In the latter gap and the woods on either side Villars took up his position facing north-eastwards, on August 29/September 9. The forces present, over 90,000 on each side, were exceptionally large, and the French army in particular represented the spirit of its nation to a degree unusual in the armies of that time. Villars was the best general in the service of Louis XIV. and the veteran Marshal Boufflers, though senior to him, had volunteered to serve as his second in command. Marlborough and Eugène lay with their army between Mons and the French camps, which were almost within cannon shot. Marlborough's own wish was for an immediate battle, but he was opposed by the Dutch deputies at his headquarters, and even by Eugène, so that it was only on August 31/September 11 that the attack actually took place. Villars had made full use of his respite. The French right stood at the fringe of the wood of Lanière, the left was strongly posted in the midst of the wood of Taisnière, and across the two and a half miles of open ground between the woods the position was entrenched with several successive lines of works. The troops were almost equally distributed along the whole line as usual, and the cavalry was massed in rear of the infantry. In the Allied army the mounted troops were also kept back, but for the most part distributed to the various infantry commands.

The intention of Marlborough and Eugène, when on the morning of the battle they examined this formidable position, was to deliver the main attack upon the French left wing, combining the assaults of several columns on its front and flanks. In this quarter the French not only held the interior of the wood but also were thrown forward so as to occupy the edges of its north eastern salient, and upon the two faces of this salient Count Lottum with the Prussians, and Count von der Schulenburg with the Austrian infantry were to deliver a convergent attack, while farther to the Allied right a column under the English General Withers was detached to make a wide turning movement through the woods. Marlborough took command on the right, Eugène on



FROM FORTESCUE, "HISTORY OF THE BRITISH ARMY" (MACMILLAN)

PLAN OF THE BATTLE OF MALPLAQUET, SEPTEMBER 9–10, 1709

the left. The centre, which was intended only to observe the enemy until the decision had been forced at the wood of Taisnière, consisted of Lord Orkney's British corps and the prince of Orange's Dutch contingent. The salient of the Taisnière wood was duly attacked, after a heavy cannonade, on its two faces by the Prussians and Austrians about 9 A.M. They encountered a sterner resistance than in any of the battles and combats of the past seven campaigns, for on this field the defenders were fighting, not as hitherto for the interests of their king, but to defend their country, and the regiments of Picardie and Champagne which held the salient were the oldest and most famous of the French line. Lottum attacked again and again without success, until three British battalions had to be sent to reinforce him, and Marlborough placed himself with a corps of cavalry in close support. At last the entrenchments were stormed. Schulenburg had by this time fought his way through the woods and undergrowth, and the united force pressed back the French. Still, so stubborn was the defence and so dense the wood that the impetus of the assault died away and the troops on both sides broke up into small disconnected bodies, fighting too fiercely to be amenable to superior control.

But the French were not reinforced from their right wing as Villars expected. The prince of Orange, far from merely observing the hostile right as he had been ordered to do, committed his corps, very early in the battle, to a serious assault upon it, which Boufflers repulsed with enormous loss. The Dutch infantry never recovered from its casualties on this day, and the memory of Malplaquet was strong even at Fontenoy nearly forty years afterwards. The only advantage to the Allies was that Boufflers did not dare send reinforcements to the hard-pressed left wing. Thanks to this the attackers made steady progress in the wood of Taisnière. Villars launched the "Irish brigade" to check the advance of the Allies, and this famous corps charged into the forest. Villars, Eugène and Marlborough personally led their troops in the encounter which followed. Eugène was wounded, but refused to quit the field. Villars was more seriously hurt, and after trying in vain to direct the fighting from a chair was carried insensible from the field. At this crisis General Withers, who commanded the force that had been ordered to turn the French extreme left, appeared on the scene. The British 18th regiment (Royal Irish), encountering the French *Royal Irlandais,* put them to the rout, and Villars' counterstroke was at an end. The French maintained themselves on this side only by the aid of troops drawn from the centre and right, and this gave the Allied centre the opportunity which the prince of Orange had so rashly anticipated. The great attack over the open was carried out, in spite of the previous repulse, with the greatest determination. Preceded by forty guns, the corps of the prince of Orange and Lord Orkney swiftly carried the first line of works. The Allied cavalry then pushed out to the front, and horse, foot and artillery were combined in the last advance. Boufflers's cavalry masses, coming into play for the first time, fought hard, and the struggle fluctuated with the arrival of successive reserves on either side, but in the end, shortly before 3 P.M., Boufflers (who had been in command since Villars's fall) decided to retreat. The Allies had no troops left intact for the pursuit, and those engaged had expended their last efforts. Moreover Boufflers, experienced soldier as he was, drew off his men before they had lost their order and discipline.

Thus this "very murdering battle" as Marlborough called it—the last and greatest pitched battle of the war—was almost barren of results. The Allies lost not less than twenty thousand men, or nearly a quarter of the whole force, the thirty battalions of the Dutch infantry losing half their numbers. On the French side there were some twelve thousand casualties.

MALSTATT-BURBACH, former German town, in the Saar Territory on the right bank of the Saar (Sarre), which separates it from Saarbrücken, with which it is now incorporated. Malstatt in 1321 received municipal rights which were afterwards resigned to the newer town of Saarbrücken, and in 1818 Malstatt and Burbach were only two small villages. About the middle of the century the population began to increase rapidly, in consequence of the development of industry and the extension of the railway system, and in 1874 the two villages were united to form a town. It lies in the midst of an important coal-mining and industrial district, and produces iron, steel and cement. In 1909 it was incorporated with other towns into the larger industrial centre of Saarbrücken (*q.v.*).

MALT, the name given to grain in which germination has been caused to proceed to a certain stage and has then been arrested by the removal of water and the application of heat. During this limited germination enzymes are developed (*see* FERMENTATION), and the constituents of the grain modified so that the finished malt, when ground and submitted to the mashing process (*see* BREWING), differs from the original raw grain in that the greater portion dissolves. This solubility is due for the most part to the action of the malt enzymes, diastase, etc., on the constituents of the grain. Thus starch, the main constituent of all graminaceous seeds, probably exists in much the same condition in raw grain and in malt. When, however, the malt is mashed, the starch is attacked by the enzyme diastase, and converted by the process of hydrolysis into a mixture of soluble compounds, *e.g.,* the crystalline sugar, maltose, together with isomaltose and glucose and a number of gummy substances known as maltodextrins. It is now known that proteolytic enzymes exist in finished malt, and that, when the mashing process is conducted under certain conditions, these are able to degrade and render more permanently soluble some of the higher proteins present. By the limited germination which constitutes the malting process, the soluble compounds left in the finished malt is from 15 to 25% of total weight of the corn.

Barley for Malt.—Barley belongs to the genus Hordeum, of which there are numerous species and varieties. Linnaeus and the earlier botanists recognized six species of cultivated barleys, but modern botanists usually consider all cultivated barleys as belonging to one species to which the name *H. sativum* has been given. Körnicke regards *H. spontaneum,* a very long thin-grained two-rowed barley (*see* below) which grows in the East as being the parent form; but E. S. Beaven inclines to the view that wild species of more than one form were originally used as food and subsequently cultivated.

Two-rowed barleys are favoured for malting purposes in Europe and are also grown to a certain extent on the Pacific coast of the United States.

Chevallier, a narrow-eared variety named for the original cultivator Rev. John Chevallier, and a wide-eared selection from this variety called Goldthorpe are widely grown although they have been replaced largely by hybrids in recent years.

In America, the six-row barleys are favoured, the principal plantings being of hybrid varieties of the former Manchurian types.

Much was gained through Wahl's study of the Oderbrucker variety although very little is grown today.

O.A.C. 21, a blue strain of Manchurian developed by the Ontario Agricultural college, and Wisconsin 38, a cross between Oderbrucker and a black smooth-awned barley, have been quite popular recently throughout the middle western sections of the United States and Canada.

In the common six-rowed English barley or Scottish bere the two lateral rows of spikelets springing from one side of the rachis either partially or entirely intersect and overlap the alternate lateral spikelets from the opposite side of the rachis. This has given rise to the term "four-rowed barley."

Barleys were formerly developed through "selection" methods but cross-fertilization has enabled the agronomist to combine the good qualities of certain strains in such a manner that both are improved.

Constitution of Barley.—A grain of barley is shuttle-shaped; the end containing the germ which was originally attached to the rachis is known as the proximal end, whilst the opposite end of the corn is called the distal end. A deep furrow runs down the more convex side, which is accordingly denoted the ventral side, the opposite side being distinguished as the dorsal side. Within the ventral furrow at the proximal end is the rachilla already referred to. The skin or husk of a barleycorn consists of two paleae, one adhering to the dorsal side (the palea inferior) and the other to the ventral side (the palea superior); the former overlaps the edges of the latter. The awn or beard is merely an elongation of the palea inferior. If the two paleae are removed from a barleycorn after soaking it in water, it will be seen that there are other skins completely enveloping the embryo and endosperm. These are the true skins, and are known as the pericarp and the testa respectively. Next to these skins will be seen the triple layer of thick-walled square-shaped aleurone cells.

The histology of the barleycorn is best studied by the examination of sections under the microscope. The grain consists of two main portions, the embryo or germ, and the endosperm, the storehouse of reserve materials for the growing plant.

Germination.—The barleycorn in its resting stage is in a state which may be described as one of dormant vitality; it respires very slowly and thus loses weight during storage. The best and driest barleys are said to lose 1·3% of their weight in the first year, 0·9% in the second, and 0·5% in the third. The loss is considerably more with coarse and damp samples. When the grain is steeped this dormant vitality gives place to that complicated series of processes comprised under the general term germination. When germination begins enzymes are secreted, and these act on the reserve materials, starch and proteins of the endosperm, converting them into simpler compounds, capable of diffusing to various parts of the growing germ. Following this, starch and proteins are reformed, the former being deposited in the tissues of the germ and in the cells of the scutellum, which previously were almost free from starch; the protein matter deposited in the latter disappears to a considerable extent, and the protoplasmic content of the cells assumes a very granular appearance. The pointed mass of cells constituting the root-sheath is pushed forward by the root which protrudes through the base of the grain. It is at this stage that the barley is said by the maltster to "chit." After the first rootlet has broken through the ends of the sheath, it is followed by others. The cotyledonary sheath begins to elongate on the third or fourth day of germination and ruptures the true covering of the seed; it then grows upwards between this and the husk and forms the acrospire or "spire" of the maltster.

Condition.—Barley is bought in the open market solely on the evidence of certain external signs, and judgment can only be acquired by very long experience. Immature barley feels cold to the hand, has a greenish-yellow colour, and, when dry, a starved wrinkled appearance. Over-ripeness in barley is distinguished by a white dead appearance of the corn. Mature or dry grains slip through the fingers more readily than unripe or damp ones. The contents of the endosperm should present a white friable or mealy appearance when the corns are bitten or cut in two with a penknife. The condition of the grain may be determined by an apparatus known as the diaphanoscope, which consists of a box fitted with a sliding tray, furnished with a certain number of shuttle-shaped holes (usually 500), each of such a size as just to hold a barleycorn longitudinally. Into the portion of the box below this tray an electric lamp is placed, and the corns are looked at from above. Thoroughly mealy corns are opaque, whilst steely corns are transparent. When certain portions of a corn are steely, these present the appearance of lakes. By this means the percentage of mealy, steely or half steely corns in a sample may readily be estimated.

E. Prior points out that steeliness of barley is of two kinds, one of which disappears after the grain has been steeped and dried, and therefore does not necessarily influence the malting value of the sample, and the other which is permanent, and therefore retards the modification of the corn. He proposed to determine what he called the coefficient of mealiness of a sample of barley by means of the formula:—

$$A = \frac{(M_1 - M)100}{100 - M} + M,$$

in which A is the degree of mealiness, M is the percentage of mealy corns in the original barley, and M_1 is the percentage of mealy corns after steeping and drying the barley. Prior points out that, generally speaking, the degree of mealiness varies inversely as the protein content.

Munro and Beaven confirming Johansen point out that "Mealy grains have a lower specific gravity than steely grains, and contain a larger amount of interstitial air. The total nitrogen content of mealy grains is less than that of steely grains. Steely grains contain a relatively high proportion of nitrogenous substances soluble (*a*) in 5% salt solution, and (*b*) in alcohol of specific gravity 0·9. Mealy barley modifies better than steely during germination. The process of drying damp and under-matured barley intact at 100° F produced an apparent mellowing or maturation. Other things being equal, maturation, which is physiologically a post-ripening process, is correlated with the mealy appearance of the endosperm." H. T. Brown and his collaborators state that thin sections of steely corns when examined under the microscope no longer exhibit a translucent appearance, but show the mealy properties as completely as if they had been cut from a mealy grain, and they suggest that in a steely corn the whole of the endosperm is under a state of tensile stress which cannot be maintained in the thin sections. If, however, a thin section of a steely barley be cemented to a slide with Canada balsam and then pared away with a razor, steeliness may be preserved even in the thinnest sections. Brown and his co-workers determine the coefficient of mealiness of a barley as follows: Five hundred corns are cut transversely in a corn cutter and the percentage of mealy, half mealy and steely corns is noted. The number 100 is taken to represent complete mealiness, 1 complete steeliness, and 50 the intermediate class. If the percentage of each class be multiplied by its special value, and the sum of the products divided by 100, the result is the coefficient of mealiness. By steeping and drying a very steely Scottish barley the coefficient of mealiness was raised from 29·7 to 87·1, whilst concurrently the specific gravity fell from 1·417 to 1·289.

Barley even of the same kind varies widely in its chemical composition, but on an average the proximate constituents of British malting barleys lie within the following limits:—

	%
Moisture	18 —12
Nitrogenous matters expressed as proteins	8 —15
Fat	2 — 2·5
Starch	42 —50
Sugars	1·5— 2·0
Hemi celluloses, pectins, etc.	8 —10
Fibre, cellulose, etc.	5 — 7
Ash	2 — 2·5

Any sample of barley which contains more than 20% of moisture would be considered damp. The late Prof. Lintner expressed the view several years ago that a good malting barley should not contain more than 10% of protein, but R. Wahl asserts that in America six-rowed barleys containing a far higher percentage of protein have been used successfully, indeed preferably, for malting purposes. A summary of our knowledge of the nitrogenous constituents of barley and malt was published by H. F. E. Hulton in 1922. According to T. B. Osborne barley contains the undermentioned proteins in the following proportions:—

		%
Soluble in water:	Leucosin (albumin), Proteose	0·30
Soluble in salt solution:	Edestin (globulin)	1·95
Soluble in 75% alcohol:	Hordein	4·00
	Insoluble protein	4·50
Total		10·75

Raw barley contains enzymes, thus diastase of translocation, so called by Horace T. Brown and G. H. Morris, and catalase (H. van Laer). Proteolytic enzymes appear only to arise with the beginning of germination; but it has been asserted that raw barley contains proenzymes (zymogens), which can be rendered active by treatment with dilute lactic acid at an appropriate temperature. The action of the diastase of raw barley on starch has been studied by Julian L. Baker. According to Ling and Nanji the diastase of barley converts the α amylose constituent of starch into maltose and the amylo-pectin constituent into $\alpha\beta$ hexa-amylose.

Maturing and Storage.—Barley should not be cut until it is properly ripe, but over-ripeness is much more to be guarded against. Very wet seasons are prejudicial to the ripening of the grain, and when the latter is stacked in too moist a condition it is apt to become what is known as mow burnt. This results in the corns becoming black at the tips; they are then said to be magpied. H. T. Brown and F. Escombe find that maturation is attended by deformation and ultimate disintegration of the cell nuclei. The change which is denoted by the term nuclear senescence is said to begin in the starch-containing cells, near the periphery of the corn, immediately underlying the layer next to the aleurone layer. This deformation is followed by complete disintegration of the nucleus, and at the end of seven or eight days nearly the whole endosperm has been involved. Malting barleys should weigh 52–56 lb. per bushel, the standard weight for malting barleys being 56 lb.

During the storage of barley access of air is necessary, otherwise the grain dies from asphyxiation. Sound barley after being kiln-dried retains its vitality for a number of years; but the statement that the corns found in the Egyptian mummy cases, in which they had remained for several thousands of years, were still capable of germination, is contrary to modern experience. Moisture must also be carefully excluded, as it initiates germination in a few cells only of the endosperm and causes heating. A constant repetition of wetting such as may take place on account of alterations of the atmospheric temperature, which causes moisture to be deposited, in the form of dew, may ultimately destroy the vitality and foster the growth and development of mould fungi which usually grow on broken and damaged corns. In this connection the advantage of screening and sweating of barley before storing it will be apparent.

An immense amount of damage is caused to the grain, during storage, by various insects, one of the most destructive of these being the common weevil (*Calandra granaria*). When fully developed this insect measures $\frac{1}{6}$ to $\frac{1}{8}$ of an inch in length, and is of a bright chestnut colour. The larvae are freshly legless grubs, shorter than the perfect insect, with a series of tubercles along each side of the body; the head is round with strong jaws. The pupa is white, clear and transparent, showing the form of the future weevil. The female bores a hole in the grain with her snout and deposits an egg. The larva when hatched lives on the contents of the grain and undergoes its changes therein. Grain which is only slightly attacked should be kilned at a temperature of 122° F., which destroys the weevil in all stages of development. To detect weevil in a sample of barley, the grain should be spread out on a sheet of white paper in bright sunlight. If weevils are present they soon appear, and betake themselves to a position outside the sunlight, to which they are averse.

Malting.—There are two systems of malting used in England—floor malting and pneumatic or drum malting. These systems will be described separately.

A floor malting consists of a rectangular building of several storeys, having the cisterns at one end and the kilns at the other. The uppermost floor is devoted to barley.

On arrival at the malting the barley has to be put through the following operations seriatim: receiving, hoisting and weighing, rough screening, drying and sweating, storing until required for use, screening, grading and removing broken corns, steeping, couching, flooring, withering, drying and curing, dressing and polishing, storing, weighing, sacking and discharging the finished malt.

In sweating barley the temperature should not be allowed to rise above 120° F.; it is usually conducted at 100° F.; and subsequently the barley should be stored for some weeks before it is steeped.

The capacity of a malting is described by the number of quarters which can be put through it every four days. A fifty quarter malting does not merely mean that the cisterns have a capacity of fifty quarters, but that this quantity of barley goes through the house every four days. The average time the germinating barley is on the floors is 12 days, and, as a rule, kilning occupies four days. If, as sometimes happens, the malt has to be kept on the floors 13, 14, 15 days, or even longer, the malting is not being worked at the capacity under which it is described, and the kilns may remain unused for a day or more. Conversely, when the malt is loaded at less than 12 days, a day or two has to be missed in steeping. In the former case when the kilns are not being used for drying and curing malt, advantage may be taken to utilize them for sweating barley.

Steeping cisterns were formerly rectangular vessels, of slate, brick or cement, from which the barley had to be discharged by shovelling it out. The forms approved most at the present day are conical and constructed of iron; they have arrangements at the apex of the cone, the lower portion, for discharging the grain by gravitation. The steeping period ranges from 48 to 70 hours; it varies according to the kind of barley, and the time of the year. In some of the older maltings there are no arrangements for heating the steep water, and in the winter steeping has occasionally to be performed with water at a temperature near its freezing-point. Steeping should be carried out at a temperature as near as possible to 55° and not higher than 60° F. The usual practice is to fill the cistern up to a certain height with water and throw the barley into it, stirring it until it is about level; the normal corns will then sink directly to the bottom, whilst the light corns and refuse float on the surface and may be skimmed off. During the time the barley remains in the cistern it is usual to change the steep water two or three times, generally at intervals of 12 hours or tides. The advantage of this is not merely to keep the grain fresh and sweet, but to bring it into contact with the air during the time it is taking up water. Aëration of the steep has long been recognized in Germany as promoting germination, and several arrangements are on the market enabling air to be passed through the grain while it is in the cistern. It has been recommended by Graham, Stopes, Moritz and Morris, and experimental evidence as to its beneficial effects has been published by Windisch, Bleisch, Will and Baker and Dick. When the corn is steep ripe it contains some 50% of water. Steeping does not consist, however, merely in the imbibition of a certain amount of water; in order to bring about germination this water must remain within the corn a certain length of time. The following average data are useful to remember in connection with the steeping process:—Amount of water in steep-ripe barley (about) 50%. Matter removed from barley during steeping (about) 1·5%. Increase in volume of barley due to water absorption (about) 18–20%.

There has been much discussion as to the influence of saline matters in water on the steeping process. Professor Lintner stated that common salt in water tended to extract the nitrogenous constituents of the grain, but impeded its germination. Mills and Pettigrew found that waters containing calcium salts extracted a minimum of nitrogenous compounds from the barley; they also came to the conclusion that the esteem in which the Lichfield water is held for steeping purposes is due to the presence of nitrates which, they assert, have a stimulating effect on the subsequent germination of the grain. The writer has added lime-water to the extent of one-third of the total volume of water at the first change, believing it to promote regularity of germination. Bearing in mind, however, the observations of Adrian J. Brown, that the barleycorn is enclosed in a membrane permeable to water but impermeable to most salts, it is difficult to see how the saline constituents of water can have any effect except in removing matter from the external portions of the grain and on those corns which are broken. The apparent beneficial effect of lime-water in the steep is probably entirely due to the removal of matters from the husks or paleae.

Malting floors may be constructed of cement, tiles or slate, the two former being preferable to the latter. Ford, in 1849, recommended 200sq.ft. per quarter of barley steeped as the area of the working floors, and he was quite convinced of the necessity of allowing ample floor room, so that the grain could be worked on the slow, cool system. Subsequently, however, maltsters reduced their floor area, and put the grain rapidly through the malting, thus producing what is termed "forced" malt. At the present time the approved area may be placed at 175–200sq.ft. per quarter of barley steeped. The area is, however, largely ruled by the kind of barley to be malted.

After the barley has been thrown out of the cistern it is made up in a rectangular heap 16–20in. deep, called the "couch"; the object of this is to enable it to gather heat and so start germinating. It usually remains in couch for 12–24 hours, until in fact the interior portion of the heap registers a temperature of about 60° F. During the days of the malt tax the exciseman gauged the quantity of the barley while it was in the couch. After couching the barley is spread thinly and evenly on the floor, forming what is known as the young floor or No. 1 piece. The first visible sign of germination is the sprouting of the rootlet, termed "chitting," and this occurs either while the grain is on the couch or on the young floor. As already mentioned, it may be quickened by aërating the grain in the cistern. From the time the barley is first cast out of the cistern up to the stage of the young floor, or No. 1 piece, it has a pleasant odour resembling apples.

The thickness at which the young floor is spread depends upon the outside temperature and the nature of the barley. If the weather be warm, or if there be a tendency for the barley to heat, the piece must be spread all the thinner. At this stage the grain loses its external wet appearance. When spread too thickly the grain will begin to sweat, and the rootlets will be thrown out suddenly and unevenly. As a rule, under these circumstances, the rootlets will be long and thin, when they are said to be "wild." A piece which has been allowed to get into this condition must at once be spread thinner. If the sweating has not continued long, the harm done may be confined to increased loss by respiration. The young floor is usually turned with a plough twice during 12 hours, and it may be forked between whiles, but no hard and fast rule can be laid down as to when this is necessary; it must be left to the maltster's judgment, as it depends entirely on what is going on within the grain. The object of turning is in the first place to aërate the grain and freshen it, secondly to check excessive rise of temperature, and thirdly to promote evenness of growth. Too frequent turning is not to be advised. After remaining four days on the young floor three or four rootlets should have appeared, and the acrospire should have begun to grow up the back of the corn. The apple-like odour of the piece then gives place to one resembling that of the common rush, and this should continue the whole time that the malt remains on the floor. On the fifth day the piece is next moved to No. 2 position, a stage nearer the kiln. It is here that sprinkling is resorted to when necessary. The amount of the sprinkling and the time it is given cannot be exactly prescribed. The amount may vary from one to five gallons per quarter, and it should only be given when the rootlets, which ought to be short and curly, and five or more in number, show signs of losing their freshness. If an excessive amount of sprinkling be given forced growth ensues. It is preferable not to add the whole of the water at one time, but to divide it over two lots; and immediately after the piece has been sprinkled it should be thoroughly and carefully mixed, otherwise some of the grain will receive an undue proportion of water. When all the sprinkling water has been given to the piece, which as a rule should not be done later than at the sixth or seventh day of flooring, the temperature should be kept down to about 55° F. by turning. Too frequent turning may, however, detach the rootlet, and it may cause the grain to lose its vitality prematurely, so that growth of the acrospire stops.

By about the eighth day of flooring the acrospire should be on an average about three-quarters up the corn. After this the germinating corn is moved forward to No. 3 piece, which is at first spread as thinly on the floors as in the previous pieces. Here it gradually dries and incipient withering of the rootlets sets in. The only treatment which is now given to the grain is to heap it up thicker and thicker by degrees until it is ready for loading on the kiln. This increase in thickness of the piece (now called the old piece) should not be too sudden, especially if the grain be fresh in appearance and contain a large quantity of water. When the piece is thickened up to say 10in. in depth, while it is in a very moist condition, heating and sweating take place, with additional growth of acrospire and rootlet. Under such forcing conditions a large production of sugar and degradation of the proteins will take place. When, however, the moisture has been gradually reduced before thickening up, the rootlet dies off; and although increase of temperature may occur, this is accompanied by little or no further growth of the acrospire, action being confined to the mellowing of the grain by the enzymes. When the malt is ready for loading on the kiln it should be possible to break down the contents of each corn between the thumb and finger. Opinions differ as to what the final temperature on the withering floor should be. If the moisture content of the malt be about 50%, the piece must be kept thin to avoid sweating. But under these conditions mellowing does not occur, hence the necessity of reducing the moisture content gradually after the last sprinkling water has been given. When the process has been conducted properly the temperature of the old piece may be allowed to rise as high as 70° F. during the six hours previous to loading. The moisture content of the green malt when loaded should not be much above 40%.

The endosperm of green malt which is ready for the kiln should be soft and mealy, and should not exude moisture when pressed between the thumb-nails, but should crumble and disintegrate to a chalky mass having little or no adhesiveness.

The foregoing observations are not to be regarded as hard and fast rules, but they are simply intended to give some indication of the malting process when it proceeds on normal lines; it may be that on account of the presence of damaged corns the piece begins to develop mould by about the tenth day, and it then has to be kept thin and sometimes even loaded on kiln prematurely.

The malt made for grain distillers, in which a high diastatic activity is required, is manufactured on quite different lines from those above indicated. It is often sprinkled late, and loaded on kiln often in a sodden condition. In some cases sprinkling on kiln is resorted to, but it is doubtful if this leads to the desired object. Other things being equal, the smaller the corns—*i.e.*, the greater number of embryos in a given weight—the higher the diastatic activity of the malt. In selecting a barley for the production of highly diastatic malt, the diastatic power of the original raw grain is a factor of great importance.

Kilning.—When loaded on kiln, malt intended for brewing ale and stout is, if properly withered, in a moribund condition; nevertheless, during the first stages of the kilning process a certain amount of vital activity is manifested, and the malt undergoes mellowing by the action of enzymes on the contents of the endosperm. If the malt be loaded while the rootlets appear fresh on account of the presence of too much moisture, rapid growth of the acrospire ensues, giving rise to overshot corns, known as "cock spurs." To check this the moisture must be rapidly removed by the passage of large volumes of air through the malt. But under such circumstances mellowing does not occur. The ideal conditions of kilning are when the malt has been properly withered on the floors before loading, and, assuming that drying and curing occupy four days, that 25–30% of the moisture be removed very gradually, this occupying the first three days, at the end of which the malt is said to be hand-dry. The thickness at which the malt is spread on the kiln should not exceed 7–8 in., and until hand-dry (that is to say, reduced to a moisture content of 12–15%) it should not be turned; if moved at all (and that only is necessary when reek occurs), it should only be lightly forked. The rate at which the temperature is raised depends largely on the kind of malt to be made and the construction of the kiln. If high flavour and colour are required, these are produced by keeping the malt for several hours near a temperature of 160° F. while it still contains 12–15% of moisture. If more than this amount of moisture be present when the temperature reaches the limit just mentioned, the conditions known as stewing would obtain, with the result that "forced" malt would be produced. A certain amount of colour is produced at the final temperature to which the malt is raised; but when such means are relied upon for the production of the greater part of the colour, reduction of extract and deficiency of flavour follow, the colour being then almost exclusively the result of caramelization of the carbohydrates.

The so-called curing stage constitutes the last part of the kilning process, and the malt must then be turned frequently to ensure uniformity of action. Mechanical turners are exceedingly useful for this purpose. Curing in a drum, as in the so-called pneumatic malting process, also effects satisfactory curing.

The following table will give an idea of the kilning temperatures usually employed for the three kinds of malt mentioned, but it must be remembered that these temperatures are largely regulated by the construction of the kiln and the amount of draught available. In this connection it may be mentioned that the final curing temperature is not necessarily a criterion of the tint of the malt. A malt may have been finished off at a very high temperature and still be a pale malt, provided the moisture percentage has been sufficiently reduced in the initial stages of kilning.

Day temp.	Pale malt.	Running ale malt.	Amber malt.
1st .	90–100° F.	90–100° F.	90–100° F.
2nd .	100–120	100–120	100–130
3rd .	120–130 (10 hrs.)	120–130 (6 hrs.)	130–150 (6 hrs.)
3rd .	130–180 (8 hrs.)	130–150 (12 hrs.)	150–160 (12 hrs.)
3rd .	180–190 (6 hrs.)	150–180 (6 hrs.)	160–180 (6 hrs.)
4th .	Drop to 170 (12 hrs.)	180–190 (12 hrs.)	180–200 (12 hrs.)
4th .	..	190–200 (6 hrs.)	200–220 (6 hrs.)
4th .	..	Drop to 180 (6 hrs.)	Drop to 190 (6 hrs.)

The average laboratory values obtained from malts of the descriptions after about two months' storage should be as follows:—

	Pale malt.	Running ale malt.	Amber malt.
Extract per standard quarter of 336 lb . . .	95–98 lb.	94–96 lb.	94–96 lb.
Moisture	about 2·0% in each case.		
Diastatic activity (Lintner)	30–35	20–30	8–10
Tint (Lovibond 52 series neutral)	3–5	6–8	20–25

Metabolic Changes.—All through the malting process metabolic changes are proceeding in which both carbohydrates and proteins are concerned. In its resting stage the embryo of a barleycorn is generally free from starch; as soon as germination sets in, however, starch appears in the scutellum, while the amount of sucrose there present increases, these being apparently formed from maltose originating from the action of diastase on the starch of the endosperm. Sucrose also augments in the aleurone layer, but starch is never formed in the aleurone cells. These changes occur when the malt is first loaded on kiln.

Fuel.—The fuel used for drying and curing malt is either anthracite or coke, and the greatest care is necessary in selecting it on account of its liability to contain arsenic, which is to a greater or less extent an invariable constituent of all coal. The fuel used for malting purposes should not contain more arsenic than $\frac{1}{20}$ grain per pound. Gas coke should on no account be used, unless it has been proved to be sufficiently free from arsenic; but the best oven coke frequently contains so little arsenic that it may be employed with perfect safety, especially if it be mixed with a proportion (*e.g.*, 5%) of milk of lime, which retains the arsenic as calcium arsenate. In Germany malt is, as a rule, dried and cured with hot air, whilst in Great Britain the products of combustion are passed through the malt, as it is believed that they exert a beneficial influence on the flavour.

Storing the Malt.—After the malt has passed through the curing stage it is generally heaped up for a few hours. This is believed to increase its flavour. The malt is then stripped from the kiln, and the rootlets, technically known as the coombs, are removed. Formerly this was effected by workmen treading the malt, who wore heavy boots for the purpose. At the present time, however, the rootlets are usually removed by machinery, special forms of which have been devised for this as well as for dressing and polishing the malt. It is the custom of some maltsters to store malt with the rootlets still attached; but this is an objectionable practice, since malt coombs attract moisture, and the presence of more than 3% of moisture in malt produces the condition known as "slackness." When the malt is packed in bins it is often covered with a layer of coombs, which then prevent access of atmospheric moisture. Malt, to preserve its good qualities intact, should be stored in bins made as nearly as possible air-tight, and it should never be placed in bin until it is quite cool. It is probably wrong to store malt in bins adjacent to the kilns, where it is kept at a higher temperature than that of the surrounding atmosphere. During storage of the malt a kind of mellowing occurs, the mechanism of which is not understood. It is, however, known by practical brewers that the best results cannot be obtained when new malt is used.

Compartment Malting.—The tremendous amount of labour involved in the floor malting system has prompted many inventions and developments to mechanize the procedure. The so-called Saladin system is best known of these and permits the germinating piece to be held in large rectangular boxes or bins. The grain is then turned by means of vertical helices which traverse the length of the compartment. This mechanical turning has replaced practically all floor malting today.

Pneumatic Malting.—Several years ago Galland suggested germinating barley in a drum, his idea being to do away with handling of the grain, and also to be independent of changes of atmospheric temperature. The latest development of this system, the so-called Galland-Henning process of pneumatic malting, has been improved by Mr. R. Blair Robertson. The drums are provided with a perforated channel for the passage of air through the malt, which is packed in the annular space between this channel and the outside wall of the drum. Each drum is capable of revolving on its axis, and there are arrangements for passing either moist, saturated or dry air through the malt. The system as now improved is capable of producing some of the best malt, especially if, after germination has been completed in the drums, the green malt is loaded on an ordinary kiln and the initial stages of kilning conducted in the usual way; the curing, however, may be carried out successfully in a special form of drum.

Yield and Weight.—The malting process is attended with a certain amount of loss of dry substance of the barley, as follows:—

In the steep	1·5 to 2·0%
By respiration on floors and on kilns	3·0 to 5·0%
Coombs	3·5 to 5·0%

In addition to this, barley, as already mentioned, contains from 12 to 18% of moisture, whereas finished malt contains 1 to 2%. The total loss in weight which barley undergoes in the malting process may be put down at from 17 to 28%. Since, however, malt is lighter than barley (and the quantity of both was in former years measured exclusively by volume) it frequently happens that a given number of quarters of barley yield a large number of quarters of finished malt. When this happens it is usual to speak of an increase having been obtained. At the present time weight replaces measure for both barley and malt, and although it is usual to speak of the quantity of grain in terms of quarters, what is meant is not the measured quarter, but so many weighed standard quarters. The standard quarter for English malting barley is 448 lb. and for malt 336 lb. From this it will be seen that when a given number of weighed quarters of barley yields the same number of quarters of finished malt, the actual yield is 75%, and there is then said to be neither increase nor decrease. As a rule, in practical working the yield of malt varies from a 4% decrease to a 10% increase, corresponding to an actual yield on the original barley of 72 to 82·5%. J. Baverstock, an old writer, says that finished malt should weigh one-fifth less than the barley from which it is produced. This corresponds to a malting increase of about 7%, which is a high yield. As a rule, foreign barley will give a greater malting increase than English barley, because, on the one hand, the former usually contains less moisture than the latter, and, further, because there is less loss on the floors by respiration and rootlet growth.

The yield of malt from barley may be determined in the laboratory in an extremely simple manner. Since every grain of barley must yield a grain of malt, if we know the respective weights of a definite number of barley and malt grains, provided that this number is large enough to represent the average, then obviously this gives the data requisite for calculating the yield of malt from barley. The number of corns the weight of which is determined for this purpose is usually 1,000, and if the weight of this number be determined on several different 1,000 corns, the average will closely approximate to the truth. Instead of counting the corns by hand, an instrument may be used for this purpose.

If 1,000 corns of a barley were found to weigh 42 grammes, and 1,000 corns of a finished malt from the same barley 32 grammes, then the yield of malt is $\frac{32 \times 100}{42} = 76{\cdot}1$, this corresponding to a 1% increase. Assuming that the moisture content of the barley was 15% and that of the finished malt 2%, 100 grammes of malt will contain 2 grammes of moisture, and 76·1 grammes will contain $\frac{76{\cdot}1 \times 2}{100} = 1{\cdot}5$ grammes moisture; therefore 76·1 grammes of malt contain $76{\cdot}1 - 1{\cdot}5 = 74{\cdot}6$ grammes of dry matter. This was obtained from $100 - 15 = 85$ grammes of barley dry substance. Hence 100 parts of barley dry substance will yield $\frac{74{\cdot}6 \times 100}{85} = 87{\cdot}7$, corresponding with a loss of dry substance equal to 12·5% of the dry substance of the barley, or with a loss of 10·7% on the barley containing 15% of moisture.

The results obtained by this method of laboratory control when it is accurately carried out agree very closely with those deduced from the practical results of weighing the barley, malt and coombs in the malting.

Special Malts.—In addition to the kinds of malt considered in what precedes, there are others mostly used for imparting specific flavours and colour to beers and stout. These are crystal malt, imperial malt, brown or blown malt, and black or roasted malt. Crystal malt is grown for a shortened period on the floors, and then placed in a wire cylinder, which is rotated over a fire so that it is dried at a very high temperature. The weight per quarter is from 250 to 280 lb. Imperial malt is dried off on an ordinary kiln at a final temperature of 240–270° F., but it is not allowed the usual length of time on the withering floor. It is placed on the drying kiln in a layer not exceeding one inch and a half in thickness. A moderate heat from burnt wood is applied until the bulk of the moisture has been driven off, when the temperature is suddenly raised so that the grains swell 25% and the malt takes up a strong empyreumatic flavour from the products of combustion. This malt weighs 270–300 lb. per quarter. Black or roasted malt is prepared by roasting malt in a cylinder. Its weight per quarter varies as much as from 215 to 290 pounds.

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MALTA. The Maltese Islands are situated between Europe and Africa, in the central channel which connects the eastern and western basins of the Mediterranean Sea. The group belongs to the British Empire and consists of Malta, 91 sq.mi., Gozo (*q.v.*) 26 sq.mi., Comino, 1 sq.mi., and the uninhabited rocks called Cominotto and Filfia. Malta (lat. of Valletta Observatory 35° 53′ 55″ N., long. 14° 30′ 45″ E.) is about 60 mi. from the nearest point of Sicily, 140 mi. from the mainland of Europe and 180 mi. from Africa; it has a magnificent natural harbour.

Malta is about $17\frac{1}{2}$ mi. long by 9 broad; Gozo is $8\frac{3}{4}$ by $4\frac{1}{2}$ mi. This chain of islands stretches 29 mi. from northwest to southeast. On the southwest the declivities towards the sea are steep, and in places rise abruptly from deep water some 400 feet. The general slope of these ridges is towards the northeast, facing Sicily and snow-capped Etna, the source of cool evening breezes. The Bingemma range, rising 726 ft., is nearly at right angles to the axis of the main island. The geological "Great Fault" stretches from sea to sea at the foot of these hills. There are good anchorages in the channels between Gozo and Comino, and between Comino and Malta. In addition to the harbours of Valletta, there are in Malta, facing northeast, the bays called Mellieha and St. Paul's, the inlets of the Saline, of Madalena, of St. Julian and of St. Thomas; on the southeast there is the large bay of Marsa Scirocco. There are landing places on the southwest at Fomh-il-rih and Miggiarro. Mount Sceberras (on which Valletta is built) is a precipitous promontory about 1 m. long, pointing northeast. It rises out of deep water; well-sheltered creeks indent the opposite shores on both sides. The waters on the southeast of Valletta form the "Grand Harbour," having its entrance between Ricasoli Point and Fort St. Elmo. The series of bays to the northwest, approached between the points of Tigne and St. Elmo, is known as the Marsamuscetto (or Quarantine) Harbour.

Geology and Water Supply.—The Maltese Islands consist largely of Tertiary Limestone, with somewhat variable beds of Crystalline Sandstone, Greensand and Marl or Blue Clay. The series appears to be in line with similar formations at Tripoli in Africa, Cagliari in Sardinia, and to the east of Marseilles. To the southeast of the Great Fault (already mentioned) the beds are more regular, comprising, in descending order, (*a*) Upper Coralline Limestone; (*b*) Yellow, Black or Greensand; (*c*) Marl or Blue Clay; (*d*) White, Grey and Pale Yellow Sandstone; (*e*) Chocolate-coloured nodules with shells, etc.; (*f*) Yellow Sandstone; (*g*) Lower Crystalline Limestone. The Lower Limestone probably belongs to the Tongarian stage of the Oligocene series, and the Upper Coralline Limestone to the Tortonian stage of the Miocene. The beds are not folded. The general dip of the strata is from west-south-west to east-north-east. North of the Great Fault and at Comino the level of the beds is about 400 ft. lower, bringing (*e*), the Marl, in juxtaposition with (*g*), the semi-crystalline Limestone. Mammalian remains found in Pleistocene deposits are of exceptional interest. Among the more remarkable forms are a species of hippopotamus, the elephant (including a pigmy variety), and a gigantic dormouse. In the Coralline Limestone the following fossils have been noted:—*Spondylus, Ostrea, Pecten, Cytherea, Arca, Terebratula, Orthis, Clavagella, Echinus, Cidaris, Nucleolites, Brissus, Spatangus;* in the Marl the *Nautilus zigzag;* in the Yellow, Black and Greensand shells of *Lenticulites complanatus,* teeth and vertebrae of *Squalidae* and *Cetacea;* in the Sandstone, *Vaginula depressa, Crystallaria, Nodosaria, Brissus, Nucleolites, Pecten burdigallensis, Scalaria, Scutella subrotunda, Spatangus, Nautilus, Ostrea navicularis* and *Pecten cristatus.*

The Blue Clay forms, at the higher levels, a stratum impervious to water, and holds up the rainfall, which soaks through the spongy mass of the superimposed coralline formations. Hence arise the springs which run perennially, several of which have been collected into the gravitation water supplies of the Vignacourt and Fawara aqueducts. There is no river or rivulet in the island, however, and the larger part of the water supply is pumped from strata at about sea-level.

Climate and Hygiene.—The climate is, for the greater part of the year, temperate and healthful. During the winter the weather is pleasantly cool and sometimes cold, owing to the strong winds, but there is much bright sunshine, and the air is clear and invigorating. The thermometer records an annual mean of 64.5° F. Between June and September the temperature ranges from 75° to 90°; the mean for December, January and February, the three coldest months, is 56°, the mean maximum being 65.5° and the mean minimum 46.6°. Pleasant northeast winds blow for an average of 150 days a year, cool northerly winds for 31 days, east winds 70 days, west for 34 days. The northwest "Gregale" (Euroclydon of *Acts* xxvii, 14) blows about the equinox, and occasionally, in the winter months, sometimes with almost hurricane force for three days together; it is recorded to have caused the drowning of 600 persons in the harbour in 1555. This wind was a constant menace to shipping at anchor; the breakwater on the Monarch shoal was designed to resist its ravages. The "Sirocco," an enervating southeast wind, blows at intervals during the summer months, causing close, damp and misty weather. The regular tides are hardly perceptible, but, under the influence of barometric pressure and wind, the sea-level occasionally varies as much as 2 ft. Rainfall is irregular; it averages 21 in., varying from 12 to 27 in. in the year. However, rainfall is uncertain, and periods of drought have extended over three years. Snow is seen once or twice in a generation; violent hailstorms occur. Undulant fever was traced by Sir David Bruce to a *micrococcus melitensis.* There is a modern system of drainage.

Flora.—It is hardly possible to differentiate between imported and indigenous plants. Among the marine flora may be mentioned *Porphyra laciniata,* the edible laver; *Codium tomentosum,* a coarse species; *Padina pavonia,* common in shallow water; *Ulva latissima; Haliseris polypodioides; Sargassum bacciferum;* the well-known gulf weed, probably transported from the Atlantic; *Zostera marina,* forming dense beds in muddy bays; the roots are cast up by storms and are valuable as a fertilizer to dress the fields. Among the land plants may be noted the blue anemone; the ranunculus along the road-sides, with a strong perfume of violets; the Malta heath which flowers at all seasons; *Cynomorium coccineum,* the curious "Malta fungus," formerly so valued for medicinal purposes that a guard was set for its preservation under the rule of the Knights; the pheasant's-eye; three species of mallow and geranium; *Oxalis cernua,* a very troublesome imported weed; *Lotus edulis; Scorpiurus subvillosa,* wild and cultivated as forage; two species of the horseshoe-vetch; the opium poppy; the yellow and claret-coloured poppy; wild rose; *Crataegus azarolus,* of which the fruit is delicious preserved; the ice-plant; squirting cucumber; many species of *Umbelliferae; Labiatae,* to which the spicy flavour of the honey (equal to that of Mt. Hymettus) is ascribed; snapdragons; broom-rape; glasswort; *Salsola soda,* which produces when burned a considerable amount of alkali; there are 15 species of orchids; the *gladiolus* and *iris* are also found; *Urginia scilla,* the medicinal squill, abounds with its large bulbous roots near the sea; 17 species of sedges and 77 grasses have been recorded.

Fauna.—There are four species of lizard and three non-venomous snakes; a land tortoise, a turtle and a frog. Of birds very few are indigenous; the jackdaw, blue solitary thrush, spectacled warbler, the robin, kestrel and the herring-gull. Over 200 migratory bird-species have been enumerated. The only wild mammalia in the island are the hedgehogs and two species of weasel.

Malta has several species of zoophytes, sponges, mollusca and crustacea. Insect life is represented by plant-bugs, locusts, crickets, grasshoppers, cockroaches, dragon-flies, butterflies, numerous varieties of moths, bees and mosquitoes.

Among the fish may be mentioned the tunny, dolphin, mackerel, sardine, sea-bream, dentice and pagnell; wrasse, of exquisite rainbow hue and good for food; members of the herring family, sardines, anchovies, flying-fish; sea-pike; a few representatives of the cod family, and some flat fish; soles (very rare); *Cernus* which grows to large size; several species of gray and red mullet; 11 species of *Triglidae,* including the beautiful flying gurnard; and 18 species of mackerel, all migratory.

People.—The upper classes have Norman, Spanish and Italian blood. The knights of St. John, commonly called "of Malta," were drawn from the nobility of Catholic Europe. They took vows of obedience and celibacy. At the time of the British occupation there were about two dozen families bearing titles of nobility granted, or recognized, by the Grand Masters, and descending by primogeniture. No government has ever recognized papal titles in Malta.

In appearance the Maltese are a handsome race, about the middle height, well formed and sturdily set up; they have escaped the negroid contamination by former importations of black troops noticeable in Sicily, and their features are less dark than those of the southern Italians. The women are generally smaller than the men, with black eyes, fine hair and graceful carriage. They are a thrifty and industrious people, prolific and devoted to their offspring, good-humoured, quick-tempered and impressionable. The Maltese are adherents to the Roman Catholic Church.

The phenomenal congestion of population gives interest to records of its growth; in the 10th century there were 16,767 inhabitants in Malta and 4,514 in Gozo. Estimates made at the arrival of the Knights (1530) varied from 15,000 to 25,000, and at the end of their rule (1798) the population was estimated at 100,000. Subsequently the population more than doubled, and in the 20th century there was a net average increase of nearly 3,000 a year. Including Gozo and Comino, the civil population on Dec. 31, 1938, was 268,668, giving a density of 2,277 to the sq.mi., compared with a density of 468 in the United Kingdom. Emigration largely reduced the overcrowding. Besides the considerable Maltese population found in the United States, colonies were built up throughout the Mediterranean (especially Egypt) and in Tunisia. (St.; X.)

Language.—For the most part the people have no racial affinities in Europe and, high and low, all speak among themselves the Phoenician Maltese, a tongue akin to Syriac and Arabic. It is altogether different from the Italian language; the latter is spoken with a limited vocabulary and peculiar intonation by only about one-sixth of the population. However, although Maltese was the medium of daily intercourse and business in the island, it had no official standing until 1933, the two official languages being English and Italian. In 1934 letters patent removed Italian from its position as one of the two official languages and provided that "the English language, as the official language of the British Empire, and the Maltese language, as the language of the people of Malta, shall be the official languages of Malta." The use of Italian was discontinued in the courts and schools (*see* below), and a knowledge of Maltese was required of all candidates for admission to the public service.

Legislation.—Latin was the language of the courts until 1784, and was not completely supplanted by Italian until 1815. Maltese were liable for trial in the courts in Italian, to them a foreign language, until 1933, when trial in their own language was permitted for the first time. In 1934 Maltese succeeded Italian as the official language of the courts, and Italian was removed from the faculty of law in the university. The laws of Justinian remained the basis of the common law, the code of Rohan was not altogether abrogated, and considerable weight was still given to the Roman canon law. Civil law was framed mainly on the Napoleonic code, with substantial alterations to meet the conditions and usages of the population. The commercial maritime laws were taken from the French commercial code and contained provisions from the Merchant Shipping act of the United Kingdom.

Education.—Elementary education is free in government schools, of which, in 1938–39, there were 157 (94 day schools and 63 night schools), with an average attendance of 32,735 pupils. In 1924 it was laid down that a parent, although at liberty to decide whether his children should or should not go to school, had to leave them therein, once admitted, until they reached the age of 14 or, alternately, until they passed the final examination of the highest class in their school. The two departments of elementary and secondary education were merged in 1933, and three years later a preparatory secondary school was opened for children who had not attended the government elementary schools but desired preparation for secondary education. The Montessori method was introduced in Malta in 1936. One central school for boys and three central schools for girls provided special secondary school courses for those planning to become teachers. The government also maintained a lyceum for boys and a secondary school for girls. The university, founded in 1769, had in 1938–39 an average attendance of about 150 students. Low fees were payable at the lyceum and the university.

About the middle of the 19th century a mixed system of both English and Italian, called *pari passu,* was adopted as the basis of Maltese education. This was followed by a new system of education based on the principle of beginning from the bottom, by teaching to read and write in Maltese as the medium for assimilating, at a later stage, either English or Italian, one at a time, and aiming at imparting general knowledge in colloquial English. Parents and guardians were called upon to select whether each child should learn English or Italian next after learning reading, writing and arithmetic in Maltese. However, the teaching of Italian in all grades again became general, and it was not until 1923 that the teaching of that language was abolished in the infant schools and in the first and second years of the elementary schools. In 1933 the teaching of Italian was discontinued in all grades of the elementary schools, both Maltese and English being taught in all government educational institutions, and the department of education produced textbooks of Maltese history, told in the Maltese language. A British institute was founded in Valletta in 1939 to impart a knowledge of British history, language, literature and music, ways of living and thinking.

Towns and Villages.—The capital is named after its founder, the Grand Master de la Valette, but from its foundation it has been called Valletta (*q.v.*); it contained the palace of the Grand Masters, the magnificent *auberges* of the several subdivisions or "Langues" of the order, the unique cathedral of St. John with the tombs of the Knights and magnificent tapestries and marble work; a fine opera house and hospital were conspicuous. During World War II attacks by Italo-German aircraft inflicted damage to these and other historic buildings beyond possibility of restoration. Before Italy surrendered in 1943, about three out of every four houses in Valletta were damaged or demolished. In January of that year the British government made a free gift of £10,000,000 toward the cost of rebuilding in Malta, but much had disappeared that money could never replace. Malta was an important naval and air base. Great naval docks, refitting yards, magazines and stores were built on the southeast side of the Grand Harbour at Valletta.

Between the inner fortifications of Valletta and the outer works, across the neck of the peninsula, is the suburb of Floriana. To the southeast of Valletta, at the other side of the Grand Harbour, are the cities of Senglea, Vittoriosa and Cospicua; this group is often spoken of as "the Three Cities." The old capital, near the centre of the island, is variously called Città Vecchia (*q.v.*), Notabile and (in Maltese) Mdina, with its suburb Rabat; here are the catacombs and the ancient cathedral of Malta. Across the Marsamuscetto harbour of Valletta is a considerable modern town called Sliema. The villages of Malta arc Mellieha, St. Paul's Bay, Musta, Birchircara, Lia, Atterd, Balzan, Naxaro, Gargur, Misida, S. Julian's, S. Giuseppe, Dingli, Zebbug, Siggieui, Curmi, Luca, Tarxein, Zurrico, Crendi, Micabbiba, Circop, Zabbar, Asciak, Zeitun, Gudia and Marsa Scirocco. In Gozo, the chief town is called Victoria (prior to 1897 known as Rabat), and there are several large villages.

Communications.—Numerous regular and occasional calls were made at Malta by both British and foreign shipping lines, despite inadequate port facilities for the loading and discharge of cargo and the lack of deep water at quayside. These deficiencies, and the necessity of allowing precedence to admiralty requirements, resulted, after World War I, in diminution of the coal bunkering trade.

Telegraphic communication was maintained by Cable and Wireless, Ltd., with Europe and the rest of the world, and the government-controlled telephone service in Malta and Gozo. The railway which ran from Valletta to Città Vecchia, and the tramway services which used formerly to operate, were replaced by an extensive motor omnibus service which was efficient and extremely cheap. Between Malta and Gozo was a ferry service on which cars could be transported. First class roads were excellent, being well surfaced and, in most cases, wide. A daily mail service travelled by way of Syracuse, in Sicily.

Money, Weights and Measures.—The legal tender currency was exclusively British. Bank of England notes and British coin were the legal tender, supplemented in 1939 with Malta's own paper notes. The three local banks were the Bank of Malta, the Anglo-Maltese bank and Scicluna's bank (the last a private institution), and there were branches of Barclays bank (Dominion, Colonial and Overseas), the Banco di Roma, the Crédit Foncier d'Algérie et de Tunisie and other foreign banks. Local weights and measures included the cantar, 175 lb.; salm, one imperial quarter; cafiso, $4\frac{1}{2}$ gal.; canna, 6 ft. $10\frac{1}{2}$ in.; the tumolo, 256 sq.ca. Imperial measures were used for most commercial purposes.

Finance and Trade.—The small area of the Maltese group of islands, the limitations of their agriculture and the inevitably restricted nature of their manufacturing activities combined to preclude any very large economic development. The agricultural produce of the islands could support the dense population only for three months in the year; the balance of foodstuffs and necessaries had to be paid for by the purchasing power of the armed forces stationed there, and by work done for the forces in the dockyard and elsewhere and for visitors and tourists. Relatives at home also received large remittances from Maltese abroad; and interest from investments outside the islands, and accumulated capital furnished margins to adjust the adverse balance.

Agriculture.—The main industry of the Maltese islands was agriculture, but its extent and productivity were severely limited. Prior to World War II, land under cultivation was decreasing as the result of encroachments by the building of houses, the widening and opening of roads, and the construction of playgrounds and aerodromes. As a rule the tillers of the soil lived away from their lands, in some neighbouring village. The total cultivable area was only about 43,000 ac., and much of this land was very near the margin, having little depth of soil above the coralline limestone. Little use was made of modern methods or machinery. Two, and often three, crops were raised in the year; on irrigated land (about 4% of the cultivable area) more than twice as many crops were possible. The presence of phosphates accounted for the fertility of the shallow soil. There were about 11,000 farms, so that their average size was less than four acres. For the most part the fields were composed of terraces by which the soil had been walled up along the contours of the hills, with enormous labour, to save it from being washed away. Owing to the operation of the laws of inheritance farms were nearly always divided up into separate strips of land not adjacent to each other.

The grain crops are wheat and barley (frequently sown together), and the principal fodder crops are green barley and a tall clover called "sulla" (*Hedysarum coronarum*), with beautiful purple blossoms. Vegetables of all sorts are easily grown, and a rotation of these is raised on land irrigated from wells and springs. Potatoes and onions are grown for exportation at seasons when they are scarce in northern Europe. Grapes are extensively cultivated (chiefly for wine making but also for table use). Some of the best oranges in the world are grown, and exported; but sufficient care is not taken to keep down insect pests, and to replace old trees. Cumin seed is produced for export, while figs, apricots, nectarines and peaches grow to perfection. Animal industries are also of some importance. Cattle, though few in number, are of fine breed, while goats abound everywhere; cows of a large and very powerful build are used for ploughing. Pig breeding and poultry keeping are carried on successfully.

Industry.—Women and children are engaged in producing Maltese lace. After World War I the demand for export diminished, partly because of deterioration in the quality of much of the lace produced, and partly because of changes in fashion. The weaving of Malta cloth by hand-looms survived as a languishing industry. Good building stone is quarried and cut in Malta and, in addition to being used locally, is exported, principally to Greece. Ornamental carvings made in Maltese stone were exported to a limited extent, and pottery was manufactured on a small scale. Maltese craftsmen turned out boots and shoes of good design and workmanship, and this industry received some measure of tariff protection.

Overseas Trade.—The most important export items were potatoes, the bulk of them generally going to the Netherlands, and that country also took more than half of Malta's shipments of onions. Germany was the largest buyer of cumin seed, and Italy and Greece purchased almost half the hides and skins. Most of the island's tallow and old and scrap metals also went to Italy.

Prior to World War II only about one-third of Malta's imports came from British territories. In 1938, of total imports amounting to £3,869,606, no less than £2,424,883 were of foreign origin. Italy did a larger trade with Malta than any other country. The principal imports were wheat, gasoline, coal, flour and semola, sugar, textiles, metals and manufactures thereof. Imports into the United States from Malta were negligible, but that country sold to the islands in 1938 goods to the value of £138,000, mainly unmanufactured tobacco, motor cars and typewriters.

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ARCHAEOLOGY

Although Malta is a fragment of an old land-bridge uniting Italy and Africa, evidence of the former existence of palaeolithic man on the island continues to be in doubt. Human teeth claimed to have Neanderthal characteristics have been found in a cave near Ghar Dalam, but they were unaccompanied by palaeolithic artefacts, and their association with fossil elephant and hippopotamus is not convincingly proved.

The neolithic civilization, however, was both rich and remarkable. A few dolmens and menhirs may perhaps be signs of its simple beginnings, and there are also one or two towers of uncertain date that can be compared with the *nuraghi* of Sardinia; but a more complicated and ambitious megalithic architecture is its most important feature. This is represented by the structures known as sanctuaries, or temples (the theory that they were palaces is untenable); of these some 15 or 16 are known in Malta, and there are also two in Gozo. Among the largest of these buildings are the Mnaidra group and Hagiar Kim on the south coast, Corradino near Valetta, and the adjacent Hal Tarxien, where there are three structures juxtaposed (and to some extent superposed), and Gigantia in Gozo. Of these only Hal Tarxien, explored by Dr. T. Zammit, has been scientifically excavated. The sanctuaries consist of two double apses facing a central passage; but are usually complicated by the presence of additional apses and small side-chambers, or even by the linking up of two or more units. They are built of orthostatic limestone blocks of large size, sometimes with courses of horizontal stones above them; it is probable that the entrances and corridors were roofed by capstones laid flat across them, and there is no doubt that many of the apses and small rooms had corbelled roofs. In the courts were many temple-accessories, such as the so-called "altars" and oracular chambers (cells with porthole apertures), conical pillars that were doubtless idols, small baetylic stones, and figurines of clay and stone; there was also abundant pottery. The spiral occurs as an ornament both in stone-carving and on pottery, but this motif is not found in the earliest building at Hal Tarxien; sculptured bas-reliefs of animals, the puncture-dressing of the columns and altars are other important characteristics of the temple ornament. Of the figures the most notable is the lower portion (the legs and bottom of a flounced skirt) of an image about 7ft. in height, still in situ at Hal Tarxien.

The Hypogeum at Hal Saflieni is clearly of the same period as the Sanctuaries, but it is peculiar in that it is cut in the solid rock. It consists of a maze of small rooms (two are decorated with red lines and spirals on the wall) disposed in two stories; and it is interesting to note that the corbelled roofs of the sanctuaries and other features of the megalithic structures above ground were imitated here. Whatever may have been its original purpose it is certain that it was eventually employed as an ossuary. But little is known of the other graves of the neolithic period; possibly the dolmens are the earliest of these. In addition, however, a series of extended and also crouched burials have been found in a cave at Burmeghez near Mkabba, while at Bukana near Casal Attard is a rock-cut tomb revealing ossuary-practice accompanied by much red ochre. As to dwelling-places, there are occasionally groups of small rooms, perhaps habitations, near the Sanctuaries, as on the Corradino Hill and it seems likely that such structures as Borg-en-Nadur in Malta and Tal-Kaghan in Gozo were fortified settlements. The question of the origin of this neolithic civilization is one of the outstanding problems of Mediterranean archaeology. There are certain architectural resemblances between the megalithic buildings and Hypogeum of Malta and those of the other western Mediterranean islands, particularly as regards the Hypogeum and the rock-cut tombs of Sardinia and Sicily. Some of the pottery, furthermore, has affinities with sherds found in Sardinia, and also in Sicily, where it is noteworthy that spiral carvings on rock are known; Spanish affinities for the Maltese pottery have also been claimed. There is, therefore, hardly room to doubt the general relationship of the neolithic civilization in Malta with the megalithic civilization of the Western Mediterranean; but stock must be taken of possible influences from other directions. The resemblance of some of the Malta pottery to the spiral-meander ware of Italy (Salerno) and central Europe and the Balkans (*e.g.* Butmir) must be noted; nor are the connections with Crete especially as regards the horned spiraliform ornament to be neglected. It now seems probable, however, that north Africa supplied a determining factor in the formation of the Maltese civilization; but, though this view is gaining ground, a fuller knowledge of the Tunisian prehistoric cultures is required before a connection between Africa and the Mediterranean islands can be effectively demonstrated.

The Bronze Age in Malta is signalized by a new pottery, but this has been found in direct stratigraphical relations with neolithic remains at Hal Tarxien where a cemetery of large urns containing cremated bones was found in a part of the second temple that, after it had first fallen into ruins, had been levelled to receive the new graves. These urns were accompanied by daggers and flat axes, mostly of copper, and by peculiar discoid "sitting" figures made of pottery. The Bronze Age ware also occurs in the Hypogeum, and in the Sanctuary of Santa Verna; it has been referred, very doubtfully, to Middle Minoan I, and on this view the beginning of the neolithic must be put back at least as far as 3000 B.C. to allow for the full development of the Sanctuary architecture and for the partial ruin of Hal Tarxien before the deposition of the cemetery. This Bronze Age ware has Italic affinities suggesting a rather later date than M.M.I.

There is seemingly a break between the Bronze Age culture and the coming of the Phoenicians. The first arrival of these folk dates from the beginning of the last millennium B.C., but the period of the foundation of the towns is later, that is to say, about the 7th or 8th century B.C. The island was clearly an important colony, and the Phoenician remains are of considerable interest. Three distinct types of Punic graves are recognised, the earliest having a round cell and round chamber, and the latest variety having both cell and chamber square. These last probably overlap the beginning of the Roman occupation.

Finally the "cart-ruts" (deep parallel grooves worn in the rock and having a span of about 4½ft.) must also be noted among the antiquities of Malta, though their age and significance is still obscure. They are at least older than the late Punic graves, since these in two instances cut across them, and the fact that they run out under the sea at Birzebuggia is another proof of their antiquity.

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HISTORY

To the Phoenician period, besides the tombs already mentioned, belong some remains of houses and cisterns, and (probably) a few round towers which are scattered about the island, while the important Roman house at Città Vecchia is the finest monument of this period in the islands.

The Carthaginians came to Malta in the 6th century B.C., not as conquerors, but as friends of a sister Phoenician colony (Freeman, *Hist. Sicily,* i. 255): Carthage in her struggle with Rome was at last driven to levy oppressive tribute, whereupon the Maltese gave up the Punic garrison to Titus Sempronius in circumstances described by Livy (xxi. 51). The Romans did not treat the Maltese as conquered enemies, and at once gave them the privileges of a *municipium;* Cicero (*in Verrem*) refers to the Maltese as "Socii." Nothing was to be gained by displacing the Phoenician inhabitants in a country from which any race less thrifty would find life impossible by agriculture. On the strength of a monument bearing his name, it has been surmised that Hannibal was born in Malta, while his father was governor-general of Sicily; he certainly did not die in Malta. There is evidence from Cicero (*in Verrem*) that a very high stage of manufacturing and commercial prosperity, attained in Carthaginian times, continued in Malta under the Romans. The Phoenician temple of Juno, which stood on the site of Fort St. Angelo, is also mentioned by Valerius Maximus. An inscription records the restoration of the temple of Proserpine by Cheriston, a freedman of Augustus and procurator of Malta. Diodorus Siculus (L. V., c. 4) speaks of the importance and ornamentation of Maltese dwellings, and to this day remains of palaces and dwellings of the Roman period indicate a high degree of civilization and wealth. When forced to select a place of exile, Cicero was at first (*ad Att.* III. 4, X. i. 8, 9) attracted to Malta, over which he had ruled as quaestor 75 B.C. Publius was "chief of the island" when St. Paul was shipwrecked (Acts xxvii. 7); and is said to have become the first Christian bishop of Malta. The site where the cathedral at Città Vecchia stands is reputed to have been the residence of Publius and to have been converted by him into the first Christian place of worship, which was rebuilt in 1090 by Count Roger, the Norman conqueror of Malta. The Maltese catacombs are strikingly similar to those of Rome, and were likewise used as places of burial and of refuge in time of persecution. They contain clear indication of the interment of martyrs. St. Paul's Bay was the site of shipwreck of the apostle in A.D. 58; the "topon diathalasson" referred to in Acts is the strait between Malta and the islet of Selmun. According to tradition and to St. Chrysostom (*Hom.* 54) the stay of the apostle resulted in the conversion of the Maltese to Christianity. The description of the islanders in Acts as "barbaroi" confirms the testimony of Diodorus Siculus that they were Phoenicians, neither hellenized nor romanized. The bishopric of Malta is referred to by Rocco Pirro (*Sicilia sacra*), and by Gregory the Great (*Epist.* 2, 44; 9, 63; 10, 1). It appears that Malta was not materially affected by the Greek schism, and remained subject to Rome.

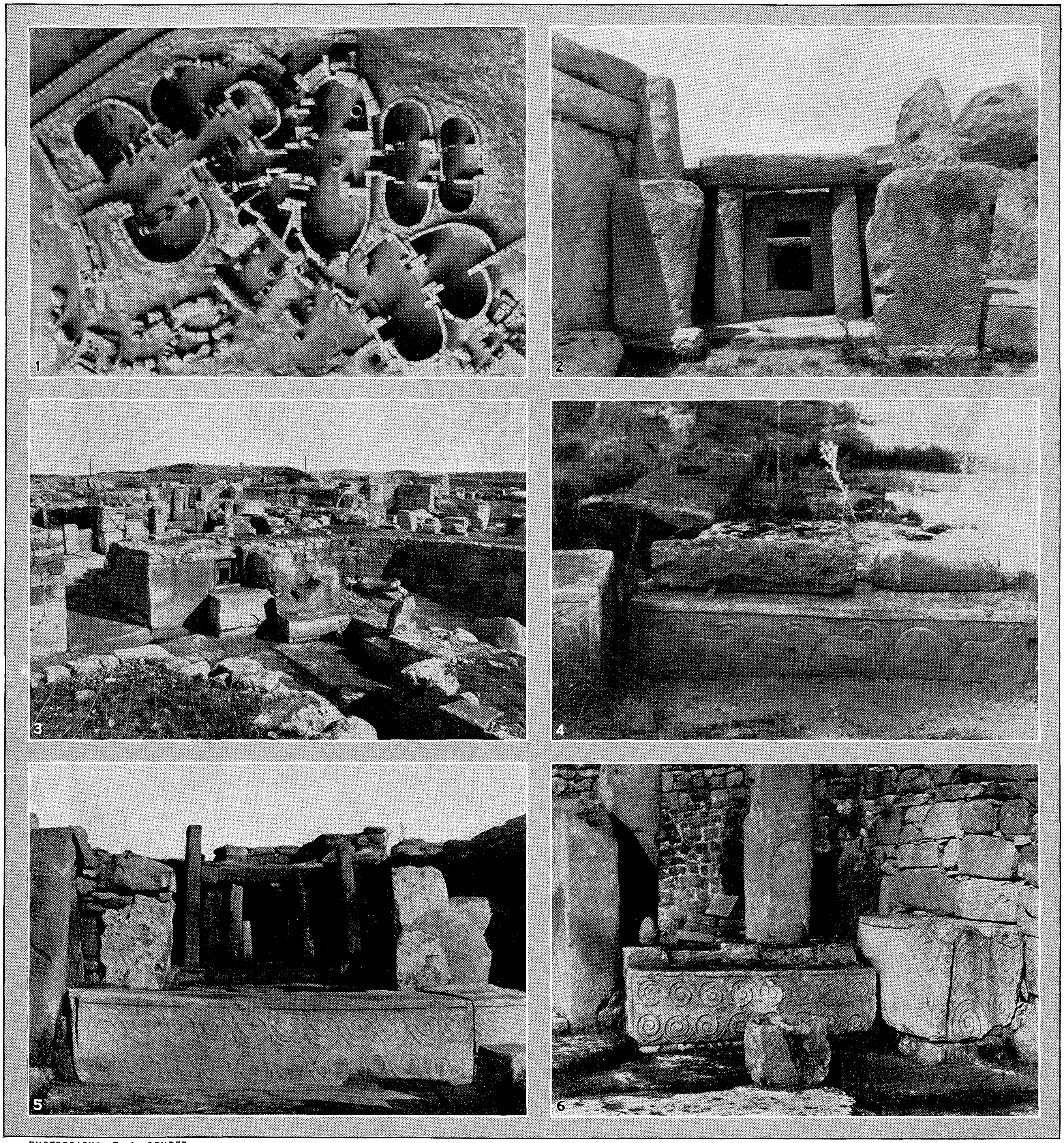
On the final division of the Roman dominions in A.D. 395 Malta was assigned to the empire of Constantinople. On the third Arab invasion, A.D. 870, the Maltese joined forces against the Byzantine garrison, and 3,000 Greeks were massacred. Unable to garrison the island with a large force, the Arabs cleared a zone between the central stronghold, Medina, and the suburb called Rabat, to restrict the fortified area. Many Arab coins, some Kufic inscriptions and several burial-places were left by the Arabs; but they did not establish their religion or leave a permanent impression on the Phoenician inhabitants, or deprive the Maltese language of the characteristics which differentiate it from Arabic. There is no historical evidence that the domination of the Goths and Vandals in the Mediterranean ever extended to Malta: there are fine Gothic arches in two old palaces at Notabile, but these were built after the Norman conquest of Malta. In 1090 Count Roger the Norman (son of Tancred de Hauteville), then master of Sicily, came to Malta with a small retinue; the Arab garrison was unable to offer effective opposition, and the Maltese were willing and able to welcome the Normans as deliverers and to hold the island after the immediate withdrawal of Count Roger. A bishop of Malta was witness to a document in 1090. The Phoenician population had continued Christian during the mild Arab rule. Under the Normans the power of the Roman Church quickly augmented, tithes were granted and ecclesiastical buildings erected and endowed. The Normans, like the Arabs, were not numerically strong; the rule of both, in Sicily as well as Malta, was based on a recognition of municipal institutions under local officials; the Normans, however, exterminated the Mohammedans. Gradually feudal customs asserted themselves. In 1193 Margarito Brundusio received Malta as a fief with the title of count; he was Grand Admiral of Sicily. Constance, wife of the emperor Henry IV. of Germany became, in 1194, heiress of Sicily and Malta; she was the last of the Norman dynasty. The Grand Admiral of Sicily in 1223 was Henry, count of Malta. He had led 300 Maltese at the capture of two forts in Tripoli by the Genoese.

In 1427 the Turks raided Malta and Gozo, they carried many of the inhabitants into captivity, but gained no foothold. The Maltese joined the Spaniards in a disastrous raid against Gerbi on the African coast in 1432. In 1492 the Aragonese expelled the Jews. Dissatisfaction arose under Aragonese rule from the periodical grants of Malta, as a marquisate or countship, to great officers of state or illegitimate descendants of the sovereign. Exemption was obtained from these incidences of feudalism by large payments to the Crown in return for charters covenanting that Malta should for ever be administered under the royal exchequer without the intervention of intermediary feudal lords. This compact was twice broken, and in 1428 the Maltese paid King Alfonso 30,000 florins for a confirmation of privileges, with a proviso that entitled them to resist by force of arms any intermediate lord that his successors might attempt to impose. Under the Aragonese, Malta, as regards local affairs, was administered by a *Università* or municipal commonwealth with wide and indefinite powers, including the election of its officers, Capitan di Verga, Jurats, etc. The minutes of the "Consiglio Popolare" of this period are preserved, showing it had no legislative power; this was vested in the king, and was exercised despotically in the interests of the Crown. The knights of St. John having been driven from Rhodes by the Turks, obtained the grant of Malta, Gozo and Tripoli in 1530 from the emperor Charles V., subject to a reversion in favour of the emperor's successor in the kingdom of Aragon should the knights leave Malta, and to the annual tribute of a falcon in acknowledgment that Malta was under the suzerainty of Spain. The Maltese, at first, challenged the grant as a breach of the charter of King Alfonso, but eventually welcomed the knights. The Grand Master de l'Isle Adam, on entering the ancient capital of Notabile, swore for himself and his successors to maintain the rights and liberties of the Maltese. The Order of St. John took up its abode on the promontory guarded by the castle of St. Angelo on the southern shore of the Grand Harbour, and, in expectation of attacks from the Turks, commenced to fortify the neighbouring town called the Borgo. The knights lived apart from the Maltese, and derived their principal revenues from estates of the Order in the richest countries of Europe. They accumulated wealth by war, or by privateering against the Turks and their allies. The African Arabs under Selim Pasha in 1551 ravaged Gozo, after an unsuccessful attempt on Malta, repulsed by cavalry under Upton, an English knight. The Order of St. John and the Christian Maltese now realized that an attempt to exterminate them would soon be made by Soliman II., and careful preparations were made to meet the attack.

The great siege of Malta which made the island and its knights famous, and checked the advance of Mohammedan power in southern and western Europe, began in May 1565. The fighting men of the defenders are variously recorded between 6,100 and 9,121; the roll comprises one English knight, Oliver Starkey. The Mohammedan forces were estimated from 29,000 to 38,500. The Sultan placed his troops under the veteran Mustapha, and his galleys under his youthful relative Piali; he hesitated to make either supreme and ordered them to await the arrival of Dragut with his Algerian allies, before deciding on their final plans. Meanwhile, against Mustapha's better judgment, Piali induced the council of war to attack St. Elmo, in order to open the way for his fleet to an anchorage, safe in all weathers, in Marsamuscetto harbour. This strategical blunder was turned to the best advantage by La Valette, who so prolonged the most heroic defence of St. Elmo that the Turks lost 7,000 killed and as many wounded before exterminating the 1,200 defenders, who fell at their post. In the interval Dragut was mortally wounded, the attack on Notabile was neglected, valuable time lost, and the main objective (the Borgo) and St. Angelo left intact. The subsequent siege of St. Angelo, and its supporting fortifications, was marked by the greatest bravery on both sides. The knights and their Maltese troops fought for death or victory, without asking or giving quarter. Finally, Mustapha was driven to his ships on Sept. 8.

The Order thus reached the highest pinnacle of its fame, and new knights flocked to be enrolled therein from the flower of the nobility of Europe; La Valette refused a cardinal's hat, determined not to impair his independence. He made his name immortal by making Valletta a magnificent example of fortification, unrivalled in the world. Throughout the 16th and 18th centuries they harassed Turkish commerce and took part as an allied Christian power in the great victory of Lepanto. With the growth of wealth and security the martial spirit of the Order began to wane, and so also did its friendly relations with the Maltese. The civil government became neglected and disorganized, licentiousness increased and riots began to be threatening. In 1614 the Vignacourt aqueduct was constructed. The Jesuits established a university, but they were expelled and their property confiscated in 1768. British ships of war visited Malta in 1675, and in 1688 a fleet under the duke of Grafton came to Valletta. The fortifications of the "Three Cities" were greatly strengthened under the Grand Master Cotoner.

In 1722 the Turkish prisoners and slaves, then very numerous, formed a conspiracy to rise and seize the island. Premature discovery was followed by prompt suppression. Castle St. Angelo and the fort of St. James were, in 1775, surprised by rebels, clamouring against bad government; this rising is known as the Rebellion of the Priests, from its leader, Mannarino. The last but one of the Grand Masters who reigned in Malta, de Rohan, restored good government, abated abuses and promulgated a code

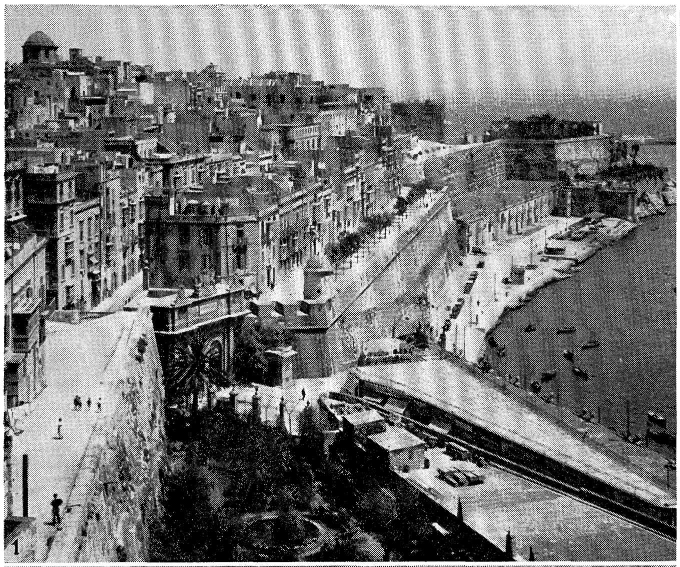


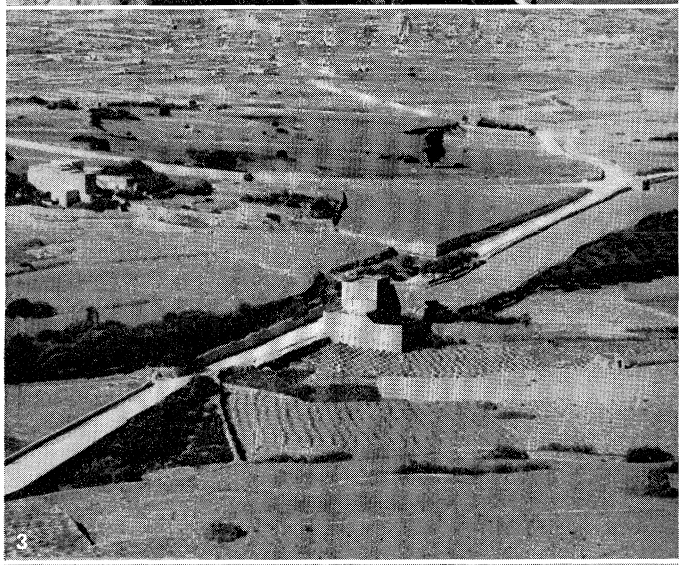
PHOTOGRAPHS, E. A. GOUDER

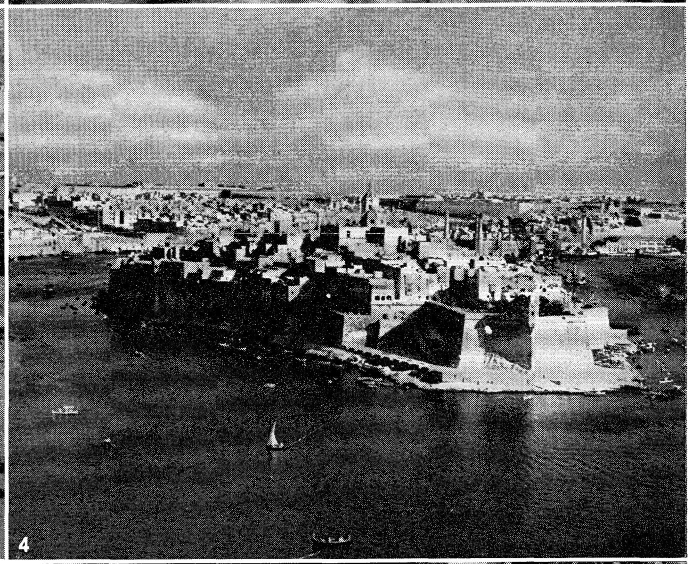
MEGALITHIC TEMPLES AND STONE ANTIQUITIES OF MALTA

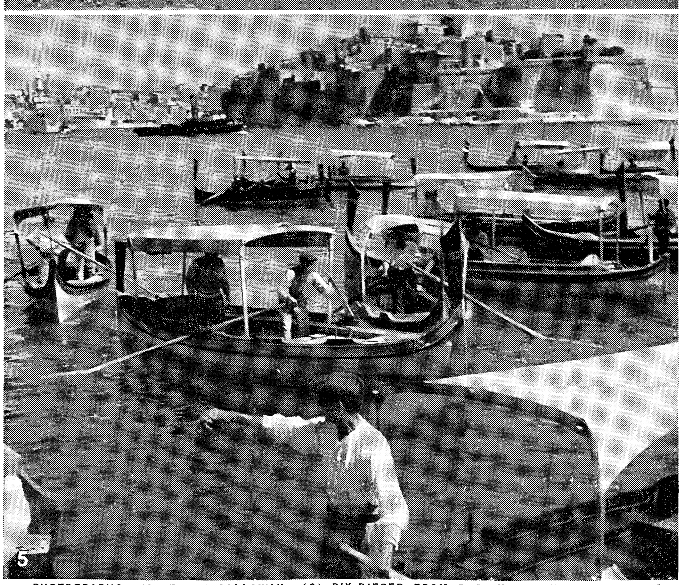
1. Bird's eye view of the temple of Hal Tarxien, from a model
2. The temple of Mnaidra, showing the entrance to the main shrine
3. General view of Hal Tarxien
4. Stones with animal frieze, from Hal Tarxien
5. Stone with spiral ornament, from Hal Tarxien
6. More examples of stones with spiral ornaments, from Hal Tarxien

MALTA









PHOTOGRAPHS, (1) EWING GALLOWAY, (2) PIX-RIEGER FROM PUBLIX, (3, 5) FRITZ HENLE FROM PUBLIX, (4) GEORGE FURST, MALTA, (6) FRITZ HENLE FROM BLACK STAR

VIEWS OF THE ISLAND OF MALTA

1. Overlooking Valletta from the ramparts of the fortifications that surround the city. Valletta is built on a promontory called Mount Sceberras
2. A street in Valletta. The capital was subjected to almost daily air raids during World War II
3. The interior of the island. There are few trees, and the heat is intense
4. View of the Grand Harbour of Malta, showing the three cities of Vittoriosa, Cospicua and Senglea
5. Bargemen in the harbour
6. A street in Malta. The woman at the foot of the stairs wears the typical black dress of the islanders

of laws. On the death of Rohan the French knights disagreed as to the selection of his successor, and a minority were able to elect, in 1797, a German of weak character, Ferdinand Hompesch, as the last Grand Master to rule in Malta. Bonaparte had arranged to obtain Malta by treachery, and he took possession without resistance in June 1798; after a stay of six days he proceeded with the bulk of his forces to Egypt, leaving General Vaubois with 6,000 troops to hold Valletta.

Towards the close of the rule of the knights in Malta feudal institutions had been shaken to their foundations, but the transition to republican rule was too sudden and extreme for the people to accept it. Among other laws Bonaparte enacted that French should at once be the official language, that 30 young men should every year be sent to France for their education; that all foreign monks be expelled, that no new priests be ordained before employment could be found for those existing; that ecclesiastical jurisdiction should cease; that neither the bishop nor the priests could charge fees for sacramental ministrations, etc. Stoppage of trade, absence of work (in a population of which more than half had been living on foreign revenues of the knights), and famine, followed the defeat of Bonaparte at the Nile, and the failure of his plans to make Malta a centre of French trade. An attempt to seize church valuables at Notabile was forcibly resisted by the Maltese, and general discontent broke out into open rebellion on the 2nd of September 1798. The French soon discovered to their dismay that, from behind the rubble walls of every field, the agile Maltese were unassailable. The prospect of an English blockade of Malta encouraged the revolt, of which Canon Caruana became the leader. Nelson was appealed to, and with the aid of Portuguese allies he established a blockade and deputed Captain Ball, R.N. (afterwards the first governor) to assume, on the 9th of February 1799, the provisional administration of Malta and to superintend operations on land. Nelson recognized the movement in Malta as a successful revolution against the French, and upheld the contention that the king of Sicily (as successor to Charles V in that part of the former kingdom of Aragon) was the legitimate sovereign of Malta. British troops were landed to assist in the siege; few lives were lost in actual combat, nevertheless famine and sickness killed thousands, and finally forced the French to surrender to the allies.

The treaty of Amiens (1802) provided for the restoration of the island to the Order of St. John; against this the Maltese strongly protested, realizing that it would be followed by the reestablishment of French influence. The English flag was flown side by side with the Neapolitan, and England actually renewed war with France sooner than give up Malta. The treaty of Paris (1814), with the acclamations of the Maltese, confirmed Great Britain in the aggregation of Malta to the empire.

A period elapsed before the government of Malta again became self-supporting, during which over £600,000 was contributed by the British exchequer in aid of revenue, and for the importation of food-stuffs. After the treaty of Paris stability of government developed, and many important reforms were introduced under the strong government of the masterful Sir Thomas Maitland. Trial by jury for criminal cases was established in 1829. A council of government, of which the members were nominated, was constituted by letters patent in 1835, but this measure only increased the agitation for a representative legislature. Freedom of the press and many salutary innovations were brought about on a report of John Austin and G. C. Lewis, royal commissioners, appointed in 1836. The basis of taxation was widened, sinecures abolished, schools opened in the country districts, legal procedure simplified, and Police established on an English footing. Queen Adelaide visited Malta in 1838 and founded the Anglican collegiate church of St. Paul. Sir F. Hankey as chief secretary was for many years the principal official of the civil administration. In 1847 R. Moore O'Ferrall was appointed civil governor. In June 1849 the constitution of the council was altered to comprise ten nominated and eight elected members.

The Crimean War brought great wealth and commercial prosperity to Malta. The nominal rule of military governors was reestablished in 1858, though the civil administration was largely confided to the chief secretary, with real power in the hands of the crown advocate. The civil service gravitated into the hands of a clique. At this period much money was spent on the Marsa extension of the Grand Harbour, while the military defenses were entirely remodelled, and considerable municipal improvements and embellishments were completed.

An executive council was established in 1881, and the franchise was extended in 1883. A policy of *laissez-faire* was changed in 1883 by the appointment of Sir Walter Hely-Hutchinson as chief secretary. A regulation excluding Maltese from the navy (because of their speaking on board a language that their officers did not understand) was protested by Gerald (later Lord) Strickland (Count Della Catena) on the ground that it was an infringement of the islanders' constitutional rights. The subject attracted considerable attention in Great Britain, and as one result, Malta received in 1887 a new (the "Strickland-Mizzi") constitution. This constitution, which ended a period of government by presidential casting votes and official ascendancy, was received by the Maltese with acclamation. Strickland, who had been elected to the legislature while an undergraduate at Cambridge university on the cry of equality of rights for Maltese and English, and Mizzi, the leader of the anti-English agitation, were, as soon as elected, given seats in the executive council to co-operate with the government; but their aims were irreconcilable. Mizzi wanted to ensure the predominance of the Italian language, while Strickland desired to replace bureaucratic government by a more democratic system and to introduce English ideas and precedents. Friction soon arose, and Mizzi resigned his post in the government.

Strickland became chief secretary in 1889, and without delay he carried out reforms that had been retarded for years. The civil service was reorganized so as to reward merit and work by promotion. Tenders were strictly enforced in letting government property and contracts; a largely increased revenue was applied on water supply, drainage and other works. Lepers were segregated by law. During the 1890s there was widespread agitation respecting the laws as to marriage, the Maltese relying on the Roman canon law and the English on the common law of England. The Holy See was consulted on the subject of civil marriage, and an agreement was made with Rome which obviated clerical agitation and obstruction in the council. However, the language question and educational reform, as well as the system of taxation, became matters of violent dispute and were contested in the legislature by the elected members of the Italian party. As a consequence, the Strickland-Mizzi constitution of 1887 was repealed by letters patent in 1903. Bureaucratic government, with an official majority, was again fully re-established for all local affairs, great and small.

During World War I the Maltese provided a garrison for the island, many seamen for men-of-war and minesweepers as well as labour battalions for service at Gallipoli and Salonika. In addition, Maltese did excellent service in various hospitals. As a mark of appreciation for these services a grant of responsible government was established by the constitution of 1921 and further letters patent in 1928. Members of the senate and house of assembly were elected by proportional representation; judges, appointed by the governor in council, could be removed only by a joint address from both houses of the legislature; while debates might be conducted in English, Italian or Maltese, all official entries were to be in English or Italian. English was declared the official language of the administration, and Italian the official language of record in the law courts. After a decade of fairly satisfactory government, friction developed between the Italian Catholic leaders and the British governor when use of the Italian language in the courts and the primary schools was restricted. The constitution was suspended in 1930 but restored in 1932. Following a second suspension of the constitution in 1933, Italian lost its position as an official language and as that of the courts, and by letters patent dated Aug. 12, 1936, the constitution was revoked. Executive power was then vested in the governor, aided by an executive council of ex-officio and nominated members, but by another constitution in 1939 limited representation without responsibility was again granted Malta. A council of government of 30 members was created, 10 being elected, with two nominated and eight officials; the governor had a casting though not an original vote.

After Italy entered World War II in 1940 Malta became subject to ceaseless aerial attacks by both German and Italian bombers from bases in Sicily, within 20 minutes flying time. The island, which was 1,000 mi. from the nearest British position, became of the very first importance as a base of operations. For three years Malta was defended by both the garrison and the people. At the height of the siege it was possible to send supplies of aviation gasoline and munitions to Malta only by submarine, while additional fighter aircraft of the R.A.F. were flown to the island from the decks of distant carriers. Despite the hardships, civilian morale stood high.

In April 1942, George VI awarded the George cross "to the island fortress of Malta to bear witness to a heroism and devotion that will long be famous in history." This was the first time that a medal had been conferred upon any part of the British commonwealth. The siege ended in 1943. By June 30 of that year 1,436 civilians had been killed, 3,415 wounded or injured, and 6,952 buildings destroyed or damaged. The British government made a gift of £10,000,000 for rebuilding, and announced that after the war full responsible government was to be restored to Malta. (*See* World War II.)

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MALTA or MEDITERRANEAN FEVER, a disease long prevalent in Malta and formerly at Gibraltar, as well as other Mediterranean centres, characterized by prolonged high temperature, with anaemia, pain and swelling in the joints and neuritis, lasting on an average four months but extending even to two or three years. Its pathology was long obscure, but owing to conclusive research on the part of Col. (afterwards Sir) David Bruce, to which contributions were made by various officers of the R.A.M.C. and others, this problem has now been solved. A specific micro-organism, the *Micrococcus melitensis,* was discovered in 1887, and it was traced to the milk of the Maltese goats. A commission was sent out to Malta in 1904 to investigate the question, and after three years' work its conclusions were embodied in a report by Col. Bruce in 1907. It was shown that the disappearance of the disease from Gibraltar had synchronized with the non-importation of goats from Malta; and preventive measures adopted in Malta in 1906, by banishing goats' milk from the military and naval dietary, put a stop to the occurrence of cases. In the treatment of Malta fever a vaccine has been used with considerable success.

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MALTE-BRUN, CONRAD (1775–1826), French geographer, was born on Aug. 12, 1775, at Thisted in Denmark, and died at Paris on Dec. 14, 1826. His original name was Malte Conrad Bruun. In 1800 he was banished from Denmark and he ultimately settled in Paris. He wrote the learned *Précis de la géographie universelle* (6 vols., 1810–29), continued by other hands after his death, and founded the *Annales des voyages* (1808), and was one of the founders of the Geographical Society of Paris.

MALTESE CROSS: *see* Cross and Crucifixion.

MALTESE LANGUAGE. The dominance of Arabic affinities in Maltese is evident, but there are good grounds for suspecting the presence of elements, probably much earlier, of Phoenician derivation. Contact with Crete existed about 2,000 B.C. (Sir Arthur Evans, *Palace of Minos,* vol. ii., 1928), and it is highly probable that the prospectors whose enterprise carried them to Britain and Scandinavia, left their mark on the linguistics of this interesting island. Italian words have been brought into use—supplementing and supplanting earlier forms. As an example of linguistic convergence, which has occasioned hot debate, the word *Missier,* "father," may be cited. It has been traced back and regarded as more primitive than Classical or Saracenic Arabic, though its resemblance to Italian is obvious.

See R. N. Bradley, *Malta and the Mediterranean Race.*

MALTHUS, THOMAS ROBERT (1766–1834), English economist, was born in 1766 at the Rookery near Guildford, Surrey, a small estate owned by his father Daniel Malthus, who was a friend and one of the executors of Rousseau. After being privately educated, Malthus entered Jesus college, Cambridge, where he was a contemporary of S. T. Coleridge. He was ninth wrangler in 1788, and was elected to a fellowship in 1793. He took orders in 1797, and held for a short while the curacy of Albury in Surrey. In 1798 he published the first edition of his great work, *An Essay on the Principle of Population as it affects the Future Improvement of Society, with Remarks on the Speculations of Mr. Godwin, M. Condorcet, and other Writers.* This was followed five years later by the second greatly enlarged and amended edition of his work in 1803; he published several subsequent revised editions, the sixth and last during his lifetime appearing in 1826. In 1805 Malthus married, and soon after was appointed professor of modern history and political economy in the East India Company's college at Haileybury where he died on Dec. 23, 1834.

Malthus's *Essay on Population* grew out of some discussions with his father respecting the perfectibility of society. His father shared the theories on that subject of Condorcet and Godwin, but his son combated them on the ground that the realization of a happy society will always be hindered by the miseries consequent on the tendency of population to increase faster than the means of subsistence. His father was struck by the weight and originality of his views, asked him to put them in writing, and then recommended the publication of the manuscript.

The first edition is in the nature of a long pamphlet. It is brilliantly written, with a marked felicity of phrase and illustration, and it immediately captured the imagination of his readers. It put forward the view that population, when unchecked, increases in a geometrical ratio while subsistence only increases in an arithmetical ratio, and Malthus asserts as a fact that population always increases up to the limits of the means of subsistence. Population is prevented from increasing beyond these limits by the positive checks of war, famine and pestilence, and by the influence of misery and vice. From this theory Malthus drew the important practical conclusion for the England of his day that the existing poor law system, with its indiscriminate doles and bounties upon large families, was utterly to be condemned as tending to aggravate the very evils which it was supposed to remedy. The publication of the *Essay* roused a storm of controversy, and bitter abuse was hurled at Malthus from the most diverse quarters. Undaunted by the attacks to which he was subjected, he set to work to collect material bearing on the rates of increase of population, in all times and countries, and five years later published the second edition of his *Essay* in an entirely different form. In its new guise the Essay is a long, soberly worded and scholarly treatise, full of detailed facts and statistics and abundantly documented. Nor was it the form alone that underwent a change. While maintaining his "principle" of population—the universal tendency of population to outrun the means of subsistence—he allowed the question of the mathematical ratios to fall rather into the background. But, above all, he introduced a most important modification into his original doctrine by recognizing the existence, in addition to the positive checks to the increase of population, of a preventive check which he termed "moral restraint." By this term Malthus understood the postponement of the age of marriage, accompanied by strict sexual continence. It may be noted that the views and methods advocated by those modern upholders of small families, who call themselves Neo-Malthusians, would have received nothing but condemnation from Malthus. The introduction of the notion of moral restraint, coupled with the realization that subsistence did not necessarily mean merely the bare necessaries for existence, give a slightly more hopeful colour to Malthus's views as set out in the later editions of his work. Nevertheless he remained profoundly pessimistic in his general outlook on the possibilities of the future progress of mankind, for he had scant faith in the capacity of the human race to regulate its numbers by the exercise of prudence and restraint. The positive checks had alone operated in the past and they, with all the vice and misery that follow in their train, were likely to continue to do so in the future.

It would be scarcely fair to convict Malthus of error on the ground that he failed to foresee the astonishing development of transport and colonization which took place in the 19th century and has increased so enormously the area from which foodstuffs and raw materials can be drawn during that period. On the other hand, he did undoubtedly underestimate the importance of the reactions of industrial progress upon the output and cost of production of agricultural produce. There is some truth in the contention of those who disagreed with him that, while every addition to the population means another mouth to feed, it also implies another pair of hands. The law of increasing returns has operated very powerfully in industry and the influence of inventions and new methods of cultivation have held in check that recourse to poorer soils which Malthus gleaned must result from any growth of population. Furthermore, progressive standards of living have contributed to raise the marriage age and lower the birth rate in western countries to a far greater extent than Malthus would ever have dared to contemplate. Even so, the decline in the death rate has been so great that the absolute rate of increase of population is still large in most countries, while in the East the Malthusian "principle" still seems to reign supreme.

Malthus's views influenced public opinion in the first half of the 19th century, yet later it had become common to disparage his doctrines as out of date. Since the European War of 1914–18, however, the spectre of over-population has returned and Malthus is coming into his own again.

A chance reading of the *Essay,* in which the phrase "struggle for existence" struck an answering chord, stimulated Charles Darwin to find the key to biological change in the process of natural selection brought about by this struggle for existence.

Malthus was also a writer of considerable importance for the development of economic theory. The close friend and correspondent of Ricardo, he not merely stimulated the latter but himself made independent contributions to the theory of value. He is generally credited with being the first writer to formulate the law of diminishing returns as applied to agriculture, though he did not call it by this name and perhaps himself failed to realize the full significance of this conception. He combated the rigid Ricardian labour cost theory of value and adumbrated a theory which was much closer to that of most modern economists.

Besides his great work, the first edition of which was reprinted by the Royal Economic Society in 1926, Malthus wrote *Observations on the Effect of the Corn Laws: An Inquiry into the Nature and Progress of Rent; Principles of Political Economy;* and *Definitions in Political Economy.* His views on rent were of real importance.

For his life see *Memoir* by his friend Dr. Otter, bishop of Chichester (prefixed to 2nd ed. 1836, of the *Principles of Political Economy*), and *Malthus and his Work,* by J. Bonar (London, 1885); *see* also Soetbeer, *Die Stellung der Sozialisten zur malthusschen Bevolkerungslehre* (Berlin, 1886); G. de Molinari, *Malthus, essai pour le principe de population* (Paris, 1889); Cossa, *Il Principio di popolazione di T. R. Malthus* (Milan, 1895); and Ricardo, *Letters to Malthus,* ed. J. Bonar (1887). (C. W. G.)

MALTHUSIANISM: *see* POPULATION.

MALTON, a town and urban district in the North Riding of Yorkshire, England, 21 mi. N.E. of York by the L.N.E.R. on the river Derwent, and connected with Norton, on the opposite bank, in the East Riding. Pop. (1938) 4,121. Area 6.3 sq.mi. Malton lies in the Malton or Kirkham gap which separates the clay Vale of Pickering from the Vale of York.

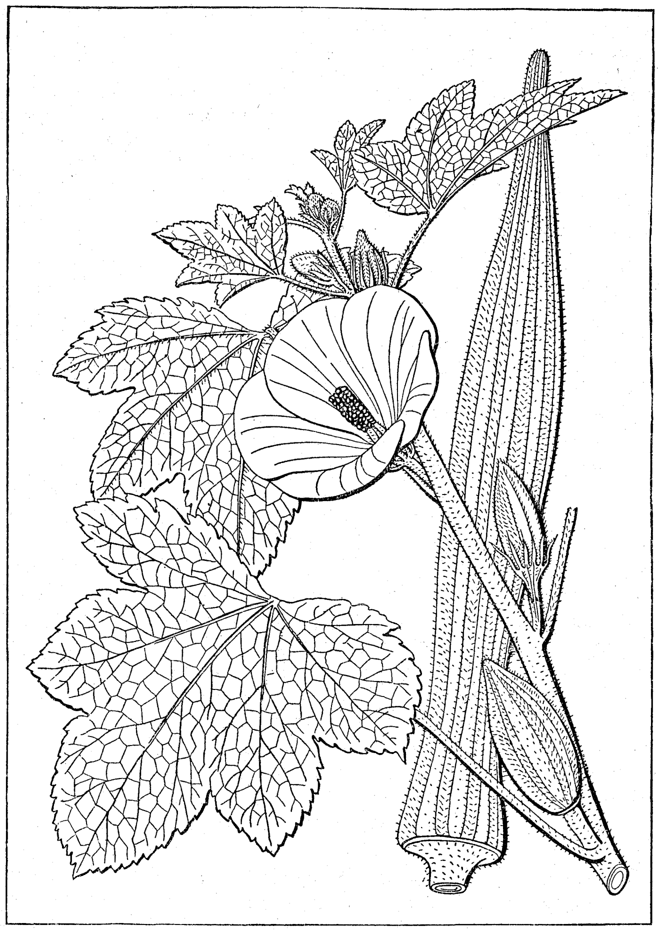
Traces of a Romano-British village exist east of the town. The greater part of the town belonged to the Crown in 1086 and was apparently retained until the reign of Henry I. The church of St. Mary at Old Malton was attached to a Gilbertine priory founded in 1150. The nave, a magnificent remain, is transitional Norman and Early English, with later insertions. Very little remains of the priory, with the exception of the crypt under a modern house. The church of St. Michael is a Late Norman building. The church of St. Leonard, with a square tower and spire, is of mixed architecture but has three Norman arches and a Norman font. Six mi. S.W. of Malton are the small but beautiful remains of Kirkham abbey, an Early English Augustinian foundation of 1131. The grammar school was founded in 1547. Castle Howard, a seat of the earl of Carlisle, lies 5 mi. to the southwest. Agricultural implements are manufactured, and there are corn mills, tanneries and breweries, also lime and whinstone quarries. Markets dating from the 13th century are held on Saturdays and Fridays and still belong to the lord of the manor.

MALTZAN, HEINRICH VON, BARON ZU WARTENBURG UND PENZLIN (1826–1874), German traveller, was born on Sept. 6, 1826 near Dresden. After extensive travels in North Africa and the Levant, he succeeded in 1860 in making the pilgrimage to Mecca, which he afterwards described in *Meine Wallfahrt nach Mecca* (Leipzig, 1865), but had to flee for his life to Jidda without visiting Medina. He died by his own hand at Pisa.

His works include *Drei Jahre im Nordwesten von Afrika* (Leipzig, 1863); *Reise nach Südarabien* (Brunswick, 1873), *Reise in Tunis und Tripolis* (Leipzig, 1870), which contains a collection of Punic inscriptions; and an edition of A. von Wrede's *Reise in Hadramaut* (Brunswick, 1870).

MALUS, ÉTIENNE LOUIS (1775–1812), French physicist, was born at Paris on June 23, 1775. He went to the military engineering school at Mezières and then served in the French army in Germany and Egypt. On his return he held official posts successively at Antwerp, Strasbourg and Paris, and devoted himself to optical research. A paper published in 1809 ("Sur une propriété de la lumière réfléchie par les corps diaphanes") contained the discovery of the polarization of light by reflection, which is specially associated with his name. In 1810 he won a prize from the Institute with his memoir, "Théorie de la double refraction de la lumière dans les substances cristallines."

MALVACEAE, a large and economically important family of flowering plants. It contains 45 genera with about 900 species, and occurs in all world regions except the coldest, the number of species increasing toward the tropics. The most conspicuously useful plant is cotton (*Gossypium*). It is represented in Britain by three genera: *Malva,* mallow; *Althaea,* marsh-mallow; and *Lavatera,* tree-mallow. In the United States there are about 20 genera, the best known ones, after *Gossypium,* being *Althaea* (marsh-mallow and hollyhock), *Malva* (mallow), *Sida Abutilon* (Indian mallow or velvet-leaf), and *Hibiscus* (rose mallow, and also okra or gumbo). The plants are herbs, as in the British mallows, or, in the warmer parts of the earth, shrubs or trees. The leaves are alternate and often palmately lobed or divided; the stipules generally fall early. The leaves and young shoots often bear stellate hairs and the tissues contain mucilage-sacs. The



HIBISCUS (HIBISCUS ESCULENTUS), SHOWING UPPER PART OF FLOWERING PLANT (ANNUAL) AND AN UNRIPE FRUIT

regular, hermaphrodite, often showy flowers are borne in the leaf-axils, solitary or in fasicles, or form more or less complicated cymose arrangements. An epicalyx formed by a whorl of three or more bracteoles is generally present just beneath the calyx; sometimes, as in *Abutilon,* it is absent. The parts of the flowers are typically in fives; the five sepals, which have a valvate aestivation, are succeeded by five often large showy petals which are twisted in the bud; they are free to the base, where they are attached to the staminal tube and fall with it when the flower withers. The very numerous stamens are united into a tube at the base, and bear kidney-shaped one-celled anthers which open by a slit across the top. The large spherical pollen-grains are covered with spines. The carpels are one to numerous; when five in number, as in *Abutilon,* they are opposite the petals, or, as in *Hibiscus,* opposite the sepals. In the British genera and many others they are numerous, forming a whorl around the top of the axis in the centre of the flower, the united styles rising from the centre and bearing a corresponding number of stigmatic branches. In *Malope* the numerous carpels are arranged one above the other in vertical rows. One or more anatropous ovules are attached to the inner angle of each carpel; they are generally ascending but sometimes pendulous or horizontal; the position may vary, as in *Abutilon,* in one and the same carpel.

The flowers are protandrous; when the flower opens the unripe stigmas are hidden in the staminal tube and the anthers occupy the centre of the flower; as the anthers dehisce the filaments bend backwards and finally the ripe stigmas spread in the centre. Pollination is effected by insects which visit the flower for the honey, which is secreted in pits one between the base of each petal and is protected from rain by hairs on the lower margin of the petals. In small pale-flowered forms, like *Malva rotundifolia,* which attract few insects, self-pollination is found, the style-arms twisting later to bring the stigmatic surfaces into contact with the anthers.

Except in *Malvaviscus* which has a berry, the fruits are dry. In *Malva* (*see* MALLOW) and allied genera they form one-seeded schizocarps separating from the persistent central column and from each other. In *Hibiscus* and *Gossypium* (the cotton-plant), the fruit is a capsule splitting loculicidally. Distribution of the seeds is sometimes aided by hooked outgrowths on the wall of the schizocarp, or by a hairy covering on the seed, an extreme case of which is the cotton-plant where the seed is buried in a mass of long tangled hairs—the cotton. The embryo is generally large with much-folded cotyledons and little endosperm.

The largest genus, *Hibiscus,* contains 160 species, which are widely distributed chiefly in the tropics; *H. Rosa sinensis* is a well-known greenhouse plant. *Abutilon* (*q.v.*) contains 120 species, mainly tropical; *Lavatera,* with 20 species, is chiefly Mediterranean; *Althaea* has about 15 species in temperate and warm regions, *A. rosea* being the hollyhock (*q.v.*); *Malva* has about 30 species in the north-temperate zone. Several genera are largely or exclusively American.

MALVASIA (Gr. *Monemvasia,* "city of the single approach"; Ital. *Napoli di Malvasia;* Turk. *Mengeshe* or *Beneshe*) on the east coast of the Morea, Greece, contiguous to the site of the ancient Epidaurus Limera, of which it took the place; one of the principal fortresses and commercial centres of the Levant during the middle ages, still represented by considerable ruins and a town of about 550 inhabitants. So extensive was its trade in wine that the name became familiar throughout Europe as that of a special kind—Ital. *Malvasia;* Span. *Malvagia;* Fr. *Malvoisie;* Eng. *Malvesie* or *Malmsey.* The wine was not of local growth, but came from the Cyclades, and Malavisi province of Crete.

The Byzantine emperors valued Malvasia as a fortress in the Morea, and rewarded its inhabitants for their fidelity by unusual privileges. The emperor Maurice made the city (previously dependent in ecclesiastical matters on Corinth) an archbishop's see, and Alexius Comnenus, and more especially Andronicus II. (Palaeologus) gave the Monembasiotes freedom from all sorts of exactions throughout the empire. It was captured after three years' siege by Guillaume de Villehardouin in 1248, but retained its liberties and privileges, and was restored to the Byzantine emperors in 1262. It placed itself under Venice from 1463 to 1540, when it was ceded to the Turks. In 1689 it was the only town of the Morea which held out against Morosini, and his successor Cornaro only succeeded in reducing it by famine. In 1715 it capitulated to the Turks, and on the failure of the insurrection of 1770 the leading families were scattered abroad. As the first fortress which fell into the hands of the Greeks in 1821, it became in the following year the seat of the first national assembly.

See Curtius, *Peloponnesos,* ii. 293 and 328; Castellan, *Lettres sur la Morée* (1808), for a plan; Valiero, *Hist. della guerra di Candia* (Venice, 1679), for details as to the fortress; W. Miller in *Journal of Hellenic Studies* (1907).

MALVERN, inland watering place, urban district, Bewdley parliamentary division, Worcestershire, England, 128 mi. N.W. of London by the G.W.R., served also by the L.M.S.R. Pop. (1938) 17,320. Area 12 sq.mi. It is situated on the eastern slopes of the Malvern hills, which rise from the valley of the Severn to a height of 1,395 ft. in the Worcestershire Beacon. The district bears the name of Malvern Chase, originally a Crown-land and forest, though it was granted to the earl of Gloucester by Edward I. An ancient trench, now the county boundary, along the summit of the hills determined the ancient boundary. Malvern was in early times an ecclesiastical settlement, but today it depends upon its schools and colleges. Mineral waters are manufactured.

The name Malvern is collectively applied to a line of small towns and villages, extending along the foot of the Malvern hills, 1,200 ac. of which to the south are administered by the National Trust. The principal is Great Malvern, lying beneath the Worcestershire Beacon. Here was the Benedictine priory which arose in 1083 out of a hermitage endowed by Edward the Confessor. The priory church of SS. Mary and Michael is a cruciform Perpendicular building, with an ornate central tower, Norman nave, and much early glass. At Malvern Wells, $2\frac{1}{2}$ mi. S., are the medicinal springs, extensive fishponds and hatcheries. Little Malvern, with remains of a Benedictine priory, lies at the foot of the Herefordshire Beacon, which is crowned by an ancient and well-preserved entrenched camp. Malvern Link, and West and North Malvern, on the hills, are suburbs of Great Malvern. The council owns the concert hall, the theatre and the cinema.

MALVY, LOUIS JEAN (1875–), French Socialist-Radical politician, was born at Figeac on Dec. 1, 1875. In 1906 he entered the chamber as a Socialist-Radical and was an under-secretary in the Monis and Caillaux cabinets (1911), minister of commerce and postal services under Doumergue (Dec. 1913) and minister of the interior in the Viviani ministry (June 1914). He retained this post under Briand and Ribot. On July 22, 1917, Clemenceau charged him with lax administration in dealing with defeatists and agitators, and he resigned on Aug. 31. His resignation brought about the fall of the Ribot cabinet. In October Léon Daudet brought against him a general accusation of treason. A commission, appointed at Malvy's own suggestion, decided on behalf of the chamber that the senate, sitting as a high court, should pronounce judgment on all the stated charges. On Aug. 6, 1918, the high court acquitted Malvy of the charge of treason, but found him guilty of *forfaiture, i.e.,* culpable negligence, in the performance of his duties as minister of the interior from 1914–17, and sentenced him to banishment for five years, which he passed in Spain. In 1924 he was re-elected to the chamber, he represented France at the Morocco negotiations which arranged for joint action against Abdel Krim, and in October of the same year became president of the finance commission of the chamber. Malvy again became minister of the interior in the Briand cabinet of March 1926, but his appointment roused old and bitter controversies and after a stormy sitting in which he was violently attacked he fainted in the chamber. The deputies then voted in support of the government, ashamed of their violence. But Malvy resigned on the ground that his presence in the cabinet deprived it support. In 1928 he was elected chairman of the finance committee of the chamber; again in 1932, serving until 1940.

See Albert, *Le procès Malvy* (1920); and E. Gomez Carillo, *Mystère de la vie et de la mort de Mata Hari* (1925).

MALWA, an historic province of India, which has given its name to one of the political agencies into which Central India is divided. Strictly, the name is confined to the hilly tableland, bounded S. by the Vindhyan range, which drains north into the river Chambal; but it has been extended to include the Nerbudda valley farther south. Its derivation is from the ancient tribe of Malavas who founded the Vikrama Samvat, an era dating from 57 B.C., which is popularly associated with a mythical king Vikramaditya. The position of the Malwa or Moholo mentioned by Hsuan Tsang (7th century) is plausibly assigned to Gujarat. The first records of a local dynasty are those of the Paramaras, a famous Rajput clan, who ruled for about four centuries (800–1200), with their capital at Ujjain and afterwards at Dhar. The Mohammedans invaded Malwa in 1235; and in 1401 Dilawar Khan Ghori founded an independent kingdom, which lasted till 1531. In 1562 Malwa was annexed to the Mogul empire by Akbar.

On the breakup of that empire, Malwa was one of the first provinces to be conquered by the Mahrattas, when it became a cockpit for fighting between the rival Mahratta powers, and the headquarters of the Pindaris or irregular plunderers. The Pindaris were extirpated by the campaign of Lord Hastings in 1817, and the country was reduced to order by Sir John Malcolm. Malwa is traditionally the land of plenty, in which sufferers from famine could take refuge. But in 1899–1900 it was visited by drought, followed by plague. A product used to be opium.

The Malwa agency comprises the states of Dhar, Jaora, Ratlam, Sitamau, Sailana, Jhabua, Barwani and Alirajpur and five petty chiefships. The area is 7,378 sq.mi. and the population in 1941 was 1,037,716 excluding the petty chiefships. The headquarters of the political agent are at Indore.

Malwa is also the name of a large tract in the Punjab, south of the river Sutlej, which is one of the two chief homes of the Sikhs, the other being known as Manjha. It includes the British districts of Ferozpore and Ludhiana, together with the native states of Patiala, Jind, Nabha and Maler Kotla.

MAM. This Indian tribe, speaking a Maya dialect, occupies in part the departments of Huehuetenango, Quezaltenango, Totonicapán and San Marcos in Guatemala, and also some of the adjacent portion of Mexico. Long ago they extended farther south and east into the ancient kingdoms of the Cakchiquel and Quiché (*q.v.*), but they were defeated by the Quiché king, Kicab, in alliance with the Cakchiquel, and forced to withdraw to their present limits. Before the conquest the Mam were regarded by their neighbours of Maya stock as uncouth and provincial. The Cakchiquel "Annals" speak of them as barbarians who did not speak distinctly. Their very name means "the stutterers." From this and other evidence it is thought that they may represent an early wave of Maya migration into Guatemala, forced to retreat to their present mountainous habitat by later comers. In 1525, after a fierce resistance, the Mam were conquered by the Spaniards under Gonzalo de Alvarado. The campaign ended by the siege of the famous fortress of Zacaleu, which the Spaniards finally starved into submission. Traces of its circular walls encompassing a steep hill can be seen today. At present the Mam number somewhat more than 100,000 individuals, of whom less than 10,000 live in Mexico. Like the other Indians of the Guatemalan highlands they follow agriculture, and dress in coloured costumes of local manufacture.

MAMAMU, the Hawaiian, it having no English name, of one of the most highly prized Pacific food fishes, *Monotaxis grandoculis,* belonging to the family Sparidae, or Sea Breams, and notable for its very large eyes. It reaches a length of over two feet, and occurs from the Red sea to the Hawaiian Islands (*see* BREAM).

(J. T. N.)

MAMARONECK (mạ-măr′ō-nĕk), a village of Westchester county, New York, U.S.A., 20 mi. N.E. of New York city, on Long Island sound, the Boston Post road and the New York, New Haven and Hartford railroad. Population in 1940 (federal census) was 13,034. The site of Mamaroneck (an Indian word meaning "where the fresh water falls into the salt") was part of a tract bought from the Indians in 1661 by John Richbell, an Englishman, and settled in 1676 by relatives of his. Heathcote hill, now dotted with residences, was the scene of a skirmish in the Revolution (Oct. 21, 1776). J. Fenimore Cooper lived in Mamaroneck for several years. The village was incorporated in 1895.

MAMELI, GOFFREDO (1827–1849), Italian poet and patriot, born at Genoa of a noble Sardinian family, studied law and philosophy at the University of Genoa. He was wholeheartedly devoted to Mazzini; among other patriotic poems he wrote a hymn to the Bandiera brothers, and in the autumn of 1847 a song called "Fratelli d'Italia," which as Carducci wrote, "resounded through every district and on every battlefield of the peninsula in 1848 and 1849." Mameli served in the national guard at Genoa, and then joined the volunteers in the Lombard campaign of 1848, but after the collapse of the movement in Lombardy he went to Rome, whence he sent the famous despatch to Mazzini: "Roma! Repubblica! Venite!" Although wounded in the engagement of April 30 for the defence of Rome, he at once resumed his place in the ranks, but on June 3 he was again wounded, and died in the Pellegrini hospital on July 6, 1849. Mameli was called "the Tyrtaeus of the Italian revolution."

MAMELUKE, the name given to a series of Egyptian sultans, originating (1250) in the usurpation of supreme power by the bodyguard of Turkish slaves first formed in Egypt under the successors of Saladin. *See* EGYPT: *History.*

MAMERTINI, or "children of Mars," the name taken by a band of Campanian (or Samnite) freebooters who about 289 B.C. seized the Greek colony of Messana at the northeast corner of

Sicily, after having been hired by Agathocles to defend it (Polyb. I. 7. 2). The members of the expedition are said to have been the male children born in a particular spring of which the produce had been vowed to Apollo (*see* SAMNITES), and to have settled first in Sicily near Tauromenium. An inscription survives (R. S. Conway, *Italic Dialects*, 1), which shows that they took with them the Oscan language as it was spoken in Capua or Nola at that date, and the constitution usual in Italic towns of a free community (*touta*) governed by two annual magistrates (*meddices*). On the Roman conquest of Sicily the town secured an independence under treaty (Cicero, *In Verr.* 3. 6. 13). The inhabitants were still called Mamertines in the time of Strabo (vi. 2. 3).

See also Mommsen, *C.I.L.* x.

MĀMERTINUS, CLAUDIUS (4th century A.D.), one of the Latin panegyrists. He was praefect of Italy (365) under Valens and Valentinian, but in 368 was deprived of his office for embezzlement. He was the author of an extant speech of thanks to Julian for raising him to the consulship, delivered on Jan. 1, 362, at Constantinople. Two panegyrical addresses (also extant) to Maximian (emperor A.D. 286–305) are attributed to an older *magister* Mamertinus, but it is probable that the corrupt ms. superscription contains the word *memoriae,* and that they are by an unknown *magister memoriae* (an official who announced imperial rescripts and decisions). The first of these was delivered on the birthday of Rome (April 21, 289), probably at Maximian's palace at Augusta Trevirorum (Trèves), the second in 290 or 291, on the birthday of the emperor. By some they are attributed to Eumenius (*q.v.*) also a *magister memoriae.*

The three speeches will be found in E. Bährens, *Panegyrici latini* (1874); *see* also Teuffel-Schwabe, *Hist. of Roman Literature* (Eng. trans.), § 417, 7.

MAMMALIA, a term invented by Linnaeus (1758) to include that class of animals in which the young are brought forth alive and nourished with milk from the mother's breasts (mammae). Typical examples are the dog, cow, rabbit, monkey, man. Whales are also mammals, although externally fish-like in appearance. Hair (*q.v.*) is a typical mammalian structure. Mammals, like birds, are "warm-blooded" or homoeothermal animals, that is, they differ from "cold-blooded" or poecilothermal forms, such as fishes, amphibians and reptiles, in their superior ability to regulate their own body temperature, so that in spite of wide variations in the temperature of the surrounding medium the body temperature of a typical mammal is maintained in health at a high level and within the relatively narrow limits that are best adapted to the needs of the animal. Some of the most characteristic features of mammals are the expression of the relatively high pace maintained by the vital processes. Here may be mentioned the flexible skin, together with the sweat glands and sebaceous glands, the diaphragm, the complex lungs and heart.

The origin of the mammals lies among the extinct mammal-like reptiles of the Triassic age. The subject may be divided into the following headings, I. Nutrition; II. Locomotion; III. Control Systems; IV. Reproduction; V. Rise of the Mammalian Orders; VI. Continental Dispersal of Orders.

NUTRITION

Jaws and Teeth.—The main divisions of the digestive tract (*see* ALIMENTARY CANAL) are already established in the vertebrates below mammals; indeed the organs and the processes of digestion (*see* NUTRITION AND DIGESTION) in the most primitive mammals have been inherited directly from their premammalian ancestors. In typical mammals the most striking morphological advances beyond the reptilian grade are the jaws and teeth.

Mammals are distinguished from lower vertebrates by the fact that the mandible, consisting on each side of a single element (corresponding with the dentary bone of lower vertebrates), articulates directly with the squamosal without the intervention of the quadrate and articular which form the functional mandibular joint in the lower vertebrates. Early embryos of man, and many other mammals, show the dentary of each side forming on the outer side of the stout cartilaginous lower jaw, which corresponds with the Meckel's cartilage or core of the lower jaw of lower vertebrates. The back of this in the embryo mammal ends in a well-developed joint corresponding to the joint between the quadrate and articular elements of the lower vertebrates. As development proceeds the dentary grows upward and establishes a new joint with the squamosal bone of the skull, while the old reptilian joint dwindles in size, pulls away from the dentary bone, and gives rise to the joint between the malleus and incus of the middle ear, which are thus vestiges of the articular and quadrate of lower vertebrates.

In the higher mammal-like reptiles of the Triassic of Russia and South Africa the adult dentition was already differentiated into four kinds of teeth: incisors, canines, premolars and molars; the premolars and molars were cuspidate and in some genera had acquired accessory basal spurs and additional cusps; moreover, the teeth were set in sockets and in some the cheek teeth show an incipient division of the single roots, while the dentition as a whole was reduced to two sets corresponding to the deciduous and permanent dentitions of mammals.

Specialization of Teeth.—The food of mammals, like that of lower vertebrates, may be either chiefly proteids, or chiefly carbohydrates, or a mixture of the two. The pure proteid eaters are typically fierce rapacious forms, in which the digestive tract, the prehensile and masticatory apparatus and the locomotor machinery are all designed for aggression. On the other hand, the carbohydrate feeders are peaceful herbivorous creatures, who spend most of their time in consuming and storing away great quantities of relatively innutritious food.

The anatomical and physiological differences between these two extreme types, *e.g.*, the cat and the cow, are largely correlated with this fundamental contrast in food habits. The cat as a proteid eater receives its food in a highly concentrated and elaborate form. Consequently its digestive tract is relatively short and simple, the stomach is not subdivided and the gastric juice shows a high percentage of hydrochloric acid.

On the other hand, the cow, representing the extreme carbohydrate-feeding type, normally has in its stomach from 14 to 18% of its own total weight in bulky herbaceous food, which contains a great amount of cellulose. The cow's digestive juices are unable to dissolve this indigestible food, but the cow produces an enormous quantity of saliva, which softens the food. By regurgitating and chewing the cud it mashes up the food in preparation for the fermentation caused by the anaerobic bacteria and infusoria in its stomach. In this way the mass gradually becomes fit for digestion by the long digestive tract.

The differences in diet between the cat and the cow are reflected in the differences in their dental mechanism and associated parts of the skull, as set forth in the following table.

	Cat	*Cow*
Jaws:	Short, powerful, wide, for strong vertical movements	Long, slender, narrow, for oblique side swing
Incisor teeth:	Present in both jaws	Absent in upper jaw, replaced by pad
Lower incisors:	Sharp, for piercing, holding and tearing flesh	Blunt, opposed to pad, for cropping grass
Canines:	Prominent, for killing and dragging the prey	Upper canines absent; lower canines incisor-like, for cropping grass
Crowns of premolars and molars:	Compressed, blade-like, for shearing flesh and cutting bones	Crescentic, long-crowned for chewing the cud
Articular condyle of lower jaw:	Placed far down, on level with teeth; to produce a scissors effect, the back teeth engaging first	Placed far above the level of teeth; to bring all the cheek teeth on one side into play at once
Ascending branch of lower jaw:	Very large, for attachment of powerful temporal muscle	Slender, for small temporal muscle
Body of jaw:	Massive, for attachment of powerful masseter muscle	Slender, for attachment of slender masseter muscle

	Cat	*Cow*
Method of cutting up food:	Into large chunks, with a few powerful bites	Into many very small bits, with many strokes of the jaw

Relatively few mammals attain either of these extreme specializations, the majority subsisting on a more or less mixed diet.

Incisors and Canine Teeth.—The front teeth of mammals are adapted, according to the nature of the food, into insectivorous, carnivorous, gnawing, omnivorous, frugivorous, browsing, grazing, piscivorous and various derived and mixed types.

In the more primitive insectivorous forms the incisors ($\frac{3}{3}$ on each side in primitive placentals and $\frac{5}{4}$ in primitive marsupials) are small nipping teeth, suitable for catching insects, the lower centrals slightly procumbent, the crowns simple with blunt points or slightly sharp edges. In the cat the incisors are fairly primitive in form but are nearly vertical, so giving a more powerful bite.

In rodents the incisors become long-crowned, curved, flattened cylinders with chisel-like edges growing continuously from persistent pulps. In the lower Oligocene forerunners of the Proboscidea (*q.v.*) or elephants (*Moeritherium*), one pair of upper incisors and one pair of lowers are moderately enlarged and adapted for cutting and plucking vegetation from the ground. In *Palaeomastodon* the next higher stage, the upper incisor tusks are much enlarged; through the development of a proboscis, they no longer oppose the lower incisors but function as levers and weapons. In certain later mastodons and elephants the lower incisors are gradually eliminated and the upper incisors attain great size, reaching in the extinct *Elephas ganesa* to 10 ft. 8½ inches.

A reduction or loss of the incisors has frequently occurred in animals with a protrusile tongue, as in the sloths, anteaters, etc.

In the horse family, which are grazers, both the upper and lower incisors have become long-crowned, with cup-like insinkings from the incisal surface of the crown. This arrangement strengthens the tooth for cutting off siliceous grass stems, while the long crown insures a long period of use.

In the cow, representing the browsing and grazing ruminant artiodactyls, the upper incisors and canines have been replaced by a horny pad, the lower incisors and lower canines have spatulate crowns arranged in a semicircle, adapted, with the horny pad above, for plucking herbage.

The canine teeth of carnivores are peculiarly fitted for killing living prey. This type of tooth culminates in the great canines of the extinct sabre-tooth tigers. On the other hand, in herbivorous forms the canine teeth are either reduced or adapted to some other function, as in the lower canines of ruminants above mentioned, or the upper canines or fighting tusks of the boar.

Deciduous or Milk Teeth.—In mammals the true molars, although erupting late, appear to belong to the same series as the deciduous incisors, canines and premolars, but have long lost their permanent successors. Since as soon as the young animal is weaned it usually feeds upon the same food as its parents, it will be obvious that it usually needs a functional set of teeth of the same general kind as those of its parents but smaller. Thus the milk teeth are usually not notably different from the permanent set. The presence of the milk teeth makes it possible for the permanent teeth to grow to any desirable size before eruption, teeth once erupted no longer grow except at the roots. Usually the hindmost milk teeth are more molariform than the permanent teeth that replace them, apparently because the young animal needs such teeth where the bite is the strongest.

Dental Formulae.—With few exceptions the right and left sides of the jaws have the same numbers of incisors, canines, premolars and molars respectively. Consequently the "dental formula" as ordinarily written represents only one side of the whole dentition and the total number of teeth is equal to twice the sum of the numbers in the "formula." The adult dental formula of man, for example:

$\left(I\frac{2}{2}\ C\frac{1}{1}\ P\frac{2}{2}\ M\frac{3}{3}\right)$, is simply an abbreviated form of:

Incisors: upper, 2 / lower, 2 Canines: upper, 1 / lower, 1 Premolars: upper, 2 / lower, 2

Molars: upper, 3 / lower, 3

The following dental formulae illustrate the progressive reduction as we pass from the more primitive forms to the highly specialized dentition of the cat:

Typical pantotherian mammal of Jurassic age	$(I\frac{?4}{4}\ C\frac{1}{1}\ P\frac{4}{4}\ M\frac{7?}{8?}) \times 2 = 66$
Typical polyprotodont marsupial (Opossum)	$(I\frac{5}{4}\ C\frac{1}{1}\ P\frac{3}{3}\ M\frac{4}{4}) \times 2 = 50$
Modern insectivore (Gymnura)	$(I\frac{3}{3}\ C\frac{1}{1}\ P\frac{4}{4}\ M\frac{3}{3}) \times 2 = 44$
Modern dog	$(I\frac{3}{3}\ C\frac{1}{1}\ P\frac{4}{4}\ M\frac{2}{2}) \times 2 = 40$
Modern cat	$(I\frac{3}{3}\ C\frac{1}{1}\ P\frac{3}{3}\ M\frac{1}{1}) \times 2 = 32$

On the other hand, a secondary increase in number of molars occurs in several groups. Thus in anthropoids and man a fourth molar is sometimes developed. The high number of simple teeth in the toothed cetaceans is the result of degenerative specialization.

Molars.—Primitive insectivorous molars are small and bear V-shaped cusps with sharp little blades; in shearing types the molars are reduced in number but are large, with one or two long blades; in omnivorous types either the cusps become rounded, often connected with other cusps by low ridges as in anthropoid apes and man, or they become conic and multiplied in number as in the wart-hog; or the whole crown becomes a swollen mass with low cusps as in the bear; in herbivorous types the molar crowns acquire crests and hillocks, arranged in patterns characteristic of the different species.

In 1883 E. D. Cope observed that the teeth and skeletons of the carnivores and primitive ungulates of the Lower Eocene were far less dissimilar than those of their modern descendants, and especially that, while the patterns of their upper molars were already diversified, there were three main cusps or elevations, two on the outer and one on the inner side of the upper molars, evidently homologous in both carnivores and herbivores. This was the "tritubercular" upper molar type of the Eocene mammals. A fourth main cusp on the hinder inner side of the upper molars could be seen in earlier stages of evolution in the carnivores and in more advanced stages in the primitive herbivorous mammals.

In the lower jaws Cope observed that in both carnivores and herbivores each lower molar tended to conform to a type in which the tooth crown was divided into two moieties arranged in tandem: the first or anterior moiety (the *trigonid*) elevated and supporting a triangle of cusps, of which the chief lay on the outer side of the crown, the other two on the inner; the second or posterior moiety (the *talonid*) depressed below the trigonid, consisting chiefly of a central concavity flanked on the inner and outer sides by single cusps. This central type of lower molar Cope called *tuberculo-sectorial*. Among recent mammals the tuberculo-sectorial pattern may still be seen in the lower molar teeth of civets, opossums, hedgehogs and other flesh-eating and insectivorous mammals.

H. F. Osborn (1888) gave names to the principal cusps of the upper and lower molars, as follows:

Upper Molar		*Lower Molar*	
Trigon		*Trigonid*	
Antero-internal: (pr)	Protocone	Antero-external: (prd)	Protoconid
Antero-external: (pa)	Paracone	Antero-internal: (pad)	Paraconid
Postero-external: (me)	Metacone	Postero-internal: (med)	Metaconid
		Talonid	
Talon		Postero-external: (hyd)	Hypoconid
Postero-internal: (hy)	Hypocone	Postero-internal: (end)	Entoconid

Both Cope and Osborn sought to trace the origin of the tritubercular molars of Eocene mammals back to the "single reptilian cone" of the earliest reptiles. For details of molar evolution *see* H. F. Osborn, *The Origin of the Mammalian Molar Teeth to and from the Tritubercular Type* (1907) and W. K. Gregory, *The Origin and Evolution of the Human Dentition* (1922).

LOCOMOTION

Origin of the Mammalian Locomotor Apparatus.—The locomotor machinery of mammals, like that of other vertebrates, involves four closely interconnected systems: (1) the motor elements proper; (2) the passive or supporting elements; (3) the combustion; (4) the activating, controlling and directive system.

The motor elements include the striped or red muscle cells and the parts built up from them, muscle fibres, muscles and muscle systems (*see* MUSCULAR SYSTEM, ANATOMY OF). The supporting elements include: (*a*) the sheaths and connective tissue surrounding the active elements; (*b*) the tendons that attach the muscles to the bones; (*c*) the ligaments that tie the parts of the skeleton together and (*d*) the articulated bony skeleton, including the backbone, skull, ribs, sternum, pectoral and pelvic girdles and limb bones. The locomotor apparatus of mammals, like that of lower vertebrates, is typically adapted for quadrupedal progression by running on relatively open ground, though many forms have learned to progress in special ways: leaping, climbing, volplaning and even flying, swimming, digging, tunneling. But no matter how elaborate the locomotor mechanism may be, it has all been evolved from the simple crawling mechanism of the earliest amphibians, and this in turn from the undulatory movements of certain air-breathing, lobe-finned fishes of Devonian age.

When the earliest amphibians crawled up out of the water the fore and hind paddles were bent downwards to assist the wriggling movement of the body. At first, the limbs sprawled widely. In such forms the humerus, or first segment of the skeleton of the forelimb, had a very short shaft and widely-expanded ends. There was a sharp bend at the elbow and the radius, or front forearm bone, articulated on the under side of the humerus rather than on its further end. Similarly in the hind-limb, the femur was short and was held widely out from the body.

But in the extinct mammal-like reptiles of the Permian and Triassic of South Africa and Russia the skeleton of the pectoral and pelvic girdles and limbs progressively approaches the mammalian type. Their limbs were adapted for running rather than crawling; the body was lifted well above the ground and the trackway became narrower so that the feet gave a more direct support to the weight. In the later mammal-like reptiles the feet were small and short, and from the reduction in the number of phalanges or toe-joints, to the mammalian number (three in each toe, except the first, which has two) we may infer that the fore-feet were at least partly "digitigrade," *i.e.*, raised off the ground at the wrist. So too the humerus of the cynodonts, or higher mammal-like reptiles, approached the lower mammalian types, and from the form and position of its joint surfaces we may infer that the angle at the elbow was opening out toward the mammalian condition.

The Fore-Limb.—The typical mammalian shoulder-girdle exhibits a distinct advance beyond that of the cynodont reptiles in the following features: (1) complete loss of all parts of the outer shoulder-girdle except the clavicles; (2) the scapula has an anterior shelf or extension supporting the supraspinatus muscle; (3) the dorsal part of the supracoracoid muscle mass has extended upward on to the scapula to give rise to the supraspinatus and the infraspinatus muscles; (4) the coracoid has become greatly reduced and has lost its contact with the sternum; (5) the anterior coracoid plate has disappeared or become vestigial; (6) the interclavicle has disappeared. All these changes have been associated with the raising of the body and the drawing-in of the fore-limbs so that the feet could be planted beneath the body. The egg-laying monotremes now the lowest of existing mammals, are still largely reptilian in the anatomy of the shoulder-girdle.

The remaining elements of the primitive mammalian fore-limb, the humerus, radius and ulna, carpus, metacarpus and digits, were derived with only minor changes from those of the cynodonts.

The Hind Limb.—The primitive mammalian ilium has apparently been derived from that of the cynodonts through the pronounced narrowing of the region above the root of the tail, accompanying the reduction of the tail muscles. The result of this and other changes has been to narrow and lengthen the gluteal area on the back of the ilium and to extend the area on the front inner surface for the origin of the iliacus muscle, so that the primitive mammalian ilium has become a narrow trihedral rod, with well defined iliacus, gluteal and sacral planes.

Meanwhile the femur has undergone corresponding changes in the passage from crawling to running habits. In the primitive crawling types the short stout femur projected widely from the body, its head, or surface for articulation with the pelvis, was a broad oval set directly on top of the shaft; there was a large deep pit for the insertion of the obturator muscles on the under-side of the femur below the head, and a high ridge for the adductor muscles, also on the under-side of the shaft. In primitive mammals, the femur is long, slender, with a cylindrical shaft, the head is globular, set off at a sharp angle and separated from the shaft by a well-defined neck; there is a large flange (greater trochanter) on the outer upper part of the shaft, the proximal pit (or digital fossa) is small, the primary adductor ridge is lost and there is a process, the lesser trochanter, not found in reptiles.

In primitive reptiles the bend between the lower end of the shank and the foot was not sharp; the two main bones of the tarsus, the astragalus and calcaneum, were flat, more or less circular elements located in the same general plane; the calcaneum did not project backward to form a heel-bone. In the running foot of the typical mammal, on the other hand, there is a sharp bend between the shin-bone and the instep, the astragalus and calcaneum are highly differentiated, the former resting upon the latter, the one forming a pulley for the tibia, the other a heel or lever for the powerful muscles of the shank.

Adaptive Radiation of the Limbs.—Among existing mammals the monotremes are adapted for burrowing and swimming but these are the habits of refugees from direct, above-ground competition with higher types. Among marsupials the primitive forms were arboreal, much like the existing opossums, and these gave rise to the numerous ground-living forms adapted for running, leaping and digging. W. D. Matthew has argued that the little-known primitive placental mammals of the early Cretaceous were also arboreal, inasmuch as many of their descendants in the Lower Eocene had five-toed spreading hands and feet, partly divergent thumbs and great toes, and a primitive skeleton not unlike that of an opossum. However, the evidence for arboreal derivation is less decisive than in the marsupials.

Scampering Types.—Small mammals in general have what may be called the scampering habit,—the ability to scurry away quickly in time of danger, without any pronounced specializations of the skeleton for running; and it seems safe to assign this habit to the pre-Eocene insectivorous ancestors of the placentals. From such a scampering type, with small semi-plantigrade hind feet and semi-digitigrade forefeet, adaptive radiation for different habits has brought about profound modifications of all parts of the skeleton.

Cursorial Types.—In quadrupedal running or cursorial forms length and rapidity of stride, combined with strength and endurance, are the great desiderata. The lower segments of the limbs become long, rod-like, angulated compound levers for striking the hard ground and catapulting the body forward; the principal muscles are bunched at the upper parts of the limbs and transmit their pulls through long cord-like tendons that pass over smooth pulley-like surfaces and are inserted into the lower segments of the leg. In extreme forms the foot is longer than the humerus, which gives great speed but requires great muscular strength.

The long narrow feet in running forms have parallel rather than spreading digits; rising on its toes, the animal finally runs on its enlarged hoofs alone. The thumb and great toe are reduced in size and raised off the ground; later they disappear, as do the fifth or outer digits of the fore- and hind-feet. In the perissodactyls or odd-toed ungulates the middle or third digit in both feet becomes predominant, in the horses finally forming the sole functional axis of the foot, the second and fourth digits being reduced to slender splints. In the artiodactyls, on the other hand, after the loss of the first digit the others become paired, the inner and outer digits, II. and V., being smaller, while III. and IV. are larger; in the final stages II. and V. become reduced and almost disappear, while III. and IV. become very long and fuse into the cannon-bone.

As the fore-and-aft movements of the limbs become emphasized, the elbows and knees are turned outward as little as possible; twisting movements diminish. Consequently the shoulder-girdle tends to lose the clavicle and the acromial process of the scapula disappears. In connection with the predominant fore-and-aft movements there are hinge-like joints between the humerus and the forearm, at the wrist and between the metacarpals and the digits.

The scapula is variously shaped: V-shaped in the swift-running artiodactyls, with vertically extended fossa for the infraspinatus muscle; it is usually at least as long as the humerus, which is relatively short with a projecting greater tuberosity for the attachment of the powerful shoulder muscles. The olecranon process of the ulna becomes a broad thickened lever for the insertion of the massive and powerful triceps; the strong tendon of the biceps passes through a broad channel in the humerus.

These and many other detailed adaptations for swift running have been worked out independently in many families and even in different orders of mammals, notably among the numerous plains-living ungulates, as in the horses of the northern world, the extinct pseudo-horses or smaller litopterns of Patagonia, the antelopes and deer. The less advanced stages are seen among the carnivorous hunters such as wolves and certain of the extinct creodonts, as well as in the marsupial wolf (*Thylacinus*) of Australia. Even some of the plains-living rodents, such as the chinchilla, show cursorial adaptations in the limbs. The ilium in cursorial types is a strongly braced T-shaped bone supporting the thick deep gluteal muscles which are inserted nearly at right angle to the long axis of the femur.

Graviportal or Striding Types.—Given an abundant food supply, many lines of evolving animals exploit the opportunity of becoming larger, living longer and leaving a larger progeny. These conditions have tended to transform slender speedy animals into great lumbering brutes. In these heavy-bodied forms the lateral or transverse growth components increase relatively faster than the linear ones; slender bodies and narrow limbs and feet become broad and robust. This is clearly seen in such races as the extinct titanotheres, the rhinoceroses and other lines of ungulates, in which the earlier forms have slender narrow feet, the later ones broad short feet.

In such cases the extent to which the earlier cursorial adaptations are disguised by the overlying graviportal changes depends *inter alia* upon how early the graviportal tendencies gain the ascendancy. When the graviportal tendency supervenes immediately upon the short-footed scampering stage, so that the cursorial stage is passed by, we have the extreme graviportal modifications illustrated in the Eocene Amblypoda and to a less extent in the elephants. The excessively short-toed feet, instead of catapulting the body, roll forward on a great elastic cushion and the straightened legs, with long humeri and femora, swing forward like massive beams. The ilium widens transversely into a huge fan.

Saltatorial or Leaping Types are usually developed from the scampering or cursorial types. In the jerboas and kangaroo rats, which have evolved from scampering rodents, the animals leap on their powerful hind-limbs, holding the body erect and using the fore-limbs chiefly in manipulating the food. The tail is used as a balancing organ in leaping. The kangaroos have doubtless been derived from arboreal phalangers, in which the fourth digit of the hind-foot was already enlarged, the first digit divergent and prehensile, the second and third small and closely appressed or syndactylous. The early hopping stage is illustrated by the tiny musk kangaroo (*Hypsiprymnodon*), in which the great toe is still present though reduced. In later stages the great toe disappears and the fourth digit becomes enormously enlarged, forming the lower joint of a catapult, the power for which is supplied by the massive muscles of the buttocks, thigh and shank. The tail acts as the third leg of a tripod. Bipedal leaping is convenient for hurdling obstacles in sudden alarms, but for heavy animals it is uneconomical for long distances.

Fossorial or Digging Types have been developed usually from scampering short-footed types with short powerful arms. In the mole, an extreme and unique fossorial type, the fore-limbs have been moved forward under the neck to enable the enormous, wide hands to reach in front of the nose. The humeri have acquired a secondary contact with the clavicles, which have become solid blocks that form the pivots of the forearm and rest on a keel-shaped forward extension of the sternum. The scapulae are elongate, to give long shoulder muscles and a long reach of the humeri; the enormous triceps is inserted into a great hooked olecranon process of the ulna, the lower surface of which supports the powerful flexors of the carpus. The hind limb is small and not much modified.

The Cape golden moles (Chrysochloridae) differ widely from the true moles. Their forefeet are very narrow and adapted for digging in hard soil, with one or two sickle-like claws. The armadillos and many rodents dig with their large claws and powerful fore-limbs.

Natatorial or Swimming Types have been developed in many orders, although the extreme form of aquatic adaptation is limited to the Cetacea and Sirenia (*q.v.*). The end-results of prolonged aquatic adaptation naturally depend partly on what type of terrestrial forms the given aquatic types took rise from. Thus among the marsupials the aquatic opossum or yapok is simply an opossum with webbed feet. Among the Mustelidae the ordinary otter, the African *Aonyx* and the sea-otter (*Latax*) represent progressive adaptation to aquatic life, in which the feet become webbed and enlarged. The sea-lions carry this line of adaptation much further, greatly enlarging the hands and feet into flippers, but retaining the power to support the body on all four limbs. Finally, the earless seals (Phocidae) have lost the power of bringing the hind limbs forward under the body and all four feet are specialized paddles. The body, enclosed in a thick layer of fat, has become streamlined and in the cetaceans becomes fish-like. These specializations were already under way in the oldest known whales, the Eocone Archaeoceti. Nevertheless, evidence from comparative anatomy and embryology proves that the Cetacea have been derived from terrestrial, quadrupedal placentals, perhaps allied with the stem of the insectivores and carnivores. The manatees and dugongs (Sirenia) approach the Cetacea in aquatic specialization, but the resemblance is due to convergence as the anatomical differences indicate that the Sirenia have been derived from herbivorous ancestors, possibly related to the ancestral elephants.

Scansorial or Climbing Types.—Many small mammals with well-developed claws and spreading hands and feet supplied with interdigital pads can climb tree-trunks. In the marsupials the opossums afford an example of a primitive stage of arboreal specialization. The phalangers illustrate a more advanced type of highly specialized hind feet; the great toe is strongly divergent and flattened, the second and third toes slender, closely appressed and enclosed in a common skin, the fourth and fifth enlarged and forming the outer fork of a clamp, the great toe forming the inner.

The tree-shrews (Tupaidae), which are probably very primitive Primates, give the initial stages of arboreal adaptation in that order. The pen-tailed tree-shrew (*Ptilocercus*) of Borneo has small spreading hands and feet and a generalized skeleton. The lemurs and their Eocene forerunners Adapidae and Notharctidae, have grasping hind-feet with a wide flat nail on the large great toe; the digits are elongate, slender with small nails, except the second digit, which bears a small claw. Lemurs are essentially arboreal quadrupeds, running along the tops of the branches, and the same is true of the typical monkeys. The New World monkeys, which have a prehensile tail, can also hang and swing from the branches. The monkeys, especially those of the Old World division, sit upright, or partly so, resting on the ischial callosities. The hands are used in manipulating the food.

Brachiating or Acrobatic Forms.—The gibbons do not run on all fours but hold the body erect, raising the long arms above the head. They make long leaps through the air, catching the branches. In their skeleton as well as in their internal anatomy they are closer to man than to the lower primates.

Of the larger anthropoids the orang-utan (*q.v.*) is extremely specialized for arboreal life, using the suspension grasp of the hands and feet. The arms are excessively long, with enfeebled thumbs, the legs very short. Progression on the ground is awkward, the long arms being used as crutches.

The chimpanzee (*q.v.*) is a moderately heavy-bodied brachiating form, less specialized than the orang. In running on the ground a secondarily quadrupedal gait is employed, the weight of the heavy forepart of the body resting on the bent knuckles. Nevertheless tame chimpanzees, when carrying large objects in their arms, walk erect.

Old male gorillas are gigantic, extremely massive animals which run on the ground on all fours upon bent knuckles. Nevertheless the locomotor skeleton as a whole is surprisingly close to that of man, except in certain parts such as the ilium and the great toe, in which the brachiating features are conspicuous.

Biped Type.—This is exemplified by man and the adaptations are treated elsewhere (*see* MAN, EVOLUTION OF).

Volplaning Types.—Certain active climbing types with long limbs, leaping boldly from the trees skim downward easily by holding extended their patagium, a fold of skin stretching from the neck outward and from the arms to the legs and sometimes from the legs to the tail. Such an adaptation has been acquired independently among marsupials in the flying phalangers, among rodents in the flying squirrels and in the anomalures, and also in the colugos ("flying lemurs"), an isolated type remotely related perhaps to the tree-shrews and lemurs. No marked skeletal specializations except the lengthening of the limbs distinguish the volplaning types from their arboreal relatives.

Flying Types.—The Chiroptera (*q.v.*) or bats are the only mammals to achieve true flight. Their wings are enormously elongated hands and arms covered with thin skin. The hind legs are weak and mostly used for suspension. It is supposed that bats have been derived from skimming forms in which the web of skin extended between the long fingers.

The Backbone.—In the line of ascent to the mammals there was a tendency toward simplification of the complex eight-piece vertebrae (*see* AMPHIBIA), with progressive reduction of certain elements, until in the dorsal vertebrae of the mammal-like reptiles four of the original eight pieces were nearly or quite eliminated, and we have left a vertebra composed of two main parts: (*a*) the neurocentrum, an inverted Y-shaped piece, arising from the fusion of the opposite "basidorsals," which cover the spinal nerve cord and afford origin for the spinal muscles; (*b*) the centrum proper, a short cylinder somewhat constricted in the middle, consisting of the opposite pleurocentra, or interdorsals, of earlier vertebrates and serving for the insertion of the ribs and for the support of the body as a whole.

In the oldest Amphibia there was a gradual regional differentiation of the backbone as we pass from the neck to the tail; in the mammal-like reptiles, especially in the cynodonts, regional differentiation is pronounced though not sudden. The ribs of the cervical or neck region are short, but still have shafts, while at least in the higher mammals these shafts are lost. The cynodonts were progressing in the direction of the mammals in the fact that their lumbar ribs were suturally connected with the sides of the vertebrae as in some very young marsupials. In many more advanced mammals the lumbar ribs are completely replaced by transverse processes which grow out from the sides of the vertebrae Similarly in the sacral region the cynodonts and less specialized mammals had free sacral ribs, whereas in more specialized mammals the rib elements of the sacrum are replaced by transverse processes.

In the older mammal-like reptiles the condyle was median and ball-like as in typical reptiles, but in the cynodonts the lateral parts grew outward while the median part retreated so that a double condyle almost of mammalian type was attained.

The mammalian atlas-axis complex is a contrivance of great functional and morphologic intricacy, the purpose of which is to provide a wide range of movement combined with automatic checks, to prevent sudden stresses from dislocating the joint and squeezing the spinal cord. One of the most essential morphological features of the atlas-axis complex of cynodonts and mammals is that the paired occipital protuberances are received into the upper or neural arches of the atlas or first vertebra and that the centrum or body of the atlas becomes a buffer which in the adult is closely united to the centrum of the second vertebra or axis, of which in adults it forms the odontoid process. Meanwhile the neural spine of the second vertebra becomes enlarged vertically to give origin to some of the powerful muscles that raise the head.

In the dorsal vertebrae the stout neural spines act as levers for the powerful spinal muscles in extending the back, while the transverse processes and centra serve as bases for the movable ribs enclosing the heart, lungs and diaphragm.

The contour of the vertebral column in the standing pose in the side view differs widely in accordance with the habits. In scampering types with short legs the column is usually strongly arched in the mid-dorsal region. This culminates in the short-footed carnivorous types such as weasels. In long-limbed running types, especially those with a long neck or a heavy head, the backbone may bear long stout spines on the neck and forepart of the back, to which are attached the heavy ligaments of the neck and the deeper muscles of the occiput.

A profound difference between a typical reptile and a typical mammal is that in the former the great muscles on the lower side of the tail act powerfully in pulling the hind limbs backward in running. In mammals, on the contrary, the tail muscles are greatly diminished and of slight importance in locomotion.

Skull.—The mammalian skull is here treated under the section locomotion because the vertebrate skull in the first place arose as a fulcrum or thrust-block to withstand the forward thrust of the locomotor muscles acting through the vertebral column in the rear and the resistance of the water in front. Hence even in the oldest known chordates, the ostracoderms, the skull consists of two parts: (1) a wedge-like sloping roof and sides, forming a bony *dermocranium* and (2) a cartilaginous or partly ossified inner skull or *endocranium,* comprising (*a*) the capsules surrounding the olfactory, optic and balancing organs and (*b*) the central brain-trough or trabecular region.

Modifications of the jaws and teeth in the mammals, in adaptation to different food habits, have a profound effect upon the form of the skull as a whole, since the jaws usually form the greater part of the bony face, while the jaw muscles cause the upgrowth of ridges on the top and sides of the braincase and condition in many ways the form of the base of the skull.

On the whole the mammalian braincase has advanced beyond that of primitive reptiles in the following features:

(1) The elimination of several dermal bones of the circum-orbital and occipito-temporal series, the tabulars, supratemporals, postorbital, postfrontal, prefrontals;

(2) The widening-out of the brain-trough through the widening of the brain; the change of the reptilian epipterygoid into the mammalian alisphenoid;

(3) The elaboration of the turbinate bones, scroll-like outgrowths from the median cartilaginous septum of the nasal chamber;

(4) The consolidation of the bony elements surrounding the inner ear into a single dense bone, the periotic, and the fusion of this with the squamosal;

(5) The shifting of the inner ear from the side to the base of the skull.

CONTROL SYSTEMS

The mammalian nervous system, which reaches unprecedented complexity in man, can scarcely be understood apart from other regulating devices or control systems, which greatly condition its activities. In all vertebrates the ductless or endocrine glands (*q.v.*) play an important part in the production and maintenance of the specific and individual patterns of growth and behaviour, since they pour into the blood-stream certain hormones which give the chemical impetus to particular changes in the direction of growth. (*See* ENDOCRINOLOGY: *Endocrinology in Animals.*)

On the whole there is a marked contrast, however, between chemically and nervously determined functions. Chemical regulation (as from the ductless glands) tends to be rigid and determinate. Nervous regulation, on the other hand, has tended toward flexibility, modifiability, choice of several courses of action. Mammals, especially man, have achieved extraordinary adaptability to wide ranges of environmental changes largely through the greater flexibility and range of response of their nervous system.

The nervous system of mammals (more fully treated in the article BRAIN), like that of other vertebrates, comprises the following elements: (1) paired organs of smell, sight, balance, hearing; (2) numerous organs of touch and taste and "somesthetic" sense (organs which convey sensations of bodily posture and movement); (3) "motor nerves," which release the activities of glands and muscles; (4) innumerable connecting tracts, relay stations and control systems of amazing intricacy.

In general the mammalian brain differs from that of lower vertebrates in the fact that the upper part and sides of the end-brain have grown outward into sack-like expansions, which form the neopallium or cerebral cortex of mammals. In the lower mammals this new part of the brain is but moderately developed and the localization of functional areas is at best incipient but in the higher mammals, including man, the neopallium becomes enormously complex, dominating the entire organism and tending to differentiate the cortical "centres" described in the article BRAIN. Meanwhile the thalamus and the "brain stem" have likewise become extremely complex, developing a bewildering maze of connections with other parts of the brain. The result of these expansions and complications is that the old primary control systems pass under the dominance of the newer and higher centres. (*See* C. J. Herrick, *Brains of Rats and Men,* and F. Tilney and H. A. Riley, *The Brain from Ape to Man.*)

REPRODUCTION

In a typical placental mammal the minute fertilized egg is developed internally and the embryo is nourished by an outgrowth of its own "allantoic bladder" which becomes appressed to the wall of the maternal uterus, finally uniting with the latter, at least along certain zones. Thus the embryo is enabled to draw nourishing blood directly from the mother (*see* VERTEBRATE EMBRYOLOGY). At birth the placenta is pulled away from the uterine wall but excessive uterine hemorrhage is normally stopped automatically by appropriate chemical substances in the maternal blood.

After birth the development of higher mammals is prolonged over the period corresponding in man to infancy, childhood and adolescence; the delayed maturity affording opportunity for long-continued growth and differentiation of the brain, with a correspondingly extended period of learning.

In wide contrast with this are the conditions found in the lowest existing mammals, the egg-laying mammals of Australia (*see* MONOTREMATA) While these lay eggs, like reptiles, the embryo nevertheless derives some of its nourishment from the uterine wall as well as from the yolk stored in the egg.

In typical placental mammals the right and left uteri are fused in the mid-line, making a single uterus. In the lowest mammals, the monotremes, the right and left uteri are entirely separate as in reptiles. Various intergrading conditions between these extremes occur in the marsupials, edentates and rodents.

The milk-glands of female mammals are highly characteristic of the whole class. They are arranged in pairs on the ventral surface of the body, varying in number from one pair in man and other primates to eleven pairs in the insectivore *Centetes.* They are usually surmounted by nipples, raised folds of skin with a central tunnel for the passage of the milk. In the placental mammals the milk is actively sucked or pumped by the young but in the monotremes the nipples are represented only by depressed glandular areas with raised borders and the milk is said to be licked by the young from the base of the hairs in the mammary field. This condition may well give the clue to the origin of the milking habit, which must have originated after the sebaceous glands of the skin had developed an albuminous secretion, which may have served originally either to attach the eggs to the under-surface of the brooding mother, or to anoint the eggs with a heat-retaining coating. At any rate, the habit of milking in its initial stages seems to require some voluntary action by the young, such as licking.

THE RISE OF THE MAMMALIAN ORDERS

During the Triassic, Jurassic and Cretaceous, the fossil record of the mammals is meagre; later it is relatively abundant; but even then there are blank intervals and imperfectly preserved records. As many existing orders of mammals began to diverge during the Age of Reptiles, when the record is most imperfect, it is difficult to reconstruct the earlier history of the mammalian orders from present data.

Probably by Upper Triassic times some of the smaller mammal-like reptiles, a group already almost mammals, had crossed the line by acquiring a hairy covering and a new contact between the dentary bones of the lower jaw and the squamosal bone of the skull. With the coming of Lower Jurassic times the mammalian stock had split into three distinct groups: (1) the Allotheria or Multituberculata (*q.v.*), rodent-like mammals with gnawing front teeth and many-cusped grinding teeth; (2) the Triconodonta, small carnivorous forms with triconodont molar teeth, each crown consisting typically of three cusps in a fore-and-aft line and (3) the Pantotheria, or Trituberculata, very small insectivorous mammals typically with sharp-cusped lower molars of the most primitive tuberculo-sectorial type. The Allotheria were probably not closely related to any other order of mammals but were a peculiar, now wholly extinct group extending in time from the Upper Triassic to the summit of the basal Eocene. The Triconodonts also appear to be an isolated and extinct group, but certain of the Pantotherians, such as *Amphitherium,* appear sufficiently generalized to be the potential ancestors of all later mammals except the recent monotremes which at present show distant relationships with the marsupials, but are still without known fossil ancestors, the features they share with the Allotheria being offset by many others that indicate wide differences. The marsupials may well be the descendants of some of the Pantotheria but actual connecting links are wanting. The same is true of the Placentals, which are first known in abundance in the basal Eocene of North America. Recently, however, the field parties of the American Museum of Natural History in Mongolia have discovered several incomplete skulls of small mammals which appear to represent some of the Cretaceous forerunners of the centetoid insectivores and perhaps also of the most primitive carnivores or creodonts.

From comparison of the osteology and anatomy of the recent monotremes, marsupials and placentals, however, we may infer with high probability that the ancestral mammal was an egg-laying vertebrate that retained a primitive reptilian type of shoulder-girdle with two complete coracoid plates on either side and with the beginnings of the neopallium in the brain. From such primitive types the marsupials (*see* MARSUPIALIA) evolved by developing, among other characters: (1) a three-way, vaginal passage; (2) the true or allantoic placenta was early replaced by a false or yolk-sack placenta; (3) the corpus callosum or great cross-band between the opposite halves of the neopallium was not developed; (4) all the milk teeth were suppressed except the hindermost premolars and (5) the dental formula of the adult dentition was reduced from a higher number to $I\frac{5}{4}\,C\frac{1}{1}\,P\frac{3}{3}\,M\frac{3}{4}$. On the other hand, the primitive placentals apparently never developed either the three-way vagina, or the yolk-sack placenta, but their true placenta early became highly developed, as did the corpus callosum; the entire set of milk teeth was retained and the dental formula was early reduced to $I\frac{3}{3}\;C\frac{1}{1}\;P\frac{4}{4}\;M\frac{3}{3}$ The marsupial group may have been dominant in the Lower Cretaceous, when fossil records are practically blank. By the Lower Eocene the marsupials were already a defeated group which took to the trees and persisted in North America only in the form of the opossums, among the most primitive of all living animals; in South America, however, they gave rise to several extinct families (Borhyaenidae, Caenolestidae, Didelphidae) and in Australia they became the dominant mammalian forms and gave rise to a great series of families, including the dasyures, bandicoots, phalangers, kangaroos and others.

The placental group is first known from primitive insectivorous representatives from Mongolia, as already noted; apparently it originated somewhere in the north and by basal Eocene times its diversified descendants are found in western North America and western Europe but as yet nowhere else. These were small-brained forms, many belonging to families that became extinct before the close of the Eocene. Here belong most of the archaic carnivores or creodonts, amblypods, tillodonts and others. Besides the "archaic" placental families that became wholly extinct were others apparently related to later groups. Here belong (1) the Plesiadapidae (apparently related to the tree-shrews and thus representing an early phase in evolution of the primates); (2) early forerunners of the tarsioid primates; (3) the insectivore *Palaeoryctes,* representing a primitive phase of the modern centetoid insectivores; (4) the progressive creodont *Didymictis* (in or near to the ancestry of the modern carnivores); (5) the palaeanodonts, including primitive relatives of the armadillo group of edentates. The bats (Chiroptera, *q.v.*), too, appear to be an old group, possibly dating back to the Basal Eocene or even earlier. Conspicuously absent from the Basal Eocene are the modernized or caeneutherian placental orders, including especially the perissodactyls, the artiodactyls, the rodents, the Proboscidea.

The condylarths or primitive ungulates of the Basal and Lower Eocene are not regarded by modern authorities as ancestral either to the perissodactyls or artiodactyls; it is however probable that some of the condylarths gave rise to the peculiar South American orders of litopterns, toxodonts, etc. By the Lower and Middle Eocene we find in Europe and western North America, side by side with the later families of meseutherian placentals, the earliest known representatives of the more progressive modern families: *Eohippus,* representing the horses (Equidae); *Hyrachyus* and other genera, forerunners of the lophiodonts and rhinoceroses; *Trigonolestes,* a primitive representative of the artiodactyls; *Metachiromys,* a specialized armadillo-like edentate; *Viveravus,* close to the ancestors of the later carnivores; *Paramys,* a forerunner of the sciuroid rodents; *Pelycodus* and *Notharctus,* early lemuroids, and the numerous anaptomorphids, relatives of the primate *Tarsius.* Even the Cetacea were represented by the peculiar zeuglodont group. During the Lower Eocene, western Europe and North America had several fossil genera in common (including the earliest stages of the horse family) which may perhaps have spread from central Asia.

In many cases the molar teeth of the Eocene placental mammals, while variously specialized, still retained distinct traces of derivation from an earlier tritubercular type characteristic of the basal Eocene; the hands and feet were either five-toed or bore clear traces of derivation by reduction from the five-toed type; the humerus had an entepicondylar foramen and the femur a third trochanter. So that it seems reasonable to infer that all the varied placental orders of Eocene times were descendants of some group that lived perhaps in the Lower Cretaceous; but as to the more precise interrelationships of the mammalian orders, extended research on the anatomy and osteology of the recent forms and on the osteology and dentition of the fossil forms has so far rather revealed the complexity of the problem than solved it. From present evidence the tree-shrews, lemuroids and primates, with *Galeopithecus* and the bats, appear to form one great superordinal assemblage, probably derived from arboreal Cretaceous insectivores. On the other hand, the old order of ungulates, formerly supposed to be a natural group, seems to consist of a heterogeneous assemblage of orders (condylarths, taligrades, amblypods, perissodactyls, hyracoids, proboscideans, sirenians, artiodactyls, notoungulates, arsinoitheres, etc.), related chiefly by descent from various as yet unknown protoungulates.

The aardvarks, formerly classed with the edentates, may prove to be highly specialized descendants of the condylarths, while the edentates themselves are probably the descendants of the palaeanodonts, which in turn may be remotely related to the insectivore-creodont stock. The earliest known cetaceans, the zeuglodonts, were not directly ancestral to the true cetaceans; nevertheless they tie in that order with the insectivore-creodont division of the placentals. On the other hand, the Sirenia, although resembling the cetaceans in general body-form, are herbivores and their real affinities are with the ungulates.

CONTINENTAL DISPERSAL OF MAMMALIAN ORDERS

From the studies of palaeontologists and mammalogists emerge the following among other general results bearing on geographic dispersal of the mammalian orders:

(1) At various times during the Age of Mammals pathways were opened by which a given group of mammals, acquiring its special characters in regional isolation, could pass from central Asia westward to Europe or eastward to North America, or from either Europe or America to Asia. Among the orders and families of placental mammals that may have originated in the northern realm (including Europe, Asia, North America) may be mentioned the perissodactyls and artiodactyls, the insectivores, the fissipede carnivores, the rodents, the edentates, the lemuroids, catarrhine primates, anthropoids and probably man. The families of rhinoceroses, lophiodonts, titanotheres and camels afford examples of the more or less free intercontinental commerce at certain periods.

(2) South America was early in contact with North America; then the contact was broken and for millions of years the country was left to develop its own fauna of litopterns, toxodonts, ground-sloths and other strange beasts. In late Tertiary times the way was again opened and mastodons, camels, tapirs, deer and other animals streamed in from the north, while South America sent platyrrhine monkeys, ground-sloths and other animals northward.

(3) Africa, especially in the north, was frequently in contact with the northern land mass but in late Eocene and early Oligocene times the Fayum district in Egypt may have been an outlier of some central African region which seems to have produced the Proboscidea, arsinoitheres, hyracoids and sirenians. The most primitive known cetaceans (*Pappocetus, Protocetus, Prozeuglodon*) are also found there. Madagascar, possibly part of a broad archipelago formerly connected with India, was the centre of peculiar families of carnivores (viverrids) lemuroids, insectivores (centetoids). Broadly, Africa's mammalian fauna to-day represents Europe and Asia of Miocene and Pliocene times.

(4) Australia, receiving its original marsupials at some early date, was then cut off from Asia and developed one of the most interesting mammalian faunas of all time, in which the marsupial stock was fashioned into herbivorous, carnivorous and rodent-like mammals, strangely similar in habitus to their analogues of the placental world and yet always preserving their marsupial heritage in brain and reproductive system and in the deeper characters of the skull and skeleton. At times during this long period placental invaders from the north managed to get in; first a peculiar family of rats and much later the dingo or native dog, together with that most devastating of all placentals, man. Australia, on the other hand, succeeded in sending some marsupials into New Guinea and as far northwest as Celebes. Some hold also that from Australia by way of Antarctica came the extinct carnivorous marsupials and caenolestoids of South America. (*See* MARSUPIALIA.)

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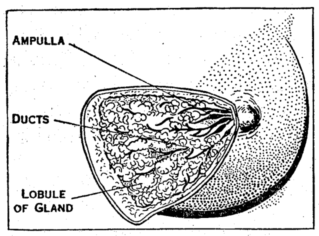
(W. K. G.)

MAMMARY GLAND, the organ by means of which the young are suckled, and the possession of which, in some region of the trunk, entitles the animal bearing it to a place in the order of Mammalia. In the male the organ is present but undeveloped.

Anatomy.—In the human female the gland extends vertically from the second to the sixth rib, and transversely from the edge of the sternum to the mid axillary line; it is embedded in the fat superficial to the pectoralis major muscle, and a process which extends toward the armpit is sometimes called the axillary tail. A little below the centre of the glandular swelling is the *nipple,* surrounding which is a pigmented circular patch called the areola; this is studded with slight nodules, which are the openings of areolar glands secreting an oily fluid to protect the skin during suckling. During the second or third month of pregnancy the areola becomes more or less deeply pigmented, but this to a large extent passes off after lactation ceases. In structure the gland consists of some 15 to 20 lobules, each of which has a *lactiferous duct* opening at the summit of the nipple, and branches in the substance of the gland to form secondary lobules, the walls of which are lined by cubical epithelium in which the milk is secreted. These secondary lobules project into the surrounding fat, so that it is difficult to dissect out the gland cleanly. Before opening at the nipple each lactiferous duct has a fusiform dilatation called the *ampulla.*



FROM A. F. DIXON, IN "CUNNINGHAM'S TEXT-BOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

MAMMARY GLAND, DISSECTED TO SHOW STRUCTURE AND CONVERGENCE OF LACTEAL DUCTS ON NIPPLE

After the child-bearing period of life the breasts atrophy and tend to become pendulous, while in some African races they are pendulous throughout life. Variations in the mammary glands are common; often the left breast is larger than the right, and in those rare cases in which one breast is suppressed it is usually the right, though this does not necessarily include absence of the nipple.

Supernumerary nipples and glands are not uncommon, and are usually situated in the mammary line which extends from the anterior axillary fold to the spine of the pubis; hence, when an extra nipple appears above the normal one, it is external to it, but, when below, it is nearer the middle line. Extra nipples are commoner in males than in females.

Embryology.—The mammary glands are modified and hypertrophied sebaceous glands, and transitional stages are seen in the areolar glands, which sometimes secrete milk. At an early stage of foetal life a raised patch of ectoderm is seen, which later on becomes a saucer-like depression; from the bottom of this 15 or 20 solid processes of cells, each presumably representing a sebaceous gland, grow into the mesoderm which forms the connective-tissue stroma of the mamma. Later on these processes branch. The last stage is that the centre of the *mammary pit* or saucer-like depression once more grows up to form the nipple, and at birth the processes become tubular, thus forming lactiferous ducts. The glands grow little until the age of puberty, but their full development is not reached until the birth of the first child.

Comparative Anatomy.—In the lower Mammals the mammary line, already mentioned, appears in the embryo as a ridge, and in those which have many young at a birth patches of this develop in the thoracic and abdominal regions to form the mammae, while the intervening parts of the ridge disappear. The number of mammae is not constant in animals of the same species. When only a few young are produced at a time the mammae are few, and it seems to depend on the convenience of suckling in which part of the mammary line the glands are developed. In the pouched Mammals (Monotremes and Marsupials) inguinal mammae are found, and so they are in most Ungulates as well as in the Cetacea. In the elephants, Sirenia, Chiroptera and most of the Primates, on the other hand, they are confined to the pectoral region, and this is also the case in some Rodents, *e.g.*, the jumping hare (*Pedetes caffer*). In the monotremes the mammary pit remains throughout life, and the milk is conducted along the hairs to the young, but in other Mammals nipples are formed in one of two ways. One is that already described in Man, which is common to the Marsupials and Primates, while in the other the margin or *vallum* of the mammary pit grows up, and so forms a nipple with a very deep pit, into the bottom of which the lactiferous ducts open. The latter is regarded as the primary arrangement. In the monotremes the mammae are looked upon, not as modified sebaceous glands, as in other Mammals, but as altered sweat glands. In these primitive Mammals the glands are equally developed in both sexes, and it is thought that among the bats the male often assists in suckling the young (*see* G. Dobson, *Brit. Museum Cat. of the Chiroptera,* London, 1878). These facts, together with the occasional occurrence of functional activity of the organ in the human male, make it probable that among ancestral Mammals both sexes helped in the process of lactation.

For further details see *Comparative Anatomy of Vertebrates,* by R. Wiedersheim, adapted by W. N. Parker (1907), and Bronn's *Classen und Ordnungen des Thierreichs.*

MAMMARY GLAND, DISEASES OF. Inflammation of the breast (*mastitis*) is apt to occur in a woman who is suckling, and is due to the presence of septic micro-organisms, which, as a rule, have found their way into the milk-ducts, the lymphatics or the veins, through a crack, or other wound, in a nipple which has been made sore by the infant's vigorous attempts to obtain food. Especially is this septic inflammation apt to occur if the nipple is depressed, or so badly formed that the infant has difficulty in feeding from it. The inflamed breast is enlarged, tender and painful, and the skin over it is hot, and perhaps reddened. The woman feels ill and feverish, and she may shiver or have a definite rigor if the inflammation is passing on to the formation of an abscess. The abscess may be superficial to, or beneath, the breast, but it is usually within the breast itself. The infant should at once be weaned, the milk-tension being relieved by the breast-pump. Fomentations should be applied under waterproof jaconette, and the breast should be evenly supported by a bandage. Belladonna and glycerine should be smeared over the breast, with the view of checking the secretion of milk, as well as of easing pain. On the first indication that pus is collecting, an incision must be made to prevent extension of the disease. As the discharge begins to cease, firm strapping of the breast will prove useful.

Chronic Eczema of the breast may occur, but when present around the nipple of a woman late in life, with perhaps, localized ulceration, it is known as *Paget's Disease* and has a sinister significance, for it indicates that the superficial layers of the true skin are in all probability infiltrated with cancer. Hence, when eczema about the nipple refuses to clear up in a few days under the influence of soothing treatment, it is well to insist on the removal of the entire breast. The nipple is retracted in most of these cases, which, however, are not often met with.

Chronic Mastitis is not very uncommon in women who are past middle age. The part of the breast involved is enlarged, hard, and more or less tender and painful. It is sometimes impossible clinically to distinguish this disease from cancer. True, the tumour is not so definite or so hard as a cancer, nor is it attached to the skin, nor to the muscles of the chest wall, and if there are any glands secondarily enlarged in the arm-pit they are not so hard as they may be in cancer. But all these are questions of degree, and the indications given for a diagnosis of cancer indicate also that the disease is so advanced as to have reduced the chance of successful operation to a minimum. Moreover, it is highly inadvisable to leave it to time to clear up the diagnosis, for a chronic mastitis, innocent at first, may become cancerous, while cancer and chronic mastitis often co-exist in the same breast. Hence the only safe course is removal of the breast, and some authorities recommend that this course should be adopted in every case of chronic mastitis.

Fibro-adenoma.—A simple glandular tumour is apt to be found in the breasts of youngish women, who may possibly give an account of some blow or other injury; there may, however, be no history of injury. The tumour is smooth, rounded or oval, and lies loose in the midst of the breast; as a rule it is not tender.

It is not associated with enlarged glands in the arm-pit. The tumour had best be removed, though innocent, for such growths may become cancerous later.

Cysts of the Breast.—A *galactocele* is a tumour due to the locking up of milk in a greatly dilated duct. Other forms of cystic disease are usually special modifications of chronic mastitis. Such cysts are best treated by free incision, and by passing a gauze dressing into their depths. If the tissue is occupied by many cysts, the whole breast had better be removed.

Cancer is the commonest disease of the breast and occurs chiefly among women between 40 and 60 years of age, but men are not entirely immune and women older or younger than the ages mentioned may suffer. The early symptoms have been given elsewhere (*see* CANCER) and the later symptoms are those of cancer in general, viz., local spread, destruction of normal tissue, ulceration, early extension to the nearest group of lymphatic glands (in this case, axillary) and from these to neighbouring groups of glands (in this case, supraclavicular) and formation of secondary growths in skin, liver, bones, muscle, indeed in any tissue of the body. With the exception of melanotic sarcoma the secondary growths in cancer of the breast are more widely spread than in cancer affecting any other primary site. Probably this is in part due to the fact that the natural duration, *i.e.*, duration apart from all treatment, of breast cancer is relatively long, viz., about three and a quarter years. The pain and distress are usually great, particularly in the later stages when probably ulceration will have occurred and pressure of the cancerous mass in the armpit on the veins and lymphatics may have led to great swelling of the arm. Death may be brought about in various ways, the immediate cause often being some intercurrent disorder which the patient, enfeebled by absorption of toxic material from the ulcerated surface, anaemia and pain, cannot resist; or by extension of the growth to the pleura and lung, with coincident pleurisy and pneumonia.

Cancer of the breast is usually spheroidal cell carcinoma but the columnar cell type also occurs notably in so-called "duct carcinoma" which is a less malignant variety. Sarcoma is also met with. Carcinoma is either hard and fibrolic (scirrhus) or highly cellular (encephaloid) but many intermediate forms occur even in different parts of the same breast. A scirrhous growth is relatively smaller and runs, locally, a less rapid and extensive course than encephaloid, but as regards extension from the primary focus and the occurrence of secondary growths there is little difference between them. Sarcoma of the breast locally forms a large growth and the secondary growths have a somewhat different distribution. Speaking generally, scirrhus is associated with an atrophied and shrivelled breast and retraction of the nipple.

It is often said that cancer runs a more rapid course in the young; statistical evidence does not support this view, though many cases in the very aged progress but slowly. On the other hand during pregnancy a cancer of the breast participates in the rapid growth of the organ. But there is no evidence that suckling conduces to cancer; on the contrary, abeyance of the natural function seems to be related to the occurrence of chronic mastitis and consequently to local cancer after a longer or shorter interval.

The *treatment* of cancer of the breast depends to an overwhelming extent upon the earliness with which the disease comes under full and proper treatment. If cancer of the breast is dealt with by the modern complete operation while the growth has not extended beyond the limits of the organ some 90% of the patients are alive and well ten years later and their expectation of life is not materially different from that of women of the same age who have not suffered from cancer. But if the cancer has extended beyond the limits of the gland, a matter of a few weeks from the time when it first becomes recognizable, the case is very different. For in spite of the same operative treatment 90% of the patients will be dead by the end of ten years. No better evidence could be given for the paramount value of early and adequate operation, but the surgeon is dependent upon the patient and there is evidence that about half the number of patients dying with cancer of the breast do not seek medical treatment at all till the last days of life and of the remainder who seek advice an average period of six months or more has elapsed between their first noticing that something was wrong and consulting a surgeon. There may be many explanations of this delay but the fact remains that with each hour they have been throwing away a good chance of healthy life. In cancer of the breast early and complete operation easily holds the first place for success so far as our present knowledge goes. Radium and *X*-ray treatment, though highly valuable in some other sites, are far inferior to surgery as curative agents in cancer of the breast with the present technique. Possibly it will remain so even with improved technique because of the special peculiarities appertaining to cancer of this organ. Upon this point no confident opinion can be given. When the disease is beyond operative treatment, radiation methods may nevertheless afford relief.

For bibliography, *see* CANCER; CANCER RESEARCH.

(W. S. L.-B.)

MAMMEE APPLE, MAMEY or ST. DOMINGO APRICOT, the fruit of *Mammea americana,* a large tree of the garcinia family (Guttiferae), with opposite leathery gland-dotted leaves, white, sweet-scented, short-stalked, solitary or clustered axillary flowers and yellow or russet fruit 3 to 6 in. in diameter. The bitter rind encloses a sweet aromatic flesh, which is eaten raw or with sugar, and is also used for preserves. There are one to four large rough seeds, which are bitter and resinous, and used as anthelmintics. An aromatic liqueur distilled from the flowers is known as *eau de Créole* in the West Indies, and the acrid resinous gum is used extensively for destroying the chigoes which attack the naked feet of the Negroes.

MAMMON, an Aramaic word *māmōn* "wealth" (ממון Ecclus. xxxi. 8; Targ. Onq. Ex. xxi. 30) found in Mt. vi. 24; Lk. xvi. 11. It is probably derived from *Ma'amōn,* something entrusted to safe keeping. In any case there was apparently a threefold play on this meaning in Lk. xvi. 11: "If therefore ye have not been *faithful* in the unrighteous *mammon,* who will *commit to your trust* the *true* riches," the words italicised representing forms of the Semitic root *'amen.* There is no evidence that the word was the name of an angel or a god, as in Milton (*Par. Lost* i. 678; *cf.* Spenser *F.Q.* II. vii. 8). (A. L. W.)

MAMMOTH. The name mammoth is supposed to be derived from an old Russian word given by ivory-hunters to an extinct elephant, *Mammuthus primigenius.* The animal is an elephant (*q.v.*) about the same size as the existing Indian form, characterized by possessing a short, high and pointed skull, which supports a pair of tusks unique in their spiral curvature, the roots diverging from one another, the middle part of the tusks turning upwards and outwards, and the tips being directed towards one another. This fully developed tusk only occurs in old individuals, the young tusks being similar to those of an Indian elephant. Mammoth tusks, although they may be extremely long, possibly reaching a maximum length of 10 ft. 6 in. from the socket, are usually rather slender, and must from their shape have been incapable of being used as pickaxes, as are those of an Indian elephant. The tusks of the frozen mammoths of Siberia are so well preserved that they can still be used industrially and the animals were so abundant that fossil ivory has been exported from Siberia to China and to Europe from mediaeval times.

The molar teeth of the mammoth are very variable in character but the number of plates is always large from 14–16 in the second molars and from 18–27 in the third molars. The teeth are very deep and wide so that in the dentition the mammoth reached perhaps the highest point in the evolution of the elephants.

The mammoth is found only in Pleistocene times and is in Europe always associated with a fauna whose character indicates a cold or arctic climate. When, as in England, warm interglacial periods intervened, the mammoth and his associates migrated to the north, following the retreating ice-field, and his place was taken by the straight tusked *Loxodonta antiquus.*

The mammoth was hunted by late Palaeolithic man who has left drawings and statuettes representing the animal in French caves. From these drawings it is apparent that the creature was covered with hair so long that it almost reached the ground, and that the body was produced into a great hump at the back of the neck; the ear was small. The accuracy of these drawings has been confirmed by the evidence afforded by frozen mammoths discovered in the tundra of north-eastern Siberia. These animals owe their preservation to the fact that, owing to their great weight, they became bogged in marshy plains, sinking down into ice cold mud, which subsequently became frozen and has so remained ever since. From these specimens we have learnt that the whole body was covered with an undercoat of yellowish brown woolly hair through which projected long black thicker hairs which formed patches on the cheeks, flanks, abdomen, etc. The tail is short and like that of a modern elephant, provided with a terminal tuft of long, stiff bristles. The small ears were covered with fur.

The food has been found in the stomach and mouth of frozen individuals and in the most recently reported case might have been gathered in north-eastern Siberia to-day. It consisted mainly of grasses and sedges, but also wild thyme, the Alpine poppy and upright crowfoot. Thus the mammoth alone of elephants became adapted to life in cold climates. It is not known when the mammoth became extinct, but it survived in France into Magdalenian times, that is to the extreme end of the glacial period. It may have lived on in Siberia to a much more recent period.

Closely related to the mammoth are several species of elephant found in Europe, India and North America. These animals were apparently inhabitants of warmer countries. They are first known in India in such forms as *Elephas hysudricus,* and wandered from thence not only throughout southern Europe and Asia, but even into America. In America these southern mammoths attained a gigantic size, *Mammuthus imperator* being perhaps the largest of all elephants, attaining a height of some 14 feet. (D. M. S. W.; X.)

MAMMOTH CAVE, a cave in Edmonson county, central Kentucky, U.S.A., 37° 14′ N. lat. and 86° 12′ W. longitude. It is a distinct part of an extensive system of caves in the soluble St. Louis limestone, overlain by the Chester (Mauch Chunk) sandstone both of the Mississippian or Lower Carboniferous series. The area of the cave-bearing formation is over 8,000 sq.m. in southern Indiana, through central Kentucky and into northern Tennessee. The cave is said to have been discovered in 1809, when a hunter named Hutchins is reported as having pursued a bear into its entrance; but it must have been known earlier, for its entrance was designated in the county records of 1797. Readily accessible to the majority of the Eastern States it is visited by many tourists. It is now a national park.

The St. Louis limestone throughout the cave-bearing area is massive and homogeneous, lying almost horizontal and showing few traces of tectonic or structural deformation. Owing to its relative purity and consequent solubility, it has been carved, chiefly since the Miocene period, by underground waters percolating and flowing along its joint and fracture planes, into a great series of caves. Where its cap of Chester sandstone has given way it has been perforated by hundreds of "sink-holes," more or less funnel-shaped depressions distinctive of the landscape of the region, and interrupted by scarp-rimmed valleys with little or no relation to surface erosion. The depth to which the cavern has been cut has been determined by the level of Green river, to which the Mammoth cave system is tributary by subterranean passages opening along its banks. As Green river graved itself deeper into its bed, the dissolving and eroding waters passing through the limestone were enabled to proceed with their carving deeper and deeper. The thickness of the St. Louis limestone approaches and in places exceeds a thickness of 300 ft. The sections of the cave ordinarily traversed have been surveyed by civil engineers and geologists; but owing to insurmountable difficulties, many avenues are still unexplored. The temperature of most of the cavern and its passages is fairly uniform at 54° F. Just within the entrance a noticeable draught sweeps, outward for most of the year when the exterior air is the warmer, inward occasionally in winter when the exterior air is the colder. The upper galleries are dry; the lower damp owing to streams and pools, and the air is pure and wholesome.

The entrance is 118 ft. below the summit of a limestone bluff and 194 ft. above the level of Green river, but a half mile distant. The arch at the entrance has a span of 70 feet. The vestibule within the entrance rapidly contracts 300 ft. within to a passage called the Narrows where a gateway has been built. A short distance beyond the Narrows the passage opens upon the Rotunda, the first notable chamber of the main cave. It was in the Rotunda where during the War of 1812 and at other times nitre was prepared for powder, from the guano, chiefly the excrement of myriad bats. By crude processes calcium nitrate worth $20,000 was obtained in 1914, when the industry reached its peak. The main cave is from 40 to 300 ft. wide and from 35 to 125 ft. high. It extends through the Rotunda, thence by Star Chamber, Chief City and minor chambers connected by long passages or narrow defiles to its rather abrupt termination 4 m. from the entrance. Though the entire cave extends under an area but 10 m. in diameter, the main cave and the accessible tributary passages with their domes and chambers on its five different levels aggregate a length of at least 150 miles. The extent charted includes 225 avenues, 47 domes, 23 pits, eight cataracts, three rivers, two lakes and one sea. Streams and pools contribute to the majesty of the cave. They are navigable from May to October when Green river, with which they are connected, subsides. The Dead sea is a pool walled by cliffs 60 ft. high and in length 100 ft., along which a pathway runs to a stairway leading downward to the River Styx, a body of water 40 ft. long, crossed by a natural bridge. Lake Lethe, in a broad basin with mural cliffs 90 ft. high, becomes shallow and turbid at times. Many blind fish have been taken from it. A narrow path along Lake Lethe leads to a pontoon at the neck of the lake, and beyond it, a beach of fine yellow sand to Echo river, a stream or pool ¾ m. long, 20 to 200 ft. wide and 10 to 40 ft. deep, with a symmetrical arched roof, varying in height from 19 to 35 feet. It is famous for the resonance of the tones given out by its vibrant stone which reverberate for from 10 to 30 sec. along its vaulted gallery. Other streams and pools, some of them even miles in length, occupy some chambers and galleries. They are fed by surface waters, which in the rainy season percolate and cascade into the cave in great volume, and collect in River Hall. For about seven months of the year these streams are unnavigable. When Green river is in freshet the waters in the cave become connected, sometimes rising 60 ft. above low-water mark.

For many years trips through the cave were designated as "The Long Route" and "The Short Route," the latter being the cisfluvial route and requiring about four hours for its passage, and the former, the transfluvial route, occupying from nine to 12 hours. These long-established routes were changed in 1924 to four routes which are summarized best as follows.

Route No. 1.—Echo River; Mammoth Dome with six majestic columns, royally fluted, 80 ft. high and 25 ft. in diameter; Gorin's Dome, 217 ft. high, the walls of which are draped with three immense calcic curtains of exquisite tint and texture; River Hall, by which the gardens of crystal roses are approached; Grand Crossing; and the Natural bridge.

Route No. 2.—Rotunda, with its ruins of the nitre works; Banquet Hall, equipped with tables, seats, lights and table service; Olive's Bower; Gothic Avenue, where the mummies of a race reputed to antedate the Indians were found; the Pillars of Hercules, gigantic columns; the Bridal Altar, a majestic shrine where many weddings have taken place; the Arm-chair; Elbow Crevice; Annetta's Dome; the Giant's Coffin 40 ft. long, 20 ft. wide, and 8 ft. deep, resembling a sarcophagus; Martha Washington's statue, a lighted silhouette in fancied resemblance of the first Lady of the Land; and the resplendent Star Chamber, a colossal hall of sable walls and ceiling thick set with immaculate patens of magnesium sulphate efflorescence gleaming by lantern light.

Route No. 3.—Violet City, the new section discovered and explored in 1908, comprising the resonant Chimes, the glorious Marble Temple, Albert's Stairway, the Grand Portal, Elizabeth's Dome and Valhalla; Proctor's Arcade, a symmetrical chamber, near the Star Chamber and one of the sensations of the cave when lighted by blue flares; Indian Relics; Wright's Rotunda, 400 ft. in its shortest diameter; Chief City, two ac. of troglodytic grandeur where Indian chiefs gathered in council and by blazing flambeaux and faggot fires smoked the calumet and decided for peace or war; cataracts, of impressive beauty; Waldach's Dome; the Epsom Salts deposits, their drifts of snow-white crystals; Haines Dome; the Grand Portal and the Marble Temple.

Route No. 4.—Echo river, its waters reflecting the beauties of every passage through which it flows and its ripples waking the tinkling cymbals of tiny stalactites and reverberant walls to eerie music; the Valley of Flowers; the Snowball Room; Cleveland Avenue, a treasure gallery of alabaster brilliants, the oulopholites of the mineralogist, which are declared to mimic in their fantastic fibrous and pellucid calcite crystals the forms of every flower; Florist's Garden, another fantasy of floral forms in stone; Donna's Garden; Diamond Grotto where Aladdin may have garnered his gems; the Rocky Mountains; Dismal Hollow; the famous Maelstrom, rich in tale and legend; Ganter Avenue; and the Corkscrew, a tortuous exit which reduces the journey from "Great Relief" to the mouth of the cave by nearly a mile.

Evidence of Indian occupancy of Mammoth cave has not been wholly lacking, but it has not yielded any such wealth of archaeologic material as have others in Europe, Asia and even America. Two mummies preserved by the nitrous earth were uncovered in 1813 in Short cave, not far from Mammoth cave. One was of an infant one year old and the other of an adult woman of a race antedating the Indians. See *Proceedings of the Boston Society of Natural History* (1875). In the early years following the discovery of Mammoth cave and while its guano deposits were mined for nitre, many valuable data may have been obliterated.

The biota of the cave is distinctly subterranean in character. The most interesting occupants are the blind, wingless grasshoppers with extended antennae; the blind colourless crayfish and blindfish, the latter (*Amblyopsis spelaeus*) being from 1 to 6 in. long. All the known forms of plant life are either fungi or allied to them, many but microscopic. A bed of mushrooms (*Agaricus sp.*) has been reported. While the true subterranean fauna is chiefly of Pleistocene origin, certain forms may possibly be Tertiary relics or developed from them.

BIBLIOGRAPHY.—*See* complete list of 90 titles referring to Mammoth and other Kentucky caves given on pp. 97–104 of *Mammoth Cave and the Cave Region of Kentucky* by Helen F. Randolph. Other works are: H. Gratz, "Green River or Mammoth Cave" in *Medical Repository* vol. xvii. (1814); A. S. Pachard, "The Mammoth Cave and Its Inhabitants" in *Annual Report* of the Peabody Academy of Science (1871); J. W. Turner, *Wonders of the Great Mammoth Cave of Kentucky* (1912); and N. C. Nelson, "Contributions to the Archaeology of Mammoth Cave and Vicinity, Kentucky" in *Anthropological Papers of the American Museum of Natural History* vol. xxii., pt. 1 (1917). (W. E. E.)

MAMORÉ, a large river of Bolivia which unites with the Beni to form the Madeira, one of the largest tributaries of the Amazon. It rises on the northern slope of the Sierra de Tunari east of the city of Cochabamba. Its larger tributaries are the Chaparé, Securé, Apere and Yacuma from the west, and the Ichila, Guapay or Grande, Ivari and Guaporé from the east. The Mamoré is interrupted by rapids a few miles above its junction with the Beni, but a railway 186 m. long has been built from below the rapids of the Madeira. Between the rapids and Chimoré at the foot of the *Sierra,* the river is navigable, as are most of its tributaries.

MAMUN (*c.* 786–833), originally ABDALLAH, surnamed AL-MA'MŪN ("in whom men trust"), the seventh of the Abbasid caliphs of Baghdad, was the second son of Harun al-Rashīd and successor-designate to his brother Amin. A five years' struggle between the two ended in the death of Amin and the proclamation of Mamun as caliph (Sept. 813). A serious rebellion, due to his countenancing the heretical sect of Ali, soon after threatened his throne. In the period of tranquillity which followed Mamun, who had already founded a college at Khorasan, did much to foster literature and science. The first Arabic translation of Euclid was dedicated to him in 813. He founded observatories at Baghdad and Kassium, determined the inclination of the ecliptic, caused a degree of the meridian to be measured on the plain of Shinar, and constructed wonderfully accurate astronomical tables.

In 827 he was converted to the heterodox faith of the Mo'tazilites. The later years of his reign were distracted by warfare and revolts, and in 833, when marching against the Greeks, he died near Tarsus, leaving his crown to a younger brother, Motasim. His death ended the period of Arabian culture and prosperity. *See* further under CALIPHATE.

MAN, EVOLUTION OF. The late Sir E. B. Tylor, writing on the evolutionary theory of man's origin, made the following statement: "In one form or another such a theory of human descent has, in our time, become part of an accepted framework of zoology, if not as a demonstrable truth, at any rate as a working hypothesis which has no effective rival." When Sir Edward Tylor made this statement in 1910 he was in his 78th year; his memory could carry him back to a time when it was believed that man had come into the world as a special creation some 4,000 years before the birth of Christ and owed no kinship to other living things. He was 27 years of age when Darwin's *Origin of Species* was published in 1859; in 1865, two years after Huxley had issued his renowned treatise on *Man's Place in Nature,* he himself published a work which threw a new light on human history, *Researches into the Early History of Mankind and the Development of Civilization.* When Darwin's *Descent of Man* came out in 1871, Tylor's *Primitive Culture; Researches into the Development of Mythology, Philosophy, Religion, Art and Custom,* kept it company. By the end of the 19th century he had seen chair after chair in the universities of the world filled by men who were convinced that evolution was true; at his death in 1917, at the age of 85, he had seen another generation of enquirers grow up who, after applying Darwin's teaching to all departments of man's world—to his body, mind and culture—remained convinced that, as a working hypothesis, the doctrine of evolution had no rival.

SUMMARY OF THE EVIDENCE

Embryology.—No matter what aspect of man the student of to-day may select for study, the conviction that evolution (*q.v.*) is true is forced on him. If he investigates the development of the child in the womb he comes across a complicated series of appearances which can be explained only if Darwin's teaching is accepted.

Comparative Anatomy.—If he studies the structure of man's body he finds it framed on the mammalian plan, and if he compares it with that of anthropoid apes he finds the points of resemblance to be so numerous and so close that he cannot think that such a degree of resemblance could be a result of mere chance. If he enquires into the periods through which a newly born child passes to reach manhood or womanhood, he finds the animals which are most human in this respect are the great anthropoids—the gorilla, chimpanzee and orang. If he takes into consideration the diseases to which man is liable, he finds that human diseases are more readily communicated to the great anthropoids than to any other living animals. Particularly is he impressed by the fact that the blood of man and of the anthropoid apes, when tested against each other, react almost in the same way. To account for the presence of so many vestigial structures in man's anatomy, he feels impelled to suppose that man has come of an ancestry in which these vestiges were fully grown and useful. A child may be born with its body malformed; it may suffer from hare-lip, cleft-palate or many other kinds of deformity, including the presence of a tail; medical men cannot account for such malformations if they look on man as a special creation; they can give a rational explanation of their occurrence if they accept evolution.

Palaeontology.—In recently formed strata of the earth fossil forms of man are found; those from the older strata are more ape-like than those from the newer. In still older strata are found fossil fragments of great anthropoids; in still more ancient, the remains of small anthropoids; deeper still in the earth's records no trace of anthropoid has yet been discovered. In these older strata occur fossil remains of small monkey-like primates. The geological records, so far as they are yet known, support Darwin's theory of man's origin; they are altogether against the belief that man appeared suddenly—by a special act of creation.

Human Races.—More especially is the student of human races driven to Darwinism for an explanation of his many problems; even if he believed that man had appeared originally by an act of special creation he must formulate a theory of evolution in order to account for the divergent races now living. Although in thought and deed man rises far above any member of the brute creation, yet students of his brain find that it is modelled, part for part, on exactly the same pattern as that of the anthropoid ape. Those who enquire into man's mental qualities, his emotions, his habits, his tendencies and his modes of thought, find many indications that he has ascended from a lower order.

But there are still numbers of unconvinced people who, impressed by the great and real differences which separate the mentality of the lowest grades of mankind from that of the highest grade of ape, cannot believe that man has arisen from a lower form by any natural or evolutionary process. The State of Tennessee has passed a law forbidding, in State-supported schools, "the teaching that man has descended from a lower order of animals." In June 1925 Scopes, a school teacher, was prosecuted under this law, found guilty and fined $100. Since then certain other States have enacted similar laws. Even in England, Darwin's native land, the theory of man's origin from an ape-like animal is far from finding universal acceptance. This was made apparent in 1927 when the writer, being then president of the British Association for the Advancement of Science, made Darwin's theory of man's origin the subject of his address. Although the opinions expressed were those held by the vast majority of anthropologists, they were met with a strenuous opposition on the part of a large section of the public.

MAN'S GENEALOGY

Darwin's Views.—Although there is a complete agreement among professional students that man is a member of that order of mammals to which Linnaeus gave the name "Primates" and that his lineage, when traced backwards, will be found to branch off from the primate tree, there is a sharp difference of opinion as to the exact point in the tree, and the approximate date in geological time, at which the human branch separates from those other main branches which represent the lineage of anthropoid apes and of monkeys. It is clear from statements made in the *Descent of Man,* that Darwin regarded the gorilla and chimpanzee as more nearly akin to man than other living primates and, on the evidence available in 1871, thought it probable that man and the African anthropoids were co-descendants of a common anthropoid which had its habitat in Africa (fig. 1). He regarded the catarhine type of monkey—the type exemplified by the monkeys of the Old World—as representatives of a still older ancestral form. Darwin traced the common anthropoid stock, which gave birth not only to the ancestral lines of man, the gorilla and chimpanzee, but also to those of the orang and gibbon, back to a common catarhine type. This catarhine type, he presumed, was the offspring of a still older common simian or monkey-like type, one which existed in the Eocene period of the earth's history and gave origin not only to the catarhine monkeys of the Old World but also to the platyrhine monkeys of the New World. Thus man's history, as Darwin saw it, did not begin until after the ancestral type of anthropoid had been evolved; the appearance of an anthropoid type from a common catarhine ancestor and this from a common simian stock, represent prehuman stages in the evolution of the higher primates. It is noteworthy that Darwin's mind remained open as to the exact point at which the human stock branched off from the general primate tree (fig. 1a).

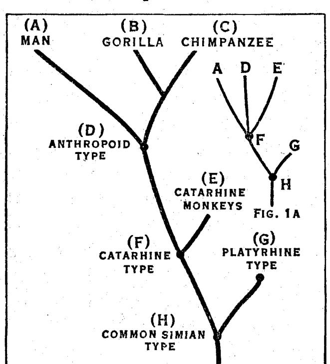


FIG. 1.—A DIAGRAM TO ILLUSTRATE DARWIN'S CONCEPTION OF MAN'S LINEAGE

FIG. 1A.—ANOTHER POSSIBLE RELATIONSHIP, ALSO MENTIONED BY DARWIN

Haeckel's Views.—On no occasion did Darwin throw his conception of man's lineage into a diagrammatic form. The first to construct an evolutionary tree of man's descent was Ernst Haeckel; this appeared in his *Generelle Morphologie* published in 1866, five years before Darwin's *Descent of Man* was issued. This pedigree is still worthy of study (fig. 2). Haeckel perceived that the small form of anthropoid ape, the gibbon, was more primitive and earlier in point of evolution than the three living great anthropoid apes (orang, chimpanzee and gorilla) and supposed that in the evolution of the great anthropoids from the ancestral catarhine type there was interposed a small anthropoid stage to which he gave the name Lipocerca (λιπεῖν, to lack, κέρκος, tail). This small anthropoid stock (Lipocerca) gave origin, he supposed, to gibbons and to the ancestral stock of the great anthropoids—for which Haeckel proposed the name Lipotyla (λιπεῖν, to lack, τύλη, cushion)—anthropoids which, unlike the gibbons, were destitute of ischial callosities or natural cushions on which gibbons and Old World monkeys seat themselves. This cushionless anthropoid stock (Lipotyla) he regarded as ancestral to the various races of mankind. From the Lipotyla, which gave origin to man, there also branched off, at an early stage, the ancestry of the orang and, at a later, the common ancestry of the chimpanzee and gorilla. Thus Haeckel regarded the gorilla and chimpanzee as more nearly related to man than other living anthropoids. It is also remarkable that he placed the extinct Miocene form of anthropoid ape, known as Dryopithecus, on the line which led up to the gorilla and chimpanzee on the one hand and to human races on the other. Thus it will be seen that in Haeckel's opinion man was the descendant of an anthropoid ape.

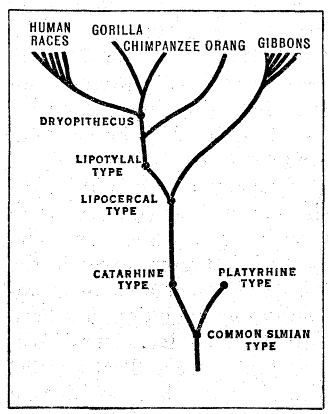


FIG. 2.—HAECKEL'S CONCEPTION OF MAN'S DESCENT AS ILLUSTRATED BY A PHYLOGENETIC TREE, PUBLISHED IN 1866

Later, he introduced considerable modifications into this family tree. In the third edition of his *Evolution of Man* (English translation, 1879) he interpolated into man's ascent from an anthropoid to a human state an intermediate stage represented by *ape-like* men—beings who were manlike in form and in gait but lacked man's power of speech. To such hypothetical beings he gave the name *Pithecanthropi.*

Modern Views.—In 1892 Prof. E. Dubois discovered in the island of Java the fossil remains of a being which answered very well to this hypothetical stage, and named this fossil form of evolving man *Pithecanthropus erectus.* Haeckel presumed that his pithecanthropi had lived in the Pliocene period; Prof. Dubois is of opinion that his transitional form of man lived in Java towards the end of the Pliocene period. Discoveries made by Dr.

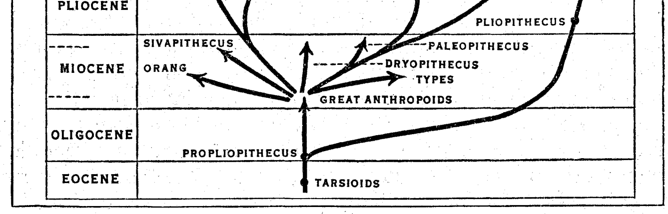


FIG. 3.—A PHYLOGENETIC TREE OF THE HIGHER PRIMATES (AFTER W. K. GREGORY, 1916)

G. E. Pilgrim of the Geological Survey of India and by members of that survey in the latter part of the 19th century have proved that India, during the Miocene period and the earlier part of the Pliocene, was the home of great anthropoids of many and diverse kinds, several of them belonging to the type of Dryopithecus which Haeckel, at an early period, regarded as a possible ancestor to man. Others of these fossil Indian or Siwalik anthropoids show affinities to the orang, to the chimpanzee and to the gorilla, while still another—*Sivapithecus*—is regarded by Dr. Pilgrim as an early representative of the human family. Notwithstanding these revelations from India and taking all their bearings into consideration the majority of modern authorities (Dubois, W. K. Gregory, Elliot Smith, Keith), in constructing diagrams to illustrate the affinities and lines of descent for the higher primates, depict the human stem (fig. 3) as springing from the vicinity of the stem which gave rise to the gorilla and chimpanzee. The conception, first formulated by Haeckel, that a Miocene anthropoid of the type of Dryopithecus (fig. 3) may stand as a common ancestor to man and to the African anthropoids is still regarded as possible.

Doubts Raised by the Occurrence of Parallel Evolution.—There is a line of evidence, accumulating at the present moment, which tends to undermine the confidence of those who have drawn up phylogenetic trees of man's descent. All who have enquired into the evolution of horses and elephants, by the study of fossil forms found in widely separated regions of the world, have become impressed by the fact that horses and elephants in America have passed through evolutionary changes of the same kind and in the same order as have done their representatives in the Old World. This tendency for the descendants of a common ancestry to undergo *parallel* or even *converging* evolution, has been very fully expounded in the published works of Dr. Henry Fairfield Osborn (*Origin and Evolution of Life,* 1918). That parallel evolution has been potent in the order of mammals to which man is assigned there can be no doubt. The monkeys of the New World parted company from those of the Old early in the Eocene period; it is probable that at the time of their separation they had only reached the stage represented by the Tarsioids, a family of monkey-like primates, which has now only one living representative—the Tarsier (*Tarsius spectrum*) of Borneo and other islands of the Malay Archipelago. Although parted thus early, New and Old World monkeys have acquired corresponding structural modifications—modifications of a kind which we cannot suppose to have been present in their common ancestor. The brain of the South American spider monkey (Ateles), that of the Old World monkeys of the semnopithek type, and that of the small anthropoid or gibbon, have many common characters which could not have been present in the brain of their Eocene ancestor.

We may legitimately infer, however, that a bias or tendency to produce similar or almost identical modifications was latent in the common ancestor. If parallel evolution has been at work in one section of the order of primates it may have been at work in another, and we must therefore keep in mind the possibility that man and the gorilla may have acquired their many and striking points of structural similarity independently. Cope (1882) and Hubrecht (1897) supposed that human lineage had parted from that of the anthropoids near the base of the primate phylum; if this were so man would have an independent pedigree of immense length. In more recent times Prof. F. Wood Jones (*The Problem of Man's Ancestry,* 1918) has put forward the theory that man, because of the number of primitive and generalized features of his structure, is to be traced back to an independent origin from a tarsioid ancestor. In 1927 Dr. Henry Fairfield Osborn also championed the early separation of man's ancestry from the primate phylum. Such a view entails the need of supposing that the multitude of structural similarities shared by man and the great anthropoids must have been acquired by each independently.

Klaatsch (*Die Stellung der Menschen im Naturganzen,* 1911) (*Evolution and Progress of Mankind,* 1923) made a larger demand on the powers of evolution to reach the same end by diverse routes. This voluminous author traced the origin of mankind to an anthropoid ancestry, but supposed that the ancient inhabitants of Europe—Neanderthal man, known only from his fossil remains, and the living Negro peoples of Africa had arisen from the same stock as the gorilla and chimpanzee, while Mongolian peoples and men of the modern European type had sprung from the same lineage as the orang. Klaatsch believed in the polygenetic origin of human races.

Man an Aberrant Primate.—In charting the family tree of the Higher Primates modern authorities differ as to the position which should be assigned to man. Prof. Eugène Dubois represents the human stem as the main and direct continuation of the trunk of the primate tree (*Nature,* vol. liii., p. 245, 1896); from this main trunk all the other members of the primate order are made to come off as side branches. Man is given the central position of his order; he forms the apex of the primate tree. Prof. Elliot Smith (*Evolution of Man,* 1925) also gives the human family the central position as a direct continuation of the main primate stem. In reality man is the most aberrant member of his order; in brain and in the modifications of his lower limbs he has departed farther from the ancestral primate state, so far as we know that state by the study of fossil remains, than any member of the order; he has retained less of the structural organization of the original primate than all the others. Apparently in the evolution of the higher primates there has been the same tendency as is to be noted in modern political parties—a tendency for an extreme wing to move ever further from the central group of conservatism. The human family represents the extreme wing in the order of primates; *Tarsius,* greatly modified as it is, retains the essentials of the central or conservative group.

MAN'S ZOOLOGICAL POSITION

Zoologists classify animals into families, sub-families, genera and species, according to their degrees of structural likeness; they presume, although fully aware that parallel evolution can and does take place, that two animals, such as the gorilla and chimpanzee, which are so similar in the structural details of their bodies, owe that similarity to their descent from a common ancestry. Darwin urged rightly that in settling the zoological relationship of one group of animals to another, more weight must be attached to the points wherein they agree than to those in which they differ.

Huxley's Views.—In the masterly analysis of man's structural relationships given by Huxley in *Man's Place in Nature* (1863), more stress was laid on the anatomical differences which separate man from the gorilla than on the points wherein they agree. Huxley held that differences which separated man from the gorilla were like in kind and similar in degree to those which separated the gorilla from any form of catarhine or platyrhine monkey a critic might choose for comparison. He held that if evolution could produce the structural gap which separates a monkey from the gorilla it could also bring about the abyss which divides the gorilla from man. Huxley's conclusions are still valid; indeed, the modern anatomist is convinced that the structural hiatus which lies between a baboon or any other form of monkey and the gorilla is much wider than that which lies between the gorilla or chimpanzee and man. When tested by modern methods, the blood of the chimpanzee shows a much closer affinity in its reactions to that of man than to that of any Old World monkey; the blood of monkeys of the New World, when submitted to the same tests, reveals a still more distant affinity (Prof. G. H. Nuttall, *Blood Immunity and Blood Relationship,* 1904). Huxley included in one family the great anthropoids (gorilla, chimpanzee and orang), the small anthropoids (siamang, gibbon), and the various genera of monkeys of the Old World; if we are to be guided by anatomical considerations we must give to each of these groups the rank of a family. The same rank—that of a primate family—must be given to the section which embraces all the various races and types of mankind, living and extinct. The various genera of New World monkeys make up a fifth family of primates.

The Primate Families.—Thus in that part of the living animal kingdom to which man belongs, there are five families—the human family, that of the great anthropoids, that of the small anthropoids, the family of catarhine or Old World monkeys and the family of platyrhine or New World monkeys. These families are separated by structural gaps of about equal magnitude. From the platyrhine monkeys upwards, these families form an ascending series in the sense that each succeeding family marks a further departure from the ancestral tarsioid type, the point of highest differentiation being reached in the human family.

EVIDENCE OF MAN'S DESCENT

Anatomical.—The members of these five families of primates have a common structural substratum—an inheritance from the ancestral stock from which they have all descended. Each family in the course of evolution has come by anatomical features which are peculiar to itself. A full analysis of the structural details of man's body shows that about 30% of them are peculiar to himself. The corresponding characters of the gorilla number 16%; the gibbon has about the same proportion of features peculiar to its own family (Keith, *Rivista di Antropologia,* vol. xx., p. 1, 1916). As examples of man's peculiar characters we may cite his nude skin, his projecting nose with well marked wings, the size of his brain, the strength of his thigh, the form of his leg, the shape of his foot.

Common Characters.—Further analysis reveals in man's body a series of characters which he shares with only two other living animals—namely, the gorilla and chimpanzee. These amount to nearly 9% of the total points selected for comparison, but if we include in this group features which man shares with the gorilla alone or with the chimpanzee alone, then man has in his body about 26% of characters which he shares with gorilla and chimpanzee or with gorilla alone or chimpanzee alone. Such characters, we presume, are derived from a common ancestor which gave birth to man and to the great anthropoids of Africa. As examples of characters common to the three we may cite the air chambers which branch off from the nasal cavity. These have the same arrangement and are of the same number in man, gorilla and chimpanzee. Another example is to be found in the small bones of the wrist. Of the higher primates, only in these three has the *os centrale* disappeared as a separate unit from the carpus; yet in a foetal stage this bone is present in all three; and as a separate element in adults of all the other higher primates.

Descending still lower in the strata of human anatomy we encounter a group of characters which man shares with the three great anthropoids. We may speak of man and these three as the giant primates, for compared with the earlier types they are giants, or we may apply to this group Haeckel's convenient name —*Lipotyla.* Man shares with the other giant primates 10% of similarities of structural detail; to this we may add 5% which he shares with the orang and with the orang only, characters which the chimpanzee and gorilla have apparently lost or perhaps never possessed. Going still lower in our analysis, we find over 8% of characters which are common to the gibbon as well as to the great anthropoids. With the gibbon, man shares 8% of structural features which are not to be seen in the bodies of the great anthropoids. In this case, again, we have to suppose that man and the gibbon came by those characters long after they separated from a common ancestor, or that the great anthropoids have lost them in the course of evolution while man and the gibbon have retained them.

Lower in the scale of our analysis we come upon features in man's body which he has apparently retained from a catarhine ancestry; at least, to find their counterparts we have to go to the bodies of Old World monkeys. In man's body there are 5% of such catarhine features; in the gorilla's body such features are three times as numerous. It is remarkable that platyrhine characters, features to be seen in the bodies of the New World monkeys, should be as numerous as catarhine in man's body.

There is a small residue of anatomical details in human anatomy attributable to a still more distant past, a heritage from a tarsioid or lemuroid ancestry. From the details revealed by anatomical analysis it is plain that evolution has not proceeded in an orderly or simple manner in shaping the bodies of the higher primates; characters are curiously scattered. Yet to explain the distribution of characters in the various families we must suppose that man's ancestry is linked closely to that of the African anthropoids—the gorilla and chimpanzee. In some instances we obtain help in explaining the distribution of characters by calling in the aid of *collateral* or parallel evolution; in other cases Mendel's discoveries in heredity assist us; further, we see that the body of man and of ape is a great mosaic work of structural elements and that progressive changes may occur in one set of units while retrograde changes affect another set.

Embryological Evidence.—In recent years the formation of the human embryo in the womb, the complicated changes which transform the embryo into a foetus and the elaborate processes which produce the organs of the ripe child from embryonic rudiments, have been studied by an ever-growing army of enquirers and by methods which possess an ever-increasing precision. Embryologists find it necessary to assume that the law of evolution holds for man; unless they make this assumption they can offer no rational explanation of the complex changes which engage their attention. In its broad lines development pursues the same course in the human body as in that of all vertebrate animals. What Francis Balfour in 1885 saw taking place with diagrammatic clearness in the embryo of the dog-fish has given clues to the more complex and obscure processes now known to occur in the embryo of man.

The developing human egg, when it becomes established in the mother's womb, undergoes a series of elaborate and peculiar changes. The investigations carried out by the late Dr. Emil Selenka (*Menschenaffen. Studien über Entwickelung und Schädelbau,* 1898–1906) revealed the fact that only in the wombs of four other living mammals, the gorilla, chimpanzee, orang and gibbon, do the same changes take place. The process by which the placenta is formed, thus establishing a means of supplying the unborn child with nourishment, is exactly the same in man as in anthropoid apes. It is true that in *Tarsius* we see outlined the basal plan of placentation met with in the higher primates, but it is also true that in the placentation of the monkeys of the Old World and also in that of the New World we see a stage which leads on from the lower or tarsioid condition to the higher or anthropoid form. In the embryos of man and of the anthropoids an external jointed tail is produced in the fifth week of development; by the end of the eighth week it has shrivelled and becomes submerged, leaving a dimple at the point of the caudal region where it sinks below the surface. These are a few examples of some of the remarkable similarities which link the embryological history of man with that of the anthropoid apes.

Recapitulation, Interpolation, Adaptation.—When in the later decades of the 19th century anatomists applied themselves to unravelling the development of man's body, they expected it to recapitulate, in full detail, the various stages of his evolution. In this they have been disappointed, because in the growth of the embryo and of the foetus we see three different processes at work. We see recapitulation taking place; we also see new characters being interpolated from the time the embryo makes its first appearance until all the parts of a formed child are laid down; further we see at every stage the body of the embryo and of the foetus being adapted to a life within the womb. When gill-clefts appear in the neck of the human embryo towards the end of the first month of development we see a recapitulatory and very distant phase exemplified. When we look at the developing human foot, with the expectation of finding an anthropoid phase, we search in vain. The great toe is never a free and separate member in the human foot as in the adults of all other primates. There is a stage in the development of the feet of primates when all the digits diverge equally from the tarsal base; man and ape pass through this stage and man clings to it as it were, whereas all the other primates pass on to a final prehensile stage. Yet in the sole of the newly born child we see the same flexion lines as in that of the gorilla; we find the same muscles in the great toe of the human foot as in that of the gorilla; we find the joint at the base of man's great toe, especially in the foetus, moulded in the same form as the gorilla. We cannot explain these appearances unless we believe that the human foot has been evolved from one like that of the gorilla, more especially as the foot of the gorilla shows a curious blend of human and monkey-like features.

The human great toe does not recapitulate ancestral history; developmental changes which mould the great toe into the human pattern set in just when the simian ones are due; the human changes do not succeed but replace those that give the ape its prehensile foot. New changes have been intercalated in the evolutionary sequence. In a multitude of details the human embryo no longer recapitulates the series of changes gone through by its ancestors. It is true of every part of the human body; human characters begin to peer through its higher primate qualities before development is a month old.

Of the changes which affect the developing human body those which represent adaptations to life within the womb are the most important. The child draws its living from its mother's body; it is sheltered and kept warm; it has not to seek its living nor defend itself; such qualities need not be attained until the time of birth; until then nature is free to work out what experiments she will. It is a remarkable fact that many of man's distinguishing features are to be met with during foetal stages in the development of anthropoid apes. A stage which is transient in the foetal ape becomes permanent in man. We may take as an example the comparative hairlessness of man's body. A foetal chimpanzee, in the eighth month of development, resembles a human foetus of the same age; both have hair growing freely on their scalps, but the rest of their bodies, although provided with lanugo, appear to be nude. By birth the chimpanzee's body is covered with hair, but the human child retains the foetal state. Yet all known primates save man have their bodies thickly covered with hair; hairlessness is not an ancestral condition, but one made possible by the retention of the young in the shelter of the womb. The skin provides us with another example of foetal inheritance. In the fair or white stock of mankind the skin has become relatively free from pigment. In their earlier stages of foetal development apes are unpigmented; they darken as the time of birth approaches. White men have come by their colouring through the inheritance of a foetal condition, one which is certainly not ancestral.

Many examples might be cited of man coming by distinctive characters by retaining foetal states, but the following may be taken as representative. In all foetal primates the brain is relatively large and the jaws absolutely small; this is certainly not an ancestral state, for in all the older forms of primate the brain is small and the jaws large. Man is distinguished by the large size of his brain and the relatively small size of his teeth and jaws. How he compares with adults of great anthropoid apes may be seen from the following data. We may take the capacity of the cranial cavity to represent the size of brain and the area of the palate to represent the size of the jaws. In a well-grown adult European male we expect a cranial capacity of 1,500 c.c. and a palatal area of 25 sq. cm., there being 60 c.c. of brain space for every square centimetre of palate. The average male gorilla has a cranial capacity of 470 c.c., a palatal area of 72 sq. cm., that is, 5·8 c.c. of brain space for every square centimetre of palate. The corresponding figures for the average male orang are: 412 c.c., 62 sq. cm., giving a cranio-palatal ratio 6·6:1; in the average male chimpanzee the figures are: 390 c.c., 46 sq. cm., giving a ratio of 8·5:1. There is a wide gap between the European cranio-palatal ratio 60:1 and that of the chimpanzee, 8·5:1. We may fill the gap somewhat by citing a Tasmanian skull with a capacity of 1,350 c.c., a palatal area of 36·7 sq. cm. and a ratio of 36·7:1.

We find a still nearer approach to the anthropoid condition in the fossil skull of Rhodesian man in which the cranial capacity is 1,300 c.c., the palatal area 41 sq. cm., the cranio-palatal ratio 31·7:1. Even this ratio is far above that of the chimpanzee, 8·5:1; but if we take a suckling chimpanzee, in which the cranial capacity is 260 c.c. and the area of palate 13·6 sq. cm., we obtain a ratio 19:1, an approach to the human proportion. If we take a still earlier stage, such as may be observed in a chimpanzee foetus during the eighth month of development, we find a ratio which is human in its magnitude. Man has come by his small palate by retaining a foetal anthropoid condition, and this is true of all the parts of man's skull which are concerned in mastication. This tendency to foetal inheritance is not confined to the human branch of primates; in certain genera of New World monkeys, particularly in Chrysothrix and Cebus, we see in their small jaws and large heads the same law at work.

The belief that many of man's foetal characters do not reflect ancestral stages, but foreshadow the trend of future evolution, was held by several anatomists in Germany towards the end of the 19th century, particularly by Ranke. The law of foetal inheritance, so far as it relates to man, has been greatly extended during recent years in a series of papers by Prof. L. Bolk of Amsterdam (*Proc. of the Roy. Acad. of Sc. of Amsterdam,* 1921–5). Embryological evidence, if it has failed to reveal the pithecoid states through which man has passed in his ascent, does provide conclusive evidence of his simian ancestry. In the development of his brain, for example, we see that the first fissures to appear are those which occur in the brains of the higher monkeys; the next are those which are found in the brains of the great anthropoids, and later still the secondary human sulci are formed; but never at any stage does the human brain correspond to that of monkey or of anthropoid. If embryology has failed to reveal the details of man's history, it has shown that the processes of evolution are at work on the foetal body; if the study of the foetus does not help us to decipher man's past, it does seem to provide a basis on which we may forecast the future of the human body. The brain of the gorilla, in the totality of its characters, is the most like that of man; these two are structural allies, yet evolution has moulded their bodies in opposite directions. During growth the gorilla replaces all its foetal characters by those of brutality and strength; in man the tendency has been to retain the delicate physique of the young and to shed those of a more brutal nature. Why the one fate overtook the gorilla and another fell to man remains an enigma.

BIOLOGICAL EVIDENCE OF MAN'S EVOLUTION

Blood Tests.—Not only are the bodies of man and anthropoid apes fashioned on similar lines, but, as was demonstrated at the beginning of the present century, their living tissues give like reactions. In 1900 Dr. Hans Friedenthal injected a small amount of human blood into the veins of a chimpanzee; its vital qualities were so similar to those of the chimpanzee that no disturbance followed the operation. When an equal amount of the blood of a macaque monkey was injected into the veins of the chimpanzee there was a slight reaction; the corpuscles of the macaque's blood were destroyed and ejected by the kidneys. When the blood of an ox was used a violent reaction was produced, the foreign blood being destroyed and thrown out.

Prof. G. H. F. Nuttall, of Cambridge university, thereafter elaborated a more precise method of estimating blood-affinities, by which very small quantities of blood can be tested against specially prepared antisera. In 1904 appeared his classical work *Blood, Immunity and Blood Relationship,* containing the results of tests carried out on three species of anthropoid apes, 28 species of Old World monkeys, and nine species from the New World. The blood of all these species was tested against a human antiserum. The blood of the anthropoids gave a full reaction—100%; that of the Old World monkeys gave a lesser reaction or precipitation, one equivalent to 92% of the full; that of the New World monkeys 78%. At the time Prof. Nuttall was making these investigations in England, Dr. Uhlenhuth was carrying out independent enquiries in Germany, and reached corresponding conclusions as to degrees of affinity. The tests devised by Nuttall and by Uhlenhuth utilize the fluid or serum of the blood. Recently Drs. Landsteiner and Miller (*Jour. Experim. Med.,* vol. xlii., p. 841, 1925) have utilized the corpuscular elements of the blood and find that they give more delicate reactions than those given by the serum. They devised tests which serve to distinguish the blood of the chimpanzee from that of man, but which fail to discriminate the blood of the white man from that of the negro.

Disease Reactions.—The reactions of living tissue are also tested by disease. Man is peculiarly susceptible to syphilis; the animals most akin to him in this respect are the great anthropoid apes. Monkeys are difficult to inoculate with syphilis, and when they suffer, take the disease in its mildest form. Anthropoid apes are almost as susceptible to typhoid fever as man is. When chimpanzees are kept in confinement they are liable to that modern disease of man—appendicitis. Anthropoids react to stimulants, sedatives and poisons in the same manner as human beings. The brains of the great anthropoid apes are smaller and are less convoluted than is the case in man, yet when the living cortex is stimulated by electrical methods, be it in man or anthropoid ape, the same reactions follow when corresponding convolutions are excited. Surgeons have found that observations made by experimental physiologists on the brains of anthropoid apes afford reliable guidance when they have to operate on the brain of man.

Thus the evidence supplied by vital tests bears out the conclusions forced on anatomists by similarity of structure—namely, that great anthropoid apes, in an evolutionary sense, are near akin to man.

EVIDENCE OF VESTIGIAL STRUCTURES

Nearly all the structures which have become greatly reduced or are mere vestiges in the body of man have undergone a similar fate in the bodies of the anthropoid apes. In them as in man the tail has disappeared, all save its basal part, which has sunk beneath the surface to form the coccyx. It is true that the vermiform appendix of man is smaller than that of any of the anthropoid apes, and that in half of the Europeans who reach the age of 70 its lumen has become closed, yet it is more than doubtful if this structure should be reckoned vestigial in the body of either man or anthropoid. The *palmaris longus,* the *plantaris,* and the *pyramidalis,* muscles which are reduced or fibrous in man, are in the same state in anthropoid apes. Such evidence points to a common origin for anthropoids and man, but it throws no light on man's more immediate relationship to any member of the anthropoid group.

There are two muscular vestiges, however, which point to man's kinship to the African anthropoids. There is a muscle in the neck of monkeys which helps to lift the shoulder; it is called the *levator claviculae.* It has almost disappeared from man's body; it is met with only once in a hundred dissections. This muscle shows definite signs of reduction in the gorilla and chimpanzee, but not in the orang or gibbon. All monkeys have a strong muscle called the *latissimo-condyloideus.* When a monkey is climbing, and has seized a branch with its hand, it uses this muscle to pull the trunk upwards. It is a particularly strong muscle in the gibbon, well developed in the orang, somewhat reduced in the chimpanzee, partly fibrous in the gorilla, wholly fibrous in man, although in 5% of human bodies some muscle fibres may be detected. Lately Dr. A. H. Schultz, of the Carnegie Institution of Washington, has found a remarkable example of the persistence of a vestige in man's body (*Amer. Jour. Physic. Anthrop.,* vol. vii., p. 149, 1924). Lemurs, which branched off from the primate stem at a very distant geological period, have a tuft of touch vibrissae at the wrist. Monkeys were supposed to have lost these vibrissae; Dr. Schultz found them in foetal stages of monkeys both of the Old World and of the New. On examining the wrists of human foetuses in the second month of development he found a raised plaque at the spot where the touch vibrissae are situated in lemurs.

THE EVIDENCE OF FOSSIL REMAINS

Pithecanthropus Erectus.—The discovery which throws most light on the evolutionary progress was made in Java in 1891–92 by Prof. Eugène Dubois (1858–1941), then a surgeon in the colonial military service, and later professor of geology in the University of Amsterdam. In a stratum which contained the fossil bones of many extinct species of animals he obtained five fragments of a strange kind of being, one of which he regarded as a transitional form between man and ape—a real missing link. He named it *Pithecanthropus erectus,* and assigned it to a separate family of primates—one lying on the borderline between anthropoids and man. (*Pithecanthropus erectus, eine menschenaehnliche Uebergangsform aus Java,* 1894.) The five fossil fragments found were: a skull cap which outwardly had the form which might be expected in a giant form of gibbon, a left thigh bone and three teeth. The most distant of the fragments were 20 paces apart. Later he added a sixth fragment—part of a lower jaw found in another part of the island but in a stratum of the same geological age. The skull cap is flat, low and has great eyebrow ridges; its characters are more simian than human, yet when Prof. Dubois succeeded in obtaining a cast from the interior of the skull cap, that cast bore on it the convolutionary pattern of the brain of Pithecanthropus, and that pattern proved to be altogether human. Pithecanthropus, the fossil man of Java, had a brain which was smaller, simpler and infinitely more primitive than that of the lowest living men.

By this discovery Prof. Dubois caught the human brain in the act of evolving. Certain cortical or convolutionary areas in man's brain are known to be concerned with sight, hearing and touch, and the reception of messages from other sense organs; a "motor" area is concerned in the initiation and control of voluntary movements. Between these primary areas of the cortex lie association areas which have to do with the memory and the interpretation of what is seen, heard or felt. The cortex of part of the frontal lobe—the prefrontal cortex—is concerned in the acquisition of skilled movements. These secondary or association areas of cortex, which lie between and separate the primary areas, are the basis of man's educability—his capacity to learn from experience. In the brain of Pithecanthropus the association areas are much less developed than in the brains of the lowest of living human races. Yet all the essentially human parts are represented. It is even possible that the owner of this brain was capable of speech.

A further study of the brain-cast has convinced Prof. Dubois that Pithecanthropus must be placed in the human family (*Proc. Roy. Acad. Sc. Amsterdam,* vol. xxvii., nos. 5, 6, 1924). The brain of this "fossil" man is now estimated to have had a volume of at least 900 c.c.; the largest-brained gorillas rarely rise above 600 c.c.; the lowest-brained of human beings occasionally falls below 1,000 cubic centimetres. Pithecanthropus in size of brain lies on the verge of humanity. His teeth, if large, are essentially human in form of crown and root; the socket for the canine, in the fragment of lower jaw, shows that this tooth was not massive and pointed as in anthropoid apes. The thigh bone is human altogether, and gives proof that Pithecanthropus walked as men do.

Pithecanthropus was assigned by Prof. Dubois, on reliable evidence, to a date late in the Pliocene period; others on weighing the evidence suppose that he lived early in the Pleistocene period. If we accept the duration of the Pleistocene as 250,000 years, and regard Pithecanthropus as representing the evolutionary stage reached by mankind at the beginning of this period, then we have to conclude that man's body had become adapted to its peculiar posture and gait before the end of the Pliocene period, and that the higher development of the brain took place in the ensuing Pleistocene period.

Eoanthropus.—The discovery which ranks next in importance to that of Pithecanthropus was made by Mr. Charles Dawson at Piltdown, Sussex, between the years 1911 and 1915. He found the greater part of the left half of a deeply mineralized human skull, also part of the right half; the right half of the lower jaw, damaged at certain parts but carrying the first and second molar teeth and the socket of the third molar or wisdom tooth. The lower jaw, in the region beneath the chin, had a bar of bone known as the "simian shelf," which until then had been regarded as a mark of the ape. Later a pointed upper canine tooth was added; its characters were simian rather than human. The stratum of gravel proved to have been laid down early in the Pleistocene period, and it is certain that the fossil fragments of this human skull were as old as the date of deposition. From the fossil fragments thus found, Sir Arthur Smith Woodward reconstructed an extinct genus of mankind, *Eoanthropus,* the dawn man (*Quar. Jour. Geol. Soc.,* 1913–15). Subsequently (1915) there was found a remarkable bone implement hewn from the thigh bone of an extinct kind of elephant; its state of mineralization and its colouring show that it had been embedded originally in the deepest stratum and was certainly as old as the human fossil remains; in a neighbouring field two other fragments of a human skull of the same kind came to light, and another molar tooth.

Some experts still doubt whether a lower jaw which resembles that of a chimpanzee in several respects should be assigned to a skull which is purely human in its characters. At first there were differences of opinion as to the size and characters of the brain of Eoanthropus. Amongst British authorities there is now agreement that the skull and jaw are parts of the same individual, and that the brain, as revealed by casts taken from the interior of the skull, is human in its size and in all its characters. If we divide living races into three classes according to the size of brain, the large-brained having a cranial capacity above 1,450 c.c., the small-brained a capacity under 1,350 c.c., then Eoanthropus certainly reached the upper limits of the small-brained class if not actually a member of the medium-brained group. The brain of Eoanthropus has risen many stages above that of Pithecanthropus; the bone implement affords evidence of manual skill and of inventive ability on the part of its owner. The eyebrow ridges of Pithecanthropus are shaped as in the gibbon, chimpanzee and gorilla; in Piltdown man they are fashioned nearer to the form seen in the skull of the orang. Professor Frassetto of Bologna has drawn attention to several points in which the Piltdown mandible resembles that of the Orang (*Man.*, July 1927). The discovery at Piltdown shows that at the beginning of the Pleistocene period a race of mankind had come by a brain that had reached a human estate, and that this race still retained certain definite simian characteristics in its jaws, teeth and face.

Neanderthal Man.—In 1857 while workmen were clearing out the Neanderthal cave near Düsseldorf, Germany, they found the vault of a fossilized skull and limb bones of a man who proved to be, in the light of further discoveries, a representative of an extinct species of man—*Homo neanderthalensis.* A fossil skull which was dug up at Gibraltar in 1848 is of the Neanderthal type. In 1926 Miss Dorothy Garrod, while excavating the floor of a recently discovered cave at Gibraltar, unearthed the greater part of the skull of a Neanderthal child, aged about five years. The stratum in which it was embedded contained flint implements worked in the upper or later Mousterian style. This skull is as capacious as that of a modern child of the same age and as the supraorbital ridges are still undeveloped, the forehead is not so unlike that of modern children. The skull of a Neanderthal child, older than the Gibraltar example, was found at La Quina, France, in 1921 by Dr. Henri Martin. Fossil remains of the same species have been found in Belgium (at Naulette, 1866, and at Spy, 1886), but the caves of France have proved the richest source of Neanderthal remains, particularly those in the valley of the Dordogne.

The evidence found at La Chapelle (1908), at La Ferrassie (1909), at Le Moustier (1908) and at La Quina (1911) made it quite clear that this extinct type of man, marked as he was by many simian traits of body, buried his dead with signs of respect. He worked flint implements with great skill, in the style or culture known as Mousterian. He was a hunter and lived in caves and rock shelters. His molar teeth were often shaped in a peculiar manner; his teeth have been found in cave deposits in Jersey (1911) and in Malta (1917). His remains have been found in Moravia (1906) and at Krapina in Croatia (1899–1906). His culture has been found in Italy and in England, but no trace of his body. Only once have fossil remains of Neanderthal man been found outside the limits of Europe, in a cave situated on the western shores of the Sea of Galilee (1925).

Neanderthal man appears to have been the sole occupant of Europe during the middle of the Pleistocene period—throughout the time in which the Mousterian culture prevailed in that continent. The date of this culture may be put down tentatively as extending from 40000 B.C. to 20000 B.C.; perhaps its duration was much longer. Remains of Neanderthal man rather more primitive in type, and found in strata older than the Mousterian strata of France, have been discovered at Taubach (1895) and at Ehringsdorf (1914), both of these sites being near Weimar, Germany. In 1925 a human skull was discovered in the limestone deposit of Ehringsdorf. This discovery is of especial importance for the geological evidence gives to it a greater antiquity than that of the Neanderthal skulls of France. The fauna embedded in the same stratum as the skull is that of the warm period which preceded the Mousterian glaciation. Yet the new Ehringsdorf skull (Weidenreich, *Verhand. Gesellsch. f. Phys. Anthrop.*, 1927, p. 34) has all the characteristics of the Neanderthal species, but is very capacious, particularly when its feminine features are taken into account. Weidenreich estimates the cranial capacity of this woman to have been 1,450 c.c. Her skull had been fractured by a blow given by a wedge-shaped weapon at, or soon after, death. *The Heidelberg mandible* was found at a depth of 78 ft. in a sandpit at Mauer, ten miles to the east of Heidelberg, in 1907. The stratum in which it was found belongs to the deeper and older Pleistocene series; this fossil jaw thus represents a race which lived long before the men who practised the Mousterian culture. Yet so like is the mandible of Heidelberg man to that of Neanderthal man, in the majority of its characters, that we may safely regard him as an ancestral representative of the Neanderthal species. In Heidelberg man the canine tooth did not project above its neighbours as in Eoanthropus. At the close of 1927 it was announced that many further fragments of Heidelberg man had been discovered at Mauer; his leg bones are even more anthropoid in their characterization than those of Neanderthal man. In a still older stratum of the same formation were found the fossil remains of a species of man—a forerunner of the Neanderthal type—of a large anthropoid ape and of two smaller apes, akin to the gibbon, showing that at the end of the Pliocene period Europe was inhabited by a low species of humanity and by various species of anthropoid apes.

At one time it was believed that Neanderthal man represented an ancestral phase of modern man. Every bone of his body shows distinctive markings, many of these being of a simian nature. His eyebrow ridges were like those of the gorilla and chimpanzee; the roof of his skull was low like theirs, and yet in size of brain he equalled, if he did not surpass, modern Europeans. He had, however, certain specializations of structure which modern or Neanthropic man does not possess. Besides, the archaeological evidence is now complete that he was replaced in Europe by the arrival of men of the modern kind—represented by people of the Cromagnon type. For these reasons Neanderthal man cannot be regarded as an ancestor of modern man. Neanderthal man and men of the modern type, however, have so much in common that they must be looked upon as descendants of a common ancestor.

Rhodesian Man.—The fossil remains of Rhodesian man which were discovered in the Broken Hill mine, Northern Rhodesia, in the summer of 1921, also bear evidence to the truth of man's evolution. His fossil remains lay deep in a filled-up cave; he was probably alive in Africa when men of the Neanderthal type dominated Europe. His limb bones show that he was tall, quite 5 ft. 10 in. in height, and stoutly made, after the manner of modern man. His skull, which is complete save the lower jaw, possesses many primitive traits. His brain space was small (1,300 c. c.); in point of development the brain falls below that of Eoanthropus. The eyebrow ridges are extremely massive, and the face has features which recall those of the gorilla. Yet his teeth, although large, are human in every respect and were ravaged by caries. Rhodesian man might well stand as an ancestral type to modern man.

Cromagnon and Other Races.—The Cromagnon type of man and other forms which appear in Europe after the disappearance of Neanderthal man are fully developed men of the modern type; they differ from us only in robusticity of build and strength of jaw. The fossilized, capacious skull discovered at Boskop, Transvaal, in 1913, represents an extinct form of man of the Bushman type. The Talgai skull, derived from a Pleistocene deposit and described by Dr. S. A. Smith (*Phil. Trans.*, ser. B, vol. ccviii., p. 351, 1918), is of the same form as that of living Australian aborigines, but possesses additional primitive features. In 1926 Dr. W. Colin Mackenzie announced the discovery of a fossil skull showing the same primitive features as the Talgai specimen. It was found in a swamp at Cohuna, in the basin of the Murray river, northern Victoria. Prof. E. Dubois discovered a Pleistocene form of man at Wadjak, Java, one with a very large cranial capacity (*Proc. Roy. Acad. Sc. Amsterdam*, vol. xxiii., pt. 7, 1920). Such discoveries, although they bear out the truth of evolution, do not throw light on man's evolutionary pedigree.

ANTIQUITY OF MAN

Until the year 1860 the majority of scientific men, relying on scriptural authority, believed that man's existence on earth covered a span of less than 6,000 years. Throughout the first six decades of the 19th century certain lines of enquiries kept bringing to their notice facts which could not be reconciled with orthodox beliefs. The first line of enquiry which brought unexpected facts to light was the systematic excavation of ancient graves and burial places. During the third and fourth decades, Danish antiquarians discovered that ancient graves could be arranged in the order of their antiquity; those which contained only weapons or implements of stone were of one period—the oldest; those, in which stone was replaced by bronze were of another and later period, and those in which iron had replaced bronze were of a third and more recent time. By 1860 archaeologists had proved that the sequence of events, first discovered in Denmark, held true for graves in all parts of Europe and that prehistoric time could be divided into three periods or ages—the age of stone, the age of bronze and the age of iron. In this way archaeologists came to realize that authentic human history could be compiled by a careful study of ancient burial places.

A second line of enquiry served to carry human history into a more remote past. This was the excavation of the materials which had accumulated in the floors of caves during prehistoric times. During the opening decades of the 19th century cave exploration was carried out with ardour in many parts of Europe; the fossil bones of many kinds of extinct animals were found, but as these were regarded as the wrack of the creation which preceded man's first appearance, it was deemed useless to search for traces of man's existence in the strata of such caves. In 1825 a Roman Catholic priest, the Rev. J. MacEnery, while excavating Kents Cavern, Torquay, found, deep in the undisturbed floor, a stone weapon in a seam containing fossil bones of extinct animals. He rightly drew the inference that man had been the contemporary of these animals. MacEnery's discovery was rejected by the leading experts of the time. The same fate was meted out to Prof. Schmerling of Liège in 1833 when he announced the discovery of a human skull in the stalagmitic floor of a cave, "surrounded on all sides by the fossilized teeth of rhinoceros, horse, hyena and bear." Then in 1858 came a discovery which arrested the attention of the most sceptical. Dr. Hugh Falconer and William Pengelly, two most reliable investigators, excavated a cave at Brixham, near Torquay, under the aegis of two learned societies—the Royal and Geological Societies of London. Deep in the undisturbed cave earth, mingled with the bones of extinct animals, they found stone implements which must have been fashioned by human hands. Then in 1860 southern France yielded incontrovertible evidence of man's great antiquity; the excavation of a cave near the village of Aurignac, Haute Garonne, by Edouard Lartet proved conclusively that man was the contemporary of extinct mammals, for in the floor of this cave were found the ashes of man's hearths, amidst which were mingled bones of extinct animals. These bones were charred, cut and artificially broken—the debris of long past feasts.

A third line of enquiry carried man's history into a still more remote period—one which in its older parts, preceded the age of caves. Beyond a doubt the man who opened up this new source of human history was Boucher de Perthes, an exciseman, stationed at Abbeville, on the estuary of the Somme. In 1832 he began to collect curiously fashioned stones which were found in gravel pits situated on the sides of the valley. These gravels and sands contained the bones of extinct animals; Boucher de Perthes was convinced that the stones he collected were human weapons and implements and that therefore man had been living in northern France when extinct animals were alive and when gravel deposits were being laid down on the sides of the valley—clear evidence that man's antiquity was infinitely greater than was then thought. Although he began to publish his discoveries in 1847 it was not until 1858 that their authenticity and importance was recognized. In that year Dr. Hugh Falconer visited Abbeville, examined the evidence and was convinced that Boucher de Perthes had opened a new chapter in the prehistory of man. In 1859 Sir John Evans, after visiting the gravel pits of the Somme valley, returned to England and discovered that the gravel pits of the lower valley of the Thames contained the same kind of stone implements as Boucher de Perthes had found in those of the lower valley of the Somme. Thus in 1860 a certain group of geologists was convinced that man's antiquity was so great that a new system of chronology would have to be devised to cover the human period.

A fourth line of enquiry, opened up by Charles Darwin, placed the problem of man's antiquity in a new setting. His *Origin of Species*, which was published at the end of 1859, clearly indicated to his readers of 1860, that man had arisen, as had all forms of life, by a gradual process of evolution from older types and thus prepared their minds for the discovery, in geological strata, of intermediate forms which would link man to a lower and older form of primate.

Evidence of Antiquity Afforded by Ancient Cemeteries.—Since 1860 all four lines of enquiry have been vigorously pursued and each has yielded evidence which compels us to place human beginnings at an ever-receding point of geological time. Excavation of ancient cemeteries and of former sites of human habitation, in Egypt, Mesopotamia and India have demonstrated that parts of these lands were densely populated before the middle of the fourth millennium B.C. and that their peoples inhabited cities, cultivated many kinds of crops, kept domesticated animals, prepared and used copper for many purposes and enjoyed the benefits of organized government. It is clear that to find the rise of man from a state of barbarism we must go far beyond the year 4004 B.C., the date which was assigned by Archbishop Usher to mark man's first appearance on earth.

Evidence of Antiquity Afforded by Caves.—Excavations carried out in the caves of France during the last four decades of the 19th century permitted archaeologists to establish a chronological system for the period which covers man's habitation of caves. The prehistoric periods thus established, with the names given to them and estimates of their duration are dealt with elsewhere. (ARCHAEOLOGY, *q.v.*) The evidence yielded by caves consists of fossil remains of man, fossil remains of animals, weapons and ornaments of stone and bone and ancient graves. In no cave in Europe, with perhaps the exception of Kent's Cavern (*q.v.*) in the south of England, is the human record carried beyond, if even up to, the middle of the Pleistocene (*q.v.*). European caves of Pleistocene date have yielded fossil remains of two species of mankind; in the upper deposits the remains are those of present-day or Neanthropic man; the deeper and older strata contain the skulls and bones of an extinct species, *Homo neanderthalensis* or *primigenius*. In size of brain both Neanthropic and Neanderthal man had reached the higher human scale long before the end of the cave period. The stone implements found in the deepest and oldest strata show that man was already a skilled workman when he took to cave life.

The Evidence of Antiquity Yielded by Valley Deposits.—During the whole of the Pleistocene period, deposits of gravel, sand and loam were being accumulated in the floor and on the sides of the river valleys of Europe. Such deposits or "terraces" thus offer us a means of tracing the changes which have overtaken man and beast during a whole geological epoch—one which witnessed several extreme changes in climate. Man's history in Europe has been traced throughout the Pleistocene period by the discovery of his fossil remains and of his stone weapons. The deeper or older valley deposits have yielded fossil remains of two types of men—the type found at Piltdown in Sussex, and that found at Mauer, near Heidelberg. Each represents a special *genus* of humanity and both differ from the *genus* to which all living races are assigned. Primitive though those early Pleistocene Europeans undoubtedly were we cannot withhold from them the right to be called human. Man was certainly in existence at the beginning of the Pleistocene period. Unfortunately we have no sure means of estimating the duration of this period in terms of years; estimates given by geologists vary from 250,000 years to 1,500,000 years, but the tendency is towards accepting the lower figure.

Shaped stones, showing evidence of human workmanship, have been found in Pleistocene deposits of all dates in France, Belgium and England. In the 100 ft. (30 metre) terrace of the Thames valley Messrs. R. A. Smith and H. Dewey (*Archaeologia*, 1912, vol. lxiv., p. 177) found deposits of three ages. The middle deposit contained implements of the *Chelles* type—pieces which show very skilful workmanship—and certainly do not represent man's earliest attempts at fabricating weapons. In the deeper and older deposit of this terrace, one laid down in early Pleistocene times, they also found implements—but of a much cruder kind, to which the elastic name *pre-Chellean* is given. In the corresponding terrace (30 metre) of the Somme valley M. V. Commont had previously found the same sequence of deposits and a corresponding succession of implements (*Les gisements paléolithiques d'Abbeville,* Lille, 1910). M. Rutot has traced a succession of implements throughout the Pleistocene deposits of Belgium. The most definite evidence of man's great antiquity in Europe comes from East Anglia. Its easternmost part is covered by deposits laid down at all phases of the Pleistocene; these accumulations cover others which were deposited in the latter half of the previous geological period—the Pliocene. The Cromerian formations mark the transition from the earlier to the later of these two periods. Even so long ago as 1863 Sir Charles Lyell expressed the opinion that "signs of man's existence" would be met with in the Cromer forest bed. In 1879 Lewis Abbott discovered flints in this bed showing unmistakable evidence of human workmanship (*Natural Science,* 1897, vol. x., p. 89). In more recent years—from 1909 onwards—J. Reid Moir (1879–1944) carried out a systematic search for traces of man in the deposits of East Anglia. He published accounts of flint implements found under the Cromer forest bed (*The Great Flint Implements of Cromer,* 1923); within the Red-Crag, a deposit of late Pliocene date (Upper Pliocene), and under the Red-Crag he has gathered many examples of early stone industries, thus carrying the evidence of man's existence—at least that of a tool-fabricating animal—far into the Pliocene period. (*Pre-Palaeolithic Man,* 1919; *Early Man in East Anglia,* 1927.) In older Pliocene deposits it becomes increasingly difficult to distinguish between stones shaped by natural forces and those fashioned by man's apprentice hand. Perhaps the earliest traces of man's handiwork are represented by the "eoliths" which Benjamin Harrison first discerned in the plateau gravels of Kent in 1885 and which were accepted by Sir Joseph Prestwich as showing definite signs of human workmanship. Reid Moir regarded the plateau "eoliths" as being at least mid-Pliocene date. Many authorities are inclined to accept shaped stones found in deposits of the geological period which precedes the Pliocene—the Miocene, as evidence of the existence of beings with brains sufficiently advanced to conceive the use of stone tools, and with hands sufficiently skilled to fashion them. By such evidence human antiquity is carried into a past which must be measured by a million, perhaps millions, of years. All the evidence of this kind, which bears on the antiquity of man, has been fully discussed by Prof. W. J. Sollas (*Ancient Hunters,* 3rd ed., 1924; *see* also *Apes and Men,* by Harold Peake and H. J. Fleure, 1927; *A Text-book of European Archaeology,* vol. i., Palaeolithic Period, by R. A. S. Macalister, 1921).

Galley Hill Man and the Antiquity of Man of the Modern Type.—In 1888 there was found in the middle or Chellean deposit of the 100 ft. terrace of the Thames valley a human skeleton amidst circumstances which led highly skilled geologists to infer that it had been naturally entombed when the terrace was being laid down. The site of discovery was near the Schoolhouse of Galley Hill and hence the skeleton became known by that name. If the skeleton was as old as the deposit in which it lay then men of the modern type had a great antiquity, for in no important respect did Galley Hill man differ from modern man. Discoveries of a similar import were made in terrace deposits at Clichy, Paris, in 1868. The evidence which has accumulated since these skeletons were unearthed make it increasingly difficult to accept the geological age attributed to them. The most reliable evidence now at our disposal leads us to believe that Neanthropic or modern man made his first appearance in Europe late in the Pleistocene period. Until we trace him to the part of the earth from whence he came and discover the transitional stages of his evolution in situ, we cannot frame any precise estimate of the antiquity of our own type. Such discoveries of fossil man as have been made lead us to infer that early Pleistocene times, so far as concerns our direct ancestry, was a period of rapid evolutionary change; it was then that our brain underwent its latest unfolding and the grosser marks of the ape were shed from our frames. When we consider the very diverse forms into which Neanthropic man is now divided—Australoid, Negroid, Mongoloid and Caucasoid—it is clear we must postulate a considerable period for the differentiation of a common ancestral stock into modern races—one which must cover the whole of the Pleistocene period at least. The faculty of speech must be of ancient origin—or how otherwise can we explain the extraordinary diversity and number of languages—extinct and living? The conquests which man has won over nature also bespeak a long past for him.

Difficulties Which Surround the Problem of Man's Antiquity.—Are we justified in giving the name of man to the beings which shaped the crude stone tools found in deposits of the Pliocene period? At what evolutionary point are we to say that the Rubicon which separates ape from man has been passed? Until we have fixed such a point we cannot discuss the antiquity of man with any measure of precision. Let us take a concrete instance. Are we to regard Pithecanthropus as man or as ape? The answer is that he was human because of the following reasons. In point of size and conformation, his brain attained almost the lowest limit of modern or Neanthropic man; his posture and mode of progression were human; his hands and arms were freed from locomotion; his teeth fall within range of human variation. Pithecanthropus represents one of the dawn forms of humanity, and with his discovery it became possible to affirm that man's antiquity could be carried back with certainty to the close of the Pliocene period. It is not unlikely that higher forms than Pithecanthropus were evolved before the end of the Pliocene period; the stage reached by Piltdown man early in the Pleistocene period supports such an inference. A consideration of all the evidence leads us to expect that the fossil remains of emerging primitive man have to be sought for in strata of the Pliocene period, and those of emerging Neanthropic man in deposits of the Pleistocene.

Indirect Evidence of Man's Antiquity.—The evidence so far considered has had a direct and positive bearing on man's antiquity; by the discovery of fossil remains and stone implements man has been traced through the Pleistocene into the Pliocene period of the earth's history. We have now to consider a line of evidence which has an indirect but very important bearing on the date of man's origin. Students of modern culture are well aware that a certain stage of knowledge has to be reached before a particular invention becomes possible. The invention of the aeroplane early in the 20th century was conditioned by the evolution of the internal combustion engine in the latter part of the 19th century; that, in turn, only became possible when a host of discoveries had been made during the length of the 19th century. The same line of evidence applies to living types. Man's body and brain became possible only after the order of primates had undergone many and profound evolutionary changes. The full anthropoid stage had to be attained before a human form became possible. We have direct evidence of the existence of great anthropoid apes in Europe and in Asia during the long Pliocene period; in the same continents we have traced them, by their fossil remains, far into the long geological period which preceded the Pliocene—the Miocene. The great anthropoidal type seems to have come into existence first during Miocene times, for we have found no trace of them as yet in the deposits of the still older period—the Oligocene. The meagre fossil remains of primates, so far discovered in strata of the Oligocene period indicate the existence of very generalized, small apes, one of which may well represent the ancestor of the gibbon—the smallest and most monkey-like of living anthropoids. It is useless to go beyond the Oligocene in search of a separate ancestry for mankind; not even the small anthropoid had come into existence in pre-Oligocene times. Thus a survey of our knowledge of the evolution of the higher primates—imperfect as that knowledge still is—leads us to the conclusion that the differentiation of the stem which culminated in modern man, cannot have commenced until the Miocene period was reached.

The oldest trace of a small anthropoid so far discovered comes from strata of the Fayum, Egypt, laid down in the earlier phase of the Oligocene period. The half of a lower jaw with its teeth is all that has been found of this small anthropoid which was described by Von Schlosser in 1911. He named it *Propliopith-*

ecus, and regarded it as an ancestral form of gibbon (W. K. Gregory, *The Evolution of the Human Dentition,* 1922).

Of Miocene and Pliocene great anthropoids at least 11 distinct species, representing several genera, are known by the discovery of fossil remains—all of them, unfortunately, being of a fragmentary nature. The type of anthropoid prevalent in Miocene times is best represented by the genus *Dryopithecus*—anthropoids representing the chimpanzee in point of size and posture and showing in their teeth and jaws characters which indicate that the ancestries of the gorilla, chimpanzee and man may have descended or ascended from a Dryopithecque form. So great and intimate are the resemblances between the teeth of primitive man and those of *Dryopithecus* that Dr. W. K. Gregory is convinced that it was this anthropoidal type which gave evolutionary birth to the human phylum. Great anthropoids of many kinds abounded in the Miocene jungles of northern India as we know from discoveries made by Dr. Guy Pilgrim (*Records of the Geological Survey of India,* 1915, vol. xlv., p. 1; *Memoirs of the Geological Survey of India,* 1927, vol. xiv., p. 1). One of these, *Sivapithecus,* known by fragments of jaws and teeth found in Siwalik deposits, is regarded as a possible ancestor of man by Dr. Pilgrim, but a definite decision cannot be made until more material is available for study.

So far no fossil trace of an anthropoidal type has been discovered in America; man had reached his Neanthropic stage of evolution before he entered the New World. In 1922 a much eroded tooth was found in beds of Pliocene date at Snake Creek quarry, Nebraska, which was attributed to an anthropoid ape—*Hesperopithecus,* was the name proposed for it—but later discoveries have shown that a mistake had been made and that the tooth belonged to a being of another order.

Early in 1925 Prof. Raymond Dart announced the discovery of the fossil skull of a young anthropoid ape, found in a limestone quarry at Taungs, on the eastern border of the Bechuanaland Protectorate and near the Transvaal frontier (*Nature,* 1925, vol. cxv., p. 195). The geological evidence goes to prove that this anthropoid which Prof. Dart named *Australopithecus,* cannot be older than the beginning of the Pleistocene—a date at which primitive types of humanity were already in existence. In size of brain, in shape of head, conformation of jaw and tooth, this very interesting and extinct form of anthropoid shows close relationships to the two surviving African anthropoids—the gorilla and chimpanzee—and, as Prof. Dart has rightly maintained, possessed certain features which may be called human.

Summary.—Thus, taking all lines of evidence into consideration, anatomical, biological, embryological and geological, we are led to the conclusion that man has been evolved from a lower form, and that human races, as we know them to-day, are the products of evolutionary processes. There remain great blanks in the line of evidence which links the origin of modern man to an extinct form of anthropoid ape. Between the highest kind of anthropoid and the lowest type of man, represented at present by Pithecanthropus, there still exists a great gap; the transitional forms which fill this gap still remain to be discovered. Yet the evidence as it stands, imperfect as it is, points to man's departure from an anthropoid status early in the Miocene period, certainly 1,000,000 years ago, perhaps more; that in the Miocene and Pliocene periods his body and limbs became adapted to a plantigrade posture; that his brain underwent expansion in the Pliocene, and particularly in the earlier part of the Pleistocene period, and that as the brain reached a full human status the coarser outward appearances of the ape were shed. Of the vital processes which brought about these changes we are as yet ignorant, but it is manifest that in his evolutionary progress man has tended to acquire and preserve in adult years states which appear at first as transient conditions in foetal or infantile stages. (Prof. L. Bolk, *Proc. Acad. of Science, Amsterdam,* 1927, vol. xxx., No. 2.)

It is becoming clear that the machinery of evolution is that which regulates development and growth, and in these matters knowledge is growing. Experimental embryologists have proved that one group of developing cells can and does regulate the growth and behaviour of a neighbouring group. The theory of hormones has thrown a flood of light on the machinery of evolution (Prof. Chas. R. Stockard, *Publications of Cornell University Medical College,* 1924, vol. 10; Keith, *Supplement to Nature,* Aug. 18, 1923). It has been proved that substances or hormones are carried by the circulation throughout the living body from a series of glands which include those of reproduction, the adrenal, the thyroid, the pituitary and pineal, and that the substances thus liberated in the body do control its vital reactions and its structural form.

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MAN, ISLE OF (anc. *Mona*), a possession of the crown of England, in the Irish sea, 33 m. long by 12 broad in the broadest part. The area is 220.7 sq.mi. Oval in general form, its outline is very irregular, being indented with numerous bays and creeks. Its chief physical characteristic is the close juxtaposition of mountain, glen and sea, which has produced a great variety and beauty of scenery. The greater part of its surface is hilly. The hills (culminating point Snaefell 2,034 ft.), have a trend in the direction of the longer axis, but throw out radiating spurs, which frequently reach the coast line. The outline of the hills is smooth and rounded, the rocks, the Manx Slate series, being a group of slates, flags, grits and conglomerates which have suffered much from folding, crushing and overthrusting.

No satisfactory fossils have yet been found in these rocks, but they are regarded provisionally as of Upper Cambrian age. The series is penetrated by masses of granite at Dhoon, Foxdale, etc. Streams have frequently rent steep-walled gulleys in the hill-sides, and the westerly winds have caused them to be treeless, except in some of the lower slopes. Rising almost directly from the sea, they present a much more imposing appearance than many hills of greater altitude. On the south-west, they descend precipitously into the sea, and unite with the cliffs to produce most striking coast scenery. The whole coast from Peel round by the Calf-of-Man, to near Ramsey, is distinguished by rugged grandeur. The Calf-of-Man is a precipitous island reaching an altitude of 360 feet. From Ramsey round by the Point of Ayre to near Peel, extend low sandy cliffs, bordered by flat sandy shores.

The low-lying northern plain extends northward from the road between Ramsey and Ballough and is composed of Carboniferous (limestones, sandstones and conglomerates) and Triassic rocks entirely covered by glacial drift. This plain is relieved only by a low range of hills, the highest attaining an elevation of 270 feet. There is a small tract (8 sq.m.) of Carboniferous rocks in the neighbourhood of Castletown, which are of great economic importance forming the only source of lime and also the best building stone in the island. The drainage of the island radiates from around Snaefell. Narrow, winding glens studded with fir, sycamore, and mountain ash, with patches of gorse, heather and fern, afford a striking contrast to the bare mountain tops. Traces of an older system of drainage are noticeable, especially in the central depression between Douglas and Peel. There are no lakes.

The chief bays are, on the east coast, Ramsey, with an excellent anchorage, Laxey, Douglas, Derbyhaven, Castletown and Port St. Mary; and on the west coast Port Erin and Peel.

Climate.—The island is liable to heavy gales from the south-west but its winters are mild, and, influenced by the less changeable temperature of the sea, its summers cool. The mean annual temperature is 49° F, the temperature of the coldest month (January) being 41·5°, and the warmest (August) 58·5°, Fuchsias, hydrangeas, myrtles and escallonias grow luxuriantly in the open air. There are remarkable divergences in the amounts of rain in the different parts of the island, varying from 61 in. at Snaefell to 25 in. at the Calf-of-Man.

Fauna.—Like Ireland, the Isle of Man is exempt from snakes and toads. Frogs have been introduced and both the sand lizard and the common lizard are found. Badgers, moles, squirrels, and voles are absent and foxes are extinct. The red deer became extinct by the beginning of the 18th century. Hares are less plentiful than formerly and rabbits are not numerous. Snipe are fairly common, and there are a few partridges and grouse. Woodcock, wild geese, wild ducks, plover, widgeon, teal, heron, bittern, kingfisher and the Manx shearwater (*Puffinus puffinus*) visit the island, but do not breed there. The puffin (*Fratercula artica*) is still numerous on the Calf islet in the summer time. The peregrine falcon and the chough have become very scarce. The legal protection of sea birds (local act of 1867) led to an enormous increase in the number of gulls. A domestic cat, the Manx, remarkable for a stunted or absent tail, is peculiar to the island.

Flora.—Like the fauna, the flora is chiefly remarkable for its meagreness. It contains at most 450 species, as compared with 690 in Jersey. Alpine forms are absent. But what it lacks in variety it makes up in beauty and quantity. For the profusion of spring flowers, the Isle of Man is famous.

The People.—The centre of the island retains remnants of an early population, mainly short, dark and long-headed, while the coastal areas are said to show a broad-headed element, tall and well-built with dark features. The majority of the population, however, show marked Nordic characters—tall, fair, with light eyes, undoubtedly due to the large Scandinavian settlements reinforced by later immigrants both Norman and English. The population of the island (est. 1939) was 50,829, but visitors considerably augment this total.

History and Early Settlement.—The earliest evidences of man on the island are probably to be found in the numerous flint chipping floors along the coasts and elsewhere. Such floors are found near Ronaldsway, Ballakaighan, German and Port St. Mary. There are evidences of pile dwellings near the foot of Snaefell and Ballakaighan. The latter site has a dug-out boat. There, also, in 1940–42, a "rath" was excavated and found to represent a single circular house 90 ft. in diameter and covered with a turf roof. It is thought to date from about A.D. 500. Almost all the polished stone axes on the island are of foreign make, a fact that suggests that they were brought as articles of trade and were in use long after the period from which they date typologically. Prehistoric burial sites range from Neolithic to Scandinavian.

The position of the island in the western seas suggests that it was a station of no little importance in megalithic times and there are many old stone monuments still surviving, though many of the sites seem to have been occupied both before and after this time. Mull Hill circle with its cists in the south of the island is well known. Other stone monuments are found on Bradda mountain, Spanish head, the Braid, Marown, the Ballachrink cairn, Maughold and the famous King Orry's grave in Laxey. The latter seems to have maintained a tradition of sanctity down until the dark ages and possibly in the local cults through the middle ages. There are cup and ring markings at Bradan camp, Oatland circle and Grainvick bay. The Bronze Age discoveries are few, but there are traces of the Iron Age.

The history of the Isle of Man during the Celtic period is mainly associated with the spread of Celtic Christianity. During this period the island had a close association with Ireland as the early Christian *Keeills* or oratories show. Man is rich in sculptured crosses, and there is a round tower on Peel islet. If the supposed conquest of the Menavian islands—Man and Anglesey—by Edwin of Northumbria, in 616, did take place, the results were hardly permanent. It is, however, possible that in 684, when Ecfrid laid Ireland waste from Dublin to Drogheda, he temporarily occupied Man.

During the period of Scandinavian domination there are two main epochs—one before the conquest of Man by Godred Crovan in 1079, and the other after it. The earlier epoch is characterized by warfare and unsettled rule, the later is comparatively peaceful. Between about 800 and 815 the Vikings came to Man chiefly for plunder; between about 850 and 990, when they settled in it, the island fell under the rule of the Scandinavian kings of Dublin; and between 990 and 1079, it was subject to the powerful earls of Orkney. The conquerer Godred Crovan was evidently a remarkable man, and it seems probable that he is the person commemorated in Manx legend under the name of King Gorse or Orry. The islands which were under his rule were called the *Suðr-eyjar* (Sudreys or the south isles, in contradistinction to the *norðr-eyjar,* or the north isles, *i.e.*, the Orkneys and Shetlands, and they consisted of the Hebrides, and of all the smaller western islands of Scotland, with Man. At a later date his successors took the title of *Rex Manniae et Insularum.* Olaf (1113–1152), Godred's son, was a powerful monarch. His son, Godred, who for a short period ruled over Dublin also, as a result of a quarrel with Somerled, the ruler of Argyll, in 1156, lost the smaller islands off the coast of Argyll. An independent sovereignty was thus interposed between the two divisions of his kingdom.

Early in the 13th century, when Reginald of Man did homage to King John, we hear for the first time of English intervention in the affairs of Man, but it was into the hands of Scotland that the islands were ultimately to fall. During the whole of the Scandinavian period the isles were nominally under the suzerainty of the kings of Norway. The first to assert this authority was Harold Haarfager about 885, then came Magnus Barfod about 1100, both of whom conquered the isles. From the middle of the 12th century till 1217 the suzerainty had been of a very shadowy character. But after that date it became a reality and Norway consequently came into collision with the growing power of Scotland. Finally, in 1261, Alexander III. of Scotland sent envoys to Norway to negotiate for the cession of the isles, but their efforts led to no result. He therefore initiated hostilities which terminated in the complete defeat of the Norwegian fleet at Largs in 1263. Magnus, king of Man and the Isles, was compelled to surrender all the islands over which he had ruled, except Man, for which he did homage. Two years later Magnus died and in 1266 the king of Norway ceded the islands, including Man, to Scotland. But Scotland's rule over Man was not firmly established till 1275, when the Manx were defeated at Ronaldsway, near Castletown. In 1290 we find Edward I. of England in possession of Man, and till 1346, when the battle of Neville's Cross decided the long struggle between England and Scotland in England's favour, there followed a confused period when Man was sometimes under English and sometimes under Scottish rule.

About 1333 it had been granted by King Edward III. to William de Montacute, 1st earl of Salisbury, as his absolute possession. In 1392 his son sold the island "with the crowne" to Sir William Le Scroope. In 1399 Henry IV. caused Le Scroope to be beheaded. The island then came into the possession of the crown and was granted to Henry de Percy, earl of Northumberland, but, he having been attainted, Henry IV., in 1406, made a grant of it to Sir John Stanley, his heirs and assigns.

With the accession of the Stanleys to the throne there begins a better epoch in Manx history. Though the island's new rulers rarely visited its shores they placed it under responsible governors, who seem to have treated it with justice. Of the thirteen members of the family who ruled in Man, the second Sir John Stanley (1414–1432), James, the 7th earl (1627–1651), and the 10th earl of the same name (1702–1736) had the most important influence on it. The first curbed the power of the spiritual barons, introduced trial by jury and ordered the laws to be written.

The second, known as the Great Stanley, and his wife, Charlotte de la Tremoille, are probably the most striking figures in Manx history. In 1643 Charles I. ordered him to go to Man, where the people threatened to revolt. But his arrival, with English soldiers, soon put a stop to anything of this kind. He conciliated the people by his affability, brought in Englishmen to teach various handicrafts and tried to help the farmers by improving the breed of Manx horses, and, at the same time, he restricted the exactions of the Church. But the Manx people never had less liberty than under his rule. They were heavily taxed; troops were quartered upon them; and they had to accept short leases for holding their land. In 1649 Stanley received a summons from General Ireton to surrender the island, which he haughtily declined. In Aug. 1651 he went to England with 300 Manxmen among his troops, to join King Charles II., and took part in the decisive defeat of the Royalists at Worcester. He was captured, confined in Chester castle, tried by court martial and executed at Wigan.

Soon after his death the Manx Militia, under the command of William Christian, rose against the Countess and captured all the insular forts except Rushen and Peel. They were then joined by a parliamentary force under Colonel Duckenfield, to whom the Countess surrendered. Fairfax had been appointed "Lord of Man and the Isles" in September. The restoration of Stanley government (1660) caused as little friction and alteration as its temporary cessation had. William Christian was tried and executed while of the other persons implicated in the rebellion three only were excepted from the general amnesty, but by Order in Council they were pardoned, and the judges responsible for the sentence on Christian were punished. Stanley disputed the permanency of the tenants' holdings, which they had not at first regarded as being affected by the acceptance of leases. Almost open rebellion and the neglect of agriculture followed. In lieu of it the people turned to the fisheries and to contraband trade.

The agrarian question was not settled till 1704, when James, Charles's brother and successor, largely through the influence of Bishop Wilson, entered into a compact with his tenants, which secured the tenants in the possession of their estates in perpetuity on condition principally of a fixed rent. This act has been called the *Magna Carta* of the Manx people. As time went on, and the value of the estates increased, the rent payable to the lord became so small in proportion as to be almost nominal. James died in 1736 and was succeeded by James Murray, 2nd duke of Atholl. In 1764 he was succeeded by Charlotte, Baroness Strange, and her husband, John Murray, who, in right of his wife, became Lord of Man. About 1720 the contraband trade greatly increased. In 1726 it was, for a time, somewhat checked by parliament, but during the last ten years of the Atholl régime (1756–1765) it assumed such proportions that it became necessary to suppress it. The "Revesting Act," was passed in 1765, under which the sovereign and manorial rights and the customs revenues and certain other perquisites were purchased.

Up to the time of the Revestment the Tynwald court passed laws concerning the government of the island in all respects and had control over its finances, subject to the approval of the lord. After the Revestment, Imperial Parliament legislated with respect to customs, harbours and merchant shipping, and, in measures of a general character, it occasionally inserted clauses by which penalties in contravention of the acts of which they formed part might be enforced in the island. It also assumed the control of the customs duties. Such were the changes which modified the Constitution of the Isle of Man. Its ancient laws and tenures were not interfered with. The hereditary lords were far from being model rulers, but most of them had taken some personal share in its government, and had interested themselves in the well-being of its inhabitants. But now officials who regarded the island as a pestilent nest of smugglers, from which it was their duty to extract as much revenue as possible, were in charge. Between 1793 and 1826, the 4th Duke of Atholl, as governor, improved matters. After his departure the English officials resumed their sway, but were more considerate than before. Since smuggling had by that time almost disappeared, and the Manx revenue was producing a large surplus, the Isle of Man came to be regarded more favourably, and it obtained a less stringent customs tariff and an occasional dole toward erecting its much neglected public works. After 1866, when they obtained at least a nominal "home rule," the Manx people flourished greatly.

The island has complete financial autonomy and until 1918 the only form of taxation was customs and excise, though the inequity of this method of taxation led to the introduction of income tax in that year. However, this tax remained considerably below that of the mainland. After World War I, old age pensions and health insurance were introduced. During World War II the island was used as an alien internment camp.

Arms.—There has been much controversy about the origin of the arms of the island—the "three-legs" found on a beautiful pillar cross near Maughhold churchyard belonging to the latter part of the 14th century. It was probably originally a sun symbol and was brought from Sicily by the Vikings. The motto *quocumque jeceris stabit* is of comparatively recent origin.

Church.—The Christianity of Early Irish associations seems to have suffered beneath the Scandinavian power, though a Christianity with both Irish and Scandinavian affinities reasserts itself in the 11th century. The two most important events in the history of the mediaeval Manx Church were the formation of the diocese of Sodor (*q.v.*) and the foundation of the abbey of Rushen, a branch of the Cistercian abbey of Furness, in 1134. From this time till the Reformation there was an almost continuous struggle between the laity and the spiritual barons and monks, who had obtained great power and much property in the island. In 1458 the diocese was placed under York. The dissolution of the religious houses in Man was brought about by the arbitrary action of Henry VIII, and the Reformation was a very slow process. Successful missions by John Wesley and others resulted in the establishment of Nonconformity. In 1878 a Sodor and Man theological school was established for the training of candidates for holy orders. In 1880 four rural deaneries were established, and commissioners were constituted as trustees of endowments for Church purposes. In 1895 a cathedral chapter, with four canons, was constituted under the name of the "Dean and Chapter of Man," the bishop being the dean of the cathedral church. Several acts give Nonconformists (probably a majority) equal rights with Churchmen. There are a few Roman Catholics and Presbyterians. The Manx Church is a separate national Church governed by its own laws, which, however, must be approved by the insular legislature.

Education.—In 1872, when the insular legislature passed the Public Elementary Education act, the Manx state undertook direct responsibility for education. It became free in 1892, and a higher-grade school was established in Douglas in 1894. The public elementary schools are managed by the Isle of Man Education authority. They are examined by English inspectors and compelled to attain the same standard of efficiency as the English and Welsh schools. In 1907 an act establishing a system of secondary education was passed by the legislature. The Manx language (*see* CELTIC LANGUAGES) still lingers, but there is now no one who does not speak English.

Government.—This is vested in a lieutenant-governor, appointed by the Crown; in a council (the upper House); in the House of Keys (the lower House); and in the Tynwald court. The two Houses sit separately as legislative bodies, but they sit in the Tynwald court as distinct bodies with co-ordinate powers to transact executive business and to sign bills. The Tynwald court controls the revenue, and is subject to the supervision of the Treasury, and it appoints boards to manage the harbour, highways, education, local government, agriculture and lunatic and poor asylums. The Imperial Government, after intimating its intention to Tynwald, fixes the rates of the customs duties, but Tynwald can by resolution "impose, abolish or vary" the customs duties, subject to the approval of parliament. The approval of the sovereign of the United Kingdom and of the lieutenant-governor is essential to every legislative enactment.

Acts of the imperial parliament do not affect the island except it be specially named in them. The lieutenant-governor (the representative of the sovereign) presides in the Council, in the

Tynwald court. He is the supreme executive authority, and he has certain powers of veto. It has been the practice for him to act as chancellor of the exchequer.

The Council consists of the lieutenant-governor, lord-bishop of the diocese, clerk of the rolls, the two deemsters, attorney general, two members appointed by the lieutenant-governor and four members appointed by the House of Keys. The House of Keys (for origin of the name *see* KEY) is one of the most ancient legislative assemblies in the world. It consists of twenty-four members, elected by male and female voters, there being manhood and womanhood suffrage for all above 21 years of age. Each of four sheadings elects three members and the other two sheadings, two members each; the towns of Castletown, Peel and Ramsey one each, and Douglas five. The House sits for five years unless previously dissolved by the lieutenant-governor.

Law.—The High Court of Justice, of which the lieutenant-governor is president, contains three divisions: viz., the Chancery division, the Common Law division, and an Appeal court. The jurisdiction of the Chancery and Common Law division is in the main similar to that of the corresponding divisions in the English courts. Appellate jurisdiction is exercised by the Appeal court consisting of the High Court judge and an appeal judge, the latter being an eminent barrister approved by the crown, and acts only when required. The Common Law courts (southern division) are held at Douglas and Castletown alternately and for the northern division at Ramsey, once in three months. Actions are heard by a deemster and a special or common jury. The Chancery court sits once a fortnight at Douglas. Deemsters' courts for minor cases are held weekly, alternately at Douglas and Castletown and alternately at Ramsey and Peel. Criminal cases are heard by the magistrates or a high-bailiff and are sent on by them for trial by a deemster and a jury of six, which discharge the functions of the Grand Jury in England. The Court of General Gaol Delivery is the supreme criminal court and is presided over by the clerk of the rolls and the deemsters. The High Bailiffs (comparable to a stipendiary magistrate) hold weekly courts in the four towns and magistrates (J.P.s) also hold regular courts. There is a coroner in each of the six sheadings.

The Manx Bar is distinct from that of England. Its members, called "Advocates," combine the functions of barrister and solicitor. The laws relating to real property still retain much of their ancient peculiarity, but other branches of law have been made practically identical with English law. As regards real property the general tenure is a customary freehold devolving from each possesser to his next heir-at-law.

Chief Political Divisions and Towns.—The island is divided into six sheadings (from the Scandinavian "Ship-District") called Glenfaba, Middle, Rushen, Garff, Ayre and Michael, each of which has its officer, the coroner, whose functions are similar to those of a sheriff; and there are seventeen parishes. The chief towns are, Douglas, Ramsey, Peel, Castletown, Onchan, Port Erin, Port St. Mary, Laxey and Braddon.

Communications.—There is communication by steamers during the summer season with Liverpool, Fleetwood, Heysham, Glasgow, Greenock and Blackpool and with Liverpool, Greenock, Dublin and Belfast throughout the year. A daily mail was established in 1879. There is a regular air service to Liverpool. The internal communications are good. The Isle of Man Railway company has lines from Douglas to Castletown, Douglas to St. John's, where the line branches to Peel, Ramsey and Foxdale. In addition, the Manx Electric Railway company has a service from Douglas to Laxey and Ramsey, and from Laxey to the summit of Snaefell, while the Southern Electric railway connects Douglas to Port Soderick. The island is also well served by road motor transport companies.

Agriculture.—The best land is in the north and south. The farms are principally held on lease and small holdings have almost entirely disappeared. In 1940 the area under crops was 78,778 ac., or about 54% of the whole, and 39,751 ac. were rough grazings, the commons and uncultivated mountain lands being used for pasturage. Oats occupied about 91% of the area under corn crops (12,059 ac.). Turnips, an excellent crop, are largely exported; potatoes are grown on the dry sandy soil of the north. The pasturage is good. Some of the low-lying land is much in need of systematic drainage. The livestock now approximates very closely in quality to the stock in the north of England. Dairying is the most profitable department of agricultural industry. Apples, pears and wall fruit do not succeed very well, but the soil is favourable for strawberries, raspberries, gooseberries, currants and vegetables. Both agricultural and market-garden produce are quite insufficient to supply the demand in the summer.

Fishing.—The most numerous fish are herring, cod, mackerel, ling, haddock, plaice, sole, fluke, turbot and brett. The industry is, however, in a decaying condition, especially the herring fishery, which fails periodically. The amount of fish caught, except herring, is not sufficient to supply the demand in the summer. About 250 vessels, aggregating 4,260 tons, with crews numbering 4,250 are employed in this industry. A fish hatchery and marine biology station have been established at Port Erin.

Industries.—In proportion to its area the metalliferous wealth of the Isle of Man has been considerable, but little or no mining is done to-day. Two of its mines, Laxey and Foxdale, have produced lead and zinc for many years. Copper pyrites and haematite iron, and small amounts of the ores of nickel and antimony have been found. The mines are rented from the Crown as lord of the manor. Other economic products are clay, granite, limestone, sandstone, slate and salt. The principal manufactured articles are woollen cloth and blankets, hemp ropes and cotton, and herring nets. A few fishing vessels are built, and brewing is a prosperous industry. The most important occupation of the people is that of the provision for summer visitors, half a million of whom ordinarily come to the island annually. The chief exports are turnips, ropes, cotton nets and salt. The imports consist chiefly of timber and various foodstuffs.

BIBLIOGRAPHY.—For History and Law see *The Manx Society's publications. See* also *Bibliotheca Monensis* (*Manx Society*) with a list of MSS. and books up to 1876, and A. W. Moore's *History of the Isle of Man* has a list of MSS. and books up to 1900. Other more recent books include:—P. M. C. Kermode, *Manx Crosses* (1907); E. A. Jones, *The old Church plate of the Isle of Man* (1907); A. Herbert, *Isle of Man* (1926); J. J. Kneen, *Place names of the Isle of Man* (1927); G. W. Lamplugh, *Geology of the Isle of Man* (Geol. Surv. 1913); A. W. Moore, *Surnames and place names of the Isle of Man* (1906); P. G. Ralfe, *Birds of the Isle of Man* (1905); P. M. C. Kermode & W. A. Herdman, *Manks Antiquities* (1914); Hall Caine's novels have no doubt tended to popularize the island as well as a novel entitled *The Captain of the Parish,* by John Quine.

MANA is a word meaning "occult power" and occurs in many languages of Oceania. It is of uncertain origin, though probably introduced by immigrants from the West. While having also a wider and vaguer application, it stands for the "divine right" of the aristocratic class to wield authority and to enforce religious prohibitions; the sanction behind the *taboo* being the *mana* of the governing class, while conversely that *taboo* serves to keep the tribal *mana* intact, that is, ensures the good luck for all that waits on sound government. As a term of general anthropology *mana* may be treated as the positive, while *taboo* is the negative aspect, of the occult. In other words the occult as such is *taboo,* or "not to be lightly approached," because it is *mana,* or charged with wonder-working power.

Noa Contrasted.—In the Pacific region the word *noa* is used to signify the opposite kind of object or situation which is "common," that is, ordinary. The man who wields *mana* with impunity must abstain from all that is sordid. There are two worlds, a low-level and a high-level condition of spiritual activity, and a man cannot dwell in both at once. Thus by the very virtue of his profession the medicine man or the divine king must hold himself apart from those who by status or by choice are *noa,* laymen. The latter may live in brutish contentment; but to the end they lack enlightenment, participating in the highest mysteries at best from without. Every member of a primitive society is in some degree versed in experience of the occult, though for the most part some better qualified person is present to help him through it.

The Crises of Life.—The initiation of youths, puberty, marriage, a battle, a hunt may all lead to privations whereby one may acquire *mana*, "a strong heart," "uplift." Tradition has devised very efficient means of coping with crises, whether of organic origin or due to circumstance, by laying down a prescribed discipline which as it were enables the sick soul to go into retreat, so as by concentration on its inner resources to obtain an access of strength and comfort. (*See* PASSAGE RITES.)

Mana and Ritual.—Old-world religion is inarticulate, and *mana* stands for the power set in motion by ritual (*q.v.*), almost regardless of the intention behind the ritual; which among savages is always apprehended rather than comprehended. Thus when the ritual is of a public nature and guaranteed by custom and tradition, the *mana* therefrom resulting is felt by all to be a good *mana*. Such and such is known to be the ceremony proper to the occasion, and everyone is sure that the society will be the better for it. If, on the other hand, a private individual in overt and sinister fashion trafficks with the occult everyone is equally sure that a bad *mana* liable to afflict all and sundry will be unloosed. Sometimes, too, it is rather difficult to know which way a professional wonder-worker will use his power; for if he can heal he can also hurt, and it might occur to him to hurt if one did not make it worth his while to play the healer. Or, again, a man in authority will certainly use his *mana* to blast the public enemy, or even to suppress the unruly within his own society, and so far he will be acting legitimately.

Ambivalence.—*Mana*, then, is, as Freud would say, an "ambivalent" notion; it cuts both ways, implying alike divine and diabolic effects as possible manifestations of the awful power lurking in the occult. It is thus equally the root-idea of religion and of black magic, since both equally use rites that, duly performed by the expert, bring *mana* into play; and the procedure will electrify or electrocute according to the will of the operator. In a dim way the primitive mind perceives, if it hardly conceives, that intention or will has to be incorporated in the notion of *mana* before its moral value can be expressed. Thus not only from the Pacific but from many other parts of the world, Australia, for example, and North America, evidence is forthcoming of a tendency to split the notion into two, and distinguish a good and a bad kind of *mana;* as, for instance, *orenda* and *otgon* in the Huron dialect. For the Huron everything had its modicum of *orenda*, the deer, for instance, that might be clever enough to escape the hunter and thus outmatch his luck by greater luck of its own; but in this world of relative powers there were some that transcended man's so completely that in regard to them he must "lay down his *orenda*," which simply meant that he must "pray." Moreover, in such a warfare of competing agencies many might be expected to display *otgon*, the bad kind of *orenda*. If the primitive mind were clearer about the direction in which to turn for help in what is a pandaemonic rather than a pantheistic universe, the moralization of religion would correspondingly be brought about. As it is, the notion of the divine power would seem to be historically prior to that of the divine goodness, whether displayed as justice or as love.

Pervasiveness.—In particular, the very fluidity of *mana* makes it hard for religion to identify it with the good will of a personal god. It is all-pervasive, manifesting itself here, there and everywhere in the most momentary experiences of the occult. Or, even when as in the case of the living medicine-man or king it can be referred to a definite owner, it is apt to discharge itself through anything that has been in contact with him; so that, with so many transmitters in the shape of his bones or other belongings, secondary storage-cells of divine energy are distributed in all directions. *Mana* thus implies a religious experience that is primarily of the perceptual order, a frame of mind in which the sacred is simply "sensed." A conceptual attitude is not likely to come into being until the manifestation is individualized by being invested with a proper name. A god, or even the merest demon who can be propitiated by name, has a chance of acquiring a personality and a moral character.

The "Numinous."—It may be, however, that little more than the binding force of the bare name is involved in the ritual invocation, as when the Roman ejaculated a number of preposterous vocables corresponding to the parts of the door that he wished to construct *rite* "according to form." When *nomina* are thus *numina* and no more, the stage of *mana* has not been left behind; and indeed the word "numinous" has been suggested to cover the sacred in its more impersonal forms. It only remains to add that the *mana-taboo* formula, together with animatism, pre-animism, dynamism, numinism, or any other terms—the now discarded word fetishism is one of them—that have been used by theorists in the same connection, may or may not apply closely to the beliefs and institutions of some particular people, and may or may not be represented by appropriate words in a given language. Their value consists entirely in such help as they may afford in describing generally a phase of the religious life in which the need of coming to terms with the mysteries that beset life at once from within and without is satisfied mainly by ritual action, running ahead of articulate and reasoned doctrine, but none the less powerfully moving.

BIBLIOGRAPHY.—*Folklore*, June 1900 and June 1904, first used as a general category by R. R. Marett; *see* also *The Threshold of Religion* (1914); R. H. Codrington, *The Melanesians*, being his source for the Oceanic use of the word; H. Hubert and M. Mauss, "Esquisse d'une théorie générale de la Magie" in *L'Année Sociologique*, VII. (1904), W. Wundt, Völkenpsychologie, VI., II., Pt. II.; A. Lovejoy, "The Fundamental Concept of the Primitive Philosophy," in *Monist*, XVI. No. 3; "Orenda and a definition of Religion" in *American Anthropologist*, N.S. IV.; K. T. Preuss, "Der Ursprung der Religion und Kunst" in *Globus* (1904); C. Fox, *The Threshold of the Pacific* (1924). (R. R. M.)

MANAAR, GULF OF, a portion of the Indian ocean lying between the coast of Madras and Ceylon. Its northern limit is the line of rocks and islands called Adam's Bridge. Its extreme width from Cape Comorin to Point de Galle is about 200 miles.

MANACOR, a town of Spain in the island of Majorca. Pop. (1940) 13,585 (mun., 19,060). Near by are the caves of Drach, with underground lakes, Els Hams and Artá, one of the largest and finest groups of stalactite caverns in western Europe.

MANADO, a residency of the island of Celebes (*q.v.*), Netherlands Indies, comprising the N.E. peninsula and the coast of the Gulf of Tomini; area 34,203 sq.mi.; pop. (1930) 1,138,655.

MANAGEMENT: *see* SCIENTIFIC MANAGEMENT.

MANAGUA, capital of Nicaragua, and of the department of Managua, the largest city in the Central American republic. Population (1940) 83,546. The city lies on the southern shore of Lake Managua (38 mi. long by 10 to 16 wide), the lesser of the two great lakes which are the chief physical characteristics of the country. It is on the Pacific R.R., 87 mi. from the port of Corinto. Its importance dates from 1855, when, as a result of the continuous rivalry between the older cities of León (*q.v.*) and Granada (*q.v.*), Managua was chosen as the capital of the country and the seat of an archbishop who would thus outrank the bishops of León and Granada. Two major catastrophes in Managua (the earthquake and fire of 1931 and the fire of 1936) necessitated the rebuilding of many parts of the city. The main business streets are paved; and many modern homes, business establishments and public buildings were built. A magnificent cathedral near the shores of Lake Managua is under construction (1943), while nearby is the attractive new capitol. On the southern outskirts of the city are the Presidential palace and the ultra-modern U. S. legation. The U. S. marines, who occupied the Campo del Marte barracks in Managua almost continuously since 1912, were withdrawn early in 1933 under one of the last acts of the Hoover administration.

MANAKIN, applied to the small birds which form the family *Pipridae*, a passerine family allied to the *Tyrannidae*. They are peculiar to the neotropical region, living in deep forests, associating in small bands, and keeping continually in motion, but feeding almost wholly on the large soft berries of the different kinds of *Melastoma*.

The manakins are nearly all birds of gay appearance, generally exhibiting rich tints, of blue, crimson, scarlet, orange or yellow, in combination with chestnut, deep black, black and white, or olive green; among their most obvious characteristics are their short bill and feeble feet, with the outer and middle toes united for a good part of their length. *P. leucilla*, one of the best known, has a wide distribution from the Isthmus of Panama to Guiana and the valley of the Amazon; but it is one of the most plainly coloured of the family, being black with a white head. They are often kept in captivity.

MANAOAG, a municipality in the north central part of the province of Pangasinan, Luzon, Philippine Islands, on the Angalacan river, 21 mi. N.E. of Lingayen. Pop. (1939) 29,030; 8 whites. Rice, tobacco, corn, sugar and various fruits and vegetables are cultivated. A statue of the Virgin Mary here is visited annually (in May) by thousands from Pangasinan and adjoining provinces. The Pangasinan and Ilocano languages are both spoken. Of the inhabitants aged 6 to 19 inclusive, 38.3% in 1939 attended school, and of those 10 years old and over 51.9% were literate.

MANASSAS, an incorporated town of Prince William county, Va., about 30 mi. W.S.W. of Washington, D.C. Pop. (1930) 1,215; and 1,302 in 1940 federal census. The town of Manassas, known also as Manassas Junction, is served by the Southern railway and by bus lines. North of the junction is Bull Run, a mountain stream which empties into the Occoquan, an arm of the Potomac. In this neighbourhood two important battles of the American Civil War, the first and second battles of Bull Run (*q.v.*), were fought on July 21, 1861 and on August 29, 1862 respectively; by Southern historians these battles are called the battles of Manassas.

MANASSEH, king of Judah, succeeded his father Hezekiah, and reigned about 692–638 B.C. That he maintained his position so long is a tribute to his statesmanship, and probably his kingdom prospered materially. We hear, however, very little about him, because his recognition of alien cults was a grave offense in the eyes of those who edited the historical writings. He is, indeed, held responsible for the ultimate ruin of the kingdom. He was very much under the influence of Assyria, and documents from his reign unearthed at Gezer disclose the presence of Assyrians in his realm, the use of their language and method of dating. No doubt his introduction of the worship of the host of heaven and other Assyrian cults was dictated by political rather than religious motives. He may well have been involved in the conspiracies of Shamash-shum-ukin, the rebellious brother of Assur-bani-pal. If so, the account of his deportation to Babylon, and subsequent return, 2 Chronicles xxxiii 11–13, may be historical, though the chronicler's religious interpretation of it is a fiction. Manasseh appears in inscriptions of Esarhaddon and Assur-bani-pal as an Assyrian vassal. (W. L. W.)

MANASSEH, a tribe of Israel, was descended, according to the traditions, from Manasseh, the elder of the two sons born to Joseph by his Egyptian wife Asenath, the younger being Ephraim. Numbers xxxii states that half the tribe received an allotment of territory in the conquered land of Gilead, east of Jordan. In Joshua iv 12 we read that this part of Manasseh joined with Reuben and Gad in support of the tribes who were fighting for a foothold on the west of the river. But other traditions tell of a Manasseh tribe settled west of the Jordan. In Joshua xvi–xviii we find Manasseh, regarded as forming with Ephraim a single tribe, settled in the hill country south of the fertile Esdraelon plain, and cut off from it by a strong chain of fortified Canaanite towns. Its western border is the Mediterranean; but the territory occupied by it cannot be defined with precision. Machir, the "son" of Manasseh, seems to represent sometimes that part of Manasseh dwelling in central Palestine, sometimes an element of that part of the tribe dwelling east of the Jordan, and sometimes the whole tribe. Machir appears in the ancient poem Judges v as taking part in the struggle against Sisera, and seems to have Zebulon on the one side, Ephraim and Benjamin on the other, as neighbours. From 1 Chronicles vii 14 it may be deduced that the tribe contained some Aramean elements. The various traditions are so confused that certainty in detail seems unattainable. To Manasseh belonged the deliverers Gideon and Jephthah. (W. L. W.)

MANASSES, CONSTANTINE, Byzantine chronicler, flourished in the 12th century during the reign of Manuel I (Comnenus) (1143–1180). He was the author of a *Chronicle* written in "political" verse, from the creation of the world to the end of the reign of Nicephorus Botaniates (1081), written by direction of Irene, the emperor's sister-in-law. The poetical romance of the *Loves of Aristander and Callithea,* also in "political" verse, is only known from the fragments preserved in the Ῥοδωνία (rose-garden) of Macarius Chrysocephalus (14th century). Manasses also wrote a short biography of Oppian, and some descriptive pieces on artistic and other subjects.

EDITIONS.—*Chronicle* in Bonn, *Corpus scriptorum hist. Byz.,* 1st ed. Bekker (1837) and in J. P. Migne, *Patrologia graeca,* cxxvii.; *Aristander and Callithea* in R. Hercher's *Scriptores erotici graeci,* ii. (1859); "Life of Oppian" in A. Westermann, *Vitarum scriptores graeci minores* (1845). A long didactic poem in "political" verse (edited by E. Miller in *Annuaire de l'assoc. pour l'encouragement des études grecques en France,* ix. 1875) is attributed to Manasses or one of his imitators.

MANASSES, PRAYER OF, an apocryphal book of the Old Testament. It purports to be the prayer of the Judaean king referred to in 2 Chron. xxiii 12, 13, 18, 19. Ewald held that the Greek was an actual translation of the lost Hebrew; but Ball more wisely takes it as a free rendering of a lost Haggadic narrative founded on the older document, from which the chronicler drew his information. This view he supports by showing that there was once a considerable literature in circulation regarding Manasseh's later history. On the other hand most scholars take the Prayer to have been written in Greek, *e.g.,* Fritzsche, Schürer and Ryssel (Kautzsch, *Apok. u. Pseud.* i 165–168).

This fine penitential prayer seems to have been modelled after the penitential psalms. It exhibits considerable unity of thought, and the style is, in the main, dignified and simple.

As regards the date, Fritzsche, Ball and Ryssel agree in assigning this psalm to the Maccabean period. Its eschatology and doctrine of "divine forgiveness" may point to an earlier date; on the other hand, there are some indications of a doctrinal character which point to post-Maccabean times.

The best short account of the book is given by Ball (*Speaker's Apocrypha,* ii 361–371); *see* also Ryle in Charles' *Apocrypha and Pseudepigrapha.* (R. H. CH.; W. O. E. O.)

MANATEE or MANATI, the name of the American representative of a small group of herbivorous aquatic mammals, constituting the order Sirenia (*q.v.*). Manatees are somewhat whale-like in shape, with a similar horizontally expanded tail-fin; but here the resemblance to the Cetacea ceases. The American manatee, *Trichechus manatus,* inhabits the rivers of Florida, Mexico, Central America and the West Indies and measures from 9 to 13 ft. in length. The body is somewhat fishlike, but depressed and ending posteriorly in a broad, shovel-like horizontal tail, with rounded edges. The head is of moderate size, oblong, with a blunt muzzle, and divided from the body by a slight constriction. The fore limbs are flattened oval paddles, placed rather low, with no external signs of division into fingers, save three diminutive flat nails near their extremities. No traces of hind limbs are discernible either externally or internally. The mouth is peculiar, the swollen upper lip being cleft in the middle line into two lobes, each of which is separately movable. The nostrils are two valve-like slits at the tip of the muzzle. The eyes are minute and nearly circular with wrinkled margins; external ears are wanting. The skin is dark grayish and finely wrinkled. There is a scanty covering of delicate hairs, and both lips are supplied with short, stiff bristles.

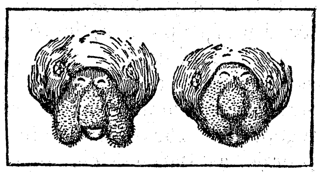
FROM VOGT AND SPECHT, "NATURAL HISTORY OF ANIMALS" (BLACKIE)

THE MANATEE (TRICHECHUS INUNGUIS), OF THE AMAZON

Manatees have a number—as many as 20 pairs in each jaw—of two-ridged teeth, of which, however, comparatively few are in use at once. They lack the large tusks of the male dugong (*q.v.*). In life the palate has a horny plate, with a similar one in the lower jaw.

Manatees inhabit bays, lagoons, estuaries and large rivers but not the open sea. As a rule they prefer shallow water, in which, when not feeding, they lie near the bottom. In deeper water they often float, with the body much arched, the rounded back close to the surface, and the head, limbs and tail hanging downward. They feed below water on aquatic plants. They are slow of movement and perfectly harmless but are persecuted for the sake of their oil, skin and flesh. From the shoulder-joint the flippers can be moved in all directions, and the elbow and wrist permit of free extension and flexion. In feeding, manatees push the food toward their mouths by means of the hands. The lateral pads of the upper lip have the power of transversely approaching toward and receding from one another simultaneously. The animal is thus enabled to introduce food placed before it without the assistance of the lower lip, the action recalling that of the mandibles of caterpillars.

The Amazonian manatee (*T. inunguis*) is smaller, not exceeding 8 ft. in length, with less well-developed lip-pads and without nails to the flippers. It ascends most of the tributaries of the Amazon until stopped by rapids. The West African *T. senegalensis* extends about 10° south and 16° north of the equator and ranges into the continent as far as Lake Tchad. From 8 to 10 ft. appears to be the normal length; the weight of one specimen was 590 lb. The colour is bluish-black, with a tinge of olive-green above and yellow below.



AFTER MURIE, IN THE "TRANSACTIONS OF THE ZOOLOGICAL SOCIETY"

AMERICAN MANATEE OR MANATI
Front view of head showing left, with the lobes of the upper lip divaricated; right, with the lips contracted

The manatee is said to be the origin of many legends of mermaids, while the Amazonian species is the object of superstitious reverence by the Indians.

MANATÍ, an important town of Puerto Rico. It is situated in the northern part of the island, about 3 mi. from the Atlantic ocean and about equidistant east and west; pop. (1940) 6,771, federal census. The pop. of the municipal district in 1940 was 29,366. Manatí is located in a beautiful valley drained by the Manatí river, from which it derives its name. The soil of the surrounding territory is very fertile and sugar-cane is extensively cultivated. Coffee is also raised in the uplands, and pineapples, grapefruit. oranges, bananas and other tropical fruits are also produced. The town is prosperous, has good schools, water-works, electric lights, a municipal market and a hospital, and has a number of small industries. (H. M. T.; X.)

MANAUS or **MANÁOS,** a city and port of Brazil, and capital of the state of Amazonas, on the left bank of the Rio Negro, 12 mi. above its junction with the Solimões, or Amazon, and 908 mi. (according to Wappäus) above the mouth of the latter, in lat. 3° 8′ 4″ S., long. 60° W. Pop. of city (1940) 67,866; *município* 109,302, including a large percentage of Indians, Negroes and mixed-bloods. Manaus stands on a slight eminence overlooking the river, 106 ft. above sea level, traversed by several *igarapés* (canoe paths) or side channels, and beautified by the luxuriant vegetation of the Amazon valley. The average annual temperature between 1911 and 1919 was 80.9°, the number of rainy days 153 and the total rainfall 78.4 in. Up to the beginning of the 20th century the only noteworthy public edifices were the church of N.S. da Conceição, the St. Sebastião asylum and, possibly, a Misericordia hospital; but a government building, a customhouse, a municipal hall, courts of justice, a marketplace and a handsome opera house were subsequently erected, and a modern water-supply system, electric light and electric tramways were provided. The *igarapés* are spanned by a number of bridges. Higher education is offered by a lyceum or high school, besides which there is a noteworthy school (bearing the name of Benjamin Constant) for poor orphan girls. Manaus has a famous botanical garden, a zoölogical garden, an interesting museum, a public library, an agricultural experiment station run by the national government, and a meteorological observatory. The port of Manaus, which is the commercial centre of the whole upper Amazon region, was nothing but a river anchorage before 1902. In that year a foreign corporation began improvements, which included a stone river-wall or quay, storehouses for merchandise and floating wharves or landing stages connected with the quay by floating bridges or roadways. The floating wharves and bridges are made necessary by the rise and fall of the river, the difference between the maximum and minimum levels being about 33 ft. The principal exports are nuts, cacao, rubber, dried fish, hides and piassava fibre. The markets of Manaus receive their supplies of beef from the national stock ranges on the upper Rio Branco, and it is from this region that hides and horns come for export. The port has direct steamship connections with New York and Liverpool by two companies, and Pan-American Airways (Panair do Brasil) maintains a regular service between Belém, Manaus and Pôrto Velho via the Amazon river.

The first European settlement on the site of Manaus was made in 1660, when a small fort was built there by Francisco da Motta Falcão, and was named São José de Rio Negro. The mission and village which followed were called Villa de Barra, or Barra do Rio Negro (the name "Barra" being derived from the "bar" in the current of the river, occasioned by the setback at its encounter with the Amazon). It succeeded Barcellos as the capital of the old *capitania* of Rio Negro in 1809, and became the capital of Amazonas when that province was created in 1850, its name being then changed to Manaus after the principal tribe of Indians living on the Rio Negro at the time of its discovery. In 1892 Manaus became the see of the new bishopric of Amazonas.

MANBHUM, a district of British India, in the Chota Nagpur division of Bihar province. Area, 4,131 sq.mi.; pop. (1941) 2,032,146. Manbhum district forms the first step of a gradual descent from the table-land of Chota Nagpur to the delta of lower Bengal. In the northern and eastern portions the country is open and consists of a series of rolling downs dotted here and there with isolated conical hills. In the western and southern tracts the country is more broken and the scenery much more picturesque. The principal hills are Dalma (3,407 ft.), the crowning peak of a range of the same name; Gangabari or Gajburu (2,220 ft.), the highest peak of the Baghmundi range; and Pachet (1,600 ft.), on which stands the old fort of the rajahs of Pachet. The hills are covered with dense jungle. The chief river is the Kasai, which flows through the district from northwest to southeast into Midnapore. A large proportion of the population is of aboriginal descent, the chief tribes being the Santals, the Bhumij and Bauris; the latter two have adopted Hindu customs and are fast becoming Hindus in religion.

Containing the Jharia coal field and part of the Raniganj coal field, which lies mainly in Bengal, Manbhum is the chief colliery district in Bihar. The growth of the industry is comparatively recent, for the output in 1894 was only 127,000 tons. In that year the railway was opened from Barakar to Dhanbad, and in the 20th century coal mining developed rapidly, especially after the Bengal-Nagpur railway was extended to the Jharia coal field in 1904. In 1938 the mines in this field had an output of 15,000,000 tons—over half the output of India. The Raniganj coal field (excluding the Bengal portion) had more than 100 coal fields and averaged more than 1,000,000 tons. The public health of the coal fields, and indeed of the whole Dhanbad subdivision and of a small area to the south, with a total area of 900 sq.mi. and a population of 500,000, is in charge of the mines board of health, which has done admirable work.

Besides the administrative headquarters, Purulia, pop. (1941) 30,445, which is at the junction of the narrow gauge line to Ranchi, the only town is Dhanbad (1941) 15,945, the headquarters of a subdivision and a railway settlement.

MANCE, SIR HENRY CHRISTOPHER (1840–1926), English scientist, was born in London. In 1863 he went to the East in the service of the Persian Gulf Telegraph department of the Indian government. He became superintendent in 1866 and engineer and electrician to the section in 1879. Mance invented the heliograph, an instrument which reflects the rays of the sun at a mirror on to a distant station; by this means signalling can be carried out. The Indian government would not adopt the heliograph, but it was used successfully by Lord Roberts during the second Afghan War. Mance also devised a method, known by his name, of detecting and localizing faults in cables, and a method of measuring the internal resistance of a battery. He recruited volunteers from the telegraph service and acted for a number of years as a captain in the Sind Volunteers. He was awarded the C.I.E. in 1883 and was knighted when he retired in 1885. After his retirement he maintained his interest in electricity. He was a member of scientific societies and acted on the board of directors of a number of electrical companies. He died at Oxford on April 21, 1926.

MANCHA, LA (Arabic, *Al Mansha,* "the dry land" or "wilderness"), in its widest sense denotes the bare and monotonous elevated plateau of central Spain that stretches between the mountains of Toledo and the western spurs of the hills of Cuenca, being bounded on the south by the Sierra Morena and on the north by the Alcarria region. It thus comprises portions of the modern provinces of Toledo, Albacete and Cuenca, and the greater part of Ciudad Real. Down to the 16th century the eastern portion was known as La Mancha de Montearagon or de Aragon, and the western simply as La Mancha; afterwards the north-eastern and south-western sections respectively were distinguished by the epithets *Alta* and *Baja* (upper and lower). La Mancha remains almost exactly as Cervantes described it. Many villages, such as El Toboso and Argamasilla de Alba, both near Alcázar de San Juan, are connected by tradition with episodes in *Don Quixote*.

MANCHE, a department of north-western France, made up chiefly of the Cotentin and the Avranchin districts of Normandy, and bounded west, north and north-east by the English Channel (Fr. *La Manche*), from which it derives its name, east by the department of Calvados, south-east by Orne, south by Mayenne and Ille-et-Vilaine. Pop. (1936) 438,539. Area, 2,476 sq. miles.

The department south of Coutances and St. Lô is composed of folded Palaeozoic rocks of the Armorican system, with east and west zones of granite, rising in the south-east to 1,200 feet. There are younger and softer deposits on the east. The west coast is an ancient structural line from north to south and is marked by cliffs up to 420 ft. alternating with bays, at the south end the great bay of Mont Saint Michel, with its famed abbey surmounting a rock 400 ft. high. Reefs off the coast make navigation perilous, the chief forming Les Iles Chausey. The north coast also seems to be a structural line and is marked by the great roadstead of Cherbourg. The greater part of the department may be described as a dissected plateau with deeply-cut valleys. The chief streams are the Vire running northwards past St. Lô and the Sienne running north-westward just south of Coutances.

The climate of Manche is mild and humid; myrtles flourish in the open air.

The characteristic industry of the department is horse and cattle rearing, carried on especially in eastern Cotentin; sheep are raised in the west. Wheat, buckwheat, barley and oats are cultivated. Manche is a foremost department for the production of cider-apples and pears; plums and figs are also largely grown. Butter, poultry and eggs are important sources of profit. Flourishing market-gardens are in the west. The department contains valuable granite quarries in the Cherbourg arrondissement and the Chausey islands; building and other stone is quarried.

There are metal industries, and the weaving of osiers is a local feature. Oyster-beds are on the coast (St. Vaast, etc.); and the maritime population, besides fishing in home and distant waters, collects seaweed for manure. Coutances is the seat of a bishopric of the province of Rouen. The north of the department forms part of the region of the III. (Rouen), and the south of the X. (Rennes) army corps and of the circumscriptions of the académie (educational division) and appeal-court of Caen. Cherbourg (*q.v.*), with its important port, arsenal and shipbuilding yards, is the chief centre of population. St. Lô (*q.v.*) is the capital; there are four arrondissements (St. Lô, Avranches, Cherbourg and Coutances), comprising 48 cantons and 647 communes. Valognes, Mortain, Coutances, Granville and Mont Saint-Michel are also important. At Lessay and St. Sauveur-le-Vicomte there are the remains of ancient Benedictine abbeys, and Torigni-sur-Vire and Tourlaville (close to Cherbourg) have interesting châteaux of the 16th century. Valognes, which in the 17th and 18th centuries was a provincial centre of culture, has a church remarkable for its dome, the only one of Gothic architecture in France.

MANCHESTER, EARLS AND DUKES OF. The Manchester title, in the English peerage, belongs to a branch of the family of Montagu (*q.v.*). The first earl was SIR HENRY MONTAGU (*c.* 1563–1642), grandson of Sir Edward Montagu, chief justice of the king's bench 1539–45. He was born at Boughton, Northamptonshire, was educated at Christ's college, Cambridge, and, having been called to the bar, was elected recorder of London in 1603, and in 1616 was made chief justice of the king's bench, in which office he passed sentence on Sir Walter Raleigh in 1618. In 1620 he was appointed lord high treasurer, being raised to the peerage as Baron Montagu of Kimbolton, Huntingdonshire, and Viscount Mandeville. He became president of the council in 1621, and Charles I. created him earl of Manchester[1] in 1626. In 1628 he became lord privy seal, and in 1635 a commissioner of the treasury. He was a judge of the Star Chamber, and one of the most trusted councillors of Charles I. In conjunction with Coventry, the lord keeper, he pronounced in favour of the legality of ship-money in 1634. He died on Nov. 7, 1642.

EDWARD MONTAGU, 2nd earl of Manchester (1602–71), eldest son of the 1st earl by his first wife, was educated at Sidney Sussex college, Cambridge. He was member of parliament for Huntingdonshire 1623–26, and in the latter year was raised to the peerage as Baron Montagu of Kimbolton, but was known generally by his courtesy title of Viscount Mandeville. At the beginning of the Long Parliament he was one of the recognized leaders of the popular party in the upper House, his name being joined with those of the five members of the House of Commons impeached by the king in 1642. At the outbreak of the Civil War, having succeeded his father in the earldom in November 1642, Manchester commanded a regiment in the army of the earl of Essex, and in August 1643 he was appointed major-general of the parliamentary forces in the eastern counties, with Cromwell as his second in command. Having become a member of the "committee of both kingdoms" in 1644, he was in supreme command at Marston Moor (July 1, 1644); but subsequently he disagreed with Cromwell, and in November 1644 he strongly expressed his disapproval of continuing the war (*see* CROMWELL, OLIVER). Cromwell brought the shortcomings of Manchester before parliament in 1644; and early in the following year Manchester resigned his command. He took a leading part in the frequent negotiations for an arrangement with Charles and was custodian with Lenthall of the great seal 1646–48. He opposed the trial of the king, and retired from public life during the Commonwealth; but after the Restoration, which he actively assisted, he was honoured by Charles II. In 1667 he was made a general. He died on May 5, 1671. Manchester was made a K.G. in 1661, and became F.R.S. in 1667.

See Lord Clarendon, *History of the Rebellion and Civil Wars in England* (7 vols., 1839) and *Life of Clarendon* (1827); S. R. Gardiner, *History of the Great Civil War, 1642–1649* (4 vols., 1886–91); *The Quarrel between Manchester and Cromwell,* Camden Soc., N.S. 12 (1875); P. Warwick, *Memoirs of the Reign of Charles I.* (1701).

CHARLES MONTAGU, 1st duke of Manchester (*c.* 1656–1722), son of Robert, 3rd earl of Manchester, was educated at Trinity college, Cambridge, and succeeded to his father's earldom in 1683. He fought under William at the Boyne, became a privy councillor in 1698, and held various important diplomatic posts between that date and 1714, when he received an appointment in the household of George I., by whom in 1719 he was created duke of Manchester. He died on Jan. 20, 1722.

GEORGE MONTAGU, 4th duke of Manchester (1737–88), was the son of Robert, the 3rd duke. He was a supporter of Lord Rockingham, and an active opponent in the House of Lords of Lord North's American policy. In the Rockingham ministry of 1782 Manchester became lord chamberlain. He died in September 1788.

WILLIAM MONTAGU, 5th duke of Manchester (1768–1843), second son of the preceding, was educated at Harrow, and having become a colonel in the army in 1794, was appointed governor of Jamaica in 1808. Here he remained, except for a visit to

[1]The title was derived, not from Manchester in Lancashire, but from Manchester (or Godmanchester) in Huntingdonshire, where the Montagu family estates were.

England (1811–13) till 1827, doing much to prepare the way for emancipation of the slaves. From 1827 to 1830 he was postmaster-general in the cabinet of the duke of Wellington.

MANCHESTER, city, county and parliamentary borough, Lancashire, England, 189 mi. N.W. of London, and 31 mi. E. of Liverpool. Pop. (est. 1938) 732,900. Area, 42.6 sq.mi. It stands for the most part on a level plain, the rising ground being chiefly on the north side. The rivers are the Irwell, the Medlock, the Irk and the Tib, the last being entirely overarched. The Irwell, which separates Manchester from Salford (*q.v.*), is crossed by a series of bridges and discharges itself into the Mersey, which is about 10 mi. distant. Most of the district is covered with superficial drift of sand, gravel and clay, beneath which is red sandstone (Trias) with Permian marls, sandstone and limestone, and carboniferous shales and clays of the contiguous coal fields. The city, as its thousands of brick-built houses show, has been for the most part dug out of its own clay fields.

There are four large railway stations:—Victoria (L.M.S.), Exchange (L.M.S. and G.W.)—these stations are contiguous—London Road (L.M.S. and L.N.E.), Central (L.M.S., L.N.E. and Cheshire lines), and many subsidiary stations for local traffic. Tramways, as well as railways, run from Manchester to all the large neighbouring towns. There is a municipal airport at Barton, 5 mi. west of the city, though that at Ringway, to the south, will be larger. A direct trunk road to Liverpool has been projected. As a matter of fact, the whole of southeast Lancashire and some portions of Cheshire are so linked that they form one great urban area. Manchester is also the centre of a network of canals, chief among them being the Manchester ship canal (*q.v.*). The making of this waterway was an event only less important than the opening of the Manchester and Liverpool railway in 1830. The township of Manchester, which forms the nucleus of the city, is comparatively small, and outlying hamlets having been added, its size has increased without regularity of plan. Manchester, probably more than other cities, has suffered by this method of growth and even to-day, after frequent widening, the streets are far too narrow. The congestion of traffic is very serious at times and an extensive regional planning scheme has been elaborated. There are 777 mi. of highways in the city. The housing problem has been felt in its acutest form in Manchester and has been attacked with great determination. Under the various housing acts after 1919 the corporation had, by 1943, erected 31,100 houses. It was also developing the Wythenshawe estate of 3,862 ac. as a planned town. This area was added to the city in 1931. The centre of the city is occupied by business premises; the factories and workshops are mainly on the outskirts. The opening of the Manchester ship canal caused the establishment of a large engineering and industrial centre around the docks, and another similar centre sprang up on the eastern side of the town upon a small coal field. The most important of the public buildings are in the centre and the south. The latter is also the most favoured residential district, and its extremity is semi-rural in character. Large masses of the population live beyond the city boundary and come to their daily work by train or tram. Manchester attracts citizens from every part of the globe; there are considerable numbers of German, Armenian and Jewish residents. The houses are for the most part brick, the public buildings of stone which is speedily blackened by the smoky atmosphere. Many of the warehouses are of considerable architectural merit, and terra cotta is increasingly used. The air is laden with black dust, and the rivers, in spite of all efforts, are in the central part of the city mere dirty ditches. The city owes its importance to the cotton industry favoured by the damp atmosphere, by soft water from the millstone grit with a heavy runoff and consequent large water power, also to the proximity of coal and to the chemical industries helped by the salt of Cheshire to the south.

Churches.—Manchester is the seat of an Anglican bishopric, and the chief ecclesiastical building is the cathedral, which, however, was built simply as a parish church and, although a fine specimen of the Perpendicular period, is not what might be expected as the cathedral of an important and wealthy diocese. In the course of restoration a piece of Saxon sculpture, the "Angel stone," came to light. The bulk of the building belongs to the latter part of the 15th century. The first warden was John Huntington, rector of Ashton, who built the choir. The building did not stand time or weather well, and by 1845 some portions of it were rapidly decaying. This led to its restoration by James P. Holden. By 1868 the tower was almost completely renovated. Further restorations and additions were carried out by J. S. Crowther, and by Basil Champneys. In the stalls there are some curious *miserere* carvings. There are two organs, one by Father Smith, and a modern one in an oak case designed by Sir G. Scott. The parish church was made collegiate in 1422, and when in 1847 the bishopric of Manchester was created, the warden and fellows became dean and canons and the parish church became the cathedral. The first bishop was James Prince Lee (d. 1869), followed by James Fraser (d. 1885), James Moorhouse (resigned 1903), Edmund Arbuthnott Knox (died 1937), Dr. William Temple (became archbishop of York, 1929), and Dr. F. Guy Warman. The church endowments are considerable and have been the subject of a special act of parliament, known as the Manchester Rectory Division act (1845), which has determined the salary of the dean and the four canons, and has provided funds for the incumbents of new churches. Hulme and Middleton are bishoprics suffragan.

Of the Roman Catholic churches, that of the Holy Name, which belongs to the Jesuits, is remarkable for its costly decoration. The Greek Church and most of the Nonconformist bodies have places of worship. There are Jewish synagogues as well as a meetinghouse of the Society of Friends.

Public Buildings.—The royal infirmary (founded 1752) occupies a new building on the south side of the city near the university. It was opened in 1909 by King Edward VII. The central site in Piccadilly, where the old infirmary stood, thus became available for other purposes, and the corporation in 1925 approved of plans for the erection of a new art gallery on the site. The present art gallery was founded as the royal institution, but in 1882 passed under the control of the city council. The most striking of the public buildings is the town hall, one of the largest municipal buildings in the country, but no longer adequate to the increasing business of the city council. It was completed in 1877 from designs by Alfred Waterhouse, who selected as the style of architecture a form of Gothic. The principal tower is 286 ft. high. The tower contains a peal of bells by Taylor of Loughborough, forming an almost perfect chromatic scale of 21 bells. The great hall is 100 ft. long and 50 ft. wide, and contains a magnificent organ built by Cavaillé-Coll of Paris. The 12 panels of this room are filled with paintings by Ford Madox Brown illustrating the history of the city. An extension to the town hall, designed by Vincent Harris, was opened by King George VI in 1938. It lies between the central library and the old town hall and faces Mount street. The new central library is circular, the exterior being in the Early English Renaissance style.

The royal exchange is a fine specimen of Italian architecture and was erected in 1869 and extended and reconstructed in 1914–21; the great meeting hall is one of the largest rooms in England. The exchange is seen at its best on market days (Tuesday and Friday). The assize courts were built in 1864 from designs by Waterhouse. The style is a mixture of Early English and Decorative, and a large amount of decorative art has been expended on the building. The branch Bank of England is a Doric building designed by C. R. Cockerell. There are separate town halls for the townships of Ardwick, Chorlton, Hulme, and Cheetham. The Free Trade hall, purchased by the corporation in 1921, is a fine structure in the Lombardo-Venetian style and its great hall will accommodate about 5,000 people. It is used for public meetings, concerts, etc., and was built by Edward Walters. The Athenaeum, designed by Barry, was founded by Richard Cobden and others for "the advancement and diffusion of knowledge." The institution has perhaps not followed exactly on the lines contemplated, but it has been very useful, having developed more along the lines of a club. The mechanics' institution developed into the municipal college of technology, which now forms a part of the university. The Portico is a good specimen of the older proprietary libraries and newsrooms. It dates from 1806. The Memorial hall (built 1662) is used for meetings, scientific, educational, musical and religious. The Whitworth Art gallery stands in the centre of a woodland park of about 25 ac., 2 mi. from the city centre to the south. The park was transferred to the corporation in 1904. John Rylands library (1899) is one of the finest specimens of modern Gothic architecture, but its magnificence is dwarfed by its enclosed position. The post office (1887), the police courts (1871) and the numerous fine buildings which house commercial firms should also be named. Many fine structures suffer from being hemmed in by streets which prevent the proportions from being seen to advantage. The town possesses many monuments and memorials, one of the most interesting being a bronze statue by Matthew Noble of Oliver Cromwell on a rough granite pedestal, which stands near the cathedral.

During World War II some fine buildings were damaged in air raids. The cathedral received a direct hit on the Derby chapel which, along with much of the fine 15th-century woodwork, was ruined, and Cross Street chapel, the city's oldest dissenting church, was wrecked. The noble Free Trade hall and the hall of the Royal exchange were completely burned out and Chetham's hospital was damaged by incendiary bombs. Among other buildings, the Victoria hotel and buildings were demolished, creating an island site in the city centre; two theatres and the assize court were considerably damaged and the university was injured.

Education.—There are many educational facilities. The oldest institution is the grammar school, founded in 1519 by Hugh Oldham, bishop of Exeter. The founder, a native of the town, forbade the appointment of any member of the religious orders as headmaster. The school is richly endowed and has 250 free scholars, while other pupils are received on payment of fees. It moved to new buildings at Rusholme in 1931. It accommodates over 1,200 boys. The oldest educational foundation is that of Humphrey Chetham, whose bluecoat school, founded in 1653, is housed in the building formerly occupied by the college of clergy. This also contains the public library founded by Chetham, and is the most interesting relic of antiquity in the city. The boys, who number about 100, dress in a 17th-century style. The educational charity of William Hulme (1631–91) is administered under a scheme drawn up in 1881. Its income is nearly £10,000 a year, and it supports a grammar school. The Nicholls hospital was founded in 1881 for the education of orphan boys. The Manchester Education committee has replaced the school boards for education supervision. The elementary education scheme embraces education in provided and non-provided schools; district central schools; secondary schools; junior technical, commercial, domestic and art schools; part-time day continuation schools, special schools and evening schools. In addition there is a large and well-equipped college of technology, attended by about 7,000 students, a school of art, teachers' day-training college, special schools for feeble-minded children, and a royal college of music. Schools for the deaf and dumb are situated at Old Trafford, in a building contiguous to the blind asylum, to which Thomas Henshaw left a bequest of £20,000. There is also an adult deaf and dumb institution.

The Victoria University of Manchester has developed from the college founded by John Owens, who in 1846 bequeathed nearly £100,000 to trustees for an institution in which should be taught "such branches of learning and science as were then or might be hereafter usually taught in English universities." It was opened in 1851 in a house which had formerly been the residence of Cobden. In 1872 a new college building was erected on the south side of the town from designs by Waterhouse. In 1880 a university charter was granted, excluding the faculties of theology and medicine, and providing for the incorporation of University college, Liverpool, and the College of Science, Leeds. The federal institution thus created lasted until 1903, when separate universities were formed in the different cities. Manchester university consists of one college—Owens college—in its greatly enlarged form. The buildings include the Whitworth hall (the gift of the legatees of Sir Joseph Whitworth), the Manchester museum and the Christie library, which is a building for the university library given by R. C. Christie who also bequeathed his own collection. Dr. Lee, the first bishop of Manchester, left his library to Owens college, and the legatees of Sir Joseph Whitworth bought and presented E. A. Freeman's books. The library has received other important special collections. In 1936–37 the greater portion of the university library was housed in a new building opened in 1937. The university has received many large gifts but is still urgently in need of help for extensions. A new physics block was opened in 1931, while in 1929 the public health laboratory was extended to house the department of pathology. In 1934 a medical students' hostel (Lister house) was opened and a new staff house was completed in 1937. The university students numbered 2,725 in 1937–38. Among chairs recently founded are those of ancient history (1929), geography (1930), physical chemistry (1933), dental surgery (1933), theoretical physics (1937) and experimental neurology (1937). The chair of social economics was restored in 1936. The Manchester museum, with important collections, is housed in an extension of the university buildings provided through a bequest of Jesse Haworth. Lord Morley, the late chancellor (d. 1923) of the university, bequeathed a large part of his library to Ashburne hall of residence for women students.

There are in Manchester a number of denominational colleges, Wesleyan, Unitarian, Baptist, etc., and many of the students preparing for the ministry receive their arts training at the university, the theological degrees of which are open to students irrespective of creed.

Libraries and Societies.—Manchester is well provided with libraries. The Chetham library contains some rare manuscripts. There is a large collection of matter relating to the history and archaeology of Lancashire and Cheshire. The collections of Broadsides formed by J. O. Halliwell Phillips, and the library of John Byrom, should also be named. The Manchester free libraries were founded by Sir John Potter in 1852. The new central library, opened in 1934 by King George V, comprises, in addition to a reference library containing over 300,000 volumes and a commercial library, the Henry Watson music library and the Thomas Greenwood library for librarians, both of which were presented, and the foreign library, which was purchased. The libraries service also provides 28 district libraries and 12 small branch libraries. The municipal libraries contain in the aggregate over 980,000 volumes. There are also libraries in connection with the Athenaeum, the school of technology, the Portico, the Literary and Philosophical society, the blind (in Braille type), the Law Library society and others. The most remarkable of the Manchester libraries is the John Rylands. This includes the famous Althorp collection of Earl Spencer, and many valuable manuscripts. It was built and richly endowed by Mrs. Rylands.

Manchester possesses numerous literary and scientific associations and there are many textile and other trade associations. The Hallé concerts were founded by Sir Charles Hallé in 1857 and the Hallé orchestra still plays weekly. Several daily papers are published, and various weekly and other periodicals. The journalism of Manchester takes high rank, the *Manchester Guardian* being its most important daily paper. The Manchester Academy of Fine Arts holds an annual exhibition in the city art gallery, whose permanent collection is mainly 19th-century English paintings and includes many works of Ford Madox Brown and the pre-Raphaelites. The sculpture includes casts of the Elgin marbles and a statue of Dr. John Dalton by Chantrey. There are six branch galleries. The Whitworth gallery (1888) contains a fine collection of Coptic garments and fabrics, besides water colours and engravings. Manchester is a favourite place for the holding of exhibitions, etc., both of a local and of a national character. It has a transmitting station of the British Broadcasting corporation.

Manufacture and Commerce.—Manchester is the most important centre for the cotton industry in the world (*see* COTTON AND THE COTTON INDUSTRY). Most of the spinning and the weaving mills, the dyeing, bleaching and finishing workshops are situated in the neighbouring towns and villages, and the city itself is principally the business and warehousing centre for the industry. The general decline in the cotton trade after World War I was offset to a certain extent by the growth of the artificial silk industry. Almost as important as the cotton industry is that of engineering, for which Manchester claims to be one of the largest centres in the world. The manufacture of heavy and light machinery, weaving and spinning plant, locomotives, stationary engines, motors and commercial vehicles, aeroplanes, electrical machinery of all kinds, etc., is carried on. Again of paramount importance to Manchester is the chemical and dye industry, so necessary to the textile trade. The manufacture of cotton goods and ready-made clothing, hats and caps, and knitted goods employs an enormous number of people. The rubber industry and the manufacture of paper, paper goods, cardboard boxes, bookbinding, etc., must also be mentioned. Manchester is one of the chief ports for the import of oil, timber, fruit and grain; and the milling industry is extending rapidly. The port of Manchester (of which the largest docks are in Salford) ranks as the sixth in the British Isles from the point of view of ocean trade. The water area of the docks is 120 ac., with $5\frac{5}{8}$ mi. of quayage. Ships drawing 28 ft. of water can reach Manchester, and steamers of 12,500 tons deadweight capacity regularly navigate the canal. The location of Manchester on the south Lancashire coal fields has had a marked influence upon its prosperity; but for this the rapid expansion of its industries would have been impossible. Manchester occupies a leading position in the English banking world, and the District bank, founded 1829, is the oldest joint-stock bank in the country. The business transacted by the Manchester bankers' clearing house exceeds that of any provincial centre. Likewise the city has an important stock exchange and holds a position next to that of London in the insurance world. There are also within the city branch offices of his majesty's stationery office and of the public trustee. Manchester is the headquarters of the Co-operative Wholesale society, and indeed of the co-operative movement generally.

Municipality.—Manchester received a municipal charter in 1838, the title of city in 1853, and became a county borough in 1889. The mayor received the title of lord mayor in 1893. The water supply is controlled by the corporation. In addition to wells sunk into the New Red Sandstone, there are reservoirs at Longendale (completed 1884), and extensive works at Lake Thirlmere at the foot of Helvellyn, 96 mi. from Manchester. From Thirlmere the water is brought in four pipe lines, and Manchester supplies in bulk many local authorities in the district *en route* as well as a large area in north Cheshire. In consequence the supply was found to be inadequate, so in 1919 powers were obtained and work commenced upon a scheme to obtain a further supply from Haweswater, northwest of Shap Fell. The work, which will involve 84 mi. of aqueducts, was still in progress in 1943. The corporation has also established works for the supply of hydraulic and electric power and lighting. The gas lighting of Manchester is also a municipal undertaking. It supplied 53 sq.mi. in 1943.

The city has a stipendary magistrate who, in conjunction with lay magistrates, tries cases of summary jurisdiction in the police courts. There are also quarter sessions presided over by a recorder. Separate sessions are held for the Salford hundred. Certain sittings of the court of chancery and of the divorce court are held in Manchester. In addition to the county court there is an ancient civil court known as the Salford hundred court of record. Assizes have been held since 1866.

With the exception of the parliament of 1654, Manchester had no representation until the Reform Bill of 1832, when it sent two representatives. In 1868 this was increased to three, but each voter had only two votes. In 1885 the city was divided into six divisions and in 1918 into ten divisions, each returning one member.

History.—Very little is known with certainty of the early history of Manchester. (*See* MANCUNIUM.) Almost the only point of certainty in its history before the Conquest is that it suffered greatly from the Danes, and that in 923 Edward sent his Mercian troops to repair and garrison it. In Domesday Book, Manchester, Salford, Rochdale and Radcliffe are the only places named in southeast Lancashire. The church of St. Mary and the church of St. Michael in Manchester are both named in Domesday, and some difficulty has arisen as to their identification. In 1301 Manchester received a charter from its baron, Thomas, Lord Grelle. The Grelles were succeeded by the De la Warrs, the last of whom became rector of the town and made considerable additions to the lands of the church. The manorial rights passed to Sir Reynold West, a descendant of Joan, sister of Lord Grelle, who was summoned to parliament as Baron De la Warr. The West family in 1579 sold the manorial rights to John Lacy, who, in 1596, resold them to Sir Nicholas Mosley, whose descendants enjoyed the emoluments derived from them until 1845, when they were purchased by the municipality of Manchester. The lord of the manor had the right to tax all articles brought for sale into the market, but although thus taxed, the inhabitants had, in the court leet, nearly all the powers now possessed by municipal corporations. This court had control over the watching and warding of the town, the regulation of the water supply, and the cleaning of the streets.

The town appears to have steadily increased in prosperity, and it early became an important seat of the textile manufactures. Fulling mills were at work in the district in the 13th century, and woollen manufactures were carried on in Ancoats at that period. The college of Manchester was dissolved in 1547, but was refounded in Mary's reign. Under her successor the town became the headquarters of the commission for establishing the Reformed religion. In 1641 Manchester people purchased linen yarn from the Irish, weaving it, and returning it for sale in a finished state. They also bought cotton wool from Smyrna to work into fustians and dimities. An act passed in the reign of Edward VI regulates the length of cottons called Manchester, Lancashire and Cheshire cottons. These were probably all woollen textures. It is thought that some of the Flemish weavers introduced into England by Queen Phillippa of Hainault were settled at Manchester. The Flemish weavers were in all probability reinforced by religious refugees from the Low Countries. Cotton, in the modern sense, is first mentioned about 1620.

In the civil wars, the town was besieged by the Royalists, but was successfully defended. The year 1694 witnessed the trial and acquittal of those concerned in the "Lancashire Plot." In the rising of 1715 the clergy ranged themselves to a large extent on the side of the Pretender; and in the rebellion of 1745, when the town was occupied by Prince Charles Edward Stuart, a regiment known afterward as the Manchester regiment was formed and placed under the command of Colonel Francis Townley. In the retreat the Manchester contingent was left to garrison Carlisle, and surrendered to the duke of Cumberland. The officers were taken to London, where they were tried for high treason and beheaded on Kennington common. The variations of political action in Manchester were marked. In the 16th century, although it produced both Roman Catholic and Protestant martyrs, it was in favour of the Reformed faith, and in the succeeding century it became a stronghold of Puritanism. Yet the successors of the Roundheads who defeated the army of Charles I were Jacobite in their sympathies, and by the latter half of the 18th century had become imbued with the aggressive form of patriotic sentiment known as anti-Jacobinism.

A change, however, was imminent. The distress caused by war and taxation led to bitter discontent, while the scandal of the pocket boroughs was very serious for Manchester, which was entirely without representation. The popular discontent was met by a policy of repression, culminating in the affair of Peterloo, which may be regarded as the starting point of the modern reform agitation. This was in 1819, when an immense crowd assembled at St. Peter's fields (now covered by the Free Trade hall and warehouses) to petition parliament for a redress of their grievances. The Riot act was read, but in such a manner as to be quite unheard by the mass of people; and drunken cavalry were then turned loose upon the unresisting mass of spectators. Several people were killed and many more injured, and the incident aroused the deepest indignation throughout the whole country. The Manchester politicians took an important part in the reform agitations; when the Act of 1832 was passed, the town sent as its representatives the Right Hon. C. P. Thomson, vice-president of the Board of Trade, and Mark Phillips. Only two other men had represented the town in parliament before: these were Charles Worsley, the man commanded by Cromwell to "remove that bauble," and R. Radcliffe, both of whom sat in the 1654 parliament. The agitation for the repeal of the corn laws had its headquarters at Manchester, and the success which attended it, not less than the active interest taken by the inhabitants in public questions, has made the city the home of other projects of reform. The Lancashire cotton famine, caused by the Civil War in the United States, produced much distress in the Manchester district, and led to a national movement to help the starving operatives. The more recent annals of Manchester are a record of industrial and commercial developments and of increase in educational opportunities of all kinds.

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(W. E. A. A.; J. I. P.; X.)

MANCHESTER, a town of Hartford county, Connecticut, U.S.A., 9 mi. E. of Hartford; served by the New York, New Haven and Hartford railroad. Pop. (1940) 23,799. Manchester covers an area of 27.1 sq.mi. The silk mills established in 1836 by Ralph, Ward, Rush and Frank Cheney are still operated by their descendants. They were the first silk factories in the United States and are the only ones which carry through all the processes of transforming raw silk into finished fabrics. Other factories also produce rayons, velvets, coats, suits, machine tools, papers, soap products and parachutes. The first settlement within the present limits of Manchester was made in 1672, and the land was bought from the Indians in 1676. In 1823 the town was separated from East Hartford and incorporated.

MANCHESTER (popularly Manchester-by-the-Sea), a town of Essex county, Massachusetts, U.S.A., on Massachusetts bay, between Beverly and Gloucester, 25 mi. N.E. of Boston. It is served by the Boston and Maine railroad. The population was 2,472 in 1940, federal census. It is one of the most beautiful resorts on the Atlantic coast, with heavily wooded areas and sandy beaches alternating with rocky headlands, and was for some years a favourite summer residence of many foreign diplomats. Manchester was settled about 1630. It was set off from Salem and incorporated in 1645.

MANCHESTER, the largest city of New Hampshire, U.S.A., and one of the county seats of Hillsboro county; on the Merrimack river at the mouth of the Piscataquog, 55 mi. N.N.W. of Boston. It is on federal highway 3, has a municipal airport of 80 ac. which has been designated as an army air base, and is served by the Boston and Maine railroad and interurban motorbus lines. In 1930 the population was 76,834, and in 1940 by the federal census it was 77,685. The city occupies 33.96 sq.mi., on a plain 90 ft. above the river. Within its limits is Lake Massabesic (2,530 ac.), a beautiful resort and the source of the city's water supply. The public parks, covering 226 ac., provide facilities for both summer and winter sports. Just above the city great ledges across the path of the Merrimack cause a fall of 55 ft., from which power is developed for the large manufacturing plants lining both banks of the river. Important manufactures are shoes (valued at $22,000,000 annually), cigars (especially a widely known "two-for-a-quarter" grade) and brushes. The 144 manufacturing plants in the city make more than 100 different products, and had a total output in 1939 valued at $52,587,341. The public school system provides special opportunities for the industrial workers. Manchester is the seat of a Roman Catholic cathedral, four convents, St. Anselm's college (Roman Catholic; 1893), the state industrial school and several charitable institutions under religious auspices. The assessed valuation in 1940 was $86,445,329. A zoning and planning board was created in 1927.

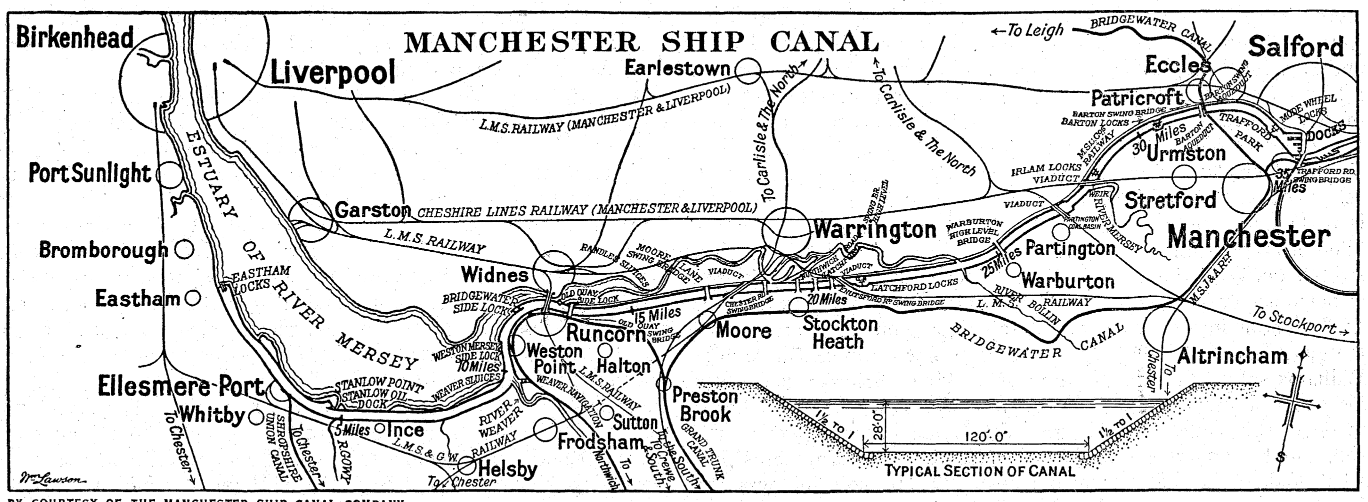
Amoskeag falls (or Namoskeag, "a place of much fish") was a favourite resort of the Penacook Indians, and tradition says that John Eliot preached to them there in the summer of 1851. The first white settlers (Scotch-Irish) came in 1722–23. Through its early years the settlement was known chiefly for its fisheries. Towards the end of the 18th century Judge Samuel Blodget saw the industrial possibilities in the falls and dreamed of duplicating here the great English textile centre. He planned and carried through the construction (1794–1807) of the first canal around the falls, which, together with the Middlesex canal in Massachusetts, gave a navigable waterway all the way to Boston; and he saw the establishment of the first cotton mills in 1805. In 1810 the name of Manchester was adopted to honour his memory, and the first mills bearing the name of Amoskeag were opened. In 1840 the population of the town was 3,235; in 1846 it was incorporated as a city, and by 1860 it had a population of 20,107. Manchester was the home of Gen. John Stark, and the house in which he lived from 1758 to 1765 still stands.

MANCHESTER SHIP CANAL, an important artificial waterway affording passage for ocean-going vessels between the inland city of Manchester, England, and the Mersey estuary opening into the Irish sea. This great undertaking plays so important a part in the commercial life of Lancashire that there is sometimes difficulty in remembering how new it is. Its making began on Nov. 11, 1887, and on May 21, 1894, Queen Victoria attended its formal opening.

Manchester lies on a plain whose many streams provided the power which made possible a prosperous cotton industry. The city became the reservoir into which the product of the hills surrounding the plain naturally flowed, and its task of disseminating that product was easy enough, as it could be carried on by pack horses and mules so long as commerce was content with the leisurely ways that preceded the Industrial Revolution. Even before that great upheaval Manchester was looking towards the sea. Barge traffic had long been in existence on the river Mersey between Liverpool and Warrington; and a body of men called the Mersey and Irwell Navigation Proprietors was empowered by an act of parliament dated 1720 to carry this process further, and to make the Mersey and its tributary the Irwell navigable from Warrington into the heart of Manchester. A second contact with the sea was given to Manchester by the third duke of Bridgewater, who, working with his famous self-taught engineer James Brindley, had made a canal to carry coal from his estate at Worsley into Manchester. Brindley, overcoming difficulties which were new to modern engineering, made the Bridgewater canal from Manchester to Runcorn, at the head of the Mersey estuary.

Thus in the 18th century Manchester had two ways open to the sea: a canal and a navigable river. Barges were used on both, and they could not carry much more than 50 tons at a time. The beginning of the 19th century saw a third way open: the Manchester-Liverpool railway. But none of these things was of much use to Manchester. Richard Arkwright's spinning jenny and Samuel Crompton's spinning mule had revolutionised the manufacture of cotton goods. The leisurely days were gone for ever. Manchester, if she was to survive, must become a port.

The position was grave when the second half of the 19th century had set in. A plague of empty houses came upon Manchester. Everywhere the fatal sign might be seen: another family gone, following the factories to the coast. In 1881 there were 18,632 empty houses in the town. In the Ancoats district alone, ten months before the canal opened, establishments employing 12,650 workers had been closed, and there were whole streets uninhabited. Fifty houses, with a rental of £14,000 per annum, were to let in the centre of the city. Nor could anyone wonder at this state of things. Trade could not prosper with Liverpool as its main outlet, for the railway charges to Liverpool, added to the Liverpool dock dues, were ruinous. A ton of goods could be carried in 1881 from Manchester to Calcutta for 19s 3d, and 12s 6d of this had been charged before the goods left Liverpool. Liverpool dock dues were so heavy that Oldham spinners could buy cotton in Bremen or Havre, pay shipping freights to Hull and railway charges from Hull to Oldham, and still save a farthing a pound on the price they would have paid for the same cotton at Liverpool. On June 27, 1882 a group of men met at dinner in the house of Daniel Adamson at Didsbury, and after dinner they and others talked about how the situation might be met. They fell



BY COURTESY OF THE MANCHESTER SHIP CANAL COMPANY

MAP OF THE MANCHESTER SHIP CANAL, 35½ MILES LONG

back on the proposal of not a barge canal but a ship canal; in a word, the transforming of an inland town into a port. That dinner-party was the turning-point in Manchester's fortunes.

The Parliamentary Fight.—On Aug. 6, 1885 the Manchester Canal bill received the royal assent. The intervening three years had witnessed a stiffer fight, it is commonly admitted, than had ever before been put up for a private bill. It was the fight mainly of the middle classes of the community for something they passionately believed in. Against them was every sort of interest: the Liverpool docks board and corporation and chamber of commerce, many Liverpool trading companies, landowners, railway companies, the ridicule, indifference or hostility of the press of the country with few exceptions. In Manchester itself only one newspaper—the *City News*—spoke up consistently for the ship canal; and while Adamson and his friends were holding meetings of workmen and small tradespeople, the rich men, for the most part, stood aside. £100,000 was asked for, and £62,000 came in sums of less than £10. There were three bills. The one of 1883 was thrown out by the Lords; the one of 1884 by the Commons; the one of 1885 was passed. The sum spent by the promoters and opponents of these three bills was estimated at £350,000. The passing of the bill caused widespread popular rejoicing. Adamson, returning from London, was met by workmen who presented him with an address, took the horses from his carriage, and dragged him home.

Daniel Adamson died in Jan. 1890 while the canal was being made. Though he was wrong in assuming that so large a sum as £8,000,000 could come from the pounds and shillings of Lancashire workers, he was right in his conviction that the feeling behind the scheme, and the hope of the scheme were democratic. The Co-operative Wholesale Society took £20,000 worth of shares, and a list published on Dec. 1, 1887 showed that of the 39,000 shareholders 36,300 were middle-class or working people. But the bulk of the capital came from the other 2,700.

Making the Canal.—On July 4, 1887 the Bridgewater Navigation Company were paid by one cheque £1,710,000 for their property. On Nov. 4 Lord Egerton cut the first sod at Eastham and the work at once began. Like the fight for the parliamentary bill, like the fight for the capital, the making of the canal was attended with every sort of disaster and delay. The engineer was Edward Leader Williams, who was knighted on the completion of the work, and the contractor was T. A. Walker, who had carried through the Severn tunnel contract. Walker died on Nov. 25, 1889, and there followed an unfortunate period of controversy between his executors and the canal directors, complicated by labour troubles and disputes, which cheered the enemies of the canal and made it clear that the work would not be finished within the contracted time. Late in 1890 the directors determined to settle with Walker's executors and to take the completion of the contract into their own hands. No sooner had they done this than floods of exceptional violence fell upon the work. Already in Jan. 1890 the work of months had been destroyed in a single night; and in November of the same year even worse befell. Storms were added to floods; six miles of the excavated bed were in parts 40ft. below water. Steam navvies, locomotives, workmen's tools and plant and material of all sorts were submerged. In places the tops of cranes could be seen a few inches above water. Bridges and temporary erections were overthrown and the slopes of the canal were washed away in long stretches. Towards the end of the month the weather repeated its blow. In Jan. 1891 ice and snow followed the floods. The Bridgewater canal—the only profit-making asset the directors possessed—was frozen and out of action; and it was realised that the work could not proceed unless more capital was raised. Once more the democratic urge behind the movement was apparent. There were ward meetings all over Manchester and district and the cry "Finish the canal" was everywhere. It was finished. The corporation of Manchester, which had already in one year applied the proceeds of a 2d. rate to the parliamentary fight, came in with £5,000,000; and from that moment the success of the canal was in no doubt. That is why the corporation of Manchester is represented on the ship canal directors' board. It has eleven directors, and the shareholders have ten.

The Canal Described.—The canal is $35\frac{1}{2}$ miles long. From Eastham to Runcorn it is near or through the Mersey estuary for $13\frac{3}{4}$m. Thence to Latchford, near Warrington, it is for $8\frac{1}{4}$m. inland. Both these sections have the same water level, which is raised by high tides. At Latchford the tidal action is stopped by locks, and from here to Manchester, $14\frac{1}{2}$m., the canal is fed by the Mersey and Irwell. At Eastham there are three entrance locks which maintain the water level in the canal nearly to mean high-water level (14ft. 2in. above the Liverpool datum). When the tide rises above that height the lock gates are opened and the tide flows up to Latchford, giving on high spring tides about 7ft. more of water. On the ebb this water is returned through sluices. The canal throughout has a minimum depth of 28ft. In 1927 the stretch from Eastham locks as far as the river Gowy was deepened to 30ft., and the approach channel to Eastham was also deepened. The minimum width at bottom is 120ft., so that large vessels may pass each other at any point. At various places under the canal it was necessary to lay cast iron siphon pipes to carry off land drainage which was at a lower level than the canal. The largest of these, 400ft. long and 12ft. in diameter, allow the tidal and fresh water of the Gowy to pass under the canal at Stanlow point, between Eastham and Ellesmere port. The whole length of the canal passes through the new red sandstone formation with overlying beds of gravel, clay, sand and silt, which in many places made it necessary to build retaining walls of stone and brick.

After the almost straight stretch from Runcorn to Latchford, the canal goes through the valleys of the Mersey and Irwell. Both these rivers wind a great deal, and therefore the line of the canal, kept as straight as possible, had to cross and recross the river channels. When these cuttings were finished, the end dams were removed, the Mersey and Irwell flowed into the new channel and became the upper portion of the ship canal. This has proved a blessing to districts which had come to regard periodical floods of great severity as something that could not be cured. There is a rise of 60ft. 6in. from the tidal part of the canal to the Manchester docks level, and the water is carried up about 15ft. at each set of locks: at Latchford, Irlam, Barton and Mode Wheel, which is at the entrance to the docks. The locks are in duplicate, and are filled or emptied in five minutes. For the greater part of the $3\frac{1}{2}$m. stretch between Barton and Mode Wheel the canal is widened at bottom from its normal 120ft. to 170ft. so that wharves may be used without impeding traffic. In solving a problem in an original manner, James Brindley left another problem which Sir Leader Williams solved in a manner no less striking. Brindley had taken his canal across the Irwell in the first navigable aqueduct to be made in this country; and when the Irwell became part of the ship canal Williams had to face the question of taking ships past what looked like an immovable obstacle. His solution was the Barton swing aqueduct—like Brindley's aqueduct, the first thing of its kind in the country. The swing aqueduct moves on a pivot. When it is closed, traffic on the Bridgewater canal goes on as usual; when it is open, pointing up and down the ship canal, vessels may pass on either side of it. The water at these times is retained in the swung portion by iron doors, and similar doors seal the ends of the Bridgewater canal. So that as the Gowy flows under the ship canal, the Bridgewater canal flows over it; and five lines of railway were taken across it, too. The viaducts give a clear headway of 75ft. at ordinary water level. Nine main roads cross the canal on swing bridges, which vary in width from 20 to 36 feet. The total amount of excavation was 54 million cu.yd., nearly one-fourth of this being sandstone rock. About 17,000 men were employed, and the plant used cost nearly £1,000,000.

In the port of Manchester there are eight docks with a water space of 120 acres, and provision has been made for a ninth which will be larger than any of these. The largest in 1928 was 2,700ft. long and 250ft. wide. The Manchester Dry Docks Company had three graving docks, and there were two pontoon dry docks with a lifting capacity of 2,000 tons. Great attention was paid at the beginning, and is still paid, to arranging docks, cranes, railways, transit sheds, grain elevators, warehouses, etc., in such relation to one another that goods can be quickly handled. Ships are unloaded straight into sheds or trains or lorries with one handling, and every quay is directly linked up by rail with the railway systems of Britain. The company's own railways cover 161m. of single track, and another 31m. are leased or worked. There are 60 locomotives and 2,438 railway wagons; and the cranes number 248: 53 hydraulic, 53 steam and 142 electric, with a radius of from 16 to 40ft. They are capable of lifting from one to seven tons up to a height of from 13 to 80ft. above rail level. There are also six electric grab cranes of 5 tons capacity each, a 30 ton steam crane, a pontoon sheers capable of dealing with weights up to 250 tons with a lift of 21ft., a coaling crane which can manipulate 12-ton waggons for cargo or bunkers, and a floating crane that can handle 60 tons. Each of the two grain elevators can store 40,000 tons (1,500,000 bushels). The warehouses, transit sheds and cold storage houses are of varying size, growing with the growth of the port. The two latest and greatest at No. 9 dock are of five floors each, 450ft. long and 110ft. wide. They cost something like £500,000. The Trafford wharf is 2,500ft. long, and near it is the lairage where cattle from Ireland and from across the Atlantic are disembarked. There is accommodation for 1,850 cattle and 1,500 sheep, and when reserve land is used these numbers will be doubled. The chief subsidiary ports along the canal are the Stanlow oil dock, near the entrance on the Mersey, where petroleum spirit and other oils of low flash point are dealt with; Runcorn where there are six docks and a water space of 15 acres; the Partington coaling basin, with 20 acres of quays and $6\frac{1}{2}$acres of water; and Ellesmere Port, which has a grain warehouse of 20,000 tons capacity and a most modern coaling plant. The total area of the dock estate is $406\frac{1}{2}$ acres. The quays are a little more than $5\frac{1}{2}$m. in length, and the quay and storage areas cover $286\frac{1}{2}$ acres. The great industrial area of Trafford Park adjoins the dock estate and is directly linked up with it, forming, as it were, one huge workshop.

The Effect on Manchester.—The effect of the canal on Manchester justified the faith of Adamson and the pioneers. Not only were the empty houses quickly filled but between 1894 and 1911 32,623 new ones were built. In that same period the rateable value of towns within 20m. of Manchester increased from £2,200,000 to £7,100,000. Old industries prospered and new industries came to the port. Their variety is seen in this list of Manchester's principal exports: manufactured cotton and woollen goods, yarns, machinery, locomotives, implements, tools, hardware, earthenware, paper-making materials, chemicals, coal, salt and pitch. Once this new duct was opened, Manchester became in a more real sense than ever before the railhead and clearing house to the enormous industrial population that lies about her. Within a 75m. radius of the city there are 14,106,432 people, compared with 13,131,319 within a similar radius of London. This is the most densely-packed population in the world, and it could not fail to ensure the prosperity of a port lying at its heart. The cotton industry alone, pursued in 32 towns, employing 60,000,000 spindles and 300,000 looms, inevitably enriched, and was in turn enriched by, the enterprising city which had removed a crippling disability. As the hub of so vast an industrial activity, Manchester, after London, is the greatest commercial centre in the British empire.

In its first year of work (1894) the canal earned £97,901 and carried 925,659 tons. With some slight fluctuations, the rise was steady after that, and in the year before the war (1913) it reached 5,780,161 tons and £654,937. After 1921, the lowest point touched since 1901, the rise began again and in 1927 6,359,420 tons were carried and the revenue was £1,576,237. The first dividend to ordinary shareholders was paid for the year 1915. At the end of 1927, the issued capital was £19,488,000, the expenditure on capital account to that date being £16,675,000.

Ship Canal House, the new headquarters of the Ship Canal Company, was opened in 1927. It is the most distinguished of the city's modern buildings, and stands out, like the realisation of Adamson's dream, dominating an inland town which has succeeded in making itself, in the face of great natural difficulties, the fourth port of Great Britain.

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MANCHOUKUO: *see* Manchuria.

MANCHU LANGUAGE. Manchu belongs to the Tungus group of languages. The Tungus people probably inhabited the present Manchuria already in the 3rd century B.C. The real founder of Manchu power was Nurhatsi who proclaimed himself emperor in 1616 and established his capital at Mukden in 1625. Under his reign the Manchus adopted for their own use the Mongolian alphabet which they had copied from the Uigurs. In course of time changes were made in order to adapt this writing to the Manchu language and in its final form it became far more elaborate and serviceable than its Mongolian prototype. Books had been printed in Manchu by 1647. The two emperors K'ang-hsi and Ch'ien-lung did most to establish and stereotype this somewhat artificial language by causing translations to be made of Chinese and Mongolian works and by the publication of numerous polyglot dictionaries. All officials had to pass an examination in Manchu; but in spite of these efforts this language continued to change more and more both in pronunciation and in grammar under the influence of Chinese, and at the death of one of the emperors in 1761 the examinations in Manchu were abolished, although imperial decrees and most official documents continued to be issued in this language in addition to Chinese.

With the abdication of the young Emperor Pu Yi and the proclamation of the Republic in 1912, Manchu may be said to have disappeared from China Proper. It is, however, still spoken in parts of northern Manchuria and elsewhere. Regarded as a dead language, Manchu has received a considerable amount of attention from European scholars because the literal translations made into that language from the Chinese classics have simplified the interpretation of the latter. The vocalic harmony is not so strictly observed in Manchu as in Mongolian and in the case of grammatical suffixes (postpositions) there are no alternative hard or soft forms. The postpositions are as follows: Accusative, *be;* genitive instrumental, *i* or *ni;* dative locative, *de;* ablative, *chi.* The Manchu verb, like the Chinese, does not distinguish either person or number, the tenses are imperfectly expressed and general notions are conveyed by adverbial and participial forms. Manchu has no relative pronoun and expresses a relative preposition by means of participles.

Manchu like the other Tatar languages adds affixes to the verbal theme to form derived verbs expressing some extended meaning; thus the syllable *bu* added to *ara,* "to write" gives *arabu,* "to cause to write," and the syllable *ja* added to *wa,* "to kill" gives *waja,* "to kill oneself," and so forth. A peculiarity of Manchu is the indication of masculine and feminine, or strong and weak, by the change of the vowel *a* into the vowel *e*. Thus *ama* "father," and *eme* "mother." Even foreign words undergo this change, and we find the Turkish *arsalan* "lion" modified into *erselen* "lioness," and the Sanskrit *garudai* "the male phoenix" becomes *gerudei* for the female of that species; *ganggan* "strong" becomes *genggen* "weak," and *wasime* "to descend" becomes *wesime* "to climb."

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MANCHURIA (MANCHOUKUO), the name of the territory to the north-east of China Proper which, at the time when European powers were beginning to establish trading relations with China, was the land of the Manchus and the home-country of the Manchu dynasty (1644–1911), then on the imperial throne.

Although long essentially marginal to China Proper and during much of its history in the occupation of hostile peoples, its fortunes came to be definitely linked with China after the Manchu conquest, and as an integral part of the Chinese Republic, it is officially styled by the national government the "Northeastern Provinces" (Fengtien or Shengking, Kirin, and Heilungkiang).

Originally a frontier territory, it has no well defined limits and the international boundary follows in large measure the river courses of the Argun, Amur, Ussuri, Tumen, and Yalu, which offer definite features but do not indicate zones of separation in the geographical sense.

The lines of the Argun, Amur, and Ussuri were adopted as the boundary between the Chinese and Russian empires by a series of treaties, of which the first was signed at Nerchinsk in 1689 after the great eastward expansion of Russia across Siberia.

By the Treaty of Nerchinsk the Russian boundary advanced to the Argun, by the Treaty of Aigun (1858) to the Amur, and by the Treaty of Peking (1860) to the Ussuri. The northern boundary of Manchuria runs therefore along the very axis of the Amur basin, leaving northern Manchuria especially open to Russian penetration.

The Tumen and the Yalu have been recognized as the boundary with Korea from the time of the Ming dynasty (1368–1644) onwards. The internal boundary with Mongolia in the west is more indefinite and has considerably changed in recent times. With the expansion of Chinese agricultural colonization, Manchuria has extended at the expense of pastoral Mongolia. The present boundary is well to the west of the scarped edge of the Great Khingan in the north and follows the crest in the centre but in the south is still to the east of it, leaving the upper basin of the Liao-ho, although draining to Manchuria, within Jehol, the easternmost part of Inner Mongolia.

The Japanese claims to special privileges in South Manchuria always specifically included Eastern Inner Mongolia, by which was meant that part lying east of the Great Khingan.

The Country.—The core of Manchuria so marked out is a vast gently undulating plain lying between the scarped edge of the Great Khingan in the west and a more tangled mountain country in the east which culminates in the Chang-pai shan overlooking the Korean border. The drainage from the highlands converges onto the plain—the Nonni from the Khingan, the Liao from Jehol, and the Sungari from the Chang-pai shan. It has been built up and levelled by their detritus. The plain narrows quickly both to the north and the south. In the north it is separated from the lowlands along the Amur by the Little Khingan which stretches across from the Great Khingan almost to the East Manchurian Highlands, and even in the gap between them the Sungari penetrates through to the Amur only by a series of gorges. In the south the uplands of Jehol also approach close to the Eastern Highlands but there still remains a lowland corridor (drained by the lower Liao-ho) through to the Gulf of Liaotung, an inner arm of the Yellow sea. Only by a narrow lowland strip guarded by Shanhaikwan ("the gateway between the mountains and the sea") does this lowland corridor of South Manchuria communicate with the great plain of North China. But the East Manchurian Highlands thrust far southward in the terminal peninsula of Liaotung which approaches close to that of Shantung in China Proper. Together these two peninsulas lie athwart the seaward approaches not only to the Manchurian plain but also to Peking (Peiping), with one interval, for six centuries prior to the summer of 1928 the capital of China. The Manchurian plain, although thus ringed round by hill-masses, is not isolated by them for they are old denuded uplands of no great complexity and of only moderate relief.

The climate of this basin-land of Manchuria is continental in its temperature regime and monsoonal in the seasonal distribution of its rainfall, thus reflecting its proximity to Central Asia and its position on the northern margins of China. Hot summers succeed intensely cold winters and light southerly breezes the northerly blasts of winter. Midsummer temperatures are uniformly high averaging 70–75° F as compared with 80° F in China Proper and in the depth of winter the variation is only in the degree of cold. The temperature of Dairen at the tip of the Liaotung peninsula falls to 24° F and of Harbin in the central plain to below zero. The rivers are all frozen over, in the north until the end of April and even in the south until the beginning of April. Only the ports, Port Arthur and Dairen, at the tip of the Liaotung peninsula are free from ice all the year round. This enhances immeasurably their strategic significance. Practically the whole of the rather scanty rains fall in the summer months, the time when they are of most agricultural value. The rainfall is heaviest in the East Manchurian Highlands, decreases westwards toward the foot of the Great Khingan, and is least in what is now north-western Fengtien but was long part of Mongolia and is still known as the Eastern Gobi. The average rainfall of the central plain, agriculturally the most valuable part of the country, is between 20 and 25 inches.

The effect of the Manchurian plain, encased by hill-masses, is heightened by its open steppe vegetation in contrast to the forests of the East Manchurian Highlands, of the Amurian lowlands and the Little Khingan, and of the scarp face of the northern Great Khingan. But the woods clothing the Manchurian face of the northern Great Khingan disappear on its Mongolian slope and do not interrupt the continuity of the belt of steppe which stretches across Eurasia to its eastern terminus in the Manchurian plain. The extreme south-west of the central plain—the Eastern Gobi—is in part covered with sand-dunes and between the Liao and Nonni forms a region of inland drainage. The lowland corridor reaching down to the Gulf of Liaotung is richer grassland. The forests of the East Manchurian Highlands and Amuria, like those of the northern Appalachians and the St. Lawrence valley in North America, contain both coniferous and deciduous species. Oak, elm, and poplar clothe the lower slopes and fir, pine, spruce, and larch reach up to the hill-tops. These forest resources have especial value in view of the treeless character of North China and of the shortage of large timber in Japan. In the Amurian lowlands only scattered copses interspersed with meadow remain and the forests of the Eastern Highlands, even those remote from Chinese agricultural colonization, are being cut into for commercial lumber.

The Peopling of Manchuria.—The historic development of Manchuria has been conditioned by its physical character as a steppe backed by immense forests to the north and east, completely open on the west to the vast grasslands of Central Asia but communicating with the agricultural civilization of China to the south by only a narrow lowland strip. It has been held until quite recent times by a non-Chinese people, the Tungus, whose racial affinities are closer with the Mongols than with the Chinese. According to the Russian anthropologist, S. M. Shirokogoroff, the Tungus originally dwelt in north-eastern China and retreated into Manchuria in the second millennium B.C. before the Chinese advancing from the loess-lands of north-western China. The tide of Chinese colonization then swung south into the Yangtze valley and, while the northern branches of the Tungus spread into the northern forest, the southern remained in possession of Manchuria. The Tungus of the forest retained their old hunting nomadic life but those of the central and southern plains in time acquired the arts of cultivation, probably from their Chinese neighbours, and, according to Chinese annals, were already dependent by the first millennium A.D. on the "five kinds of cereal." Although excellent horsemen as befitted dwellers on the steppe, the Tungus of the plain, as evidenced by the Manchus, were ignorant of the art of milking and were essentially not pastoral nomads. True pastoral nomads of Mongol affinities did however occupy the drier western part of the Manchurian steppe adjacent to Mongolia.

Until the final victory of the Manchus in the early 17th century first one group and then another gained the upper hand and for a time dominated Manchuria. Now, Manchuria is the north-eastern antechamber of China and the Power holding it is in a unique position for the invasion of the Celestial Empire. On three occasions has this position been utilized by steppe-land dynasties—by the Khitan Tatars in the 10th, by the Kin Tatars in the 12th, and by the Manchus in the early 17th centuries. The Manchu dynasty when on the imperial throne (1644–1911) continued to regard Manchuria as the recruiting ground for the garrisons with which it held China.

The immigration of Chinese was long forbidden but after 1776 this prohibition was relaxed in the case of Fengtien, the southern province, and in the third quarter of the 19th century the Manchus had to recognize colonization in Kirin. The dense agricultural population of North China was beginning to spill over in considerable numbers into vacant lands whose settlements, always sparse, had been further depleted by recruitment for the Manchu garrisons in China. By the end of the 19th century the population of Manchuria is estimated to have reached 14,-000,000 of which 80% were Chinese. In comparison with what was to follow this movement, however, was no more than an infiltration and consisted mainly of males who intermixed with the Manchus and in time absorbed them. Pure Manchu groups remain only in northern Manchuria, chiefly in the Aigun district, and these are the descendants of soldier-colonists planted by the early Manchu emperors in the Amur valley. The rapid economic development of South Manchuria under Japanese auspices after 1905 and the security which it offered in contrast to the turmoil of China, rent by civil war and ravaged in the north by frequent famines, set in motion a mass migration. Coming mainly from Hopei (Chihli) and Shantung, the most densely peopled provinces of North China, this for years involved 300,000–400,000 annually, but of these half or three-quarters used to return to China after the Manchurian harvest. In the 1920s this seasonal migration of labourers became a permanent migration of families which in 1927 was more than 800,000 and in the summer of 1928, 40,000 a week. These Chinese peasant-farmers penetrated inland along the railways and settled in central and southern Manchuria, along the Chinese Eastern as well as the South Manchurian railway. They constituted quite 90% of the total population which was estimated in Dec. 1937 at 37,000,000, exclusive of 1,000,000 in the Kwantung leased territory. The Japanese in both regions together numbered about 600,000, and there were nearly 1,000,000 Koreans. The net inflow of Chinese in 1938 was 291,000, then the highest figure since 1927, the peak year, when over 1,000,000 entered. Population is densest in the plains of South Manchuria and in the eastern part of the central lowland, traversed by the railway leading toward Harbin. The total population of Manchuria (including Jehol and the leased territory) was 43,233,954 in 1940.

Modern Political Evolution.—This enormous increase in the Chinese population is destined to play a very important part in the political future of Manchuria. But for the last few decades Manchuria has been a frontier territory only partly under the control of the Chinese Government and subject to the penetration of foreign Powers, Russia and Japan. Their interests in Manchuria developed in the closing decades of the 19th century when China, politically weak, seemed on the eve of disruption, and when the Great Powers were carving out "spheres of influence" which often, as in Africa, were but the prelude to the declaration of protectorates and ultimate annexation. Such seemed likely to be the fate of Manchuria, which both on account of its intrinsic resources and as the antechamber of China, threatening the imperial capital, Peking, was coveted. For Tsarist Russia, Manchuria was to be the eastern outpost and the eastern terminus of the Trans-Siberian railway which was to bind that empire together. But Japan with an overflowing population and with only limited resources had a more vital interest than Russia in Manchuria, which, as a relatively undeveloped but potentially productive country, promised not only an exportable surplus both of foodstuffs and industrial raw materials but a field for Japanese colonization. Manchuria has failed to attract the surplus population of Japan, but as this has been in part absorbed by industrial development within the country itself, Japan has a greater interest in Manchuria as a source of supplies and as a market.

The conflict between Russia and Japan for the control of Manchuria first raged over the possession of the Liaotung peninsula, which is not only the southern gateway into Manchuria but commands the seaward approach to Peking. Its possession by a foreign power seemed to China a veritable pistol pointed at her head. The first move was taken by Japan. As the prize of her victory in the Sino-Japanese war of 1894–95, she demanded the cession of the Liaotung peninsula from the mouth of the Yalu to the mouth of the Liao. But Russia, backed by France and Germany, forced her to abandon this claim. Then by means of intrigue and a show of force, Russia (1898) acquired the lease for 25 years of the territory of Kwantung at the very tip of the peninsula, containing the naval station of Port Arthur and what has since become the great commercial entrepôt of Dairen. Japan returned to the attack and by the Treaty of Portsmouth (1905), which registered her victory over Russia in the war of 1904–05, obtained the transfer of the Kwantung lease. Meanwhile Russia had been pushing forward her scheme of railway construction. She had already built the Chinese Eastern railway (C.E.R.) across northern Manchuria to connect with the line to Vladivostok and when the Russo-Japanese War broke out was engaged in the construction of a branch from it through southern Manchuria to Port Arthur. By the Treaty of Portsmouth Japan became heir not only to the lease of Kwantung but also to the rights of railway construction in Fengtien, to be vested in the South Manchuria Railway Company (S.M.R). Russian interests were thus pushed back into northern Manchuria, into the provinces of Kirin and Heilung-kiang traversed by the Chinese Eastern railway. Neither of these companies were nominally Government concerns and the properties of each were held on leases, the S.M.R. on one of 99 years and the C.E.R. on one of 80 years. China had also the option of purchasing the latter after 36 years, an option which was to fall due in 1932. But investment in the S.M.R. was limited to Chinese and Japanese subjects and in the C.E.R. to Chinese and Russian and in effect the paramount interests were the Japanese and the Russian. In fact the officials of the S.M.R. were appointed by the Japanese Government from the share-holders.

In possession of the arterial railway through South Manchuria and of its seaward terminus in the entrepôt of Dairen, Japan held the chief key to the economic penetration of South Manchuria. It became in effect if not in name the Japanese "sphere of influence" in which Japan time and time again claimed a privileged position. The famous Twenty-One Demands presented to China in 1915 affirmed "the predominant position of Japan in South Manchuria and Eastern (Inner) Mongolia," and on the formation of the banking Consortium in 1920, which was an agreement to pool loans to the Chinese Government equally between the four great Powers (Britain, France, the United States, and Japan), Japan secured the exclusion of nearly all South Manchurian railways from its scope.

At the Washington Conference of 1921–22 Japan was a party to the Nine Power Treaty which repudiated the policy of "spheres of influence" and re-affirmed the principle of the Open Door. But on the strong representation of Baron Shidehara the original resolution committing the Powers concerned to submit existing concessions, so far as they were judged inconsistent with these declarations, to a board of reference was dropped altogether, and the revision of the 1915 treaties was not pressed. At the conclusion of the Conference Japan voluntarily made certain concessions with regard to her railway monopoly but in essentials her status in South Manchuria was left unchanged by the Washington agreements. During the Chinese Civil War, which broke out almost immediately afterwards, Japan continued to exercise a controlling influence in South Manchuria and the presence of Japanese troops in the railway zone was the chief factor in the maintenance of peace in that country. Japan repeatedly declared that her only military concern in Manchuria was the preservation of order necessary to safeguard her economic interests and the security of her own shores. What was in effect a *condominium* could not but be unstable and must sooner or later be terminated. With China, Japan, and Russia each having holdings in the region, any adjustment of the claims of the three could not but be an uneasy truce. Partition would scarcely be the solution, for the great plain of Manchuria is too clearly a geographic unit to permit of a natural boundary across it. Sooner or later two of the three contestants would have to withdraw and leave one in control. Nor was it clear that even this would be a permanent settlement of the conflict. The dispossessed would be certain to remember their historic interests and to seek to repossess them. Because of its history and of its geographic location between three strong peoples, the Russians, the Japanese, and the Chinese, Manchuria was certain to remain indefinitely a bone of contention.

For a few years it looked as though the first of the three Powers to be eliminated would be Russia. The Russian Revolution of 1917 was followed by the break-down of orderly Russian administration in the Far East. The situation was complicated by the dispatch of troops to Eastern Siberia by Great Britain, France, Japan, the United States, and China. In numbers of troops Japan outdistanced the others and for a time it appeared that Japan might supplant Russia in that region. That would, of course, have led to Japanese ownership of the former Russian holdings in Northern Manchuria. Partly to prevent this development, the C.E.R. was placed under the control of an inter-allied commission with an American at its head. In 1919, after the Communists had gained control in Russia, they announced their renunciation of all special privileges acquired by the Tsarist Government in China and promised the restoration to China of the C.E.R. and of the mines and forests acquired by the Tsarist regime. When it came to actual negotiations with China, however, by an agreement signed May 31, 1924, Soviet Russia, while surrendering extraterritoriality and the former Russian concessions and agreeing in principle to the eventual repurchase by China of the road, insisted upon retaining a share in the administration of the C.E.R. A somewhat similar agreement regarding the C.E.R. was signed between Russia and Chang Tso-lin, the ruler of Manchuria, Sept. 20, 1924. Friction followed, accentuated by the anti-Communist, anti-Russian reaction in China after 1927. In 1929, under the youthful successor of Chang Tso-lin, Chang Hsüeh-liang, and impelled by the rising tide of nationalism, the Chinese attempted to oust the Russians from their participation in the C.E.R. The Russians struck back, and in a sharp, brief, undeclared war compelled the Chinese to restore the *status quo*.

Creation and History of Manchoukuo.—It was not Russia but China which was the first of the three Powers to be eliminated from Manchuria. The mounting Chinese nationalism clashed with Japanese militarism, the latter made more aggressive in an effort to solve the economic ills of Japan which had been accentuated by the world-wide economic depression which began in 1929.

In various ways the Chinese were attempting to restrict the Japanese. Notable was the progress in constructing a system of railways which would be independent of the islanders and have an outlet to the sea through the port of Hulutao, free from Japanese domination. Friction, too, developed between Koreans and Chinese in Manchuria, the former being Japanese subjects. On the night of Sept. 18–19, 1931, the Japanese military forces struck, giving as the reason what they alleged to be the blowing up by Chinese of a part of the South Manchurian railway just outside of Mukden. In the following few weeks they occupied a number of strategic centres. At the time Chang Hsüeh-liang had most of his forces south of the Great Wall and before the Japanese Army his rule in Manchuria quickly collapsed.

China appealed to the League of Nations. That body appointed a commission, headed by the earl of Lytton, which, after investigation, in the autumn of 1932 reported in the main unfavourably to the Japanese. Geneva proved unable to implement its decision, but its action led to Tokyo's withdrawal from League membership.

In the meantime the Japanese, faced with the necessity of maintaining some kind of order in the provinces where they had destroyed Chang Hsüeh-liang's regime, were stimulating the erection of a new administration. Local and provincial provisional governments were set up, mostly by resident Chinese (and, in some areas, Mongols) with Japanese advisers. Early in 1932 a Manchuria-wide government was organized and on February 18 of that year this declared the independence of the Three Eastern Provinces under the name of Manchoukuo. Pu Yi, who with the title of Hsüan T'ung had been the emperor of the Manchu dynasty when it abdicated its control of China in 1912, and who had since been living in retirement in Peking and Tientsin, became "chief executive." This seemed to connect Manchoukuo ("The State of Manchu"), or Manchoutikuo ("The Empire of Manchu"), with its historic past and to give it an air of legitimacy. A step farther was taken when, on March 1, 1934, Pu Yi formally announced his ascent to the throne under the title of Kang Tê. His residence was established at Changchun, renamed Hsinching, or Hsinking ("The New Capital"), and here extensive building operations produced an impressive physical emblem of the new State. In Jan. 1933, Japanese and Manchoukuoan forces invaded Jehol, the easternmost province of what is often known as Inner Mongolia, and soon added it to Pu Yi's domains. Conjointly with the Japanese, Manchoukuo has undertaken extensive projects for the economic development of its resources. Railways have been built rapidly. Currency and banking have been reorganized. Efforts have been made, sometimes successfully, to repress banditry.

The Japanese have poured capital into Manchoukuo in an attempt to develop the land and to realize economic profit on their huge investment in military expenditure. They have sought to encourage Japanese immigration. They have endeavoured to knit Manchoukuo into an economic bloc with the other parts of their empire. Even so late as 1939, however, their success was in doubt. Some of Manchoukuo's products, including coal, compete with those of Japan. World economic conditions have diminished the demand for one of the former chief exports, products of the soya bean.

Japanese immigration has not taken kindly to farming and has been confined chiefly to soldiers, businessmen, and Government employees. Manchoukuo, on a short view, except for its strategic value, seemed to be an unprofitable investment.

In Manchoukuo the Kwantung army (that section of the Japanese army which serves in the land) is dominant. The other major Japanese unit is the South Manchuria Railway company, but by

1939 it had lost most of its autonomy to the army.

Administratively Manchoukuo was in 1939 organized into 18 divisions (Fengtien, Kirin, Lungkiang, Jehol, Pinkiang, Chinchow, Antung, Chientao, Sankiang, Tunghua, Mutankiang, Heiho, Peian, Tungan, East Hsingan, West Hsingan, South Hsingan, North Hsingan) together with the special municipality of Hsinking, the capital. The former division into the three provinces of Chinese days (Liaoning, Kirin and Heilungkiang) is no longer observed and the Japanese, when creating the province of Hsingan (subsequently subdivided into four areas), where the Mongols were given a special status, incorporated in it the Mongol-inhabited portion of northern Jehol, a province which by the Chinese had been regarded as part of Inner Mongolia and not of Manchuria.

Manchoukuo has had a most anomalous position internationally. It has been recognized by no governments except those of Japan and her axis partners and El Salvador, though some degree of recognition was implicit in the U.S.S.R. nonaggression pact of 1941 with Japan.

Relations with Russia have entailed peculiar difficulties, partly because of the long common frontier, partly because of Russian influence in another neighbour land, Outer Mongolia, but chiefly over the Chinese Eastern railway. After long negotiations, in March 1935, the Russian interest in the line was sold to Manchoukuo. Thus the already tenuous Russian sphere of influence was finally eliminated.

Manchoukuo, although held by Japan to be independent, is closely supervised and controlled by Japanese advisers. Presumably it would fall if not supported by Japanese bayonets. By practically all the rest of the world it is technically regarded as still a part of China. The Chinese are not reconciled to Japanese control, apparently not even in Manchoukuo itself. Continued clashes with the Russians occurred on the borders until the conclusion of the Russo-Japanese nonaggression pact—notably in 1937 over an island in the Amur, in 1938 near the corner where Korea, Manchoukuo and Siberia join, and in 1939 on the ill-defined border between Manchoukuo and Outer Mongolia.

Modern Economic Development.—However baneful and dangerous the political effects of foreign penetration may have been, it has certainly stimulated the economic development of the country. The influx of foreign capital—Japanese investments alone in Manchuria were said to amount to more than 3,500,000,000 yen at the end of 1938—and of a Chinese peasant population have combined to expand the area of the plain under cultivation, to exploit the mineral and forest resources of the hills, and to increase enormously the contribution of Manchuria to foreign trade. The framework on which this economic development has proceeded, and is still proceeding, is the railway system. It offers an avenue of penetration into the interior both for Japanese capital and for Chinese immigration and a way of communication with the coast for the export of surplus production. Moreover, the leases of both the S.M.R. and the C.E.R. (now incorporated in the "Manchoukuo" system, but here for convenience called the North Manchuria railway or N.M.R.) included a wide zone on either side of the railway line, in which the companies could themselves engage in productive enterprises, work collieries and direct agricultural development. The story of the opening up of the Manchuria steppe is not unlike that of the Canadian prairie with which it is physically comparable, for in both the railway has preceded settlement and further railway construction will bring in its train an expansion of the area under cultivation. The economic development of Manchuria can therefore be best understood after an outline of the railway system.

The arterial railway lines are, firstly, the main line of the C.E.R. (N.M.R.) from Manchouli to Suifenho, which when under Russian control formed the chord to the arc of the Trans-Siberian, the latter keeping on the outside of the northern river boundary of Manchuria, and, secondly, at right angles to the above, the main line of the S.M.R. from Dairen to Changchun where it connects with a branch of the N.M.R. from Harbin. Harbin is thus the great railway junction and, as Manchuria is a "new" country, the metropolis of northern Manchuria. The corresponding railway junction and metropolis in South Manchuria is Mukden, where the main line of the S.M.R. is joined from the southeast by its own branch from Antung, which is connected with the Korean railways, and from the southwest by the Peking-Mukden railway, one of the arterial lines of the Chinese railway system. It is therefore by way of Manchuria that China communicates by rail with Europe. This outline system as well as that of North China was completed before the Revolution of 1911. But while in China Proper, distracted by civil war, there was very little construction for nearly 20 years after that date, the "new" and comparatively peaceful country of Manchuria, with its constant stream of immigrants, was the scene of active railway development.

So long as it was under the direction of the Chinese, much of this activity had as its objective the construction of north-south lines parallel to the S.M.R. and leading toward independent junctions on the east-west main line of the C.E.R. (N.M.R.). Japanese capital built an exceedingly important railway leaving the S.M.R. main line at Supingkai, half-way between Mukden and Changchun (Hsinching), and passing by way of Taonanfu to join the main line of the N.M.R. at Angangchi, near Tsitsihar. This line parallels not so much the S.M.R. as the branch of the N.M.R. from Changchun (Hsinching) to Harbin and gives the S.M.R. direct access, without the intermediary of Harbin, to a rapidly developing part of the central plain. Farther south the Chinese themselves were engaged in railway construction on both sides of the S.M.R. main line. On the west a branch led off from the Peking-Mukden line and headed toward the Japanese Supingkai-Taonanfu-Angangchi branch, with the possibility that in the future it might effect a junction with the N.M.R. independently of the Japanese line. On the east the Peking-Mukden railway was extended beyond its Mukden terminus to Hailung, half-way to Kirin, to which it was planned ultimately to continue it. Both of these railways paralleled the S.M.R. main line and both communicated with Hulutao on the Peking-Mukden system, an ice-free port on the Gulf of Liaotung whose harbour works the Chinese engaged in developing. Japan saw in this Chinese railway construction a threat to Dairen and alleged that China had on two occasions, in 1905 and in 1915, promised not to construct any lines parallel to and in competition with the S.M.R. until the expiry of the company's lease. China in reply maintained that the agreements referred only to foreign projects other than Japanese. It was generally admitted, however, that these lines, although numerous, would be no more than sufficient to carry the intense traffic that was likely to develop in the future.

After the creation of Manchoukuo, the Japanese entered upon a period of intense railway building. They purchased from Russia (1935) the latter's interest in the Chinese Eastern railway. To the approximately 4,000 mi. of railway in existence in 1931 they have added about 2,000 mi. They completed some of the lines begun by the Chinese. They pushed the Changchun (Hsinching) line eastward to Seishin and Rashin, on the northern coast of Korea. At Rashin, only a short distance south of the Russian border, they developed a new port, obviously partly with strategic purposes in mind. From Harbin and Tsitsihar they built lines northward toward the Amur, obviously again in part with the purpose in mind that they would prove useful in the war with Russia which the army regarded as inevitable. They completed a new line from Mukden to Peking by way of Jehol. All of these lines also contributed to the economic development of the country.

In parentheses it must be noted that the waterways within Manchuria function only as the adjunct of the railway system. The main objective of the river traffic is Harbin, the point of transhipment from the river to the railway of the trade of the whole Sungari valley.

Many of the steamers plying on the Sungari were until recently the property of the C.E.R. (N.M.R.). The course of the Amur is not the great artery of river traffic that might be expected, for its mouth lies far to the north away from all ocean trade routes, and its middle course from the point of view of through traffic is paralleled by both the Trans-Siberian and the North Manchuria railways.

Apart from the lines penetrating across or skirting the edges of the great timber reserves of the East Manchurian Highlands, this intense railway activity is primarily intended to promote the agricultural development of the plains. The lowland corridor of South Manchuria has hitherto been the main seat of cultivation but it is being rapidly overtaken by the central plain which is not only much greater in area but has also, apart from its southwestern section (eastern Gobi), considerably more fertile soils. Potentially the richest districts of all lie in an arc passing from Changchun (Hsinching) and Kirin through Harbin toward Tsitsihar, and it is this area that in the 1920s was the main scene of Chinese colonization. It lay significantly enough, in the zone of the C.E.R. (N.M.R.) rather than of the S.M.R. and was therefore the objective of the branch railways constructed by Japanese interests, seeking to divert traffic from Vladivostok to Dairen. Although the three provinces of the Chinese regime divided the central plain between them, yet the following figures for Fengtien and for Kirin and Heilungkiang give some indication of the relative agricultural value of south and north respectively. Fengtien had a total area of 57,800,000 ac. of which 19,100,000 were cultivable and 12,700,000 actually cultivated. Kirin and Heilungkiang (*i.e.*, North Manchuria) together had an area of 187,200,000 ac. of which 38,200,000 were cultivable and 18,200,000 cultivated.

Manchuria is climatically similar to North China and has much the same agricultural character. The cold winters limit cultivation to the summer half-year during which only one crop can be grown, apart perhaps from a catch-crop after the main harvest. The staple crops are those adapted to a relatively low rainfall: millet, kaoliang, maize, wheat, barley, and legumes, especially beans. Cereals and beans form the essential elements in the rotation system. These features are characteristic of all Manchuria and indeed of North China, but as between the north and south there is a difference as regards the relative importance of particular crops. In South Manchuria the warm temperate cereals (millet, kaoliang, and maize) predominate, but northwards they gradually give place to wheat, barley, and oats (not grown at all in the south) which are the staple crops of Heilungkiang. Moreover, much of the millet grown in North Manchuria is harvested green, because of the short growing season. Certain subtropical crops, rice, and cotton, characteristic of the Yangtze valley, are cultivated where the conditions are favourable in North China and even as far north as South Manchuria, which has over 1,000,000 ac. under rice and about 400,000 under cotton. Some rice is grown in Kirin, but both crops are absent from Heilungkiang.

Although, on the whole, similar both in the type of its crops and in the antecedents of its population, Manchuria has a far greater surplus production available for export than North China. The one is a new and relatively under-peopled country, the other saturated with population. But as the Chinese peasants, who constitute the bulk of its farming population, are by tradition and practice subsistence farmers, there is little of the purely commercial farming that characterizes the Canadian prairies. The surplus production that enters commerce is mainly of soya beans and wheat, both of which receive some industrial treatment in the region of their production before they are exported out of the country. A small sugar beet industry is developing on exactly the same lines. It is in the industrial treatment of field crops on a large scale that Manchurian agriculture differs from that of North China.

To the Chinese the soya bean is a crop, like bamboo, which can be made to serve innumerable purposes (*see* under CHINA: *Agriculture*) and, as it has a great number of varieties adapted to varying rainfall conditions, its cultivation is widespread and in most districts of Manchuria it constitutes the largest single crop. It is estimated that of a total bean production in Manchuria of 6,000,000 tons about half is available for export, 2,000,000 tons of which originates from the zone of the N.M.R. and over 1,000,000 tons from that of the S.M.R. There was long intense competition between the two railways for the transport of this exportable surplus to the coast, and between Dairen and Vladivostok for its shipment abroad. Of the total exported about half is of raw beans and half in the semi-manufactured form of bean-oil and bean-cake. These are products of the oil mills spread along the railway zone but focused especially in the South Manchurian ports, above all Dairen, and in Harbin, the railway centre of North Manchuria. At present oil mills are much more numerous in South than in North Manchuria but the latter is already the centre of surplus bean production and the number of oil mills is steadily increasing. The bulk of the export of beans and bean-cake goes to Japan for use as food and fertilizer and the bulk of the bean-oil to Europe for industrial consumption. After beans the most important commercial crop in Manchuria is wheat, whose cultivation is centred especially in North Manchuria. Much of this wheat production is handled by flour mills along the railway zone which are most numerous in Harbin and Changchun (Hsinching). Of nearly 200 flour mills in the whole of China in 1928, North Manchuria accounted for 62 (Harbin 30) and South Manchuria for 12. Flour-milling was originally introduced by Russian interests to feed the Russian population in Manchuria and along the Trans-Siberian, but the dominant interest became Chinese and the industry already supplies the greater part of the Manchurian market, once an American preserve. Only during World War I did an export trade in flour of any magnitude develop from the country. The consumption of wheat-flour in China is steadily increasing and it would seem that wheat cultivation in Manchuria is assured of a continually expanding market.

The most important of all the Manchurian forests, the distribution of which has been indicated above, are those of the East Manchurian Highlands whose lumber supplies the needs not only of the Manchurian plain but also of North China and to a less degree of Japan. These are being tapped in three districts—along the Yalu valley which opens out into Korea bay, along the headstreams of the Sungari which focus on Kirin, and along the N.M.R. in its traverse of the Highlands. Logs are rafted down the Yalu and Sungari to Antung and Kirin respectively, whence they are transported by the S.M.R. into the plains of Manchuria or shipped by steamer across to Tientsin and the Shantung ports. The timber resources of the East Manchurian Highlands are therefore being rapidly exploited, but there are few efforts as yet at re-afforestation, apart from those in the S.M.R. zone. On the bare hills of the Liaotung peninsula considerable numbers of oak seedlings have been planted not so much for their lumber as for the needs of the tussah silk industry, dependent on the leaves of the oak tree. (*See* ANTUNG.)

The economic wealth of Manchuria is not confined to agriculture in the plains or to lumbering among the hills, but includes also the mining of coal and iron, for which South Manchuria is one of the chief centres in the Far East. This intensity of production is the result partly of the accessibility of the coal and iron-fields and partly of the interests of Japan. Considering the scale of her industrial development, the coal resources of Japan are of no great magnitude and her iron resources are quite insufficient for her needs. Manchuria has coal reserves about equal to those of Japan (4,000,000,000 tons) and iron reserves that are quite ten times as great. The bulk of both coal and iron lies in South Manchuria, whose attraction to Japan on this account alone requires no further emphasis.

The coalfields of Manchuria fall into two main divisions, those occurring in isolated synclines within the East Manchurian Highlands and those lying in a more or less continuous strip along their western foothills where the Highlands sink down into the plain. The fields within the Highlands yield the better bituminous coals but only those which are accessible from the railways crossing the Highland zone are worked for more than local consumption. These include the Penchihu field along the Mukden-Antung line, the Mulin field along the N.M.R., and the Suchan field (actually outside Manchuria) close to Vladivostok. The belt of coalfields along the western foothills of the Highlands, lying near to the arterial railway from Mukden to Harbin, is more accessible but produces brown coals of much poorer quality, and they are worked only on a small scale. The coalfield of Fushun close to Mukden is of quite a different nature from any of the above. Although Tertiary in age, its seams are of enormous thickness and its coals of good quality. Its intrinsic character combined with its strategic position near to the railway focus of Mukden and the Japanese interest in its development have given it the greatest production (by 1940 over 10,000,000 tons) of all the Manchurian coalfields. It dominates the coal trade of South Manchuria, supplies one-fifth of the coal consumption of North Manchuria and even then has about half of its total production available for export to the ports of North China and Japan. The consumption of coal in North Manchuria is more limited than in the south. It is supplied partly from Fushun, partly from Mulin and Suchan along the eastern N.M.R., and partly from the Chalainor field along the western N.M.R. on the Mongolian slope of the Great Khingan.

The Liaotung peninsula contains the iron-field with the greatest reserve of iron ore workable by modern methods in the whole of China. According to the Chinese Geological survey, its reserve amounts to 740,000,000 tons out of a total of 952,000,000 tons for the whole country. These have not, however, a very high content of iron, and until strategic considerations became paramount the Japanese tended to rely more upon the richer ores of the Yangtze valley than on intensive working of the Liaotung fields. A handicap to the iron and steel industry of Manchuria has been the shortage of suitable coking coal, large quantities of which now have to be brought from the Kailan mines in North China for the blast furnaces at Anshan, near Mukden.

As the economy of Japan progressed from a quasi-wartime economy between 1932 and 1937 to a full wartime economy after the outbreak of war with China, and as state control of industry was intensified in Japan, so the Manchurian authorities, under pressure from the Japanese army, embarked upon a parallel policy which included a five-year industrial plan and a program of state control and state monopolies designed principally to supplement deficiencies in Japan's strategic industrial fabric. The emphasis was laid upon mining and metallurgical industries, but it included also a number of other undertakings designed to increase Japan's war potential and to promote self-supply of a number of important strategic materials and munitions of war within the "inner zone" of the so-called co-prosperity sphere. A revised five-year plan announced in 1938 aimed at the annual production by 1941 of 5,000,000 tons of pig iron, 5,000,000 tons of steel, 12,000,000 tons of iron ore, and 28,000,000 tons of coal, as well as considerable increases in the output of electric power, liquid fuel, chemicals, machinery and other items. It is doubtful whether these ambitious targets could have been approached in favourable peacetime circumstances, and it is certain that after the outbreak of war with China neither capital, materials nor labour were available in sufficient quantities. Figures are not, of course, published to show the actual performance, but it is unlikely that pig iron capacity, to say nothing of production, had by the end of 1941 reached half the projected quantity and something of the kind is no doubt true of other items in the program. There can be no doubt, however, that the Japanese are making strenuous efforts (1944) to increase industrial output in Manchuria, despite the handicaps mentioned above and the additional difficulties created by the war in the Pacific; and it is certain that Manchuria has played a very important part in providing Japan with essential war materials.

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MANCHUS. The term Manchu, which is recent in origin, has a dynastic connotation, and refers to those people, linguistically and culturally, connected with the eastern Tungus, who in the 17th century conquered China and placed their chief on the Dragon Throne. Somatologically they appear to belong to two strains; one is closely akin to the northern Chinese, the other to an element extremely common among the Buriats. While the first are only moderately roundheaded, the latter are extremely brachycephalic and probably represent an old mixture of Alpine and Yellow man. While some of the Manchus are hardly to be distinguished from the northern Chinese, others have a distinctly western type of countenance. It has been suggested by Shirokogoroff that originally the distribution of the people culturally akin to the Tungus stretched into the plain of China. If this is the case, the gradual absorption of the Manchus by immigrant Chinese is a continuation of a process which has been going on for a long period.

Since the advent of the Manchu dynasty the Manchus, organized on a military basis as "bannermen," have been widely scattered over China, where as a kind of hereditary militia they were supported as a charge on the imperial treasury. For the most part, however, they have become absorbed physically and culturally among the Chinese, and have acquired Chinese culture in the place of their old fishing and hunting habits.

An interesting problem is raised by the long association of the Manchus and the Chinese, first as enemies but with definite separate organizations, and later as a mixed people with the Manchus in a nominal ascendancy, occupying the Dragon Throne. The Manchus achieved supremacy in north China at a time when Chinese activity was at a low ebb, all the glories of the T'ang and Lung periods had become submerged and scholars felt the oppression of the long Mongol régime still upon them. Moreover, the Chinese were wasted and weakened by the struggle of warfare.

The Manchu dynasty provided just this necessary stimulation. Flushed with victory and with long-desired power over her southern neighbour, Manchuria determined to mark the whole empire with her personality. The arts were encouraged and special schools for research were established. The Manchus were fully alive to the necessity for continuing Chinese customs and a form of government which, by long usage, had become not merely palatable but sacrosanct to the Chinese.

Perhaps the greatest work of the Manchus was the issue of parallel editions of Chinese texts. Many of the Chinese classical books, written in the *Ku Wên,* a very complicated, highly elliptical style, were in later days not understood in parts. Various commentators had attempted expansion of the text in order to bring some meaning out of the passages in question but textual criticism had not yet become a real study.

The Emperor K'ang Hsi, however, gathered together from all parts of the empire the best scholars and grammarians and set them to work on an "Imperial Edition" of the classics. This edition was to appear with the text in parallel columns, Chinese and Manchu, and since an acceptable Manchu translation of a passage not understood was impossible, the best commentators were employed to elucidate the texts before they went to the Board of Translators. From a careful study of the Manchu versions, light was for the first time thrown on many obscure passages in the classical library.

Another activity of the Manchu dynasty, of great importance to the literary student of Further Asia, was the publication, again bilingual, of Manchu works which were now translated into Chinese. This brought a new force into Chinese effort and the literary changes, small though they were, passed into art in its various forms, being especially marked in the pottery of the Ming dynasty. Paintings also suffered a slight change; again the stream of active life was informing the latent powers of the Chinese and another golden age was begun.

The well-known capacity of the Chinese for absorption of an alien people is clearly shown in the case of the Manchu. Originally essentially different from the Celestial, he has, through the centuries been impressed with the Chinese seal until to-day there is no means of distinguishing between the members of the two peoples; they are in effect one and the same. The Manchus began well, full of vigour and animated by a passion for reorganization, they occupied themselves with multifarious activities calculated to bring again the Chinese Empire into its former eminence. But the inevitable result of a too highly concentrated period of achievement was the incidence of a time of indulgence and licence and the Manchus were finally overthrown by their subjects.

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MANCINI, PASQUALE STANISLAO (1817–1888), Italian jurist and statesman, was born at Castel Baronia, in the province of Avellino, on March 17, 1817. In 1848 he helped to persuade Ferdinand II. of Naples to participate in the war against Austria. Upon the triumph of the reactionary party he undertook the defence of the Liberal political prisoners. Threatened with imprisonment in his turn, he fled to Piedmont, where he obtained a university professorship and became preceptor of the crown prince Humbert. After the fall of the Bourbons, he went to Naples as administrator of justice, in which capacity he suppressed the religious orders, revoked the Concordat, proclaimed the right of the state to Church property, and unified civil and commercial jurisprudence. In 1862 he became minister of public instruction in the Rattazzi cabinet, and induced the Chamber to abolish capital punishment. For the next 14 years, he devoted himself chiefly to questions of international law and arbitration, but in 1876, upon the advent of the Left to power, became minister of justice in the Depretis cabinet.

Mancini's Liberalism found expression in the extension of press freedom, the repeal of imprisonment for debt and the abolition of ecclesiastical tithes. During the Conclave of 1878 he succeeded, by negotiations with Cardinal Pecci (afterwards Leo XIII.), in inducing the Sacred college to remain in Rome, and, after the election of the new pope, arranged for his temporary absence from the Vatican for the purpose of settling private business. Resigning office in March 1878, he resumed the practice of law, and secured the annulment of Garibaldi's marriage. The fall of Cairoli led to Mancini's appointment (1881) to the ministry of foreign affairs. An indiscreet announcement of the limitations of the Triple Alliance contributed to his fall in June 1885, when he was succeeded by Count di Robilant. He died in Rome on Dec. 26, 1888.

MANCUNIUM, the name often (though probably incorrectly) given as the Romano-British name of Manchester. Here, close to the Medlock, in the district still called Castlefield near Knott Mill, stood in Roman days a fort of 5 acres garrisoned by a cohort of Roman auxiliary soldiers. The site is now obscured by houses, railways and the Rochdale canal, but vestiges of Roman ramparts can still be seen, and other remains were found in 1907 and previous years. Traces of Romano-British inhabitation have been noted elsewhere in Manchester, especially near the cathedral. But there was no town here; we can trace nothing more than a fort guarding the roads running north through Lancashire and east into Yorkshire, and the dwellings of women-folk and traders which would naturally spring up outside such a fort. The ancient name is unknown. Our Roman authorities give both Mancunium and Mamucium, but it is not clear that either form is correct.

See numerous articles by J. J. Phelps, C. Roeder and F. A. Bruton throughout the *Transactions of the Lancashire and Cheshire Antiquarian Society*.

MANDAEANS, also known as Subba (Ṣabians), Naṣoraeans, or St. John's Christians, are an ancient sect akin to the Gnostic Christians of the 2nd and 3rd centuries, which still exists in lower Mesopotamia, in such places as Basra and Kut and Sūḳ-esh-Shuyūkh. They number now not more than about 2,000, and are said to be diminishing. Ṣubba (sing. ṣubbi) is the modern Arabic name, referring to their frequent baptisms (in Mandaean *maṣbuta*); Naṣoraeans, like the Arabic *Naṣāra*, is ultimately connected with Ναζωραῖοι (*comp.* Acts 24, 5 and נוצרי), and is used by Mandaeans in the sense of "true believers"; St. John's Christians is the inappropriate name given to the Mandaeans by Christian missionaries from the 17th century onwards, who mistook their frequent immersions and the reverence paid by them to John the Baptist for signs that they were derived from the Baptist's disciples. This is not so, and their interest in the Baptist is grounded in their hostility to the Church as it was under the Sassanian empire, *i.e.*, the Nestorians. Mandaeans means γνωστικοί (מאנדאייא, from מאנדא, Syriac *mad'ā*): the Gnosis of which they profess themselves adherents is a personification, the aeon and mediator "knowledge of life" (*Manda d'hayye*).

The present condition and practices of the Mandaeans may be gathered from Siouffi's book, published in 1880. A later account, including a detailed description of a Mandaean baptism, is to be found in the *Quest* for Oct. 1924 and Jan. 1925. (See *Bibliography.*) The sacred books of the Mandaeans are: (1) the *Ginza* ("Treasure"), known also as *Sidra rabba* ("the Great Book"); (2) the *John-Book*, a later collection; (3) *Qolasta*, a sort of hymnbook, *cf.* the Syriac *ḳullāsā* ("praise") and some minor works, partly astrological. The editions of the *Ginza* (1925) and the *John-Book* (1905–15), both by Mark Lidzbarski, have now made the chief Mandaean writings generally accessible to scholars.

Mandaean mss. are written in a peculiar Aramaic. As in the Babylonian (cuneiform) documents the characteristic Semitic gutturals have disappeared; on the other hand the vowels are represented, *a* by א, *e* by ע, while י is used both for *i* and *y*, ו for *w* and *u* and *o*. Initial *u* (or *o*) is represented by עו, initial *i* by עי. No ms. older than the 16th century seems to have survived, but the texts show few variations of importance.

The *Ginza* is the oldest document. It begins at both ends, like many ms. note-books. The longer part is called the Right-hand Ginza (GR), the shorter (about a quarter of the whole) is the Left-hand Ginza (GL). It is usually cited by the pages of Peterman's facsimile, given in the margin of Lidzbarski's edition. The last chapter of GR presents a kind of world-history, and as the dominion of the Arabs is placed at only 71 years it is evident that it must have been compiled very shortly before A.D. 700.

GR contains general cosmological, hortatory and doctrinal pieces. GL consists chiefly of hymns and doctrinal pieces about the fate of the soul after death. This part (GL) shows most clearly the essence of the Mandaean religion; this is the σῶμα-σῆμα ("the body, a tomb") philosophy, which Mandaism shares with almost all the religions which flourished in the early days of Christianity, except Judaism and Catholic Christianity itself. For the world in itself, both visible heavens and this earth, together with the bodies of all men, there is no redemption, and the final end of everything on the earth, except for the souls of the righteous, is to be swallowed by Leviathan and so annihilated (GR 393). Our world had been a kind of mistake from the beginning. There was a light-world, and a world of darkness in which the evil woman-demon lived, whom the Mandaeans call *Ruha*. That world seems to consist of the dark (or black) waters and things thereto allied, and in GR v. 134–172 we read the fantastic tale of how Hibil the Bright (Hibil-Ziwa, lit. "Abel-Splendouro": Hibil is the Mandaean form, *Hābēl* the Syriac form of Abel), son not of Adam but of Manda d'Hayye, traversed all these dark lower regions, despoiling the principalities and powers and enchaining them. But somehow—the account itself is not clear (GR 150ff.)—Ruha, as the result of this visit, bore a monstrous son called *Ur* (possibly a corruption of ὕλη), and from Ur and his mother Ruha came broods of Seven and of Twelve, which are the planets and the zodiacal constellations. Meanwhile a lower being of the light-world called *Abathur* had looked below into the dark waters and seen his image, which thereupon took independent shape and was called *Ptahil*. This Ptahil had in him therefore some of the substance or quality of the dark waters: he was told to form a solid world out of the dark waters, but failed to do so till he was helped by Hibil, who put some of his brightness into the mixture. Ruha also took some part, for she saw that this new world was partly formed out of her waters. This is our world, formed out of the dark substance, yet with a little of the light mingled with it.

Hibil set the sons of Ruha as sun and moon and planets in the sky. When man was made these constructed the body of Adam, while Hibil brought out a soul from the treasury of life and put it into Adam's body (GR 172).

No satisfactory derivation for the names Abatur and Ptahil has yet been found. (*See* Pallis: *Mandaean Studies*, pp. 111–114.) Abathur has become the judge and "weigher" of Mandaean souls (*see* esp. *JB* 70–72), but this does not seem to have been his original function.

Manda corresponds exactly to the Syriac *mad'ā*, which Bardaisan used for the Divine element in man (Mitchell ii. 158), distinct from knowledge, and corresponding to something between "reason" and "revelation." The actual phrase *mad'ā d'ḥayyē* occurs in the Syriac Bible in Luke i. 77 (=γνῶσιν σωτηρίας).

The Mandaean hostility to *Eshu mshiha* (Syr. *Ishō' mshīḥā*, Jesus Christ) is hostility to the fully developed post-Nicene Church. In several places "Christ" is actually called "the Byzantine" (Rumaya), and we read that the disciples of this Christ become "Christians," and turn into monks and nuns who have no children and who keep fasts and never wear white clothes like the Mandaeans (GR 55). The Holy Spirit of Catholic theology is identified by the Mandaeans with the evil Ruha. The peculiar Mandaean terminology sometimes makes the ordinary use of familiar terms impossible and other words have to be substituted. Thus *Ruha* to the Mandaeans means exclusively the evil spirit, so that they never use it, as all other Aramaic dialects do, for "wind," but use *ziḳa* (lit. "storm") instead. Similarly *Alaha* means to them "false god," so for "true God" they speak of "the Great *Mana*" or other titles. Now we have seen that "Jesus Christ" was to the Mandaeans only the Pseudo-messiah worshipped by the official Christians: the Mandaean name for the true Jesus was *Anush* (or *Enush*). In GR 29 and 53 we read that Anush-Utra comes into the world in the days of Piliaṭus (or Palṭus, *i.e.*, Pilate) the king of the world; he heals the sick, makes the blind to see, cleanses the lepers, etc. (*cf.* Luke vii. 22). (*Utra* [Syr. uthra, lit. "wealth," "treasure"] is the Mandaean term for a good spirit, so that Anush-Utra might almost be rendered "St. Enosh.") With the power of the high King of Light he raises the dead. Those who believe in him among the Jews he teaches that there is truth and error, life and death, light and darkness and burning fire. At his word 360 (or 365) prophets go out of Jerusalem and preach: then Anush ascends to the Mandaean paradise (Mshune-Kushta, "the abode of Truth") and will not be seen again by mankind till the end comes. *Kushṭa*, lit. "truth," is much used by Mandaeans for "true religion" generally; "to give Kushṭa" means to shake hands (always the *right* hand), a ceremony which takes the place of the laying on of hands in Catholic ritual. (Note that this word is spelt by Mandaeans with *k* not *ḳ*.) Before he ascended, however, he will have unmasked the Deceiver, the Byzantine Christ, who will confess that he is only Hermes-Mercury (*Nbo*), one of the deceiving Seven Planets; he will be seized by the Jews and crucified (GR 58).

What more or less orthodox Christians thought of the Mandaeans we learn from the *Scholion* of Theodore bar Konai (?Kēwāni=Saturninus) who compiled a sort of catalogue of heretics in A.D. 792. He treats them as a comparatively recent sect, founded by one Ado, a beggar (*i.e.*, a wandering fakir) from Adiabene, and says that their doctrine is borrowed from the Marcionites, from the Manichees and from the Kantaeans (or Knathaeans). Of these last, who are only known from Theodore himself, the one significant fact handed down is that they professed to derive their teaching from Abel, as in part the Mandaeans do.

In polemic against Catholic Christianity some Mandaean writers must have studied the Bible. In all cases it is the *Syriac* Bible (the Peshiṭta) of which they show knowledge. Their general grasp of Bible history and geography is extremely slight and they do not clearly distinguish the Jews from the Church Christians. (*See* esp. Pallis: *Mandaean Studies,* p. 141.) The evidence which has from time to time been brought forward to show independent Mandaean knowledge of Jewish traditions or literature breaks down on closer investigation.

Especially is this the case with regard to Mandaean tales about John the Baptist. Mandaeans use for Baptism a different word from that used by Catholic Christians, so that their conception of baptism may be more or less independent of Catholic Christianity, but the fact that they call all running water in which baptism may be performed "Jordan" must ultimately be based on the biblical stories about John.

John plays very little part in the *Ginza.* Manda d'Hayye goes down to the place where he baptizes, but the Jordan draws back before him, and he takes John (*Yuhana*) away to heavenly regions. In the *John-Book,* on the other hand, a long section is devoted to John, in which he is also called *Yahia,* the Arabic form of the name John. The tale, at least in its present form, is therefore later than the Arab conquests. In this, and also in GR 57, we read of John's aged parents, the priest Zacharia and his wife Enishbai (*i.e.,* the Syriac name *Elishba'* corrupted): it is difficult to believe that this is not derived from Luke i. Presently *Eshu meshiha* goes down and asks baptism from John, who is at first unwilling but finally complies on hearing a voice from heaven. It was, of course, a trump card for the Mandaean controversialist to be able to point out that the Jesus of the Catholics had had to be baptized by John, while the Mandaean Anush-Utra had not needed baptism. (Note that in GR v. 189–196 we have what Lidzbarski calls "the baptism of Manda d'Hayye by John." But in this tale Manda d'Hayye is *not* baptized: Manda d'Hayye asks baptism from John, but at His approach Jordan is driven back, and when Manda d'Hayye at length "gives truth"; *i.e.,* holds John by the right hand, John's soul is drawn out of his body and goes to Paradise.) But from the point of view of the modern investigator of Christian origins, the Mandaean accounts of the Baptist are both too fantastic and too near in some details to the Christian tale preserved in Luke to be regarded as in any sense independent tradition.

Baptism is called by Mandaeans *maṣbuta,* the corresponding form of which in Syriac would be *maṣbo'ithā.* The common Syriac term for baptism is *ma'modīthā,* only used by Mandaeans in speaking of Catholic baptism, which they regard with contempt as being administered in "cut off," *i.e.,* not running water. It should be noted that the Christian Palestinian dialect uses the term *maṣbo'ithā.* The Jewish term is *ṭibbūlā.* But the main difference between the Mandaean and the Christian rite is that the Mandaean *maṣbuta* is continually being repeated; it is a purification, not an initiation. Everything defiles, but running water makes all things clean: that is the Mandaean idea.

The Mandaeans have a clergy: the assistant or deacon (*shkanda*), the priest (*tarmida,* lit. "disciple") and the bishop (*ganzibra,* lit. "treasurer"). The priestly garment is called *rasta.* A sort of eucharist is given, consisting of a dough-cake (*pehta,*? Syr. *pitthā* "bit of bread") and a draught of water (*Mambuha,* lit. "fountain"): there is some reason to think that the original rite consisted of the *mambuha* alone. Their temples (*mashkana*) are small, being merely receptacles for objects used in the services, which are conducted in the courtyard outside. The congregations assemble on Sundays.

History.—No Arab accounts of "Ṣabians" or "Mughtasila" are detailed or accurate enough to be useful. Portuguese missionaries came to lower Babylonia as a result of the Portuguese occupation of Basra at the end of the 16th century, and found the Mandaeans there, a flourishing community estimated at over 14,000 souls. They were regarded as Christians of John the Baptist, and as such amenable to the Inquisition. The first account of them in Europe was in a letter from the Jesuit Pietro della Valle, dated June 1622, in which year the Portuguese lost their ascendancy in the Persian gulf. From about 1622–1651 the Jesuits were replaced by Carmelites under Ignatius a Jesu, who published in 1658 at Rome an account of the Mandaeans. A few years later some Mandaean mss. were bought for Robert Huntington, then in Aleppo, who left them to the Bodleian Library at Oxford. In 1854 the German orientalist, H. Petermann, spent three months at Suḳ esh-Shuyūkh and learnt the language from the local priest Yahya; in 1875 the grandson of this Yahya, having become a Christian, expounded the Mandaean religion to N. Siouffi, then French Consul at Baghdad, who published a full account of the modern Mandaeans at Paris in 1880.

Incantation Documents.—Quite distinct from the religious literature of the Mandaeans are two series of magical formulae described respectively by H. Pognon and M. Lidzbarski. (See *Bibliography.*) The former are written on earthenware saucers found at Khouabir, on the Euphrates between Baghdad and Kerbela. They are all formulae designed to protect so-and-so from hostile incantations.

Lidzbarski's documents consist of leaden tablets of similar content: in these the names of deities, etc., are of a more definitely Mandaean caste.

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MANDALAY, formerly capital of independent Burma, now headquarters of the Mandalay division and district, as well as the chief town in Upper Burma, stands on the Irrawaddy, in 21° 59′ N. and 96° 8′ E. Built in 1856–57 by King Mindōn, it is now a municipality.

The area inside the old walls of the palace and environs was called Fort Dufferin after the annexation, though no longer used as a fort. In the centre the palace, a group of wooden buildings, many of them highly carved and gilt, resting on a brick platform 900 ft. by 500 ft., and 6 ft. high, stood until its destruction during World War II. Pop. (1941) 163,537. The population is mixed, but Burmese Buddhists number over 77% of the whole. Mandalay is thus far more Burmese than Rangoon and is a great Buddhist religious centre and the abode of very large numbers of monks (*Hpongyis*). Besides Burmese there are Zerbadis (the offspring of a Mohammedan with a Burman wife), Mohammedans, Hindus, Jews, Chinese, Shans and Manipuris (called Kathe). Trains run from Mandalay to Rangoon, to Myit-kyina, and to Lashio, the beginning of the Burma road to Kunming. Steamers also ply in all directions. There are 20 bazaars.

The MANDALAY DISTRICT has an area of 2,115 sq.mi. and a pop. (1941) of 408,926. About 600 sq.mi. along the Irrawaddy are flat land, nearly all cultivated. In the north and east there are 1,500 sq.mi. of hills and table-lands, forming geographically a portion of the Shan table-land. This part of the district is well wooded and watered. The Maymyo subdivision has plateaux of 3,000 to 3,600 feet.

The highest peaks are between 4,000 and 5,000 feet. The Irrawaddy, the Myit-ngè and the Madaya are the chief rivers. The last two come from the Shan States, and are navigable for between 20 and 30 mi.

The Sagyin hills near Madaya are noted for their alabaster. On the plains the climate is dry and healthful, the rainfall averaging about 30 inches. Considerable areas are irrigated. The hilly eastern tracts have a heavier rainfall—about 60 in.—and are forested. The extremes of temperature on the plains are considerable, the thermometer in December going down to 55° and in July up to 110°.

The DIVISION in 1941 included the districts of Mandalay, Kyaukse, Meiktila, Myingyan and Yamethin, with an area of 12,504 sq.mi. and a pop. of 1,907,703.

MANDAMUS, WRIT OF: *see* PRACTICE AND PROCEDURE; WRIT.

MANDAN. This Siouan tribe formed, with the Hidatsa and Arikara (*q.v.*), the so-called village Indians among the bison-hunting nomads of the plains in central United States. Their speech allies them rather with the Winnebago than with the Hidatsa, who in turn are close to the Crow. They lived in dome-shaped, earth-covered lodges clustered in stockaded villages; planted maize, beans, pumpkins and sunflowers; hunted buffalo seasonally; made pottery; had an origin myth of emergence from the lower world by a vine; treasured a sacred palladium in an ark; and performed ceremonies which, while containing Plains elements, were rather distinctive. The culture thus had eastern or south-eastern affiliations; their drift in the historic period was upward along the Missouri river. Numbering 1,250 in 1804, they were reduced to a fraction a few decades later by disease, especially smallpox. The recent population has been variously given, owing to virtual loss of tribal identity among the Hidatsa. Theories deriving them from the mound builders of Ohio are unwarranted, and from the Welsh, fantastic. They were known as "tattooed people" in the sign language.

BY COURTESY OF THE MUSEUM OF THE AMERICAN INDIAN, HEYE FOUNDATION
MANDAN CHIEF OF SIOUAN STOCK

See G. Catlin, *North American Indians* (1841); *O-kee-pa* (1867); J. O. Dorsey, *Bur. Am. Ethn. Rep.* xi. (1894), xv. (1897); G. F. Will and H. J. Spinden, in *Pap. Peabody Mus.*, vol. iii. (1906). (A. L. K.)

MANDAN, a city of North Dakota, U.S.A., on the west bank of the Missouri river and the north bank of the Heart, 1,667 ft. above sea level; the county seat of Morton county. It is on federal highway 10 and the main line of the Northern Pacific railway. The population was 5,068 in 1925 (state census) and was 5,037 in 1930 and 6,685 in 1940 by the federal census. It is an important grain and live stock market, and division headquarters for the railroad, which has large repair shops here. There is a large flour-mill, 2 creameries, a turkey-packing plant and other manufacturing industries, and several wholesale houses with a trade territory 400 m. wide. Mandan is the seat of the State training school, a Federal dairy unit, and the U.S. Northern Great Plains Station of the Department of Agriculture, the largest dry-farming experiment station in the country. The region has vast deposits of lignite coal. Several Indian reservations are near the city, and representatives of various tribes (Sioux, Gros Ventres, Arikara and Mandan) frequent the streets. Crying Hill, now crowned by the county court-house, was the site of a village of the Mandan Indians, and was visited by La Vérendrye about 1738. Lewis and Clark spent the winter of 1804–05 a few miles north of the city. From Ft. Abraham Lincoln, 5 m. south, Gen. Custer started on his last campaign in 1876. Mandan was founded in 1872. The railroad was laid through it in 1878–79. Since 1907 it has had a commission form of government.

MANDARIN, the common name for all public officials in China, the Chinese name for whom is *kuan.* The word comes through the Portuguese from Malay *mantri,* a counsellor or minister of state. With the passing of the old order in China the term, as applied to officials, is going out of use.

By the "mandarin language" was originally meant the Chinese spoken in official and legal circles. This was the language of the capital and that of the capital was one form of the vernacular of the northern and central parts of China. Hence Mandarin is the name given to the language of common speech of these regions. It has variations, but as used by the educated it provides a commonly understood speech for more than half the nation. Latterly it is being taught in the schools in the non-Mandarin speaking sections, and so is becoming the national tongue.

Mandarin duck (*anas galericulata*) and Mandarin orange (*citrus nobilis*) possibly derive their names, by analogy, from the sense of superiority implied in the title "mandarin."

MANDASOR or MANDSAUR, a town of Central India, in the state of Gwalior, 31 mi. S. of Neemuch. Population 16,217. It gave its name to the treaty with Holkar, which concluded the Mahratta-Pindari War in 1818. It was a centre of the Malwa opium trade.

Mandasor and its neighbourhood are full of archaeological interest. An inscription discovered near the town indicated the erection of a temple of the sun in 437, and at Sondani are two great monolith pillars recording a victory of Yasodharma, king of Malwa, in 528. The fort dates from the 14th and 15th centuries.

MANDATE, a contract in Roman law constituted by one person (the *mandatarius*) promising to do something gratuitously at the request of another (the *mandator*), who undertakes to indemnify him against loss. (*See* ROMAN LAW.) The essentials and the terminology of the contract are preserved in most modern systems; but in English law mandate, under that name, can hardly be said to exist as a separate form of contract. To some extent the law of *mandatum* corresponds to the law of principal and agent (*q.v.*). "Mandate" is retained to signify the contract more generally known as gratuitous bailment. It is restricted to personal property, and it implies the delivery of something to the bailee, both of which conditions are unknown in the *mandatum* of the civil law (*see* BAILMENT).

The Mandate System.—This is a term applied to the conditions set up by the Treaty of Versailles for the administration of the former overseas possessions of Germany and Turkey. Mandatory Powers are those Powers which were selected by the Supreme Council of the Allies to administer these territories under mandate. The system is a novel experiment in the relations between a sovereign State and a country under its control, involving new departures in international law. It was created by Art. 22 of the Covenant of the League of Nations, which formed part of the Treaty of Versailles, and has thus gained the recognition of all States that are members of the League.

In its origin it was in the nature of a compromise. After the World War the victorious Allies naturally wished to retain the German and Turkish colonies, in the conquest of which they had in most cases made great sacrifices. It was believed that these colonies had been subjected to misrule; pledges had been made to the native inhabitants, some of whom had taken part with the victors in the fighting, that they should not be handed over to the vengeance of their former masters; and finally, a misgiving existed lest, in case of rendition, Germany might use them as recruiting grounds for black armies, and their ports as bases for submarines in a future war. On the other hand the Allies had declared (more particularly in the pre-Armistice statement of Nov. 5, 1918) that annexation of territory was not their aim in the war.

International control of some kind was the only alternative. Joint administration was condemned as impracticable and opposed to the interests of the people. Even as a condominium between two Powers only, it had given rise to friction in Egypt, Samoa and the New Hebrides. The only other course lay in the appointment of an individual Power in whom could be vested responsibility for the administration of each separate territory as an agent, or mandatory, of the League. For this course there were analogies in the delegation of quasi-sovereign powers to British and Dutch chartered companies and in the control of the Ionian Isles on behalf of the Powers by Great Britain in 1859. Individuals also had been appointed as mandatories of the Powers, as when King Leopold undertook control of the "International Free State of the Congo," and when Prince George of Greece was made governor of Crete in 1898.

The main defect of these delegations of sovereignty was that they provided no machinery to ensure the due execution of the trust, and it is the distinctive feature of the mandate system that it attempts to remedy this defect. The League of Nations afforded just such a supervisory authority as was needed, and its supervision is exercised through the medium of a standing committee, known as the "Permanent Mandates Commission." The League had nothing to do with the assignment of the mandates or with their terms, or with the extent and boundaries of the territories. These were determined by the Supreme Council. The United States, not being a member of the League, was no party to this arrangement, and she insisted that as an Associated Power her consent was necessary. The mandates therefore were submitted to her, and approved on condition that "free and equal treatment in law and in fact was secured to the commerce of all nations." Where the mandate did not ensure this she negotiated separate treaties with the mandatory concerned.

Terms of the Mandates.—The mandates were framed to give expression in detail to the principles embodied in Art. 22 of the Covenant (*q.v.*), and since that article prescribes that their character must vary with the varying conditions of each territory, they were divided into three classes to correspond with the three paragraphs of that article.

Class A included the former Turkish vilayets of 'Iraq, Palestine and Syria, whose independence was to be provisionally recognized until they were able to stand alone. The two former were assigned to Great Britain, the latter to France. The mandates for 'Iraq and Syria ended in 1932 and 1936 respectively.

Class B comprises the ex-German central African colonies—Togoland, Cameroons, Tanganyika and Ruanda—in which the mandatory is responsible for the administration and undertakes to promote the moral and material welfare of the people. Tanganyika, and a small part of the Cameroons and Togo fell to Great Britain, the major portions of the two latter being assigned to France, while Belgium became responsible for Ruanda.

Class C territories include those which "can best be administered under the laws of the mandatory as integral portions of its territories, subject to the safeguards in the interests of the indigenous population" which are laid down for Class B. They are south-west Africa, Samoa, New Guinea, the islands north of the equator in the west Pacific and the tiny island of Nauru. For these respectively the Union of South Africa, New Zealand, Australia, Japan and the British empire accepted mandates.

In the case of Nauru, Great Britain, Australia and New Zealand had by agreement in July 1919 (before the issue of the mandate), jointly acquired control of the phosphate deposits, which constitute the sole value of the island, and they jointly undertook the execution of the mandate. Since, however, the British empire has no single code of laws, the administration was assigned by the two others to Australia for five years.

The "safeguards in the interests of the indigenous population" to which reference is made are: (1) freedom of conscience and religion, subject only to the maintenance of public order and morals; (2) prohibition of abuses such as the arms and liquor traffic and the slave-trade; and (3) prevention of fortifications, naval and military bases, and the military training of natives except for police and the defence of the territory.

The mandates after acceptance by each mandatory were submitted to the Council of the League, which was charged with the duty of seeing that their terms were in accord with the Covenant. The A class could not be issued until the Treaty of Lausanne came into force (Aug. 1924). Meanwhile an Arab Government had been set up in 'Iraq, and a treaty had been concluded by Great Britain with it. On Sept. 27, 1925, the council formally accepted the undertaking of the mandatory to see that the terms of this treaty (which embodied the obligations of the Covenant) were adhered to, and this undertaking was substituted for the mandate. Pending the issue of the mandate, the territories were administered in accordance with the terms of the Covenant or under provisional mandates. These terms are explicit. The mandate is a "sacred trust of civilization" to be assumed by nations who (*inter alia*) "by reason of their resources can best undertake this responsibility and are willing to accept it." The altruistic nature of this pledge was confirmed in a reply to a German protest. "The Mandatory Powers," said the Allies, "in so far as they may be appointed trustees by the League of Nations, will derive no benefit from such trusteeship."

A mandated territory differs from a protectorate in that the protecting Power in the latter obtains rights over the population and against other Powers, whereas a mandatory in its capacity as guardian assumes obligations both toward the population and the League.

League Supervision.—The system, it has been said, differs from such partial precedents as have been cited, in that it attempts to set up machinery by which the proper execution of the mandate may be assured. This consists in the unqualified right of supervision vested in the League which imposes upon each mandatory the obligation to submit an annual report on its administration.

These reports are examined by a permanent mandates commission in the presence of an accredited representative of the mandatory concerned. The commission originally consisted of nine members of the following nationalities: Belgian, British, Dutch, French, Italian, Japanese, Portuguese, Spanish and Swedish. To these a Swiss and a German have since been added. The majority are nationals of non-mandatory States. They are selected "for personal merit and competence" as private individuals, and not as representatives of their respective nations. They are nominated by their Governments, but approved and appointed by the Council of the League, and may not hold any office under their Government. A representative of the International Labour office attends the sessions, and takes part in any discussions relative to labour. This international composition negatives any suspicion of bias, and gives to the commission the aspect of an impartial tribunal of practical men, whose object it is to promote co-operation while fearlessly exposing any breach of the Covenant. Its functions are purely advisory to the council.

In addition to the annual review of the reports of the mandatories, the commission receives any petitions and memorials from inhabitants of the territories and others interested, and these, unless trivial or irrelevant, are forwarded to the mandatory concerned for his comments before examination by the commission. The proceedings are conducted in French and English, and are generally held in private to facilitate freedom of discussion. Full minutes are printed, which, together with the memoranda on special subjects and all other pertinent papers, can be obtained from the League publication department, or from its agents in London and other European capitals. A permanent secretariat, under a director, collects and circulates all documents of interest concerning mandates and conducts the routine business. The commission meets at least twice in the year at Geneva, and its procedure is governed by rules approved by the council.

The weak point in the system lies in the impossibility of independent verification of statements contained in the reports—a difficulty inherent in the circumstances. For information not contained in the report, therefore, the commission must rely on those public bodies or individuals who interest themselves in the welfare of native races, and on such memorials and petitions as may be presented to it. In order to obtain more accurate information, the actual administrators now generally appear as the mandatory's representatives. The sole means at the disposal of the League for compelling the proper execution of the mandate is the force of public opinion.

The French mandates in west Africa—unlike the British mandates for portions of the same territories (Cameroons and Togo) —contain a clause to the effect that "troops thus raised" (*i.e.*, for purposes of local defence and police) "may in the event of general war be utilized to repel an attack, or for defence of the territory outside that subject to the mandate." It is difficult to reconcile this clause with the words of the Covenant. At the instance of the Mandates Commission the British Government was willing to go even further than the Covenant prescribes, and to agree to pledge itself not to enlist the natives of a mandated territory, even though they offered themselves for enlistment outside its frontiers—thus limiting its sovereign rights in adjacent territories not under mandate. The French Government has declared its willingness to accept the same restriction.

Liquor Traffic.—The Covenant enjoins the "prohibition of abuses such as the slave-trade, the arms traffic and the liquor traffic." Some have urged that these words mean the enforcement of total prohibition alike for natives and non-natives. The mandates, however, only prescribe a "strict *control* over the sale of spirituous liquors," and the St. Germain Convention (Sept. 1919), concluded soon after the Versailles Treaty by the same signatories, forbids the import of "trade spirits" only. The commission, therefore, asked the council for an authoritative decision as to the precise meaning of the terms used in the mandates and the Covenant, and at its request submitted the following definitions which were referred to the mandatories.

Spirituous Liquors shall be taken to mean (*a*) all distilled beverages, (*b*) all fermented beverages to which distilled products have been added so as to contain over 20 degrees of pure alcohol by weight. *Trade Spirits* shall be taken to mean cheap spirits utilized as articles of trade or barter with the natives. *Intoxicating beverages* means any beverage containing more than three degrees of pure alcohol by weight.

In the matter of equal commercial opportunity for all nations, the Covenant itself failed to fulfil the expectations raised by the pre-Armistice declarations of the Allies. No obligation in this regard is imposed in the C mandates, while in the B class it is restricted to States which are members of the League.

Boundaries.—Another cause of practical difficulty is presented by the fact that in most cases the boundaries of the territories assigned under mandate were not defined, and it was apparently left to the individual mandatories to adjust them without reference to the League.

In the case of 'Iraq this led to an acute dispute with Turkey in regard to the northern boundary. It was eventually settled by a special commission appointed by the League, at the instance of Great Britain. The southern frontiers were the subject of an agreement with the sultan of Nejd, and an Anglo-French agreement determined the frontiers with Syria. The French in northern Syria had similar difficulties with Turkey, to whom they ceded Cilesia. In the Cameroons a joint commission was set up to determine the precise boundaries, while as regards Ruanda, the mandatory (Belgium) complained that the agreed boundary involved the loss to King Musinga of a considerable part of his territory. The British at once agreed that this area should be restored to him, and the consequent changes in the mandates were approved by the council. In south-west Africa a "neutral zone" had long existed between the German and Portuguese colonies, which has now been replaced by a precise demarcation, embodied in a treaty between the Union of South Africa and the Portuguese Government.

Wider issues are raised by such questions as the nature and extent of sovereignty exercised by a mandatory and the international status of the inhabitants of a mandated territory. The former—which has been much debated by American publicists—is rather academic and juridical than of practical interest. It suffices for practical purposes that the mandatory has the absolute right to make and enforce laws, to raise troops, to set up tribunals, to appoint officials and to raise and spend revenues. Sovereignty was not ceded by the Treaty of Versailles to the League, but to the victorious Allies—indeed the highest court in South Africa has recorded the opinion that the territories were not ceded at all, but placed by Germany at the disposal of the Allies, to be administered under mandate—a status new to international law.

The mandatory's powers are exercised "in its capacity as such." It has, for instance, been satisfactorily established by the Mandates Commission that such terms as "Crown (or State) lands" and *domaines d'état*, where they appear in local ordinances, refer only to lands which are the property of the mandatory as such, in other words, to the mandated territory, and that any action on the part of the mandatory which had for its object (or would ultimately involve) annexation—as for instance the acquisition of large monopolistic rights, or of essential public services—would be contrary to the spirit of the Covenant and the mandate.

Status of Natives.—The status of the indigenous inhabitants of a B or C mandate territory has on the other hand been the subject of special definition. Obviously, since the country is not annexed, they do not become the subjects of the mandatory. The formula was therefore adopted by the council that "they should be designated by some form of descriptive title which will identify them as such," viz., as "persons administered or protected under mandate." This confers no juridical status, and no privilege of citizenship, but Art. 327 of the treaty stipulates that they should be entitled to the diplomatic protection of the mandatory when outside the mandated territory, and individuals may if they so desire become naturalized subjects of the mandatory.

The application to mandated territories of special conventions, entered into by a mandatory Power, has also been the subject of investigation and recommendation by the Mandates Commission, in order to ensure that "persons protected under mandate" shall not be in a less favourable position in regard to their persons and property and their economic interests than the inhabitants of a protectorate or colony.

The revocation of a mandate for maladministration, though theoretically possible, is in practice unthinkable. The terms of the Covenant therefore contemplate self-government as the natural fruition of the mandate—in the case of the A class at no distant date. The new State would then take its place as a member of the League.

The mandate system accords, for the first time in history, international sanction to the principle of trusteeship, and of public responsibility to a supervising authority for the obligations laid down in the trust deed in regard to mandated territories. The annual report forms an effective means of inviting a popular verdict on the fulfilment of the trust, and this supervision constitutes a fundamental distinction from annexation, whatever the degree of assimilation to other possessions of the mandatory. The League exercises supervision but not control, for the ultimate authority to which the stewardship of the mandatory is submitted is the public opinion of the civilized world. The standards of the Covenant must obviously in the future be regarded as principles of general application. The mandate system is an international acknowledgment of the responsibility which the advantages of a superior intellectual culture and 20 centuries of Christian ethics no less than the physical superiority conferred by the monopoly of firearms impose upon those Powers which have accepted control of backward races. (*See* LEAGUE OF NATIONS.)

BIBLIOGRAPHY.—The mandates section of the League secretariat has issued a *List of Books and Pamphlets relating to the Mandates System and to Territories under Mandate*. A bibliography has also been prepared by the Royal Colonial Institute. *See* especially Freda White, *Mandates, etc.* (1926); D. P. W. Van Rees, *Les Mandats Internationaux* (1927); L. M. Palacios, *Los Mandatos Internacionales de la Sociedad de Naciones* (1927). (LU.)

MANDAUE, a municipality (with administrative centre and 26 *barrios* or districts) of the province and island of Cebu, Philippine Islands, on the east coast about four miles N.E. of Cebu, the provincial capital. Pop. (1939) 17,431 of whom 8,464 were males and four white. The principal industries are agriculture and the manufacture of salt from sea water. The chief crops are maize (corn) and sugar. The vernacular is Cebuano, a dialect of Bisayan. Of the inhabitants aged 6 to 19 inclusive, 39·2% in 1939 attended school; 47·7% of the population 10 years old and over was literate.

MANDAYA, a tribe of Mindanao island in the Philippines, which lives in tree dwellings, several families in one house; cultivates scanty plots of rice and other crops; practises slavery and ceremonial cannibalism, eating part of the liver of a slain enemy, but not genuine head-hunting (*q.v.*). As offensive weapons, spears, daos, daggers and poisoned arrows are used; as defensive, light wooden shields, cloth protective armour, and bamboo caltrops. The turtle-dove is regarded as sacred and spirits are worshipped by mediums (*ballyan*), generally female, and are associated with wooden figures representing ancestors. Groups are governed by warrior leaders (*bagani*) whose rank is acquired by the killing of many enemies, as insignia for which a red costume is worn. Half a red costume (trousers only) is awarded for exploits not worthy of the whole. They do not tattoo, but file and blacken the teeth. They have been erroneously reported to be white in complexion.

See Cole, *Wild Tribes of Davao District* (1913).

MANDELIC ACID, discovered by F. L. Winckler (1832) in an emulsion of bitter almonds. (*See* GLYCOSIDES, NATURAL.) It is most conveniently obtained in colourless rhombic prisms, melting at 118° C, with sp.gr. 1.364, and soluble in water, alcohol or ether, from commercial benzaldehyde (*q.v.*) by adding concentrated aqueous sodium hydrogen sulphite to a mixture of benzaldehyde and aqueous sodium cyanide; oily mandelonitrile, $C_6H_5.CH(OH).CN$, separates and is hydrolysed to mandelic acid (phenylglycollic acid, phenyl-α-hydroxyacetic acid), $C_6H_5.CH(OH)\cdot CO_2H$, at the ordinary temperature with concentrated hydrochloric acid. The acid may be extracted with benzene or ether (*see* H. Gilman and others, *Organic Syntheses,* vol. VI., 1926). Mandelic acid contains an asymmetric carbon atom and is accordingly resolvable into two optically active isomerides (*see* STEREOCHEMISTRY). This resolution has been accomplished, (1) through the agency of the alkaloid cinchonine, which furnishes a less soluble salt with *dextro*-mandelic acid, and (2) by means of living organisms. The yeast *Saccharomyces ellipsoideus* removes the *d*-modification and leaves the *laevo*-mandelic acid, whereas the mould, *Penicillium Glaucum,* destroys the *l*-form in a solution of ammonium mandelate, leaving the *dextro*-mandelic acid. The two optically active forms, which melt at 132·8° C, are less fusible and more sparingly soluble in water than the inactive or racemoid variety, which has been termed paramandelic acid. A mixture of equal weights of the two active forms produces the inactive acid, which is also obtained on heating either active form at 160° C.

MANDER, CAREL VAN (1548–1606), Dutch painter, poet and biographer, was born of a noble family at Meulebeke. He studied under Lucas de Heere at Ghent, and in 1568–69 under Pieter Vlerick at Courtrai and Tournai. The next five years he devoted to writing religious plays, for which he painted the scenery. Then for three years (1574–1577), he studied in Rome under various masters and drew in the catacombs. On his return journey he passed through Vienna, where, together with the sculptor Hans Mont, he made the triumphal arch for the entry of the emperor Rudolph. After many vicissitudes he settled at Haarlem, where, with Goltzius and Cornelisz, he founded a successful academy of painting. His fame is principally based upon a biographical work on the paintings of various epochs—a book that has become for the northern countries what Vasari's *Lives of the Painters* became for Italy. It was completed in 1603 and published in 1604, in which year Van Mander went to Amsterdam, where he died on Sept. 2, 1606. He translated Virgil's *Bucolics* and *Georgics.*

His *Het Schilderbouck* (Haarlem, 1604) was translated into French by H. Hymans (Paris, 1884), and into German by H. Floerke (Munich, 1906). The poem in 14 chapters dealing with the technique of painting, which forms the introduction, was used as a source of information by Charles Eastlake in *Materials for a History of Oil Painting* (1847, pub. separately with German trs. by R. Haecker, *Das Lehrgedicht des Karel van Mander,* The Hague, 1916).

MANDEVILLE, BERNARD DE (1670–1733), English philosopher and satirist, was born at Dordrecht, where his father practised as a physician. On leaving the Erasmus school at Rotterdam he gave proof of his ability by an *Oratio scholastica de medicina* (1685), and at Leyden university in 1689 he maintained a thesis *De brutorum operationibus,* in which he advocated the Cartesian theory of automatism among animals. In 1691 he took his medical degree, pronouncing an "inaugural disputation," *De chylosi vitiata.* Afterwards he came to England "to learn the language," and succeeded so remarkably that many refused to believe he was a foreigner. He died in January (19th or 21st) 1733–4 at Hackney.

The work by which he is known is the *Fable of the Bees or Private Vices made Public Benefits,* published first in 1705 under the title of *The Grumbling Hive, or Knaves Turn'd Honest* (two hundred doggerel couplets) and often reprinted, with additions. The book was primarily written as a political satire on the state of England in 1705, when the Tories were accusing Marlborough and the ministry of advocating the French War for personal reasons. The edition of 1723 was presented as a nuisance by the Grand Jury of Middlesex, was denounced in the *London Journal* by "Theophilus Philo-Britannus," and attacked by many writers, notably by Archibald Campbell (1691–1756) in his *Aretelogia* (published as his own by Alexander Innes in 1728; afterwards by Campbell, under his own name, in 1733, as *Enquiry into the Original of Moral Virtue*). Berkeley attacked it in the second dialogue of the *Alciphron* (1732) and John Brown criticized him in his *Essay upon Shaftesbury's Characteristics* (1751).

Mandeville's main thesis is that the actions of men cannot be divided into lower and higher. The higher life of man is merely a fiction introduced by philosophers and rulers to simplify government and the relations of society. It is the vices (*i.e.,* the self-regarding actions of men) which alone, by means of inventions and the circulation of capital in connection with luxurious living, stimulate society into action and progress. Mandeville's ironical paradoxes are interesting mainly as a criticism of the "amiable" idealism of Shaftesbury, and in comparison with the serious egoistic systems of Hobbes and Helvetius. He may be said to have cleared the ground for the coming utilitarianism.

WORKS.—*Typhon: a Burlesque Poem* (1704); *Aesop Dress'd, or a Collection of Fables writ in Familiar Verse* (1704); *The Planter's Charity* (1704); *The Virgin Unmasked* (1709, 1724, 1731, 1742), a work in which the coarser side of his nature is prominent; *Treatise of the Hypochondriack and Hysterick Passions* (1711, 1715, 1730) admired by Johnson (Mandeville here protests against merely speculative therapeutics, and advances fanciful theories of his own about animal spirits in connection with "stomachic ferment": he shows a knowledge of Locke's methods, and an admiration for Sydenham); *Free Thoughts on Religion* (1720); *A Conference about Whoring* (1725); *An Enquiry into the Causes of the Frequent Executions at Tyburn* (1725); *The Origin of Honour and the Usefulness of Christianity in War* (1732); *A Letter to Dion occasioned by his book called Alciphron* (1732). Other works attributed, probably wrongly, to him are *A Modest Defence of Public Stews* (1724); *The World Unmasked* (1736) and *Zoologia medicinalis hibernica* (1744).

See Hill's *Boswell,* iii. 291–293; L. Stephen's *English Thought in the Eighteenth Century;* A. Bain's *Moral Science* (593–598); Windelband's *History of Ethics* (Eng. trans. Tufts); J. M. Robertson, *Pioneer Humanists* (1907); P. Sakmann, *Bernard de Mandeville und die Bienenfabel-Controverse* (Freiburg i/Br., 1897), and articles ETHICS; SHAFTESBURY, ANTHONY ASHLEY COOPER; HOBBES, THOMAS.

MANDEVILLE, GEOFFREY DE (d. 1144), earl of Essex, succeeded his father, William, as constable of the Tower of London in or shortly before 1130. Though a great Essex landowner, he played no conspicuous part in history till 1140, when Stephen created him earl of Essex in reward for his services against the empress Matilda. After the defeat and capture of Stephen at Lincoln (1141) the earl deserted to Matilda, but before the end of the year, learning that Stephen's release was imminent, returned to his original allegiance. In 1142 he was again intriguing with the empress; but before he could openly join her cause he was detected and deprived of his castles by the king. In 1143–1144 Geoffrey maintained himself as a rebel and a bandit in the fen-country, using the Isle of Ely and Ramsey Abbey as his headquarters. He was besieged by Stephen in the fens, and met his death in Sept. 1144 in consequence of a wound received in a skirmish. His career is interesting for two reasons. The charters which he extorted from Stephen and Matilda illustrate the peculiar form taken by the ambitions of English feudatories. The most important concessions are grants of offices and jurisdictions which had the effect of making Mandeville a viceroy with full powers in Essex, Middlesex and London, and Hertfordshire. His career as an outlaw exemplifies the worst excesses of the anarchy which prevailed in some parts of England during the civil wars of 1140–47, and it is probable that Mandeville inspired the rhetorical description, in the Peterborough Chronicle of this period, when "men said openly that Christ and his saints were asleep."

See J. H. Round, *Geoffrey de Mandeville, a Study of the Anarchy* (1892). (H. W. C. D.)

MANDEVILLE, JEHAN DE ("Sir John Mandeville"), the name claimed by the compiler of a singular book of travels, written in French, and published between 1357 and 1371. By aid of translations into many other languages it acquired extraordinary popularity, while a few interpolated words in a particular edition of an English version gained for Mandeville in modern times the certainly spurious credit of being "the father of English prose."

In his preface the compiler calls himself a knight, and states that he was born and bred in England, of the town of St. Albans; had crossed the sea on Michaelmas Day 1322; had travelled by way of Turkey (Asia Minor), Armenia the little (Cilicia) and the great, Tartary, Persia, Syria, Arabia, Egypt upper and lower, Libya, great part of Ethiopia, Chaldaea, Amazonia, India the less, the greater and the middle, and many countries about India; had often been to Jerusalem, and had written in Romance as more generally understood than Latin. In the body of the work we hear that he had been at Paris and Constantinople; had served the sultan of Egypt a long time in his wars against the Bedawin, had been vainly offered by him a princely marriage and a great estate on condition of renouncing Christianity, and had left Egypt under sultan Melech Madabron, *i.e.,* Muzaffar or Mudhaffar[1] (who reigned in 1346–1347); had been at Mount Sinai, and had visited the Holy Land with letters under the great seal of the sultan, which gave him extraordinary facilities; had been in Russia, Livonia, Cracow, Lithuania, "en roialme daresten" (? of Daresten or Silistria), and many other parts near Tartary, but not in Tartary itself; had drunk of the well of youth at Polombe (Quilon on the Malabar coast), and still seemed to feel the better; had taken astronomical observations on the way to Lamory (Sumatra), as well as in Brabant, Germany, Bohemia and still farther north; had been at an isle called Pathen in the Indian Ocean; had been at Cansay (Hangchow-fu) in China, and had served the emperor of China fifteen months against the king of Manzi; had been among rocks of adamant in the Indian Ocean; had been through a haunted valley, which he places near "Milstorak" (*i.e.,* Malasgird in Armenia); had been driven home against his will in 1357 by arthritic gout; and had written his book as a consolation for his "wretched rest."

This personal history of Mandeville is mere invention. There is no reasonable doubt that the travels were in large part compiled by a Liége physician, known as Johains à la Barbe or Jehan à la Barbe, otherwise Jehan de Bourgogne, who drew his information not from his own travels, but from the works of Odoric, Carpini, Vincent de Beauvais, and others. Jehan à la Barbe is himself a man of mystery.

A modernized extract quoted by the Liége herald, Louis Abry (1643–1720), at third or fourth hand from the lost fourth book of the *Myreur des Hystors* of Johans des Preis, styled d'Outremeuse, states that "Jean de Bourgogne, dit à la Barbe," revealed himself on his deathbed to d'Outremeuse, whom he made his executor, and described himself in his will as "messire Jean de Mandeville, chevalier, comte de Montfort en Angleterre et seigneur de l'isle de Campdi et du château Pérouse." Having had the misfortune to kill an unnamed count in his own country, he engaged himself to travel through the three parts of the world, arrived at Liége in 1343, was a great naturalist, profound philosopher and astrologer, and had a remarkable knowledge of physic. In the now destroyed church of the Guillelmins was a tombstone of Mandeville, with a Latin inscription stating that he was otherwise named "ad Barbam," was a professor of medicine, and died at Liége on Nov. 17, 1372; this inscription is quoted as far back as 1462.

[1]The *on* in Madabron apparently represents the Arabic form, though, as a matter of fact, its use in such a case is very odd.

Whether after the appearance of the *Travels* either de Bourgogne or "Mangevilayn" visited England is very doubtful. St. Albans Abbey had a sapphire ring, and Canterbury a crystal orb, said to have been given by Mandeville; but these might have been sent from Liége, and it will appear later that the Liége physician possessed and wrote about precious stones. St. Albans also had a legend that a ruined marble tomb of Mandeville (represented cross-legged and in armour, with sword and shield) once stood in the abbey.

It is a little curious that the name preceding Mangevilayn in the list of persons pardoned is "Johan le Barber." But Dr. G. F. Warner has ingeniously suggested that de Bourgogne may be a certain Johan de Bourgogne, who was pardoned on Aug. 20, 1321. Did this suggest to de Bourgogne the *alias* "à le Barbe," or was that only a Liége nickname? Note also that the arms on Mandeville's tomb were borne by the Tyrrells of Hertfordshire (the county in which St. Albans lies); for of course the crescent on the lion's breast is only the "difference" indicating a second son.

The Sources.—Leaving aside the stories which have grown up around the Liége physician, there remains the question whether the book contains any facts and knowledge acquired by actual travels and residence in the East. Possibly it may, but only in a small portion of the section which treats of the Holy Land and the ways of getting thither, of Egypt, and in general of the Levant. Even this section seems to be based on the travels of William of Boldensele (1336). The prologue, indeed, points almost exclusively to the Holy Land as the subject of the work. The mention of more distant regions comes in only towards the end of this prologue, and (in a manner) as an afterthought.

By far the greater part of these more distant travels, extending in fact from Trebizond to Hormuz, India, the Malay Archipelago, and China, and back again to western Asia, has been appropriated from the narrative of Friar Odoric (written in 1330). These passages, as served up by Mandeville, are almost always, indeed, swollen with interpolated particulars, usually of an extravagant kind, whilst in some cases the writer has failed to understand the passages which he adopts from Odoric and professes to give as his own experiences. Thus where Odoric has given a most curious and veracious account of the Chinese custom of employing tame cormorants to catch fish, the cormorants are converted by Mandeville into "little beasts called *loyres* (*layre,* B), which are taught to go into the water" (the word *loyre* being apparently used here for "otter," *lutra,* for which the Provençal is *luria* or *loiria*). Much, again, of Mandeville's matter, particularly in Asiatic geography and history, is taken from the *Historiae Orientis* of Hetoum, an Armenian of princely family, who became a monk of the Praemonstrant order, and in 1307 dictated this work on the East, in the French tongue at Poitiers. A good deal about the manners and customs of the Tatars is demonstrably derived from the famous work of the Franciscan Joannes de Plano Carpini (*q.v.*), but Dr. Warner considers that much was taken at second hand and that Mandeville's immediate source was the *Speculum historiale* of Vincent de Beauvais.

The account of Prester John (*q.v.*) is taken from the famous *Epistle,* which was so widely diffused in the 13th century, and created that renown which made it incumbent on every traveller in Asia to find some new tale to tell of him. Many fabulous stories, again, of monsters, such as Pliny has collected, are introduced here and there, derived no doubt from him, Solinus, the bestiaries, or the *Speculum naturale.* And interspersed, especially in the chapters about the Levant, are the stories and legends that were retailed to every pilgrim, such as the legend of Seth and the grains of paradise from which grew the wood of the cross, that of the shooting of old Cain by Lamech, that of the castle of the sparrow-hawk (which appears in the tale of Melusina), those of the origin of the balsam plants at Maṭarīya, of the dragon of Cos, of the river Sabbation, etc.

While recording Mandeville's borrowings it is only fair to recognize his imaginative powers; a notorious passage, filched, with additions, from Boldensele, seems likely to have inspired the Valley of the Shadow of Death in *Pilgrim's Progress.* Nor does it follow that the whole work is borrowed or fictitious. In such works as those of Jan van Hees and Arnold von Harff we have examples of pilgrims to the Holy Land whose narratives begin apparently in sober truth, and gradually pass into flourishes of fiction and extravagance. So in Mandeville also we find particulars not yet traced to other writers, and which may therefore be provisionally assigned either to the writer's own experience or to knowledge acquired by colloquial intercourse in the East.

BIBLIOGRAPHY.—The oldest known ms. of the original—once Barrois's, afterwards the earl of Ashburnham's, now Nouv. Acq. Franç. 4515 in the Bibliothèque Nationale, Paris—is dated 1371, but is nevertheless very inaccurate in proper names. The first English translation direct from the French was made (at least as early as the beginning of the 15th century) from a ms. of which many pages were lost.

For Mandeville's sources *see* A. Bovenschen, *Die Quellen für die Reisebeschreibung des Johann von Mandeville, Inaugural-Dissertation . . . Leipzig* (Berlin, 1888), revised and enlarged as "Untersuchungen über Johann von Mandeville und die Quellen seiner Reisebeschreibung," in the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin,* Bd. 23, Heft 3 u. 4 (No. 135, 136), and G. F. Warner, in the edition prepared for the Roxburghe Club.

All English printed texts before 1725, and Ashton's 1887 edition, follow these defective copies.

The Egerton text (Brit. Mus. ms. Egerton 1982) edited by Dr. G. F. Warner, has been printed by the Roxburghe Club, while the Cotton text (Brit. Mus. ms. Cotton Titus C xvi.), first printed in 1725 and 1727, is in modern reprints the current English version.

That none of the forms of the English version can be from the same hand which wrote the original is made patent by their glaring errors of translation, but the Cotton text asserts in the preface that it was made by Mandeville himself. Mätzner (*Altenglische Sprachproben,* I., ii., 154–155) seems to have been the first to show that the current English text cannot possibly have been made by Mandeville himself. Other works bearing the name of Mandeville or de Bourgogne are a short French life of St. Alban of *Germany,* the author of which calls himself Johan Mandivill[e], knight, formerly of the town of St. Alban, contained in ms. Add. C. 280 of the Bodleian; a *Lapidaire* printed in L. Pannier, *Les Lapidaires français;* and there are medical and alchemical receipts in the Ashmolean mss. in the Bodleian by John de Villa Magna. Finally, de Bourgogne wrote under his own name a treatise on the plague, *see* David Murray, *The Black Book of Paisley,* etc. (1885), and *John de Burdeus,* etc. (1891) extant in Latin, French and English texts, and in Latin and English abridgments. Herein he describes himself as Johannes de Burgundia, otherwise called *cum Barba,* citizen of Liége and professor of the art of medicine; says that he had practised forty years and had been in Liége in the plague of 1365; and adds that he had previously written a treatise on the cause of the plague, according to the indications of astrology (beginning *Deus deorum*), and another on distinguishing pestilential diseases (beginning *Cum nimium propter instans tempus epidimiale*). "Burgundia" is sometimes corrupted into "Burdegalia," and in English translations of the abridgment almost always appears as "Burdews" (Bordeaux) or the like. Ms. Rawlinson D. 251 (15th century) in the Bodleian also contains a large number of English medical receipts, headed "Practica phisicalia Magistri Johannis de Burgundia."

See further Dr. G. F. Warner's article in the *Dictionary of National Biography* for a comprehensive account, and for bibliographical references; Ulysse Chevalier's *Répertoire des sources historiques du moyen age* for references generally; and the *Zeitschr. f. celt. Philologie* II., i. 126, for an edition and translation, by Dr. Whitley Stokes, of Fingin O'Mahony's Irish version of the *Travels.* (E. W. B. N.; H. Y.)

MANDHATA, a famous place of Hindu pilgrimage in the Nimar district of the Central Provinces of India, partly on the south bank of the River Nerbudda and partly on an island in the river. One of the temples is famous for containing one of the twelve great *Lingas* of Siva. Its annual fair was formerly the scene of the self-immolation of devotees who threw themselves from the high cliffs into the river. The last sacrifice, which was witnessed by a British officer, occurred in 1824.

MANDI, an important Indian hill State, within the Punjab, under British influence since the first Sikh War (1846). The country is intersected by two great parallel ranges, with average height 5,000 to 7,000 ft. above sea-level. The valleys are fertile, and produce all ordinary grains, besides more valuable crops of rice, maize, sugar-cane, and tobacco. Area, 1,139 sq.mi.; pop. (1941), 232,593; estimated revenue, £93,000. An important product of the state is salt, mined in two places.

The town of Mandi is on the Beas, a mountain torrent, crossed by a fine iron bridge, 2,991 ft. above sea-level. Pop. (1941), 9,033. It is a mart for transfrontier trade with Tibet and Yarkand.

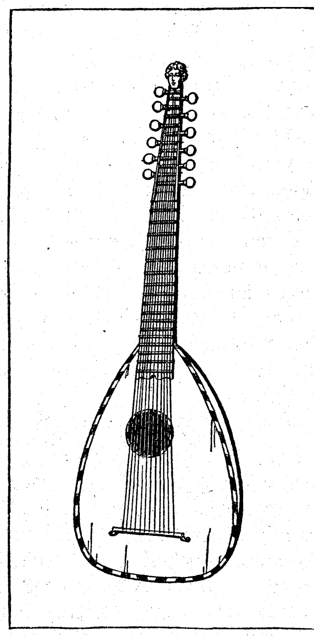
MANDINGA, a vigorous, well-proportioned, longheaded, big-jowled, flat-nosed people with projecting cheekbones and regular features, inhabiting the western Sudan, originally from an area known as Mane, Mande, Mani, Mandi or Manding, in the Upper Niger. The Fulani call them Malinke and the Hausa name for them is Wangara. From 1235 to 1680 they formed an empire but are no longer even a political unity. The following groups are distinguishable: (*a*) the Malinke (upper valleys of the Niger, Bafing and Gambia, and the district on the fringe of the dense forest); (*b*) the Bambara or Banmana (between the Niger and the Bani rivers, the Bamako district, and Sahel); and (*c*) the Jula (colonies east of the Bani). The language of the Mandinga belongs to the Niger-Senegalese family, with dialects Malinke, Bambara and Jula. Marriage by exchange is common, the women having no voice in the matter; both dowry and dower are customary. Descent is matrilineal among the Malinke. The extended family group (*Gwa* or *Gba*), ordinarily comprising four generations, is the social unit, with family property in common but individual ownership of personal possessions. Inheritance passes to the brother of the deceased and then to the eldest son; women never inherit but are themselves part of the heritable property. A number of such family groups form the village (*dugu*); several villages and their townlands constitute the territorial group (*kafo*), and a number of such groups constitute the county (*jamana*) ruled by the *Mansa* or *Massa* with councillors and a chancellor of the exchequer. Clans, whose members have the same name and common taboos, still exist but are unorganized. The village and the territorial group are the units of Mandinga organization; the politico-religious hierarchies depend on the secret societies (*Ntomo, Nama, Komo*), which group the people into age classes. Cultivators and cattle-raisers for the most part, some of the Mandinga (the Jula) are traders. In mediaeval times certain noble families became adherents of Islam but the people in general are still animists and have agrarian festivals and seasonal rites.

See Monteil, *Les Khassonké* (1915), *Les Bambara de Ségou et de Kaarta* (1924); Moussa Travelé, *Proverbes et Contes Bambara accompagnés d'une traduction française et d'un abrégé de droit coutumier* (1923).

MANDLA, a town and district of British India in the Jubbulpore division of the Central Provinces on the river Nerbudda, notable for the manufacture of bell-metal vessels. A large part of the town was submerged by the flood of 1926. Pop. (1941), 12,209.

The district of Mandla (area 5,115 sq.mi.) is in the Satpura hills. It is a wild highland region broken up by the valleys of numerous rivers and streams. The Nerbudda flows through the centre of the district receiving several tributaries which take their rise in the Maikal hills, a range thickly clothed with "sal" forests, and forming part of the great watershed between eastern and western India. Except for one small fertile area producing wheat, it is a district of jungle, rice and millets, with a large aboriginal population. The forest area is very large, including some "sal" forests and some fine grazing areas on the plateau lands. The forests abound with big game and tigers are numerous. A few main roads have opened up the district to some extent and the Bengal-Nagpur railway (Satpura section) touches the district at Mandla town. The great famine caused a large decrease in the population and the influenza of 1918 was severe, but the pop. (1941) has nevertheless expanded to 504,580 (60% aboriginal tribes, principally Gonds). The backwardness of the district has excluded it from political reforms. There is some export of food grains and oil seeds, and a larger export of timber and forest produce. It is a favourite shooting district, but very malarious.

MANDOLINE, the treble member of the lute (*q.v.*) family, and therefore a stringed instrument of great antiquity. There are two varieties and both Italian: (1) the *Neapolitan,* 2 ft. long, the best known, which has for strings four courses of pairs of unisons, tuned like the violin in fifths; (2) the *Milanese,* which is slightly larger and has five or six courses of pairs of unisons. The strings, of wire-spun gut, steel and brass, are twanged by means of a plectrum or pick. The Neapolitan mandoline was scored for by Mozart as an accompaniment to the celebrated serenade in *Don Giovanni.* Beethoven wrote for it a "Sonatina per il mandolino" and an Adagio for mandoline and harpsichord. Grétry and Paisiello also introduced it into their operas as an accompaniment to serenades.



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THE MANDOLINE, THE DESCENDANT AND ONLY SURVIVOR OF THE LUTE

MANDRAKE (*Mandragora officinarum*), a plant of the potato family, Solanaceae, and a native of the Mediterranean region. It has a short stem bearing a tuft of ovate flowers, with a thick fleshy and often forked root. The flowers are solitary, with a purple bell-shaped corolla; the fruit is a fleshy orange-coloured berry. The mandrake has been long known for its poisonous properties and supposed virtues. It acts as an emetic, purgative and narcotic, and was much esteemed in old times; but, except in Africa and the East, where it is used as a narcotic and antispasmodic, it has fallen into disrepute. In ancient times, according to Isidorus and Serapion, it was used as a narcotic to diminish sensibility under surgical operations. Shakespeare more than once alludes to this plant, as in *Antony and Cleopatra*: "Give me to drink mandragora." The notion that the plant shrieked when touched is alluded to in *Romeo and Juliet*: "And shrieks like mandrakes torn out of the earth, that living mortals, hearing them, run mad." The mandrake, often growing like the lower limbs of a man, was supposed to have other virtues, and was much used for love philtres, while the fruit was supposed, and in the East is still supposed, to facilitate pregnancy. The North American may apple (*q.v.*) is known also as mandrake.

MANDRILL, the most hideous and most brilliantly coloured of the baboons (*Papio*). The mandrill (*P. sphinx*) inhabits West Africa and is characterized by the shortness of its tail, heavy body, prominent brow-ridges, small, deeply-sunk eyes placed close together, and by the vivid colouring of the bare skin on the face and buttocks. In the latter region it is crimson, shading into blue at the sides and varying in intensity according to the condition of the animals. The cheek-prominences are intense blue, while the central line and termination of the nose are scarlet. The fur is light olive above and silvery-gray beneath, with a small pointed yellow beard. The female is much smaller and less brightly coloured. Young males have black faces. Mandrills feed on fruit, roots, reptiles, insects, scorpions, etc., and inhabit rocky country in large troops. The old males are very ferocious, but, when young, the animals can be easily tamed.

MANDU or MANDOGARH, a ruined city in the Dhar state of Central India, the ancient capital of the Mohammedan kingdom of Malwa. The city is situated at an elevation of 2,079 ft. and extends for 8 m. along the crest of the Vindhyan mountains. It reached its greatest splendour in the 15th century under Hoshang Shah (1405–1434). The circuit of the battlemented wall is nearly 23 m., enclosing a large number of palaces, mosques and other buildings. The oldest mosque dates from 1405; the finest is the Jama Masjid or great mosque, a notable example of Pathan architecture, founded by Hoshang Shah. The marble-domed tomb of this ruler is also magnificent.

MANDURIA, city, Apulia, Italy, province of Taranto, 27 m. west by road from the town of Lecce (22 m. east of Taranto), 270 ft. above sea-level, and 8 m. north of the coast. Pop. (1936), 17,475 (town); 19,594 (commune). It is close to the site of the ancient Manduria, the defences of which consisted of a double line of wall built of blocks of stone, with a broad ditch in front. Some tombs with gold ornaments were found in 1886. It was an important stronghold of the Messapii against Tarentum, and Archidamus III., king of Sparta, fell beneath its walls in 338 B.C., while leading the army of the latter (*see* ARCHIDAMUS). It revolted to Hannibal, but was stormed by the Romans in 209 B.C. Pliny mentions a spring here which never changed its level, and may still be seen. The town was destroyed by the Saracens in the 10th century; the inhabitants settled themselves on the site of the present town, at first called Casalnuovo, which resumed the old name in 1789.

MANES, the inhabitants of the underworld, especially the ghosts of the dead. (Lat. "good people," an obvious euphemism.) In pure Roman cult we hear nothing of the worship of individual dead persons, and fear of ghosts does not seem to have been prevalent. But the collectivity of the inhabitants of the underworld was regarded as divine (*di manes*). Properly, the ancestral ghosts of a family are called *di parentes* or *parentum,* the *di manes* being the same as the *di inferi;* but this distinction tends to disappear about the beginning of our era, hence the common formula on tombstones, *dis manibus* followed by a name in the genitive or dative, *i.e.,* "to the glorified spirit of so-and-so" or "to so-and-so, a glorified spirit." The formula is clumsy at best.

Of public cult of the *manes* we hear little. They are mentioned in a few prayers (*see* ANCESTOR-WORSHIP); such things as burial-grounds are sacred to them; certain persons guilty of very serious offences were devoted (*sacri*) to them (*see* CONSECRATION). It was supposed, at least in later times, that they came forth when the *mundus,* or ritual pit dug at the foundation of a city and opened three times a year (Aug. 24, Oct. 5, Nov. 8) was uncovered. Their dwelling-place was the bowels of the earth, to which any deep chasm might lead (*see* Livy, vii., 6, 4).

In private cult, they, or properly the *di parentes,* were propitiated with offerings of food, wine, garlands, etc., left on potsherds in the middle of the road, during the *dies parentales,* Feb. 13–21. On Feb. 22 followed a family reunion, the Caristia. At the Lemuria (May 9, 11, 13) each householder rose in the night, dropped beans from his mouth, saying "with these beans I ransom me and mine," and then bade the *manes paterni, i.e.,* the *di parentum,* be gone (Ovid, *Fasti,* ii., 531, *et seq.;* v. 419 *et seq.*). Hence, perhaps, is derived the name *lemures* for ghosts. The *larvae* were malignant phantoms, supposed to possess and madden people (Plautus, *Capt.,* 598, *Menaech.,* 890); they had no part in cult.

See G. Wissowa, *Religion u. Kultus* (2nd ed.) p. 232, *et seq.,* and in Pauly-Wissowa, *Realencyklopädie, s.v.* Lemuria; W. Warde Fowler, *Roman Essays,* p. 24 *et seq.*

MANET, ÉDOUARD (1832–1883), French painter, regarded as the most important master of Impressionism (*q.v.*), was born in Paris on Jan. 23, 1832. He studied at Collège Rollin, where his passion for drawing led him to neglect all his other lessons. In 1848 he was placed on board the ship *Guadeloupe,* voyaging to Rio de Janeiro. On his return he first studied in Couture's studio (1851), where his independence often infuriated his master. For six years he was an intermittent visitor to the studio, constantly taking leave to travel, and going first to Cassel, Dresden, Vienna and Munich, and afterwards to Florence, Rome and Venice, where he made some stay. Some important drawings date from this period, and one picture, "A Nymph Surprised." Then, after imitating Couture, more or less, in "The Absinthe-drinker" (1866), and Courbet in "The Old Musician," he devoted himself almost exclusively to the study of the Spanish masters in the Louvre. A group was already gathering round him—Whistler, Legros and Fantin-Latour haunted his studio in the Rue Guyot. His "Spaniard playing the Guitar," in the Salon of 1861, excited much criticism. Delacroix alone defended Manet, but, this notwithstanding, his "Fifer of the Guard" and "Breakfast on the Grass" were refused by the jury.

Then the "Exhibition of the Rejected" was opened, and round Manet a group was formed, including Bracquemond, Legros, Jongkind, Whistler, Harpignies and Fantin-Latour, the writers Zola, Duranty and Duret, and Astruc the sculptor. In 1863, when an amateur, M. Martinet, lent an exhibition-room to Manet, the painter exhibited fourteen pictures; and then, in 1864, contributed again to the Salon "The Angels at the Tomb" and "A Bullfight." Of this picture he afterwards kept nothing but the toreador in the foreground, and it is now known as "The Dead Man." In 1865 he sent to the Salon "Christ reviled by the Soldiers" and the famous "Olympia," which was hailed with mockery and laughter. It represents a nude woman reclining on a couch, behind which is seen the head of a negress who carries a bunch of flowers. A black cat at her feet emphasizes the whiteness of the sheet on which the woman lies. This work (now in the Louvre) was presented to the Luxembourg by a subscription started by Claude Monet (1890). It was hung in 1897 among the Caillebotte collection, which included the "Balcony," and a study of a female head called "Angelina." This production, of a highly independent individuality, secured Manet's exclusion from the Salon of 1866, so that he determined to exhibit his pictures in a place apart during the Great Exhibition of 1867. In a large gallery in the Avenue de l'Alma, half of which was occupied by Courbet, he hung no fewer than fifty paintings. Only one important picture was absent, "The Execution of the Emperor Maximilian"; its exhibition was prohibited by the authorities. From that time, in spite of the fierce hostility of some adversaries, Manet's energy and that of his supporters began to gain the day. His "Young Girl" (Salon of 1868) was justly appreciated, as well as the portrait of Lola; but the "Balcony" and the "Breakfast" (1869) were as severely handled as the "Olympia" had been. In 1870 he exhibited "The Music Lesson" and a portrait of Mlle E. Gonzales.

Not long before the Franco-Prussian War, Manet, finding himself in the country with a friend, for the first time discovered the true value of open air to the effects of painting in his picture "The Garden," which gave rise to the "open air" or *plein air* school. After fighting as a gunner, he returned to his family in the Pyrenees, where he painted "The Battle of the *Kearsarge* and the *Alabama*." His "Bon Bock" (1873) created a *furore*. But in 1875, as in 1869, there was a fresh outburst of abuse, this time of the "Railroad," "Polichinelle," and "Argenteuil," and the jury excluded the artist, who for the second time arranged an exhibition in his studio. In 1877 his "Hamlet" was admitted to the Salon, but "Nana" was rejected. The following works were exhibited at the Salon of 1881: "In the Conservatory," "In a Boat," and the portraits of Rochefort and Proust; and the Cross of the Legion of Honour was conferred on the painter on the 31st of December in that year. Manet died in Paris on Apr. 20, 1883. He left, besides his pictures, a number of pastels and engravings. He illustrated *Les Chats* by Champfleury, and Edgar Allan Poe's *The Raven*. (H. Fr.)

See Zola, *Manet* (Paris, 1867); E. Bazire, *Manet* (Paris, 1884); G. Geffroy, *La Vie artistique* (1893). Th. Duret, *Manet et son Oeuvre* (1902). E. Moreau-Nélaton, *Manet, graveur et lithographe* (1906).

MANETHO (Μανέθων in an inscription of Carthage; Μανεθῶς in a papyrus), Egyptian priest and annalist, was a native of Sebennytus in the Delta. The evidence of Plutarch and other indications connect him with the reigns of Ptolemy I. and II. His most important work was an Egyptian history in Greek, for which he translated the native records. It is now only known by some fragments of narrative in Josephus's treatise *Against Apion,* and by tables of dynasties and kings with lengths of reigns, divided into three books, in the works of Christian chronographers. The earliest and best of the latter is Julius Africanus, besides whom Eusebius and some falsifying apologists offer the same materials; the chief text is that preserved in the *Chronographia* of Georgius Syncellus. Notwithstanding all their defects, the fragments of Manetho have been of great service to scholars ever since Champollion's first decipherments.

See C. Müller, *Fragmenta historicorum graecorum,* ii. 511–616; A. Wiedemann, *Aegyptische Geschichte* (Gotha, 1884), pp. 121 *et sqq.;* J. Krall in *Festgaben für Büdinger* (Innsbruck, 1898); Grenfell and Hunt, *El Hibeh Papyri,* i. 223; also the section on chronology in Egypt, and generally books on Egyptian history and chronology.

MANFRED (*c.* 1232–1266), king of Sicily, was a natural son of the emperor Frederick II. by Bianca Lancia, or Lanzia. Frederick appears to have regarded Manfred as legitimate, and by his will named him as prince of Tarentum and representative in Italy of his half-brother, the German king, Conrad IV. Manfred acted loyally and with vigour in the execution of his trust, and when Conrad appeared in southern Italy in 1252 his authority was quickly and generally acknowledged. When Conrad died (1254) Manfred, after refusing to surrender Sicily to Pope Innocent IV., accepted the regency on behalf of the infant Conradin.

On a rumour (1258) that Conradin was dead, Manfred was crowned king of Sicily at Palermo on Aug. 10 in that year. The report was false; but the new king declined to abdicate, and pointed out the necessity for a strong native ruler. The pope declared Manfred's coronation void and pronounced sentence of excommunication. In conjunction with the Ghibellines Manfred's forces defeated the Guelphs at Monte Aperto on Sept. 4, 1260. He was eventually defeated and killed near Benevento, Feb. 26, 1266. Contemporaries praise his noble and magnanimous character. He was renowned for his physical beauty and great intellectual attainments.

Manfred forms the subject of dramas by E. B. S. Raupach, O. Marbach, F. W. Roggee and Byron. Three letters written by Manfred are found in *Bibliotheca historica regni Siciliae.* (Palermo, 1732).

MANFREDONIA, town and archiepiscopal see (with Vieste), Apulia, Italy, province of Foggia, 22½ mi. N.E. of Foggia by rail, on the coast, 13 ft. above sea-level, to the south of Monte Gargano, and giving its name to the gulf to the east of it. Pop. (1936) 18,787 (town), 19,228 (commune). Founded by Manfred (1263); the Turks destroyed it in 1620, but the castle of the Angevins and parts of the walls are preserved. In the church of S. Domenico, the chapel of the Maddalena contains 14th century paintings. Two miles southwest is the cathedral of S. Maria Maggiore di Siponto, built in 1117 in the Romanesque style, with a dome and crypt. This marks the site of the ancient Sipontum, the harbour of Arpi, which became a Roman colony in 194 B.C., and was not deserted in favour of Manfredonia until the 13th century, having become unhealthy owing to the stagnant lagoons.

See A. Beltramelli, *Il Gargano* (Bergamo, Arti Grafiche, 1907); A. Haseloff, *Bauten der Hohenstaufen in Unteritalien,* i. (Leipzig, 1914), 385 *sqq.*

MANGABEY, a name applied to the West African monkeys of the genus *Cercocebus,* characterized by their bare, flesh-coloured upper eye-lids, and the uniformly coloured hairs of the fur. (*See* Primates.)

MANGALDAN, a municipality (with administrative centre and 29 *barrios* or districts) in the north part of the province of Pangasinan, Luzon, Philippine Islands, about 2 mi. from the Gulf of Lingayen, and located on the Manila-Dagupan railway. Pop. (1939) 18,997 (a gain of 2,236 since 1918) of whom 8,877 were males and none was white. The cultivation of palay (rice) is the chief occupation in the surrounding country. Pangasinan is the vernacular, but Ilocano is also spoken. Of the inhabitants aged 6 to 19 inclusive, 41% in 1939 attended school, while 51·9% of the population 10 years old and over was literate.

MANGALIA, a town and watering-place in the department of Constanţa, Rumania, situated on the Black sea, and at the mouth of a small stream, the Mangalia, 18 m. S. of Constanta. Pop. (1931) 2,776. The inhabitants, among whom are many Turks, Tatars and Bulgarians, are mostly fisherfolk. Mangalia is to be identified with the Thracian Kallatis or Acervetis, a colony of Miletus which continued to be a flourishing place to the close of the Roman period.

In the 14th century it had 30,000 inhabitants, and a large trade with Genoa. Mangalia has a small harbour, with a depth alongside of 3 to 12 ft.

MANGALORE, a seaport of British India, administrative headquarters of the South Kanara district of Madras, and terminus of the west coast line of the Madras railway. Pop. (1941), 81,069. The harbour is formed by the backwater of two small rivers, and large vessels lie 3 mi. offshore. The chief exports are coffee, pepper, sandalwood, fish and fish manure, etc. Mangalore trades directly with Ceylon and the Persian gulf, and is a port of call of the British India Company. There is a small shipbuilding industry, and fishing, coffee-curing and manure-making are carried on. The town has a large Roman Catholic population, with a European bishop, several churches and a convent, and is an industrial and educational centre. It is the headquarters of the Basel Lutheran mission, which has successfully introduced the industries of printing, carpentry and the manufacture of tiles. There are two colleges and a training school. Mangalore was gallantly defended by Colonel John Campbell in 1784, with a garrison of 1,850 men, of whom 412 were English, against Tippoo Sultan's whole army.

MANGAN, JAMES CLARENCE (1803–1849), Irish poet, was born in Dublin on May 1, 1803. His baptismal name was James, the "Clarence" being his own addition. His father, a grocer, who boasted of the terror with which he inspired his children, had ruined himself by imprudent speculation and extravagant hospitality. The burden of supporting the family fell on James, who entered a scrivener's office, at the age of fifteen, and drudged as a copying clerk for ten years. He was employed for some time in the library of Trinity college, and in 1833 he found a place in the Irish ordnance survey. He suffered a disappointment in love, and continued ill health drove him to the use of opium. He was habitually the victim of hallucinations which at times threatened his reason. For Charles Maturin, the eccentric author of *Melmoth,* he cherished a deep admiration, the results of which are evident in his prose stories. He belonged to the Comet Club, a group of youthful enthusiasts who carried on war in their paper, the *Comet,* against the levying of tithes on behalf of the Protestant clergy. Contributions to the *Dublin Penny Journal* followed; and to the *Dublin University Magazine* he sent translations from the German poets. The mystical tendency of German poetry had a special appeal for him. He also wrote versions of old Irish poems, though his knowledge of the language, at any rate at the beginning of his career, was but slight. Some of his best-known Irish poems, however, *O'Hussey's Ode to the Maguire,* for instance, follow the originals very closely. Besides these were "translations" from Arabic, Turkish and Persian. How much of these languages he knew is uncertain, but he had read widely in Oriental subjects, and some of the poems are exquisite though the original authors whom he cites are frequently mythical. He took a mischievous pleasure in mystifying his readers, and in practising extraordinary metres. For the *Nation* he wrote from the beginning (1842) of its career, and much of his best work appeared in it. He afterwards contributed to the *United Irishman.* On June 20, 1849 he died at Meath hospital, Dublin, of cholera. It is not true that starvation was the real cause, but there is no doubt that his wretched poverty made him ill able to withstand disease.

Mangan's fame was deferred by the inequality and mass of his work, much of which lay buried in inaccessible newspaper files under his many pseudonyms, "Vacuus," "Terrae Filius," "Clarence," etc. Of his genius, morbid though it sometimes is, as in his tragic autobiographical ballad of *The Nameless One,* there can be no question. He expressed with rare sincerity the tragedy of Irish hopes and aspirations, and he furnished abundant proof of his versatility in his excellent nonsense verses, which are in strange contrast with the general trend of his work.

The Poems of James Clarence Mangan (1903), and the *Prose Writings* (1904), were both edited by D. J. O'Donoghue, who wrote in 1897 a complete account of the *Life and Writings* of the poet.

MANGANESE, a metallic chemical element which is of a slightly brown appearance and has considerable hardness. Its dioxide (pyrolusite) has been known from very early times, and was at first mistaken for a magnetic oxide of iron. In 1740 J. H. Pott showed that pyrolusite did not contain iron and that it yielded a definite series of salts, whilst in 1774 C. Scheele proved that it was the oxide of a distinctive metal. Manganese (symbol Mn; atomic number 25, atomic weight 54·93) is found widely distributed in nature, being generally found to a greater or less extent associated with the carbonates and silicates of iron, calcium, and magnesium and also as the minerals braunite, hausmannite, psilomelane, manganite, manganese spar and hauerite. It has also been recognized in the atmosphere of the sun, in sea water, and in many mineral waters.

The metal was isolated by J. G. Gahn in 1774, and in 1807 J. F. John obtained an impure metal by reducing the carbonate at a high temperature with charcoal mixed with a small quantity of oil. R. Bunsen prepared the metal by electrolysing manganese chloride in a porous cell surrounded by a carbon crucible containing hydrochloric acid. Various reduction methods have been employed for the isolation of the metal. C. Brunner reduced the fluoride by metallic sodium, and E. Glatzel the chloride by magnesium; H. Moissan reduced the oxide with carbon in the electric furnace. Mostly, manganese is now prepared by the reduction of the oxide by aluminium as in H. Goldschmidt's "thermite" process. It is also prepared in large quantities as ferro-manganese by reduction of the mixed ores of iron and manganese in the blast furnace. (*See* IRON AND STEEL.)

Manganese has a specific gravity of 7·42, and the variety obtained by distilling pure manganese amalgam *in vacuo* is pyrophoric, and burns when heated in a current of sulphur dioxide. The pure metal readily evolves hydrogen when acted upon by sulphuric and hydrochloric acids, and is readily attacked by dilute nitric acid. It precipitates many metals from solutions of their salts. It melts at 1230° C.

COMPOUNDS

Oxides.—Manganous oxide, MnO, is obtained by heating a mixture of anhydrous manganese chloride and sodium carbonate with a small quantity of ammonium chloride; or by reducing the higher oxides with hydrogen or carbon monoxide. It is a dark coloured powder of specific gravity 5·09. *Manganous hydroxide,* $Mn(OH)_2$, is obtained as a white precipitate on adding a solution of a caustic alkali to a manganous salt. It rapidly oxidizes on exposure to air and turns brown, going ultimately to the sesquioxide. Trimanganese tetroxide, Mn_3O_4, is produced more or less pure when the other oxides are heated. It may be obtained crystalline by heating manganese sulphate and potassium sulphate to a bright red heat. It is a reddish brown powder, which when heated with hydrochloric acid yields chlorine. *Manganese sesquioxide,* Mn_2O_3, is found native as the mineral braunite. The hydrated form, found native as the mineral manganite, is produced by the spontaneous oxidation of manganous hydroxide. In the hydrated condition it is a dark brown powder which readily loses water at above 100° C; it dissolves in hot nitric acid, giving manganous nitrate and manganese dioxide: $2MnO(OH)+2HNO_3=Mn(NO_3)_2+MnO_2+2H_2O$. *Manganese dioxide,* or pyrolusite (*q.v.*), MnO_2, which is the most important oxide, may be prepared by heating crystallized manganous nitrate until red fumes are given off, decanting the clear liquid, and heating to 150° to 160° C for 40 to 60 hours, or by heating manganese carbonate to 260° C in the presence of air and washing the residue with very dilute cold hydrochloric acid. It is a hard black solid which readily loses oxygen when strongly heated, leaving a residue of Mn_3O_4. When heated with concentrated hydrochloric acid it yields chlorine, and with concentrated sulphuric acid it yields oxygen. It is reduced to the monoxide when heated in a current of hydrogen. It is a strong oxidizing agent. It dissolves in cold concentrated hydrochloric acid, forming a dark brown solution which probably contains manganic chloride, since salts of the type $MnCl_3,2KCl$ may be prepared from it. Salts corresponding to $MnCl_4$, *e.g.,* K_2MnCl_6, have been obtained by boiling potassium permanganate in glacial acetic acid and separating the solution with hydrogen chloride. It is almost impossible to prepare a pure hydrated manganese dioxide owing to the readiness with which it loses oxygen, leaving residues of the type $x MnO,y MnO_2$. Such mixtures are obtained by the action of alkaline hypochlorites on manganous salts, or by suspending manganous carbonate in water and passing chlorine through the mixture. Manganese dioxide combines with other basic oxides to form *manganites,* and on this property is based the Weldon process for the recovery of manganese from the waste liquors of the chlorine stills. (*See* CHLORINE.) The manganites are amorphous brown solids, insoluble in water, and decomposed by hydrochloric acid with the evolution of chlorine. *Manganese trioxide,* MnO_3, is obtained in small quantity as an unstable deliquescent red solid by dropping a solution of potassium permanganate in sulphuric acid on to dry sodium carbonate. Above 50° C it decomposes into the dioxide and oxygen. It dissolves in water, forming manganic acid, H_2MnO_4, and permanganic acid. *Manganese heptoxide,* Mn_2O_7, prepared by adding pure potassium permanganate to well cooled, concentrated sulphuric acid, when the oxide separates as a dark oil, is very unstable, continually giving off oxygen. It decomposes violently on heating, and explodes in contact with hydrogen, sulphur, phosphorus, etc. It dissolves in water to form a deep red solution which contains *permanganic acid,* $HMnO_4$. This acid is also formed by decomposing barium or lead permanganate with dilute sulphuric acid. It is only known in aqueous solution. This solution is of a deep violet red colour, and is somewhat fluorescent; it decomposes on exposure to light, or when heated. It is a monobasic acid, and a very powerful oxidizing agent.

Manganous Salts.—The anhydrous *chloride,* $MnCl_2$, is obtained as a rose red crystalline solid by passing hydrochloric acid gas over manganese carbonate, first in the cold and afterwards at a moderate red heat. The hydrated chloride, $MnCl_2 4H_2O$, is obtained in rose red crystals by dissolving the metal or its carbonate in aqueous hydrochloric acid and concentrating the solution. It may be obtained in at least two different forms, one isomorphous with $NaCl,2H_2O$, by concentrating the solution between 15° C and 20° C; the other, isomorphous with $FeCl_2 \cdot 4H_2O$, by slow evaporation of the mother liquors from the former. It forms double salts with the chlorides of the alkali metals. The *bromide,* $MnBr_2,4H_2O$, *iodide,* MnI_2, and *fluoride,* MnF_2, are known.

Manganous sulphate, $MnSO_4$, is prepared by strongly heating a paste of pyrolusite and concentrated sulphuric acid until acid fumes cease to be evolved. The ferric and aluminium sulphates present are thus converted into insoluble basic salts, and the residue yields manganous sulphate when extracted with water. The salt crystallizes with varying quantities of water, according to the temperature at which crystallization is effected: between −4° C and +6° C with $7H_2O$, between 15° C and 20° C with $5H_2O$, and between 25° C and 31° C with $4H_2O$. It crystallizes in large pink crystals and combines with the sulphates of the alkali metals to form double salts.

Manganous nitrate, $Mn(NO_3)_2,6H_2O$, obtained by dissolving the carbonate in nitric acid and concentrating the solution, crystallizes from nitric acid solutions in long colourless needles, which melt at 25·8° C.

Manganous carbonate, $MnCO_3$, found native as manganese spar, may be prepared as an amorphous powder by heating manganese chloride with sodium carbonate in a sealed tube to 150° C, or in the hydrated form as a white flocculent precipitate by adding sodium carbonate to a manganous salt. In the moist condition it rapidly turns brown on exposure to air.

Manganous sulphide, MnS, found native as manganese glance, may be obtained by heating the monoxide or carbonate in a porcelain tube in a current of carbon disulphide vapour. R. Schneider obtained a crystalline variety by melting sulphur with anhydrous manganous sulphate and dry potassium carbonate, extracting the residue and drying it in a current of hydrogen. Ammonium sulphide alone gives incomplete precipitation of the sulphide. In the presence of ammonium salts the precipitate is dirty white in colour, whilst in the presence of free ammonia it is a buff colour. This form of the sulphide is readily oxidized when exposed in the moist condition, and is easily decomposed by dilute mineral acids.

Manganic Salts.—The sulphate, $Mn_2(SO_4)_3$, is prepared by gradually heating at 138° C a mixture of concentrated sulphuric and manganese dioxide until the whole becomes of a dark green colour. The excess of acid is removed by spreading the mass on a porous plate, the residue stirred for some hours with nitric acid, again spread on a porous plate, and finally dried quickly at about 130° C. It is a dark green deliquescent powder which decomposes on heating or on exposure to moist air. It is readily decomposed by dilute acids. With potassium sulphate in the presence of sulphuric acid it forms $K_2SO_4 \cdot Mn_2(SO_4)_3 \cdot 24H_2O$, potassium manganese alum. *Manganic fluoride,* MnF_3, a solid obtained by the action of fluorine on manganous chloride, is decomposed by heat into manganous fluoride and fluorine. It readily forms double fluorides such as K_2MnF_5. Manganifluorides, K_2MnF_6, are also known.

Manganese carbide, Mn_3C, is prepared by heating manganous oxide with sugar charcoal in an electric furnace, or by fusing manganese chloride and calcium carbide. Water decomposes it, giving methane and hydrogen, $Mn_3C+6H_2O=3Mn(OH)_2+CH_4+H_2$ (H. Moissan).

Manganates.—These salts are derived from manganic acid, H_2MnO_4. Those of the alkali metals are prepared by fusing manganese dioxide with sodium or potassium hydroxide in the presence of air or of some oxidizing agent (nitre, potassium chlorate, etc.), $MnO_2+2KHO+O=K_2MnO_4+H_2O$. In the absence of air the reaction proceeds slightly differently, some manganese sesquioxide being formed, $3MnO_2+2KHO=K_2MnO_4+Mn_2O_3+H_2O$. The fused mass has a dark olive green colour, and dissolves in a small quantity of cold water to a green solution, which is, however, only stable in the presence of an excess of alkali. The green solution is readily converted into a pink one of permanganate by a large dilution with water, or by passing carbon dioxide through it: $3K_2MnO_4+2CO_2=2K_2CO_3+2KMnO_4+MnO_2$.

Permanganates are the salts of permanganic acid, $HMnO_4$. The *potassium salt,* $KMnO_4$, may be prepared by passing chlorine or carbon dioxide through an aqueous solution of potassium manganate, or by the electrolytic oxidation of the manganate at the anode. It crystallizes in dark purple-red prisms, isomorphous with potassium perchlorate. It acts as a powerful oxidizing agent both in acid and alkaline solution; in the first case two molecules yield five atoms of available oxygen and in the second, three atoms:

$$2KMnO_4+3H_2SO_4=K_2SO_4+2MnSO_4+3H_2O+5O;$$
$$2KMnO_4+3H_2O\quad=2MnO_2,H_2O+2KHO+3O.$$

It completely decomposes hydrogen peroxide in sulphuric acid solution—

$$2KMnO_4+5H_2O_2+3H_2SO_4=K_2SO_4+2MnSO_4+8H_2O+5O_2.$$

It decomposes when heated to 200°–240° C:

$$2KMnO_4=K_2MnO_4+MnO_2+O_2;$$

and when warmed with hydrochloric acid it yields chlorine:

$$2KMnO_4+16HCl=2KCl+2MnCl_2+8H_2O+5Cl_2.$$

It is used extensively in analytical work, especially in estimating ferrous salts and oxalic acid or oxalates, and also in organic chemistry for oxidations.

Sodium permanganate, $NaMnO_4,3H_2O$ (?), may be prepared in a similar manner, or by precipitating the silver salt with sodium chloride. It crystallizes with great difficulty. A solution of the crude salt is used as a disinfectant (Condy's Fluid).

Ammonium permanganate, $NH_4 \cdot MnO_4$, explodes violently on rubbing, and its aqueous solution decomposes on boiling: $2NH_4MnO_4=2MnO_2+N_2+4H_2O$.

Barium permanganate, $BaMn_2O_8$, crystallizes in almost black needles, and is formed by passing carbon dioxide through water containing suspended barium manganate.

Detection.—Manganese salts can be detected by the amethyst colour they impart to a borax-bead when heated in the Bunsen flame, and by the green mass formed when they are fused with a mixture of sodium carbonate and potassium nitrate. Manganese may be estimated quantitatively by precipitation as carbonate, this salt being then converted into the oxide, Mn_3O_4, by ignition, or to the sulphate, $MnSO_4$; or by precipitation as hydrated dioxide by means of ammonia and bromine water, followed by ignition to Mn_3O_4. The valuation of pyrolusite is generally carried out by means of a distillation with hydrochloric acid, the liberated chlorine passing through a solution of potassium iodide, and the amount of iodine liberated being ascertained by means of a standard solution of sodium thiosulphate. (X.)

PRODUCTION

The principal use of manganese is in the manufacture of iron and steel, about 95% of the world's production of manganese ores, manganiferous iron-ores, and manganiferous zinc residuum being consumed in metallurgical processes. Its chief chemical uses are as a constituent of oxidizing agents and colouring materials, and as a flux in the smelting of silver and lead ores. Salts of manganese are used as fertilizers and massive rhodonite as an ornamental stone. Manganese is also used for medical purposes. Ores of the metal are widely distributed, but deposits of commercial importance are known only in a few countries. The principal of these are Russia (Caucasus), the ore of which consists mainly of pyrolusite; India, Brazil and West Africa. Minor producers of the metal are Italy, Spain, the United States, Cuba and Japan; while deposits are also known in Germany, Greece, Egypt, Canada, Mexico, Colombia, Chile and Queensland. *See* PHYSICAL RESOURCES: *Manganese.*

Manganese Ore Produced in Principal Countries (in metric tons)

Country	1933	1935	1937
Russia	1,021,300	2,384,600	3,002,000*
Gold Coast†	269,395	405,117	535,838
British India	221,811	651,779	826,498*
Japan	43,535	71,659	67,753*
Brazil	24,893	41,767	253,661†
Union South Africa	21,229	95,450	631,194
Cuba	27,625	35,269	131,299
United States	19,453	26,852	40,887
Egypt	187	87,303	134,972*
World output	1,717,000	3,920,000	5,136,000*

*1936. †Exports. "Minerals Yearbook 1938," U.S. Bureau of Mines.

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MANGANESE STEEL. In modern steels manganese is used as a strengthener and toughener; carbon-free alloys are remarkably ductile in a wide range; while cast manganese steel containing over 10% of manganese is the toughest material known. Crucible or electric steels can be properly deoxidized without manganese, consequently high carbon steels have a sharply limited quantity. Bessemer or open-hearth steels require at least 0·3% manganese to counteract the effect of oxygen and sulphur; a slight excess also improves the rolling properties. For these reasons the tonnage steels contain from 0·3% to 0·9% manganese. Increasing wheel loads have caused a demand for harder rails to resist the wear. Recent American specifications for 120 to 140-lb. rails call for carbon 0·72 to 0·89, manganese 0·5 to 0·9 and silicon more than 0·15%.

A new high strength boiler plate and structural steel has been produced, misnamed in America "silicon steels." This and the excellent ship-building material (D-Quality Structural Steel) of this general type, used by the British admiralty since the Washington conference, is described in the article on STEELS, ALLOY. Continental engineers favour even higher silicons. The "Freund" or "F" steel produced in Germany contains 0·13 to 0·17 carbon, 0·90 to 1·20 silicon, and 0·7 to 1·0 manganese. Freund steel's ultimate strength is somewhat less than that of D-steel, and the elongation correspondingly higher. Most leaf springs for vehicles are made with a "silico-manganese" steel containing 0·45 to 0·60 carbon, 1·8 to 2·2% silicon and 0·6 to 0·9 manganese. European practice favours the lower chemical ranges. Such steels permit a wider temperature range in forming the hardening than high carbon spring steels. "Non-deforming" steels for gauges, master tools, intricate dies, and broaches contain 0·80 to 0·95 carbon and 1·5 to 1·75 manganese. For any of these steels a heat treatment schedule can be fixed so that the principal dimensions will be the same after hardening, drawing, and polishing off the scale as when the piece left the machine tool. High strength steel castings, made in America since 1909, contain 0·20 to 0·30 carbon and 1·10 to 1·40 manganese. Such castings when properly made approach D-steel and are used for artillery mounts, freight car couplers, and places where the maximum quality is desired.

Manganese acquired a bad reputation as an alloying element, except in large quantities, from Hadfield's early experiments wherein carbon always increased with the manganese. When ferromanganese with low carbon became available, its moderate use had no bad effects—quite the contrary. (Commercial production of electrolytic manganese in 1939 presages an entirely new alloy family of hitherto unattainable properties.) Hence we find wide use for plain carbon steels, strengthened by 1% manganese rather than the ordinary 0·5% for deoxidation; 1½% manganese added to free-cutting steels with high sulphur to improve their toughness; 1¾% manganese added to medium carbon steels (0·30 to 0·50% carbon) for a type of true alloy steel, for such important parts as automobile axles, oil quenched forgings, steam valves, rifle barrels, cylinders for compressed gas; and the same with 0·15% vanadium for forgings too large to be effectively quenched. Manganese, properly proportioned to the carbon, in a well-made steel will increase its hardenability in a very useful way. Mass production also approves of the low cost of this alloying element. Development of special open-hearth furnace techniques, and especially of new deoxidizers and addition agents, produces these medium manganese steels of fine grain, and therefore of unusually good toughness added to inherent strength. For these reasons American use is rapidly growing at the expense of alloy steels containing the more expensive nickel and chromium. (E. E. T.)

MANGANITE, a mineral consisting of hydrated manganese sesquioxide, $Mn_2O_3.H_2O$, crystallizing in the orthorhombic system and isomorphous with diaspore and goethite. Crystals are prismatic and deeply striated parallel to their length; they are often grouped together in bundles. The colour is dark steel-grey to iron-black, and the lustre brilliant and submetallic; the streak is dark reddish-brown. The hardness is 4, and the specific gravity 4·3. There is a perfect cleavage parallel to the brachypinacoid. The mineral contains 89·7% of manganese sesquioxide; it dissolves in hydrochloric acid with evolution of chlorine. The best crystallized specimens are those from Ilfeld in the Harz, where the mineral occurs with calcite and barytes. As an ore of manganese it is much less abundant than pyrolusite or psilomelane. French authors use the name "acerdèse" (Gr. ἀκερδής, unprofitable), because the mineral is of little value for bleaching purposes as compared with pyrolusite.

MANGBETTU (*Monbuttu*), a negroid people of Central Africa living to the south of the Niam-Niam in the Welle district of Belgian Congo. The Mangbettu were some of the most inveterate cannibals in Africa. Physically the Mangbettu differ from their negro neighbours, are not so black and are less negroid, many having quite aquiline noses. The beard, too, is fuller than in most negroes. The men wear bark cloth, the women a simple loin cloth, often not that. Both sexes paint the body in elaborate designs. As potters, sculptors, boatbuilders and masons the Mangbettu have had few rivals in Africa. Their huts, with pointed roofs, were larger, better built, and cleaner than those of their neighbours, and some of their more important buildings were of great size and exhibited some skill in architecture.

See G. A. Schweinfurth, *Heart of Africa* (1874); W. Junker, *Travels in Africa* (1890); G. Casati, *Ten Years in Equatoria* (1891); C. van Overbergh and Ed de Jonghe, *Les Mangbetu* (1909).

MANGEL, mangel-wurzel or mangold is a large type of beet belonging to the species *Beta vulgaris* which also includes vegetable and sugar beets and Swiss chard. These types interbreed freely. The species probably originated from the wild beet *Beta maritima* and had its principal developmental centre in the eastern Mediterranean region. Mangold, the original name, is German and it has been somewhat modified in use. In France mangels are known as disettes. The mangel root is a store of food stuffs in the forms of sugar and other carbohydrates. The sugar percentage is approximately 7-8%, being about half that of sugar beets. The principal use of the crop is to provide a high tonnage of a succulent, nutritious feed for use in livestock, including poultry, feeding. As feed for cattle and sheep, mangel roots are highly regarded and being very palatable they are often utilized as a relish for stimulating milk production. They are also considered valuable in conditioning animals for show purposes. Pound for pound the dry matter of mangels is equivalent in feed value to grain. The crop is usually grown in regions too cool or seasons too short for corn and where other conditions, such as soil fertility, soil type, and moisture supply, are particularly favourable. Corn as compared with mangels will produce nearly double the yields of dry matter in the regions of its adaptation. Mangels are grown chiefly in northern and coastal western Europe and on the Pacific coast of the United States and Canada.

The plant is a biennial. During the first year of growth the stem remains very short and a rosette of large, crisp, prominent-veined leaves arises from it. In the second year the upper portion of the primary root becomes very large during midsummer and autumn, attaining a diameter of from 4–10 in. and a length of from 6–30 in. The shape of the root is a varietal characteristic. If it remains in place and survives the winter, or if it is properly stored, and transplanted the following spring, tall angular, branching stems grow to heights of 3 ft. or more and produce inconspicuous flowers and seeds. The flowers are perfect and arranged in dense, sessile clusters, each subtended by a small bract, along an axis. The seeds are embedded in the flower parts and usually several flowers clustered together give rise to the "seed ball," from which several seedlings may develop. Five groups of varieties are recognized based upon root shape and colour and leaf colour. Shapes recognized are globular, flattened, cylindrical and fusiform while colours may be white, yellow, orange or red. Zonal colouration may also occur within the root.

Culture.—Like other root plants the mangel is a row crop. The seed is drilled about 1½ in. deep in rows 24–36 in. apart at a rate of 10–15 lb. per acre. After emergence of the seedlings cultivation is begun and continued until late summer. When the plants reach the four-leaved stage they are spaced about 10–14 in. apart in the rows by thinning. Hand-hoeing is then begun and the crop is weeded as required. Harvesting is done by mechanically lifting the roots previous to heavy frosts in the fall and removing the tops by cutting. The roots may be stored in large heaps or in covered pits or root cellars. Successful storage is dependent upon careful handling to avoid severe bruising, and also upon good ventilation. The roots may be pulled and fed directly as needed without topping.

Best soils for mangels are those rich, well drained and in good tilth. On more shallow land varieties with shorter roots may be grown. The crop responds markedly to heavy applications of barnyard manure and to potash, phosphate and nitrogen fertilizers. Although mangels are sometimes grown for several years on the same land they more commonly occupy a place in rotation with grain and forage crops. Requiring careful cultivation and weed control, they leave the soil in excellent condition for succeeding crops.

The principal values of the mangel are its productiveness, yields usually being 20–45 tons per acre, and its succulence. Very few crops will produce as much succulent feed per area. Mangels require much hand labour in thinning, cultivating, harvesting and storage. In corn regions cost of producing corn ensilage for succulent feed is much less than with mangels or other root crops. Mangels are more drought and heat-tolerant but more sensitive to frost than turnips or rutabagas, often grown for similar uses. Also, they are less affected by root maggots and aphis than the latter crops. Important objectives sought in better varieties are high yield of sugar and dry matter, freedom from disease and premature seed-stalk formation (bolting) and smooth, well shaped roots of good keeping quality. (D. C. SH.)

MANGIN, CHARLES EMMANUEL (1866–1925), French soldier, was born at Sarrebourg, Moselle, on July 6, 1866, of a military family. Mangin left the École Spéciale Militaire at Saint Cyr in 1888 for Africa, and with the exception of three years spent in Tongking, and 10 months in France, he remained for 26 years in different parts of Africa. In Aug. 1913 he was promoted to the rank of general of brigade. He was a member of Marchand's expedition and was one of the legendary company who were said to have marched "for three days without a halt." It was he who, at the head of 5,000 men routed the bandit El'hiba in the plain of Ben Guerir and so relieved Marrakesh. His book, *La Force Noire* (1910) brought home to Frenchmen the immeasurable resources of their empire.

In 1917 during World War I he was in command of the 5th army, and in the following year the supreme command imposed upon him the hard task of checking the German offensive directed against Compiègne. Eight fresh divisions were entrusted to him, and with these 60,000 men he checked von Hutier's advance at Noyon. Subsequently he was entrusted with the 10th army and was ordered in conjunction with General Degoutte, to break in the German salient south of the Aisne. This he accomplished. For a year he commanded the Army of Occupation on the Rhine. He died on May 12, 1925.

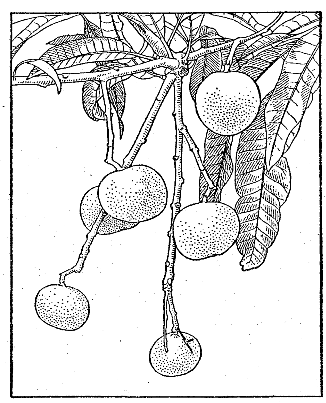
MANGNALL, RICHMAL (1769–1820), born probably at Manchester, on March 7, 1769, became a schoolmistress at Crofton Hall, Yorkshire, which she conducted most successfully until her death. She was the author of *Historical and Miscellaneous Questions for the Use of Young People* (1800), generally known as "Mangnall's Questions," which was prominent in the education of English girls in the first half of the 19th century. She died on May 1, 1820.

MANGO, one of the most important and widely-cultivated fruits of the tropical world. Its origin is lost in antiquity: according to some authorities, horticultural forms are derived from *Mangifera indica* (family Anacardiaceae), considered indigenous to the region of eastern India, Burma and Assam; but other species, such as *M. laurina* may have entered into the composition of some, particularly those of the Malayan region.

Few fruits have the historic background of the mango, and few are so inextricably connected with the folklore and religious ceremonies of India. Buddha himself was presented with a mango grove, that he might find repose in its grateful shade. The economic importance of the mango in ancient times is attested by one of the Sanskrit names, *am*, which has an alternative meaning of provisions or victuals. The Chinese traveler Hwen T'sang, who visited Hindustan between A.D. 632 and 645, was the first person, so far as known, to bring the mango to the attention of the outside world. Friar Jordanus wrote of it in 1328, and John de Marignolli in 1349. Akbar, the Mughal emperor who reigned at Delhi from 1556 to 1605, planted near Darbhanga the Lakh Bagh, an orchard of 100,000 mango trees. Nothing better attests the esteem in which the fruit has long been held than this immense planting, made at a time when large orchards of fruit trees were almost unknown.

The name mango, by which the fruit is known in English- and Spanish-speaking countries, is derived from the Tamil *man-kay* or *man-gay*, which the Portuguese adopted as *manga* when they settled in western India. Probably because of the difficulty in transporting seeds (they retain their viability a short time only), introduction of the tree into the western hemisphere did not take place until about 1700, when it was planted in Brazil; thence it reached the West Indies about 1740. It has taken on the appearance of a wild species in many parts of tropical America, trees springing up everywhere from seeds scattered by the roadside. During the ripening season, mangos are a major foodstuff wherever grown.

The tree is evergreen, often reaching large size (50–60 ft.) and attaining great age. It is one of the favourite shade trees of the tropics. The leaves are lanceolate, up to 12 in. long: the flowers, which are small, pinkish and fragrant, are borne in large terminal panicles. They are polygamous, *i.e.*, some have both stamens and pistil, others stamens only. The fruit varies greatly in size and character, as would be expected of a species (or combination of species) which has been in cultivation for a long time. The smallest mangos are no larger than plums, while others may weigh 4 or even 5 lb. The form is oval, round, heart-shaped, kidney-shaped or long and slender. Some varieties are beautifully coloured with shades of red and yellow, while others are dull green. The single large seed is flattened, the flesh which surrounds it yellow to orange in colour, juicy and of delicious spicy flavour. Fryer, writing of mangos in 1673, said "for Taste, the Nectarine, Peach and Apricot fall short." Hamilton, who wrote in 1727, went even further. "The Goa mango," he declared, "is reckoned the largest and most delicious to the taste of any in the world, and I may add, the wholesomest and best tasted of any Fruit in the World." There are ample grounds for considering the mango—as has been done by many writers—the "king of tropical fruits."



BUREAU OF PLANT INDUSTRY, U.S. DEPARTMENT OF AGRICULTURE

CLUSTER OF FRUIT OF ITOMARACA MANGO TREE (MANGIFERA INDICA), RIO DE JANEIRO, BRAZIL

But the seedlings so abundant throughout the tropics do not represent this fruit at its best. These are characterized by coarse fibres throughout the flesh which makes eating an annoying process; while the fine varieties of India as well as those of the race cultivated in the Philippines, Indo-China, and the Malayan region generally, are devoid of fibre and frequently are of excellent quality.

In 1889 the U.S. department of agriculture introduced into Florida the first of the grafted East Indian varieties, *Mulgoba.* In subsequent years, mainly through the efforts of Reasoner Brothers and of David

Fairchild, more than fifty others were taken to the U.S., whence their cultivation gradually spread to many parts of the American tropics. Some of the best Indian sorts are *Amini, Pairi,* and a seedling of Mulgoba which originated in Florida and is known as *Haden.* The Philippine or Cambodiana race is represented by such varieties as *Saigon* and *Carabao. Julie* is an excellent dwarf variety which first received horticultural attention in the French West Indies.

Mango trees are injured by a few degrees of frost. They are successfully cultivated in southern Florida, where a small commercial industry developed, but they have not been wholly successful in any part of California, though occasional trees have fruited in that state. They are not particular as to soil, but the finer varieties produce fruit abundantly only in regions where there is a well-marked dry season corresponding to the flowering and fruiting period of the tree. This is due in large part to a fungous disease known as anthracnose (*Colletotrichum*) which destroys flowers and young fruits whenever moist atmospheric conditions prevail.

Propagation of the finer sorts is by means of grafting or budding. Inarching is generally practiced in tropical Asia; crown-grafting and shield-budding are more popular in Florida, since they are less laborious and result in better trees. It is to be noted that the Indian varieties do not come true from seed, whereas seedlings of the Philippine race produce fruit closely resembling that of the parent. This is due to the fact that the Indian sorts are usually monoembryonic, while those of the Philippine race are polyembryonic; several young plants, not the result of fertilization of the egg-cell, but arising as vegetative buds in the nucellar tissue, may grow from a single seed.

Except with dwarf varieties such as Julie, commercial plantings are spaced 30x30 or even 35x35 ft. Cultural requirements are difficult to satisfy in most regions, due to the tendency of many fine varieties to fruit sparingly under orchard conditions favourable to many other fruit trees. The mango has a number of enemies, the most serious of which are anthracnose, mentioned above, and fruit flies of several species. Larvae of the latter infest the ripe fruits in many countries.

(W. Po.)

MANGOLD: *see* MANGEL.

MANGOSTEEN (*Garcinia mangostana*), a tree belonging to the family Guttiferae. It is a native of the Malay peninsula, and is extensively cultivated in southern Tenasserim, and in some places in the Madras presidency. Poor results have followed the attempt to introduce it to other countries; and A. de Candolle refers to it as one of the most local among cultivated plants both in its origin, habitation and cultivation. It belongs to a family in which the mean area of the species is very restricted. It is an evergreen about 20 ft. high, and is somewhat fir-like in general form, but the leaves are large, oval, entire, leathery and glistening. Its fruit, the much-valued mangosteen, is about the size and shape of an orange, and is somewhat similarly partitioned, but is of a reddish-brown to chestnut colour. Its thick rind yields a very astringent juice, rich in tannin, and containing a gamboge-like resin. The soft and juicy pulp is snow-white or rose-coloured, and of delicious flavour and perfume. It is wholesome, and may be administered in fever.

MANGROVE. The "mangrove forests" along tidal estuaries, in salt marshes, and on muddy coasts in the tropics of both old and

BY COURTESY OF A. M. HALLIGEY

A LAGOON, SHOWING MANGROVES

new worlds, are composed of trees and shrubs belonging mainly to the genus *Rhizophora* of the family Rhizophoraceae, but including, especially in the eastern mangrove formations of Further India and the Malay archipelago, members of other families, such as Lythraceae (*Sonneratia*), Verbenaceae (*Avicennia*), and the acaulescent Nipa-palm. Their trunks and branches constantly produce adventitious roots, which, descending in arched fashion, strike at some distance from the parent stem, and send up new trunks, the forest thus spreading like a banyan grove. An advantage in dispersal, very characteristic of the order, is afforded by the seeds, which have a striking peculiarity of germination. While the fruit is still attached to the parent branch the long radicle emerges from the seed and grows rapidly downwards. When the seed falls the young root is in the right position to be driven into the mud; the plant being thus rooted the plumule makes its appearance. The young root may grow to such a length that it becomes fixed in the mud before the fruit separates from the parent tree. An interesting feature of the mangrove is the air-roots, erect or kneed branches of the roots, which project above the mud, and are provided with minute openings (lenticels), into which the air diffuses and then passes by means of passages in the soft spongy tissue to the roots which spread beneath the mud. The wood of some species is hard and durable, and the astringent bark is used in tanning, yielding *cutch.* The fruit of the common mangrove, *Rhizophora mangle,* is sweet and wholesome.

MANHATTAN, an island $12\frac{1}{2}$ mi. long and $2\frac{1}{2}$ mi. wide lying between the Hudson and East rivers, is one of the five boroughs comprising New York city, U.S.A. Broadway, the longest street in the world, runs 16 mi. from the southern tip of the island, cutting through financial, civic, needle-trades, amusement, automobile, residential and educational sections, to a semisuburban road at the northern city limits. It is the world's greatest business centre. The population in 1940 was 1,889,924. (*See* NEW YORK CITY.)

MANHATTAN, a city of northeastern Kansas, U.S.A., on the Kansas (Kaw) river near the mouth of the Big Blue; the county seat of Riley county and the seat of the Kansas state college. It is on federal highways 40 and 24 and is served by the Rock Island and the Union Pacific railways. The population was 7,989 in 1920 (92% being native white) and was 11,659 in 1940 by the federal census. The college was opened in 1863 in the building of Bluemont college (chartered 1858) and moved in 1873 to its present location on the western edge of the city. The city was founded in 1854 and incorporated in 1857.

MANICHAEISM, the religion of Mani or Manes, which spread from Babylonia and during the 4th century was widely influential in the Empire.

Life of Mani.—According to the Mohammedan tradition, Mani was born in the year 527 of the astronomers of Babylon (A.D. 215–216). He received a careful education at Ctesiphon from his father Fatak or Patak (Πατέκιος). As the father connected himself at a later period with the confession of the *Moghtasilah,* or "Baptists," in southern Babylonia, the son also was brought up in the religious doctrines and exercises of this sect. These Baptists were apparently connected with the Elkesaites and the Hemerobaptists, and certainly with the Mandaeans. It is probable that this Babylonian sect had absorbed Christian elements. Thus the boy early became acquainted with very different forms of religion.

When Mani had reached the age of twenty-five or thirty years he began to proclaim his new religion. This he did at the court of the Persian king, Shāpūr I, and, according to the story, on the coronation day of that monarch (241–2). He did not remain in Persia, but undertook long journeys for the purpose of spreading his religion, and also sent forth disciples. According to the *Acta Archelai,* his missionary activity extended westwards into the territory of the Christian church; but from oriental sources it is certain that Mani rather went into Transoxiana, western China, and southwards as far as India. His labours there as well as in Persia were not without result. Like Mahomet after him and the founder of the Elkesaites before him, he gave himself out for the last and highest prophet, who was to surpass all previous divine revelation, which only possessed a relative value, and to set up the perfect religion. In the closing years of the reign of Shāpūr I. (*c.* 270) Mani returned to the Persian capital, and gained adherents even at court. But the dominant priestly caste of the Zoroastrian Magians, on whose support the king was dependent, were naturally hostile to him, and after some successes Mani was made a prisoner, and had then to flee. The successor of Shāpūr, Hōrmizd (272–273), appears to have been favourably disposed towards him, but Bahrām I. abandoned him to the fanaticism of the Magians, and caused him to be executed in the capital in the year 276–7. The Persian government made great efforts to exterminate the new religion, but in vain. Mani composed a number of books and epistles in Aramaic and at least one in Persian. These were in great part still known to the Mohammedan historians, but are now mostly lost.

Manichaean System.—The Manichaean system is one of consistent, uncompromising dualism, in the form of a fantastic philosophy of nature. The distinction between the physical and the ethical, the natural and the spiritual, did not exist for Mani. When he co-ordinates good with light, and evil with darkness, this is no mere figure of speech, but light is actually good and darkness evil. From this it follows that religious knowledge involves the knowledge of nature and her elements, and that redemption consists in a process of freeing the element of light from the darkness. Under such circumstances ethics becomes a doctrine of abstinence in regard to all elements originating within the sphere of darkness.

The self-contradictory character of the present world forms the point of departure for Mani's speculations. From the contradictory character of the world he concludes the existence of two beings, originally quite separate from each other—light and darkness. Each is to be thought of according to the analogy of a kingdom. Light presents itself to us as the good primal spirit (God, radiant with the virtues of love, faith, fidelity, high-mindedness, wisdom, meekness, knowledge, understanding, mystery and insight), and then further as the heavens of light and the earth of light, with their guardians the glorious aeons or angels. Darkness is likewise a spiritual kingdom (more correctly, it also is conceived of as a spiritual and feminine personification), but it has no "God" at its head. It embraces an "earth of darkness." As the earth of light has five tokens (the mild zephyr, cooling wind, bright light, quickening fire, and clear water), so has the earth of darkness also five (mist, heat, the sirocco, darkness and vapour). Satan with his demons was born from the kingdom of darkness. These two kingdoms stood opposed to each other from all eternity, touching each other on one side, but remaining unmingled. Then Satan made an incursion into the kingdom of light, into the earth of light. The God of light, with his *syzygy*, "the spirit of his right hand," now begot the primal man, and sent him, equipped with the five pure elements, to fight against Satan. But the latter proved himself the stronger, and the primal man was for a moment vanquished. And although the God of light himself now took to the field, and with the help of new aeons (the spirit of life, etc.) inflicted total defeat upon Satan, and set the primal man free; the latter had already been robbed of part of his light by the darkness, and the five dark elements had already mingled themselves with the generations of light.

Creation of Man.—It is significant of the pessimistic character of the system that, while the formation of the world is considered as a work of the good spirits, the creation of man is referred to the princes of darkness. The first man, Adam, was engendered by Satan in conjunction with "sin," "cupidity," "desire." But the spirit of darkness drove into him all the portions of light he had stolen, in order to be able to dominate them the more securely. Hence Adam is a discordant being, created in the image of Satan, but carrying within him the stronger spark of light. Eve is given him by Satan as his companion. She is seductive sensuousness, though also having in her a small spark of light. But if the first human beings thus stood entirely under the dominion of the devil, the glorious spirits took them under their care from the very outset, sending aeons down to them (including Jesus), who instructed them regarding their nature, and in particular warned Adam against sensuality. But this first man fell under the temptation of sexual desire. Cain and Abel indeed are not sons of Adam, but of Satan and Eve; Seth, however, who is full of light, is the offspring of Adam by Eve. Thus did mankind come into existence, its various members possessing very different shares of light, but the men having uniformly a larger measure of it than the women. In the course of history the demons sought to bind men to themselves by means of sensuality, error and false religions (among which is to be reckoned above all the religion of Moses and the prophets), while the spirits of light carried on their process of distillation with the view of gaining the pure light which exists in the world. But these good spirits can only save men by imparting to them the true *gnosis* concerning nature and her forces, and by calling them away from the service of darkness and sensuality. To this end prophets, preachers of true knowledge, have been sent into the world. Mani, following the example of the gnostic Jewish Christians, appears to have held Adam, Noah, Abraham (perhaps Zoroaster and Buddha) to be such prophets. Probably Jesus was also accounted a prophet who had descended from the world of light—not, however, the historical Jesus, but a contemporaneous phantom Jesus, who neither suffered nor died (*Jesus impatibilis*). According to the teaching of some Manichaeans, it was the primal man who disseminated the true gnosis in the character of Christ.

Mani, the "Ambassador of Light."—But at all events Mani himself, on his own claim, is to be reckoned the last and greatest prophet, who took up the work of Jesus impatibilis, and first brought full knowledge. He is the "leader," the "ambassador of the light," the "Paraclete." It is only through his agency and that of his imitators, "the elect," that the separation of the light from the darkness can be completed. The system contains very fantastic descriptions of the processes by which the portions of light when once set free finally ascend even to the God of light. He who during his lifetime did not become one of the elect, who did not completely redeem himself, has to go through a severe process of purification on the other side of the grave, till he too is gathered to the blessedness of the light. When the imprisoned elements of light have at last been completely, or as far as possible, delivered from the world, the end of all things comes. All glorious spirits assemble, the God of light himself appears, accompanied by the aeons and the perfected just ones. The angels supporting the world withdraw themselves from their burden, and everything falls in ruins. A tremendous conflagration consumes the world; the perfect separation of the two powers takes place once more.

Ethics of the Manichaeans.—On the basis of such a cosmical philosophy, ethics can only have a dualistic ascetic character. Manichaean ethics is not merely negative, however, since it is necessary to cherish, strengthen and purify the elements of light, as well as free oneself from the elements of darkness. The aim is not self-destruction, but self-preservation; and yet the ethics of Manichaeism appears in point of fact as ascetic, to an extent that could only be practised by few; hence the religion must have abandoned all attempts at an extensive propaganda had it not conceded the principle of a twofold morality. A distinction was made in the community between the *electi* (*perfecti*), the perfect Manichaeans, and the *catechumeni* (*auditores*), the secular Manichaeans. Only the former submitted themselves to all the demands made by their religion; for the latter the stringency of the precepts was relaxed. They had to avoid idolatry, sorcery, avarice, falsehood, fornication, etc.; above all, they were not allowed to kill any living being (the ten commandments of Mani). They had also to free themselves as much as possible from the world; but in truth they lived very much as their non-Manichaean fellow-citizens. We have here essentially the same condition of things as in the Catholic Church, where a twofold morality is also in force, that of the religious orders and that of secular Christians—only that the position of the *electi* in Manichaeism was a more distinguished one than that of the monks in Catholicism. For, after all, the Christian monks never quite forgot that salvation is given by God through Christ, whereas the Manichaean *electi* were actually themselves redeemers.

It is evident that the religion of Mani borrowed various elements from older Oriental faiths, especially from Babylonian and Zoroastrian sources. It arose "in a country where several religions were competing with one another, and where, in consequence of this, various hybrid sects had been formed." The relations of Manichaeism to other religions have been investigated in much detail by Kessler and Cumont (*see* references given below); but special mention must be made here of its relation to Christianity.

Manichaeism and Christianity.—It is very difficult to determine what was the extent of Mani's knowledge of Christianity, how much he himself borrowed from it, and through what channels it reached him. It is certain that Manichaeism, in those districts where it was brought much into contact with Christianity, became additionally influenced by the latter at a very early period. The Western Manichaeans of the 4th and 5th centuries are much more like Christians than their Eastern brethren. In this respect Manichaeism experienced the same kind of development as Neo-Platonism. As regards Mani himself, it is safest to assume that he held both Judaism and Catholic Christianity to be false religions.

Finally, the Manichaean doctrines exhibit points of similarity to those of the Christian Elkesaites. The historical relation of Mani to Christianity is then as follows. From Catholicism, of which he very probably had no detailed knowledge, he borrowed nothing. On the other hand, he looked upon what he considered to be Christianity proper—that is, Christianity as it had been developed among the sects of Basilidians, Marcionites, and perhaps Bardesanites, as a comparatively valuable and sound religion. He took from it the moral teaching of the Sermon on the Mount, and a criticism of the Old Testament and of Judaism so far as he required it. Indications of the influence of Marcionitism are found in the high estimation in which Mani held the apostle Paul, and in the fact that he explicitly rejects the Book of Acts.

The Secret of Manichaeism.—How are we to explain the rapid spread of Manichaeism, and the fact that it really became one of the great religions? What gave it strength was that it united an ancient mythology and a thorough-going materialistic dualism with an exceedingly simple spiritual worship and a strict morality. On comparing it with the Semitic religions of nature we perceive that it was free from their sensuous *cultus,* substituting instead a spiritual worship as well as a strict morality. Manichaeism was thus able to satisfy the new wants of an old world. It offered revelation, redemption, moral virtue and immortality, spiritual benefits on the basis of the religion of nature. A further source of strength lay in the simple yet firm social organization which was given by Mani himself to his new institution. The wise man and the ignorant, the enthusiast and the man of the world, could all find acceptance here, and there was laid on no one more than he was able and willing to bear.

Originally furnished from fragments of various religions, Manichaeism could increase or diminish this possession without rupturing its own elastic framework. And, after all, great adaptability is just as necessary for a universal religion as a divine founder in whom the highest revelation of God may be seen and reverenced. Manichaeism indeed, though it applies the title "redeemer" to Mani, has really no knowledge of a redeemer, but only of a physical and gnostic process of redemption; on the other hand, it possesses in Mani the supreme prophet of God. If we consider in conclusion that Manichaeism gave a simple, apparently profound, and yet convenient solution of the problem of good and evil, a problem that had become peculiarly oppressive to the human race in the 2nd and 3rd centuries, we shall have named the main factors which account for the rapid spread of the system.

History of Manichaeism.—Manichaeism first gained a firm footing in the East, *i.e.,* in Persia, Mesopotamia and Transoxiana. The persecutions it had to endure did not hinder its extension. Even after the conquests of Islam the Manichaean Church continued to maintain itself, indeed it seems to have become still more widely diffused by the victorious campaigns of the Mohammedans, and it frequently gained secret adherents among the latter themselves. Its doctrine and discipline underwent little change in the East; in particular, it drew no nearer to the Christian religion. It first penetrated the Greek-Roman Empire about the year 280, in the time of the emperor Probus (*see* the *Chronicon* of Eusebius).

It was only subsequent to about 330 that Manichaeism spread rapidly in the Roman Empire. Its adherents were recruited on the one hand from the old gnostic sects (especially from the Marcionites—Manichaeism exerted besides this a strong influence on the development of the Marcionite churches of the 4th century), on the other hand from the large number of the "cultured," who were striving after a "rational" and yet in some manner Christian religion. Its polemics and its criticism of the Catholic Church now became the strong side of Manichaeism, especially in the West. It admitted the stumbling-blocks which the Old Testament offers to every intelligent reader, and gave itself out as a Christianity without the Old Testament. Instead of the subtle Catholic theories concerning divine predestination and human freedom, and instead of a difficult theodicaea, it offered an exceedingly simple conception of sin and goodness. The doctrine of the incarnation of God, which was especially objectionable to those who were going over to the new universal religion from the old cults, was not proclaimed by Manichaeism.

The farther Manichaeism advanced into the West the more Christian and philosophic did it become. In Syria it maintained itself in comparative purity. In North Africa it found its most numerous adherents, gaining secret support even among the clergy. Augustine was an *auditor* for nine years, while Faustus was at that time the most esteemed Manichaean teacher in the West. Augustine in his later writings against the Manichaeans deals chiefly with the following problems: (1) the relation between knowledge and faith, and between reason and authority; (2) the nature of good and evil, and the origin of the latter; (3) the existence of free will, and its relation to the divine omnipotence; (4) the relation of the evil in the world to the divine government.

Opposition of Roman Emperors.—The Christian Byzantine and Roman emperors, from Valens onwards, enacted strict laws against the Manichaeans. But at first these bore little fruit. The *auditores* were difficult to trace out, and besides they really gave little occasion for persecution. In Rome itself between 370 and 440 Manichaeism gained a large amount of support, especially among the scholars and public teachers. It also made its way into the life of the people by means of a popular literature in which the apostles were made to play a prominent part (*Apocryphal Acts of the Apostles*). In Rome Leo the Great was the first who took energetic measures, along with the state authorities, against the system. Valentinian III. decreed banishment against its adherents, Justinian the punishment of death. In North Africa Manichaeism appears to have been extinguished by the persecution of the Vandals. But it still continued to exist elsewhere, both in the Byzantine Empire and in the West, and in the earlier part of the middle ages it gave an impulse to the formation of new sects, which remained related to it. It is at least undoubted that the Paulicians and Bogomils, as well as the Catharists and the Albigenses, are to be traced back to Manichaeism (and Marcionitism). Thus the system, not indeed of Mani the Persian, but of Manichaeism as modified by Christian influences, accompanied Catholicism until the 13th century.

Sources.—(*a*) Oriental. Among the sources for a history of Manichaeism the most important are the Oriental. Of these the Mohammedan, though of comparatively late date, are distinguished by the excellent manner in which they have been transmitted to us, as well as by their impartiality. They must be named first, because ancient Manichaean writings have been used in their construction. At the head of all stands En-Nedīm, author of the *Fihrist* or "Catalogue" (*c.* 980) containing an account of Manichaeism which has been published separately with translation and notes by G. Flügel, *Mani, seine Lehre u. seine Schriften* (1862).

Of the Christian Orientals those that afford most information are Ephraem Syrus (d. 373), in various writings; the Armenian Esnik (German translation by J. M. Schmid, 1900, *see* also *Zeitsch. f. hist. Theol.,* 1840, ii.; Langlois, *Collection,* ii. 375 *seq.*), who wrote in the 5th century against Marcion and Mani; and the Alexandrian patriarch Eutychius (d. 916), *Annales,* ed. Pococke (1628). There are, besides, scattered pieces of information in Aphraates (4th cent.), Bar-Hebraeus (13th cent.) and others. The newly found Syriac *Book of Scholia* of Theodor bar Khouni (*see* Pognon, *Les Coupes de Kouabir*, Paris, 1898) gives many details about Mani's teaching (also ed. without translation by Dr. M. Lewin, Berlin, 1905).

(*b*) Greek and Latin. The earliest mention of the Manichaeans in the Graeco-Roman Empire is to be found in an edict of Diocletian (*see* Hänel, *Cod. Gregor.*, tit. xv.), which is held by some to be spurious, while others assign it to one or other of the years 287, 290, 296, 308 (so Mason, *The Persec. of Diocl.*, pp. 275 *seq.*). Eusebius gives a short account of the sect (*H. E.*, vii. 31). It was the *Acta Archelai*, however, that became the principal source on the subject of Manichaeism for Greek and Roman writers. In the form in which we now possess them, they are a compilation after the pattern of the *Clementine Homilies*, and have been subjected to manifold redactions, and give an account of Manichaeism which is largely legendary. These *Acta* were used by Cyril of Jerusalem (*Catech.* 6), Epiphanius (*Haer.* 66), and a great number of other writers. Important matter is to be found in the resolutions of the councils from the 4th century onwards (*see* Mansi, *Acta concil.*, and Hefele, *Conciliengeschichte*, vols. i.–iii.), and also in the controversial writings of Titus of Bostra (6th century), Πρὸς Μανιχαίους (ed. Lagarde, 1859), and of Alexander of Lycopolis Λόγος πρὸς τὰς Μανιχαίου δόξας (ed. Combefis; transl. in *Ante-Nic. Lib.*, vol. xiv.). Of the Byzantines, the most worthy of mention are John of Damascus (*De haeres.* and *Dialog.*) and Photius (*cod.* 179 *Biblioth.*).

Bibliography.—The most important works on Manichaeism are Beausobre, *Hist. critique de Manichée et du Manichéisme* (2 vols., 1734 *seq.*; the Christian elements in Manichaeism are here strongly, indeed too strongly, emphasized); Baur, *Das manich. Religionssystem* (1831; in this work Manichaean speculation is exhibited from a speculative standpoint); Flügel, *Mani* (1862; a very careful investigation on the basis of the *Fihrist*); Kessler, *Untersuchung zur Genesis des manich. Religionssystems* (1876); and the article "Mani, Manichäer," by the same writer in Herzog-Hauck's *R.E.*, xii. 193–228; Kessler, *Mani* (2 vols., Berlin, 1889, 1903); *Recherches sur le manichéisme: I. La cosmogonie manichéenne d'après Théodore Bar Khôui*, by Franz Cumont (Brussels, 1908); *II. Fragments syriaques d'ouvrages manichéens*, by Kugener and F. Cumont. *III. Les Formules grecques d'abjuration imposées aux manichéens*, by F. Cumont. *See* also A. A. Bevan, art. "Manichaeism" in Hastings' *Encyclopaedia of Religion and Ethics* (vol. viii. 1915).

MANICURING is the art of treating the nails of the hands to protect and improve their health and to beautify them according to the current standards of fashion. In the days of Salome and Cleopatra, women stained their nails with henna, and this vogue persists among some primitive peoples to-day. Under the social régime of the Chinese Empire, finger nails worn several inches long, and covered with gold cases, were a symbol of the aristocracy who did not have to work with their hands. The present mode is to shape the nails like the finger-ends and pink them to emphasize or suggest their healthy colour.

These rules, almost the same as those for a professional manicure, should be followed in the home manicure:

The nails should be thoroughly cleaned with a nail brush and warm soap suds. They should then be filed and shaped. Extreme points or blunt nails are not natural or in good taste. The tip of the nail should conform to the curved shape of the cuticle at the base of the nail, when this is normal.

When the filing is completed, immerse the fingers in soapy water for about three minutes to soften the cuticle. Then use a cuticle solvent with an orangewood stick (the end of which has been wrapped in a bit of cotton) around the base of the nail, under the edge of the cuticle surrounding the base of the nail, and under the free edge of the nail at the tip of the finger. Gently remove the accumulated loosened cuticle with a blunt pointed cuticle knife, holding the blade of the knife flat against the cuticle at the side of the nail, and wipe off with the end of a small towel.

A little bleach may be applied under the nails to whiten them. Then rub in a little nail cream around the cuticle to nourish the nail and keep the cuticle from becoming dry and cracking or forming hang-nails. Remove any loose bits of cuticle with a nipper or manicure scissors.

If a powder polish is used, first apply a bit of nail burnish cream to the nails and then the powder. Polish each nail with a chamois-covered buffer, using long strokes from left to right until the desired gloss is secured. (D. Co.)

MANIFEST, in commercial law, a document delivered to the officer of customs by the captain of a ship before leaving port, giving a description of the shipped goods of every kind, and setting forth the marks, numbers and descriptions of the packages and the names of the consignors thereof. In England, by the Revenue Act 1884, s. 3, where goods are exported for which no bond is required, a manifest must be delivered to the officer of Customs by the master or owner of the ship within six days after the final clearance, or a declaration in lieu thereof, the penalty in default being a sum not exceeding five pounds.

The U.S. Rev. Stat., § 2807, specifically sets forth the requirements of a manifest. It should list, among other items, the ports of lading and destination, names of consignees, passengers and owners of the vessel.

MANIFOLDS. Two geometrical figures are said to be *homeomorphic* if it is possible to set them into point for point continuous correspondence with one another. To illustrate: a closed curve (of the simple sort which passes through no point more than once) is homeomorphic with the circumference of a circle; the surface of a sphere is homeomorphic with the surface of an ellipsoid or of a cube, but not with a ring shaped surface such as a torus (fig. 1). The *topological* properties of a figure F are those which are shared by all figures homeomorphic with F. For instance, one of the topological properties of a line segment is its separability into two pieces by the removal of just one of its points; a non-topological property of the segment is its length. *Analysis Situs* (*q.v.*), or *Topology*, is the theory of the topological properties of figures. Theorems of analysis situs are very general in character and often synthesize results originally obtained in widely separated fields of mathematics.

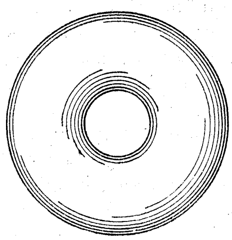


Fig. 1

n-Dimensional Manifolds.—The theory of functions of several variables leads directly to the study of a special class of figures called n-dimensional manifolds. These figures are hard to define with precision in non technical terms. We may say that a *one-dimensional manifold* is a simple, closed curve, a *two-dimensional manifold* a closed surface without singularities and, broadly speaking, an *n-dimensional manifold* the generalization to n dimensions of a closed curve or surface without singularities. One of the important outstanding problems of analysis situs is to classify higher dimensional manifolds into *types* such that two manifolds are of the same type if, and only if, they are homeomorphic. Up to the present, a complete classification has been carried out only for manifolds of dimensions one and two. The case $n=1$ is trivial: all one-dimensional manifolds are of the same type since every simple, closed curve is homeomorphic with the circumference of a circle. We shall outline below the results of the classification for the case $n=2$.

Möbius Strip.—First, it will be necessary to call attention to a rather curiously shaped surface known as a *Möbius* strip. This surface may be obtained by taking a plane rectangular region *ABCD*, where A and C denote diagonally opposite points, and deforming the region in three dimensional space so as to bring the point A into contact with the point C and the edge AB into contact with the edge CD. The resulting strip will be a belt-shaped surface with a twist in it (fig. 2). It obviously differs in type from an ordinary belt-shaped surface without the twist, since its boundary consists of a single curve, whereas the boundary of the untwisted surface consists of a pair of curves.

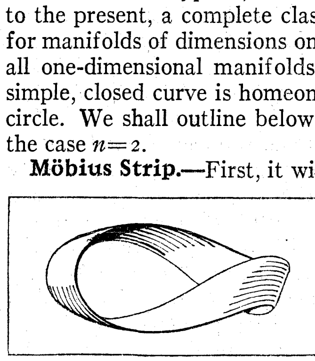


Fig. 2

A two dimensional manifold is said to be *orientable* if no portion of it is homeomorphic with a Möbius strip; otherwise, it is said to be non orientable. The manifold is said to have the *connectivity* k if the maximum number of simple, closed curves that may be traced upon it without separating it into two or more pieces is $k-1$. The type of a two dimensional manifold is completely fixed when we know the connectivity of the manifold and whether or not the manifold is orientable.

A model of the most general orientable, two dimensional manifold M may be obtained by making a target out of a spherical block and shooting a suitable number of bullet holes completely through the block. The surface of the pierced block will then be homeomorphic with the manifold M. The connectivity of the manifold M is $k=2p+1$, where p is the number of bullet holes in the target; consequently, the connectivity of M is always odd in this case. The number p is called the genus of the manifold M. The sphere is of genus zero, the torus of genus one.

Genus of a Manifold.—The notion of the genus of a manifold plays an important rôle in the theory of algebraic equations of the form

$$F(x, y) = 0 \tag{1}$$

The solutions (x,y) of an irreducible algebraic equation (1) may always be represented by the points of an orientable two dimensional manifold of suitable genus p, where p is a function of the expression $F(x,y)$. Many of the properties of equation (1) depend upon the value of the number p. In Riemann's classical theory of the integrals of rational functions,

$$\int \Phi(x, y)dx, \tag{2}$$

where x and y are connected by a relation of the form (1) the genus of the manifold determined by (1) again comes into evidence. When p is zero the integral (2) is elementary, in the sense that it may be expressed in terms of rational functions and logarithms; when p is unity, the evaluation of (2) leads to the theory of elliptic functions, and so on.

A non orientable two dimensional manifold M cannot be immersed in a Euclidean space of less than four dimensions. It may, however, be represented schematically by a plane region R bounded by a suitable finite number q of non intersecting circles, where pairs of opposite points on the various bounding circles are each to be thought of as representing a single point of the manifold. In four dimensional space it would be possible to reconstruct a model of the manifold M by deforming the region R in such a manner as to bring into coincidence opposite points on the bounding circles. The connectivity of the manifold M is $k=q+1$, so that, in this case, k may be any integer greater than unity. The plane of real, projective geometry (with a line of points at infinity) is a non orientable manifold of the simplest type, with k equal to two.

Combinatorial Method.—A very effective way of studying manifolds is the so-called *combinatorial* one. Consider a convex polyhedral surface in ordinary space. Regarded as a set of points, the surface is an ordinary manifold of genus zero of the same type as the sphere. But the surface may also be regarded as a collection of vertices, edges and faces. Let the number of these vertices, edges and faces be α_0, α_1 and α_2 respectively. We then find that a relation of the form

$$\alpha_0-\alpha_1+\alpha_2 = 2 \tag{3}$$

is always satisfied, irrespective of the polyhedron chosen. Now, in reality, relation (3) has an underlying topological significance. Let us use the terms 0-*cell*, 1-*cell* and 2-*cell* to denote figures homeomorphic with the vertices, edges and faces respectively of a convex polyhedron. Then if we take any two dimensional manifold M and subdivide it in a perfectly arbitrary manner into a finite number of cells we always obtain the relation

$$\alpha_0-\alpha_1+\alpha_2 = 3-k \tag{4}$$

where, this time, α_0, α_1 and α_2 denote the number of 0-, 1- and 2-cells of the subdivision respectively. Relation (3) is a special case of relation (4), where we have $k=1$, and where the cells are all straight. The number $\alpha_0-\alpha_1+\alpha_2$ is called the *Euler number* of the manifold M. In view of relation (4), a knowledge of the Euler number of a manifold is equivalent to a knowledge of the connectivity number k.

Manifolds of more than two dimensions were considered by Riemann and Betti, but Poincaré was the real founder of the higher dimensional theory. Poincaré extended to n dimensions the combinatorial method of cellular subdivision described above and discovered a number of new topological invariants. Of these last, the most important ones are his "Betti numbers" $P_1, P_2, \ldots, P_{n-1}$ which are generalizations of the connectivity number k. The Betti numbers satisfy a duality relation

$$P_i = P_{n-i}, \; (i = 1, 2, \ldots, n-1)$$

and a generalized Euler relation

$$\sum_{i=0}^{n}(-1)^i\alpha_i = 1+\sum_{i=1}^{n-1}(-1)^iP_i+(-1)^n$$

which reduces to (4) in the two dimensional case. Alexander has shown that the invariants of Poincaré are insufficient to fix the type of a higher dimensional manifold, and has found further invariants which appear, also, to be insufficient. Heegaard has studied the theory of three dimensional manifolds by a somewhat different method which would, no doubt, bear further exploitation.

An important class of problems has to do with the possible types of continuous transformations of a manifold into itself, and with the existence of points left invariant by these transformations. Brouwer has studied the transformations of a sphere of n dimensions and has shown, in particular, that a one-to-one sense preserving transformation of a two dimensional sphere always leaves at least one point invariant. Lefschetz has obtained a very general theorem about the fixed points of an arbitrary transformation of an arbitrary n-dimensional manifold. Morse, Nielsen and others have made noteworthy contributions to the theory. Numerous applications are to be found for this branch of analysis situs. For example, to take a very simple case, the so-called fundamental theorem of algebra to the effect that every algebraic equation

$$F(x) = 0$$

has a root obviously reduces to the theorem that the transformation

$$y = x+F(x)$$

has a fixed point. Birkhoff and Kellogg have proved that extremely general systems of differential and integral equations admit solutions by studying the transformations of a sphere of infinitely many dimensions. (*See* also KNOTS; ANALYSIS SITUS.)

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(J. W. A.)

MANIHIKI (MANAHIKI), a scattered archipelago in the central Pacific Ocean, between 4° and 11° S., and 150° and 162° W., seldom visited, and producing only a little copra and guano. Manihiki may be taken to include Caroline Island, Vostok and Flint to the east; Suvorov, Manihiki or Humphrey, and Tongareva or Penrhyn to the west, and Starbuck and Malden to the north, the whole thus roughly forming the three corners of a triangle. There are pearl and pearl-shell fisheries at Tongareva and Suvorov. The natives are Polynesians. The islands were mostly discovered early in the 19th century, and were annexed by Britain mainly in 1888–89. Pop. (1936) 1,244 (25 non-native).

MANILA (Spanish pronunciation mah-nee-lah; probably from Tagalog *manilad,* place of nilads—*Ixora Manila,* a white blossoming shrub which grew there in profusion); the capital and largest of the twelve chartered municipalities of the Philippines, chief port and centre of political and intellectual activity in the islands. It has a polyglot population: brown race (Tagalogs predominating) 556,141; yellow race (Chinese 46,233; Japanese 4,730) 51,088; white race (U.S. 3,191; Spaniards 2,124; British 481) 8,372; blacks 86; mixed 7,517; others 2,345. These were the figures of the 1939 census, which also gave a total of 623,492, of which 326,287 were males. Compared with the 1918 census of 285,306, these figures disclosed a remarkable growth, mainly among the oriental elements.

Geography and Topography.—Situated at latitude 14° 35′ 31″ N. and longitude 120° 58′ 8″ E., Manila is about 5,450 mi. from Honolulu, 1,550 mi. from Singapore and 1,400 mi. from Nagasaki, the nearest port in Japan proper. Hongkong, the nearest Chinese port, is about 600 mi. to the northwest. The city lies on the eastern shore of Manila bay, one of the world's largest landlocked harbours, with a circumference of about 120 mi., on the west coast of Luzon island and on the plain stretching from Lingayen gulf to the bay. Sunsets on the latter, viewed from the city, are among the most gorgeous to be seen anywhere. To the north Mt. Arayat, a sacred mountain of the early Malays, is plainly visible from the bay; to the west are the Mariveles mountains, and to the east the terrain rises to Laguna de Bay, a large lake from which the Pasig river issues and flows through the city, bisecting it, into the bay. Various *esteros* (tidewater creeks) find their way through the city, connecting with the river or directly with the bay.

The city is divided into 14 districts of unequal size, half of them on each side of the Pasig. As there are three Romes—classical, Christian-mediaeval and modern—so there are three Manilas—not indeed, distinct, like watertight compartments, but rather as layers and threads running through the city.

(1) *The primitive Malay,* typical of which is Tondo, the most populous district. It lies north of the Pasig, bordering the bay, and is almost entirely inhabited by native labourers and fisherfolk, living, as did their ancestors for unnumbered generations, in houses of nipa and bamboo, built along narrow streets and *esteros.* The district of Santa Cruz lies east of Tondo and has a narrow frontage on the Pasig, which is crossed there by the Santa Cruz bridge. Besides a large native population it contains the *Cementerio del Norte* and the racing park and grandstand. Still farther east is Sampaloc, largest in area of all the districts and mainly native, but containing the modern suburb of Santa Mesa, inhabited largely by whites. South of Tondo, and fronting the Pasig, are the two small districts of San Nicolas, with shipping establishments, and Binondo, which contains the city's most famous business thoroughfare—the Escolta—and Calle Rosario, with its "Chino" stores and embroidery shops. The approach from the south is by the Jones bridge. South of Sampaloc, and east of Santa Cruz, are the districts of Quiapo, a former Jesuit mission station, and San Miguel, in which is located, at the river's brink, the stately Malacañan palace, formerly the residence of Spanish and U.S. governors general, then occupied by the commonwealth president. Leaving the north side of the Pasig we cross either the Jones or Santa Cruz bridge to (2) *Spanish mediaeval Manila,* represented by Intramuros (the walled city). This was founded and fortified by the early Spanish *conquistadores.* Its thick stone walls, some two-thirds of which were intact in 1941, are about $2\frac{1}{2}$ mi. in circumference and rise to a height of about 25 ft. Ft. Santiago, the oldest portion of the wall, was long used as the headquarters of the United States army in the Philippines. Formerly the wall abutted on the bay at the west; but the creation of the Port Area from land reclaimed from the bay left the wall inland while the ancient moat which once flanked it on the land side was drained and filled about 1905 and converted into sunken gardens and a municipal golf course. Along the western side of the wall and between it and the Port Area is the Bonifacio drive, extending from the Anda monument on the south bank of the Pasig to the Luneta. Until late Dec. 1941, when the Japanese aerial depredations began, Intramuros was a museum of Spanish architecture; but on Dec. 27 of that year it became "a roaring mass of flames" and a cable four days later announced the destruction of Santo Domingo church and convent and the colleges of Santa Rosa, Santa Catalina and San Juan de Letran. Apparently the Roman Catholic cathedral, located on Plaza McKinley, the Dominican University of Santo Tomás and the Jesuit Ateneo were still intact. Reminiscent of Spanish art are the statue of Magellan, the pioneer world navigator; of his lieutenant El Cano (in the Ayuntamiento), who guided the expedition back to Spain; of Legazpi and Urdaneta, who founded the first successful Spanish colony in the Philippines (1565, also the year of St. Augustine's founding); of Benavides (near the Dominican convent), first Roman Catholic archbishop of the Philippines; of Simon de Anda y Salazar, who resisted the British occupation (1762–64); of Carlos IV in Plaza McKinley; and of Isabela II in Malate. Native art is represented by Juan Luna's famous painting (in Malacañan palace), *El Pacto de Sangre* ("The Blood Compact"), and by the Rizal monument on the Luneta; while American art is most apparent in the architecture of new structures, especially at Quezon City. For (3) *modern Americanized Manila* finds a striking representative in the Port Area (El Puerto), created entirely under U.S. auspices with soil reclaimed from the bay, into which were extended the substantial government piers. The area is protected from the sometimes heavy surf of the bay by an extensive breakwater, constructed also under U.S. direction, enclosing a basin regularly dredged to a depth of about 30 ft., through which most of the country's foreign shipping enters the city, thus largely superseding the channel connecting the bay with the sluggish Pasig, which, however, is dredged to a depth of about 18 ft. so that lighter craft may enter the river for a considerable distance. The government customhouse faces the bay in the Port Area.

South of Intramuros lies the Luneta, Manila's "common," where an official band plays in the evening and vast gatherings of the populace are held. It was extended, like the Port Area, by reclaiming land from the bay, and it is in the centre of this park that the Rizal monument rises. West of the old Luneta lies Burnham green, named from its designer, and to the east is Wallace field, also a place of assembly, and the site of the annual Philippine carnival. Some noted boulevards, reminiscent of U.S. rule, touch this area. Taft avenue, a broad thoroughfare, stretches from the eastern wall of Intramuros to the Luneta. Traversing it, one passes notable buildings like the General hospital, the new Scottish Rite temple and the Jai-alai building, "the city's best designed edifice." The Dewey boulevard extends from the Luneta and Burnham green southward to the Pasig, and fronting it is the spacious, combined residence and office building of the United States high commissioner. Southeast of Intramuros and the Port Area is Ermita and still farther south, Malate. Both are leading white residential districts with broad streets and attractive homes. East of Ermita lies Paco, containing a large cemetery, and beyond it Pandakan and Santa Ana. The latter extends over the San Juan river, where San Juan Heights, another white residential suburb, is located.

Quezon City.—Northeast of Sampaloc, but outside the limits of Manila, a new city was rising in 1941, administratively independent of the old, but apparently destined to have an important influence on its future. Quezon City (the name may have been suggested by Ciudad Trujillo in Santo Domingo) is located on elevated land northeast of Manila and is two and a half times its area (30 sq.mi.). A chartered municipality with villages aggregating 40,000 in population in 1941, this project was intended as the future Philippine capital.

Corregidor.—At the entrance to the bay, 28 mi. from Manila, is Corregidor island, a natural fortress of volcanic rock, approximately 3 mi. wide and 5 mi. long. First fortified by the Spanish, it was greatly strengthened by the Americans, who built Ft. Mills, installed coastal defense guns and carved a maze of underground tunnels and galleries in the rock. The island was the anchor of the U.S.-Filipino army's epic defense of Bataan against the Japanese, Jan.–April 1942.

Climate.—Manila has a Type I climate (*see* PHILIPPINE ISLANDS), the three warmer months coming from April to June, the four colder ones from November to February and the other five of intermediate temperature. In 1939 the mean air temperature was 80·2° F., less than one-half of a degree above normal for the period 1885 to 1939. The highest mean monthly reading was 83·5° F. in April, and the lowest was 75·6° F. in December—a range of 7·9° F. The absolute maximum for the year was 98·1° F. on April 17 and the absolute minimum was 64·4° F. on March 3 and December 14 and 26, giving an absolute range of 33·7° F. The city had a total rainfall of 86·3 in. in 1939, 44·3 in. above normal for the period 1865–1939. It had 158 rainy days, 12 more than normal, the heaviest fall in a single day being 7 in. on July 14.

Cultural, Religious and Eleemosynary Institutions.—The early schools and churches in the islands were founded mostly by the religious orders and in Manila. The Dominican order, which specializes in higher education, founded the University of Santo Tomás in 1619 and, as a feeder thereto, the Collegio de San Juan de Letran in 1640. Both were limited to male students and the university confers degrees upon Catholics only. It and the Dominican church and convent were all located in the walled city. The main university buildings, built later, are in Sampaloc. Public schools in 1941 numbered 87—42 primary, 38 intermediate and 7 secondary, with a total enrolment of 110,702 or 56.4% of the school population (1939 census)—a decline of nearly 14% since 1926. Under the insular bureau of education the city superintendent is in charge of these schools. At the apex of the public educational system is the University of the Philippines, opened in 1908, and with an enrolment in 1940 of 8,109. In 1938 President Quezon vetoed a bill, supported by the Roman Catholic clergy, requiring religious instruction in the public schools.

The Jesuit order, as early as 1601, founded the Collegio de San José. In 1859, after the Jesuit order returned to the islands, it established the Escuela Municipal which later became the Ateneo de Manila. The policy, from early in the 20th century, was to replace Spanish with U.S. Jesuits. At the close of the academic year 1939–40 there were in the islands 79 Jesuits, of whom 23 were Filipinos, reported as engaged in educational work. The Ateneo offers instruction in the grades, high school and college, premedical, prelaw, law, commerce and industrial technology. It reported, in the year last mentioned, a student body of 2,094 and a faculty of 43 Jesuits and 92 lay professors and instructors. The order also undertook an interesting experiment, long antedated in the public school system, of extension, in establishing a trade school with classes for labourers at night, in the old convento of Sampaloc. Instruction is given in "English, Tagalog, arithmetic, automechanics, mechanical drawing, good citizenship and religion." No prior educational tests were imposed in 1941, and tuition was limited to one peso per month for those able to pay. The Jesuit church of San Ignacio (Intramuros) is noted for its artistic carvings. The order has also a church in Ermita and conducts the government observatory and weather bureau. The Augustinians (original and Recollectos) also have churches and convents in the walled city, and those of the first named—the oldest parts of which antedate 1600—are ascribed to a nephew of Herrera, builder of the Escorial.

The Protestant churches have generally supported the public schools; but there is a union theological school—Ellinwood seminary—for the training of Protestant ministers, and a school for Moros in Jolo was established under Episcopalian auspices. The imposing Episcopal Cathedral of St. Mary and St. John is located in Ermita, as is the Union (formerly Presbyterian) church.

Libraries.—Though there had been attempts to found a Philippine library as early as 1887, the real foundation dates from the arrival in the islands of Dr. James A. Robertson, who had been selected for the task because of his work in compiling the monumental enterprise of 55 volumes on *The Philippine Islands*. In an all too brief service of about six years, he established the library on a modern basis with an especially good start in Filipiniana, including the purchase of the valuable collection of the Compañia General de Tabacos. In 1941 the library's division on that subject was the most extensive anywhere save possibly that in the royal archives at Seville, Spain. The library also contains large collections of other orientalia and of works on history and economics; but thousands of volumes on special subjects are housed in buildings attached to other departments. There is a modern publishing house, the Ramon Roces Publications, Inc. Besides the Philippine General hospital on Taft avenue there is a U.S. Army hospital, St. Paul's, the Hospicio de San Juan de Dios, the San Lazaro (the three latter being Roman Catholic), St. Luke's (Episcopal), Mary J. Johnson Memorial (Methodist), the Mary Chiles Christian and a Chinese hospital.

Administration.—Under the Spaniards the city formed part of a province of the same name. This was abolished by the U.S. government after about three years of military rule, and on July 31, 1901, by an act of the Philippine commission, Manila became the first of the Philippine chartered cities; other municipalities of the old province had become part of the new province of Rizal. The so-called "administrative code" of 1917, amended in 1921, provided for a mayor appointed by the governor general (later by the commonwealth president) and confirmed by the senate, and a municipal board of 10 members elected at large and serving for three years. Administrative departments were: engineering and public works, police, law, fire, finance, assessment, health and welfare, the latter serving under the general supervision of the Philippine public health department. In 1941 there was a court of first instance for the city, a municipal court, with four judges, and a fiscal (city attorney), with 22 assistants.

With the Japanese invasion came a return to military rule, but of a very different character from that enjoyed by the city from 1898 to 1901. As in Shanghai, where the Japanese had been in control since 1937, their soldiers appeared to delight in subjecting the civilian, especially the white, population to indignities and oppressions. Martial law was declared and an attempt was made soon after entry to establish a puppet government, as in Manchuria and Nanking, by the appointment as "mayor" of a Filipino, who had remained in the city after the U.S. high commissioner and the commonwealth government had moved therefrom, and who is said to have "issued a statement promising to do everything in his power to create a greater East Asia" and to have agreed to the "inclusion of Japanese controllers and advisers in the city administration."

Trade and Industry.—By the census of 1939 there were 313,748 persons over ten years of age (about 50% of the total population) engaged in gainful occupations. Of these, 142,882 were in domestic and personal service; 60,127 in manufacturing and mechanical industries; 34,572 in trade, of whom 521 were wholesale dealers; 18,669 in professional service; 6,960 in the public service; 1,688 in fishing; 1,411 in agriculture; and 421 in mining and quarrying. By the same census there were 3,183 corporations in the city; the assessed valuation of all buildings and structures declared for taxation was 219,695,790 pesos; those of private ownership were assessed at 168,462,480 pesos. Figures for exports and imports, mainly through the port of Manila, later than 1939, obtained through the U.S. trade commissioner in Manila, showed: imports: 1st half, 1940, 143,387,398 pesos; 1st half, 1941, 135,901,992 pesos; exports: 1st half, 1940, 157,601,529 pesos; 1st half, 1941, 177,754,390 pesos. Most of the 1941 increase of 12,717,455 pesos was due to the output of minerals. For the Philippines, once almost exclusively an agricultural country, had rapidly become a mining country as well. Exports of manganese, for example, reached 43,515 tons (valued at $627,243) in 1940, as compared with 6,966 tons (valued at $89,784) in 1939 and 4,002 (valued at $44,075) in 1938. Exports of chromite, most of which went to the U.S., were as in the accompanying table.

Year	Metric Tons	Valuation, pesos
1935	1,292.0	27,558
1936	11,890.6	307,518
1937	69,855.6	1,542,100
1938	66,910.8	1,576,845
1939	126,748.6	2,153,640

These figures may serve to illustrate the vast extent of the

Philippines' mineral wealth, barely touched in 1941.

History.—When Miguel López de Legazpi, who in 1565 had established a Spanish colony in Cebu, came to found another on the banks of the Pasig in 1571, a Mohammedan rajah (Lakandola) reigned in Tondo. We read soon after of "a lucrative trade with the Chinese"; that thrifty race had probably been in touch with the locality for a considerable period. The so-called "piratical" expedition of Li Ma Hong in 1574 may have been the last of many. Legazpi, who was the first Spanish governor, died Aug. 20, 1572, and Guido de Lavezares, treasurer of the expedition, acted instead until the second governor's arrival in 1575. As the Philippines were placed under the viceroy of new Spain in Mexico City, official communication between the two widely separated areas was maintained by a galleon, which plied annually between Acapulco and Manila, and trade of considerable proportions was developed. Chinese junks crossed the China sea about the time of each galleon's arrival in order to exchange cargoes. As the galleon was the sole medium of communication with the western world, Spanish culture filtered in from Mexico, which accounts for the variety of Spanish in the islands being Mexican rather than Castilian.

Accompanying Legazpi to the islands was an Augustinian friar, Urdaneta, with others of that order, some of whom went on to Manila. In 1577 came Franciscans, who were followed by Dominicans, Jesuits and Augustinian Recollectos. These orders founded convents, churches and schools and became very powerful in the government. In 1580 the first, and only, Roman Catholic bishop of Manila arrived in the person of Domingo de Salazar, a Dominican; but in 1595 the diocese was raised to a metropolitan see, and Ignacio Santibañez became the first of a long line of Spanish archbishops which ended with Nozaleda about 1900. In 1583 an *audiencia* (supreme court) was established. Abolished later, it was re-established in 1598 and continued as a Spanish institution for three centuries. The Spanish law was applied in those portions of the archipelago actually ruled by Spain; but the Spanish civil code came into force there only in 1889.

In the 17th century Spain warred with the Dutch and Moros, and Manila was menaced repeatedly. During the "World War" of the 18th century, in 1762, the city was captured by British forces under General Draper and Admiral Cornish, who held it until 1764, the treaty of Paris (1763) having restored it to Spain. The 19th century was marked by some signs of progress. In 1825 Russell and Sturgis of Boston opened a branch of their Canton mercantile house—the first U.S. enterprise in the Philippines—and in 1837 the city was opened generally to foreign trade. On the completion, a generation later, of the Suez canal, direct means of communication with Europe were provided and commerce accordingly was stimulated. The first Masonic lodge was founded at Cavite, near Manila, in 1856 and the Katipunan, a revolutionary society, borrowing some of its features from Masonry, but never sanctioned by Rizal, acquired a large following. The execution of Rizal on Dec. 30, 1896, was the signal for the outbreak of revolution, and the Spanish-American War brought Admiral Dewey and his fleet, which destroyed the Spanish fleet at Cavite on May 1, 1898. The city of Manila surrendered to the United States forces on Aug. 13 and for nearly 44 years the Stars and Stripes floated continuously thereover. Then came the Japanese invasion on Dec. 8, 1941 (Philippine time), and their occupation of the city on Jan. 2, 1942—its fourth capture by a foreign power. (C. S. L.)

MANILA HEMP: *see* ABACÁ FIBRE.

MANILIUS, a Roman poet, author of a poem in five books called *Astronomica.* The work is never quoted in antiquity, and even his name is uncertain. It was probably Marcus Manilius. The poem seems to have been written in the time of Augustus or Tiberius, the latest event mentioned being the defeat of Varus in A.D. 9.

The work, which is incomplete and was probably never published, is of great learning and represents the most advanced views on the subject. He frequently imitates Lucretius, whom he resembles in his power of giving life to his subject.

See editions by J. Scaliger (1579); R. Bentley (1739); F. Jacob (1846); A. G. Pingré (1786); T. Breiter (Leipzig, 1907; and commentary 1909); H. W. Garrod (with trans., 1911); with introd. by A. E. Housman (1903). On the subject generally *see* M. Bechert, *De emendandi Manilii Ratione* (1878) and *De M. M. Astronomicorum Poeta* (1891); B. Freier, *De M. Astronom. Aetate* (1880); A. Cramer, *De Manilii Elocutione* (very full; 1882); G. Lanson, *De Manilio Poeta* (1887, bibl.); P. Monceaux, *Les Africains* (a study of the Latin literature of Africa; 1894); R. Ellis, *Noctes Manilianae* (1891); J. P. Postgate, *Silva Maniliana* (1897), chiefly on textual questions; P. Thomas, *Lucubrationes Manilianae* (1888), a collation of the Gemblacensis (Gembloux) ms.

MANILIUS, GAIUS, Roman tribune of the people in 66 B.C. At the beginning of his year of office (Dec. 67) he promoted a law (*de libertinorum suffragiis*) which gave freedmen the privilege of voting in the same tribe as their patroni (*see* PATRON AND CLIENT); this law was almost immediately declared void by the senate. Manilius then endeavoured to secure the support of Pompey by proposing to confer upon him the command of the war against Mithridates with unlimited power (*see* POMPEY). The proposal was supported by Cicero in his speech, *Pro lege Manilia,* and carried almost unanimously. Manilius was later accused by the aristocratical party on some unknown charge and defended by Cicero. He was probably convicted, but nothing further is heard of him.

See Cicero's speech; Dio Cassius xxxvi 25–27; Plutarch, *Pompey,* 30; Vell. Pat. ii 33; art. ROME: *Ancient History.*

MANIN, DANIELE (1804–57), Venetian patriot and statesman, was born in Venice, on May 13, 1804. He was the son of a converted Jew, who took the name of Manin because that patrician family stood sponsors to him, as the custom then was. He studied law at Padua, and then practised at the bar of his native city. A man of great learning and a profound jurist, he was inspired from an early age with a deep hatred for Austria. The heroic but foolhardy attempt of the brothers Bandiera, Venetians who had served in the Austrian navy against the Neapolitan Bourbons in 1844, was the first event to cause an awakening of Venetian patriotism, and in 1847 Manin presented a petition to the Venetian congregation, a shadowy consultative assembly tolerated by Austria but without any power, informing the emperor of the wants of the nation. He was arrested on a charge of high treason (Jan. 18, 1848), but this only served to increase the agitation of the Venetians, who were beginning to know and love Manin. Two months later, when all Italy and half the rest of Europe were in the throes of revolution, the people forced Count Palffy, the Austrian governor, to release him (March 17). The Austrians soon lost all control of the city, and under the direction of Manin a civic guard and a provisional government were instituted.

The Austrians evacuated Venice on March 26, and Manin became president of the Venetian republic. He was already in favour of Italian unity, and though not anxious for annexation to Piedmont (he would have preferred to invoke French aid) he gave way to the majority, and resigned his powers to the Piedmontese commissioners on Aug. 7. But after the Piedmontese defeats in Lombardy, and the armistice by which King Charles Albert abandoned Lombardy and Venetia to Austria, the Venetians attempted to lynch the royal commissioners, whose lives Manin saved with difficulty; an assembly was summoned, and a triumvirate formed with Manin at its head. Toward the end of 1848 the Austrians, having been heavily reinforced, reoccupied all the Venetian mainland. Early in 1849 Manin was again chosen president of the republic and conducted the defense of the city.

After the defeat of Charles Albert's forlorn hope at Novara in March the Venetian assembly voted "Resistance at all costs!" and granted Manin unlimited powers. Meanwhile the Austrian forces closed round the city; but Manin, assisted by G. Pepe, showed an astonishing power of organization. On May 26, however, the Venetians were forced to abandon Ft. Malghera, halfway between the city and the mainland; food was becoming scarce, on June 19 the powder magazine blew up and in July cholera broke out. Then the Austrian batteries began to bombard Venice itself, and when the Sardinian fleet withdrew from the Adriatic the city was also attacked by sea, while certain demagogues caused internal trouble. At last, on Aug. 24, 1849, Manin, who had courted death in vain, negotiated an honourable capitulation, on terms of amnesty to all save Manin himself, Pepe and some others, who were to go into exile.

On the 27th Manin left Venice forever on board a French ship. His wife died at Marseilles, and he himself reached Paris broken in health and almost destitute, having spent all his fortune for Venice. In Paris he became a leader among the Italian exiles. There he became a convert to monarchism, being convinced that only under the auspices of King Victor Emmanuel could Italy be freed, and together with Giorgio Pallavicini and Giuseppe La Farina he founded the *Società Nazionale Italiana* with the object of propagating the idea of unity under the Piedmontese monarchy.

His last years were embittered by the terrible sufferings of his daughter, who died in 1854; and he himself died on Sept. 22, 1857, and was buried in Ary Scheffer's family tomb. In 1868, two years after the Austrians finally departed from Venice, his remains were brought to his native city and honoured with a public funeral.

Manin was a man of the greatest honesty and possessed genuinely statesmanlike qualities. He believed in Italian unity when most men, even Cavour, regarded it as a vain thing, and his work of propaganda by means of the National society greatly contributed to the success of the cause.

See A. Errera, *Daniele Manin e Venezia (1804–1853)* (Florence, 1875); A. Errera and C. Finzi, *La vita e i tempi di D. Manin (1804–1858)* (Venice, 1873); Ferrari-Bravo and Maloni, *Daniele Manin e i suoi tempi* (1904); and G. M. Trevelyan, *Manin and the Venetian Revolution* (1923).

MANIN, LODOVICO or **LUDOVICO** (1726–1802?), last doge of Venice, was born June 23, 1726. He held a number of state positions before 1789, when, on the death of Paolo Renier, he was elected doge. He was far from eager to accept the office and protested strenuously that he was not qualified, but to no avail. He took office on March 9, 1789, less than two months before the opening of the French Revolution, the results of which were ultimately to cause the downfall of the Venetian republic.

Venetian policy in the subsequent years was one of unarmed neutrality. The nobles of the Great Council, mistakenly thinking that these tactics would preclude attack and that no harm could come to the oldest government in Europe, would not agree to join Austria in that country's anti-Napoleonic war. Napoleon encouraged the Venetians in this view by continually professing his friendship, but he had determined to take Venice and on April 18, 1797, nearly a month before he actually captured it, promised the republic to Austria. He then seized on a minor excuse to declare war on Venice, and Manin and the nobles were too frightened to resist. On May 12 the Great Council, in its final session, voted itself out of existence, substituting a representative government. Manin resigned his office and spent the rest of his life in retirement.

It is probable that the Venetian republic, as it existed in the late 18th century, was doomed in any case, and Manin was certainly not wholly responsible for the conditions which led to its final downfall. He was in large part only a victim of the circumstances in which he happened to be placed, but he has been widely censured for his refusal to face the fact that the French were a definite menace until too late, and for his weak behaviour immediately preceding Venice's fall, when he was too frightened to allow the citizens to attempt to defend the city of Venice, although they were eager to do so.

MANING, FREDERICK EDWARD (1812–1883), New Zealand judge and author, son of Frederick Maning, of Johnville, county Dublin, was born July 5, 1812. His father emigrated to Tasmania in the ship "Ardent" in 1824 and took up a grant of land there. Young Maning served in the fatuous expedition which attempted to drive in the Tasmanian blacks by sweeping with an unbroken line of armed men across the island. Soon afterward he decided to try the life of a trader among the wild tribes of New Zealand and, landing in the inlet of Hokianga in 1833, took up his abode among the Ngapuhi. With them the tall Irish lad—he stood 6 ft. 3 in.—full of daring and good humour and as fond of fun as of fighting, quickly became a prime favourite, was adopted into the tribe, married a chief's daughter and became a "Pakeha-Maori" (foreigner turned Maori). With the profits of his trading he bought a farm of 200 ac. on the Hokianga, for which, unlike most white adventurers of the time, he paid full value. When New Zealand was peacefully annexed in 1840, Maning's advice to the Maori was against the arrangement, but from the moment of annexation he became a loyal friend to the government, and in the wars of 1845–46 his influence was exerted with effect in the settlers' favour. Again, in 1860, he persuaded the Ngapuhi to volunteer to put down the insurrection in Taranaki. From 1865 to 1881 he was a judge of the native lands court, where his unequalled knowledge of the Maori language, customs, traditions and prejudices was of solid value. He died in London on July 25, 1883. At his wish, his body was taken back to New Zealand and buried there. Maning wrote *Old New Zealand* and *History of the War in the North of New Zealand against the Chief Heké,* reprinted in London in 1876 and 1884.

MANIPLE, a liturgical vestment of the Catholic Church, proper to all orders from the subdeacon upward. It is a narrow strip of material, silk or half-silk, about a yard long, worn on the left fore-arm in such a way that the ends hang down to an equal length on either side. In order to secure it, it is sometimes tied on with strings attached underneath, sometimes provided with a hole in the lining through which the arm is passed. It is ornamented with three crosses, one in the centre and one at each end, that in the centre being obligatory, and is often elaborately embroidered. It is the special ensign of the office of subdeacon and at the ordination is placed on the arm of the new subdeacon by the bishop with the words: "Take the maniple, the symbol of the fruit of good works." It is strictly a "mass vestment," being worn, with certain exceptions (*e.g.,* by a deacon singing the Gospel at the service of blessing the palms), only at mass, by the celebrant and the ministers assisting.

The earliest extant specimen of the band-like maniple is that found in the grave of St. Cuthbert (early 10th century); by the 11th century (except in the case of subdeacons, whose maniples would seem to have continued for a while to be cloths in practical use) the maniple had universally assumed its present general form and purely ceremonial character.

The maniple was originally carried in the left hand. In pictures of the 9th, 10th and 11th centuries it is represented either as so carried or as hung over the left fore-arm. By the 12th century the rule according to which it is worn over the left arm had been universally accepted. According to present usage the maniple is put on by priests after the alb and girdle; by deacons and subdeacons after the dalmatic or tunicle; by bishops at the altar after the *Confiteor,* except at masses for the dead, when it is assumed before the stole.

In the east the maniple in its western form is known only to the Armenians, where it is peculiar to subdeacons. This vestment is not derived from the Roman rite but is properly a stole, which the subdeacons used to carry in the left hand. It is now laid over the subdeacon's left arm at ordination. The true equivalent of the maniple (in the Greek and Armenian rites only) is not, as has been assumed, the *epimanikion,* a sort of loose, embroidered cuff (*see* VESTMENTS), but the *epigonation.*

See J. Braun, S. J., *Die liturgische Gewandung* (Freiburg im Breisgau, 1907), pp. 515–561, and the bibliography to VESTMENTS.

MANIPULATIVE SURGERY. The earliest practitioners of "bone-setting"—the old name for what is now described as manipulative surgery—date back into very remote times, and Hippocrates was the author of a treatise on dislocations. The history of the Roman Republic tells of successful practitioners of this ancient craft.

During the years when surgery was gradually being regularized and its seats of learning were being established, "bone setters" were the only orthopaedic surgeons of those days, and the doctors apparently countenanced them as legitimate exponents of that section of therapeutics. The famous surgeon William Cheselden, in the middle of the 18th century, used to send cases to the bone-setters for treatment, and frankly admitted that he did so because he was not competent to treat them himself.

The renowned surgeon, John Hunter, was amongst the first of eminent surgeons to realize the value of early movements in cases of sprains and joint injuries. He wrote: "Nothing can promote contraction of a joint as much as motion before the disease is removed, but when all inflammation is gone off . . . a little motion and frequently repeated is necessary to prevent healing taking place with the parts fixed in one position."

The world of conservative surgery owes an unpayable debt of gratitude to Sir James Paget who, in his desire for the public weal and the true interests of science, wrote to *The British Medical Journal* in Jan. 1867, urging his professional brethren to "learn what was good in the methods of the bone-setter, and eschew what was harmful." Paget stood on firm ground when he declared that "too long rest is by far the most frequent cause of delayed recovery after the injuries of joints, and not only to injured joints but to those that are kept at rest because parts near them have been injured."

Later, Dr. Wharton Hood, who had conceived the greatest admiration and respect for Robert Hutton, the bone-setter, and who recognized the false teaching of his profession in regard to many forms of joint injuries and derangements, made a thorough investigation of Hutton's methods, and after the bone-setter's death published a description of them in *The Lancet*.

Types of Cases.—Flat-foot, with its distressing deformity and painful crippling of the patient, occupies a front place amongst those cases which yield most satisfactorily to skilled manipulative treatment. To commence to correct this abnormality in its early stages is important, though cases might be instanced of patients even up to 60 years of age making perfect recoveries. The time of puberty is the period at which the irregularity usually makes its appearance, and the progress of the trouble is usually rapid and the deformation very marked.

It is difficult to assign with certainty the predisposing factor in such cases, though heredity probably plays some part in its origin. As many as four members of one family have been known to suffer from the complaint. The hands of the operator—if sufficiently powerful—constitute a much more effective instrument for forcing the foot and ankle into their normal positions than the Thomas wrench which is largely used even now. Several corrections should be made at short intervals, followed immediately by certain exercises in place of the one or two adjustments which used to be considered sufficient. The encasement of the joint in plaster of paris is secure immobilization and rest in bed must on no account be recommended. The anatomical contour of the foot is palpably bettered even after the first manipulation, and each operation brings the patient nearer full recovery. Almost all cases of adhesive and acquired flat-foot should recover. Congenital cases are much less satisfactory, though even in these improvement can generally be looked for. The technique is difficult and should be taught by cinematographic pictures so slowly reproduced that students can follow each manipulation carefully.

The Shoulder Joint.—The habitual derangement of the shoulder joint—sometimes on the slightest provocation, such as sneezing, stretching or ordinary reaching—is a most troublesome affection and is usually attributed to a rent or tear in the capsule, brought about in the first instance by a severe wrench, although cases could be recorded where no history of accident can be remembered. The disability is probably more often caused by adhesive contracture of a section of the capsule with an accompanying exaggerated relaxation of the remaining portion which allows the dislocation to take place. Although surgeons frequently advise a surgical operation, certain manipulations bring about a condition of the capsule which will enable it to exercise normal control of the head of the bone followed by exercises designed to re-establish the surrounding weakened tissues. Out of a number of cases only two or three can be remembered as not having yielded satisfactorily to treatment. The procedure, under an anaesthetic, is quite devoid of danger, and the after-effects are of brief duration and only slightly painful.

Subluxations and Dislocations.—The actual reductions of gross dislocations do not enter to any great extent into the purlieu of the manipulative surgeon. There is, however, a large number of conditions due to minor displacements which constitute an important branch of his work. Principal among these must be placed displacements and fracture-displacements of the semilunar cartilages of the knee-joint. This field is an enormous and most important one, for the number of persons of both sexes who sustain such injuries is legion. In original unreduced displacements, reduction must be carried out by appropriate manipulation at the earliest possible moment. In chronic or recurrent cases, manipulation is also very frequently effective in bringing about a cure of a very troublesome and disabling condition.

The brilliant results obtained in this type of case have been known for many years, but the underlying pathology has been a profound puzzle until it was recently shown:

(a) that by far the commonest type of injury of the internal semi-lunar cartilage is the complete longitudinal tear;

(b) that in this type of case, the outer portion of cartilage is nearly always found in the interior of the joint;

(c) that by appropriate manipulative technique this displaced fragment may be made to retrace its steps and come into apposition with the inner fragment;

(d) that when this has been effected, there is a good chance of repair occurring between the two fragments.

Cases with Adhesions.—These constitute another important class. It is essential first of all to make quite clear what we mean by the term "adhesion." It is probably known to most that an inflammatory process is usually accompanied by the exudation of lymph from the blood-vessels of the part. This lymph tends after a short while to become organized, *i.e.,* changed into connective tissue, or, as it is usually called, "fibrous tissue." Let us imagine, for example, that owing to a severe sprain of the knee the lining membrane of the joint has become inflamed. As a result there is an outpouring of this lymph by the blood-vessels of the membrane, and various folds and layers of this self-same membrane tend to become adherent by this inflammatory exudate. When this has become converted into fibrous tissue, adhesions are actually present which may give rise to marked disability. It is characteristic of adhesions, that, when pulled upon or stretched, severe pain usually results. Further adhesions give rise to a variable amount of limitation of some particular movement or movements of the joint, which is apt to be overlooked unless a most careful examination be made.

Swelling of the joint after exercise, muscular wasting and a sensation of weakness and often an actual giving-way of the joint, are not infrequent characteristics of adhesions.

Danger of Rest for Joint Cases.—As previously stressed, the doctrine "rest inflamed structures" has been responsible for the formation of countless thousands of joints disabled by adhesions. However true the doctrine may be in certain other organs and structures of the body, and even this is debatable, in the case of a joint it is dangerous, for the function of a joint is movement and movement must always be instituted at the earliest possible moment in almost any inflammatory condition, except in those ultra-acute conditions where movement is impossible and in some cases of tubercular disease and of myositis ossificans. When a joint has become crippled owing to the presence of adhesions, how is the joint to be restored to its pristine health and vigour? The answer is manipulation.

It is obviously impossible, in a short article of this nature, to detail the various technical methods of manipulation that apply to the different joints. Anaesthesia, although not absolutely essential, is a valuable aid in many cases, owing to the complete muscular relaxation thereby attained. The cases that are attended with the greatest success are those in which the adhesions are slight and in which the subsequent reaction is negligible. In more marked cases much benefit often follows from a series of manipulations separated by short intervals.

Although particular emphasis has been laid on adhesion in connection with joints, it is most important to remember that this may occur in many other important situations, particularly in the vicinity of muscles, or in their sheaths, or between different groups of muscles. This may also occur in connection with tendons and their sheaths, and in fascial or connective-tissue structures.

Functional or Hysterical Cases.—These constitute an interesting and important group in which good results by manipulation are sometimes attained. It must be remembered that a functional case is primarily mental and this condition is particularly apt to occur after injury in a person of nervous temperament. Although there is no actual organic disease of the joint—at any rate in the early stages—yet it is extraordinary how a functional condition of a joint may simulate some organic disability of the same joint. Great experience and clinical acumen are often required to form a correct diagnosis of such types.

The great value of manipulation in these cases is that a vicious circle is thereby broken, and, although an anaesthetic is not absolutely essential, yet, if some such anaesthetic as gas or gas and oxygen be given, it has a powerful suggestive effect upon the patient. It is usually found that, as soon as the patient is under the influence of the anaesthetic, the joint, which previously was held awkwardly and stiffly, becomes relaxed. The manipulator places the joint in the position which was erstwhile impossible and retains it thus until the patient is fully conscious. The patient is then shown the increased mobility and encouraged immediately to move the joint through this increased range. Much subsequently depends upon the patient being surrounded by an atmosphere of cheerfulness and encouragement, and everyone with whom the patient comes in contact must endeavour to play his or her part in the cure and to assure the patient of its completeness and finality.

In cases of long standing, actual organic changes may occur in an hysterical contracture, and the contracture, which was previously due to muscular sprain, becomes fixed by scar tissue. It is therefore important that manipulation should not be delayed too long, especially as the mental state becomes more fixed and more difficult to treat with the passage of years.

Cases Partially Relieved by Manipulation.—This large group includes a great many conditions due to disease rather than injury, the principal probably being the group of infections and intoxications usually known by the name "rheumatic," especially in its more chronic forms. Here again it is obvious that those cases in which only a slight degree of stiffness of a joint is present are much more satisfactory from the point of view of treatment than cases of marked stiffness or cases in which well marked destruction of the joint surfaces has occurred. It is important also to wait until all signs of activity have subsided and furthermore to eradicate the cause wherever possible before having recourse to manipulative measures. In nearly all cases of strains and sprains gentle manipulation at the earliest moment is recommended because the reparative processes of nature act most effectually when, as far as possible, no interference whatever with their functions is resorted to.

(*See* JOINTS AND LIGAMENTS: *Diseases and Injuries.*)

(H. BAR.)

MANIPUR, a state on the northeast frontier of India. Area, 8,620 square miles. Pop. (1941) 512,069. It is bounded on the north by the Naga country and the hills overlooking the Assam valley, on the west by Cachar district, on the east by Upper Burma, and on the south by the Lushai hills. The State consists of a wide valley, with an area of about 650 sq.m., and a large surrounding tract of mountainous country. The hill ranges generally run north and south, with occasional connecting spurs and ridges of lower elevation between. Their greatest altitude is in the north, where they reach to upwards of 8,000 ft. above sea-level. The principal geographical feature in the valley is the Loktak lake, over 25 sq.m. in area, but said to be gradually growing smaller. The valley is watered by numerous rivers, the Barak being the most important. The hills are densely clothed with tree jungle and large forest timber. Rice and forest produce are the principal exports. The road from Manipur to the Assam-Bengal railway at Dimapur is the principal trade route.

Although their general facial characteristics are Mongolian, there is a great diversity of feature among the Manipuris, some of them showing a regularity approaching the Aryan type. In the valley the people are chiefly Hindus, that religion being of recent introduction. Their own name for themselves is Meithei, and their language is a branch of the Kuki-Chin family. One of their peculiarities is the high position enjoyed by women, who conduct most of the trade of the valley. The aboriginal hillmen belong to one of the two great divisions of Nagas and Kukis, and are subdivided into innumerable clans and sections. The State is noted for the excellence of its breed of ponies. The English game of polo was introduced from Manipur, where it forms a great national pastime.

The first relations of the British with Manipur date from 1762, when the rajah solicited British aid to repel a Burmese invasion and a treaty was entered into. Little further communication took place until 1824, on the outbreak of the first Burmese War. British assistance was again invoked by the rajah, and the Burmese were finally expelled from both the Assam and the Manipur valleys. Disputed successions have always been a cause of trouble and in 1891 of a tragedy. In 1890 a brother of the rajah, the *senapati,* or commander-in-chief, dethroned the rajah, and installed the *jubraj* or heir-apparent as rajah. In 1891 the chief commissioner of Assam (Quinton) marched to Manipur with 400 Gurkhas, in order to recognize the new ruler, and remove the *senapati.* An attempt was made to arrest the *senapati,* but after some sharp fighting he escaped. The Manipuris then attacked the British residency with an overwhelming force. An armistice having been declared, Quinton with the Political Resident (Grimwood) and three other officers went to the fort, under promise of safe conduct, to negotiate. They were all treacherously murdered. The attack on the Residency was resumed and the defenders, thinking it untenable, retreated to Cachar, taking Mrs. Grimwood and the wounded with them. A month later a military expedition occupied Manipur. The *senapati* was captured, tried and hanged and the new rajah transported for life. It was decided to preserve the existence of the State, and a child of the ruling family, named Chura Chand, of the age of five, was nominated rajah.

During his minority the administration was conducted under British supervision. The opportunity was seized to abolish slavery and unpaid forced labour, to open up the State by roads and to introduce other reforms. In 1907 the government of the State was handed over to the rajah and Darbar, or council, with a member of the Indian civil service as vice-president. Subsequently the administration of the State was transferred to the rajah from the Darbar, of which the vice-president became president. During World War I a corps of 2,000 labourers was raised in Manipur and sent to France. When an attempt was made to raise a second corps in 1917, the Kukis broke out in rebellion, which was not suppressed until the cold weather of 1918–19 by a large force of Assam Rifles and Burma military police. A new system of administration was adopted after this, three subdivisions being established, each under an officer lent by the Assam government. Revenue is estimated at Rs. 9,62,000. The capital is Imphal, which is a collection of villages. Pop. (1941) 99,716. The ruler, a maharaja, has a salute of 11 guns.

See Mrs. Ethel St. Clair Grimwood, *My Three Years in Manipur* (1891); *Manipur State Gazetteer* (Calcutta, 1905); T. C. Hodson, *The Meitheis* (1908).

MANIS: *see* PANGOLIN; EDENTATA.

MANISA (anc. *Magnesia ad Sipylum*), the chief town of the Manisa vilayet in Turkey, situated in the valley of the Gediz Chai (Hermus), at the foot of Mt. Sipylus, and connected by railway with Smyrna and Afium Kara-Hissar. Population (1940) 37,623. Manisa is an important commercial centre, and contains interesting buildings dating from the times of the Seljuk and early Osmanli sultans, including mosques built by Murad II. and III. and a Mevlevi *Tekke* second only to that at Konia. In 1204 Manisa was occupied by John Ducas, who when he became emperor made it the Byzantine seat of government. In 1305, Roger de Flor besieged it unsuccessfully. In 1313 the town was taken by Saru Khan and became the capital of the Turcoman emirate of that name. In 1398 it submitted to the Osmanli sultan Bayezid

I, and in 1402 was made a treasure city by Timur. In 1419 it was the scene of the insurrection of Bedr ed-Din, which was crushed by Prince Murad, residing in the town as Murad II. In the 17th century Manisa became the residence of the greatest of the Dere Bey families, Kara Osman Oglu, Turcoman in origin, and possibly connected with the former emirs of Sarukhan.

MANISTEE, a city of western Michigan, U.S.A., on Lake Michigan and Lake Manistee, which is formed by the Big Manistee and Little Manistee rivers. A port of entry and the county seat of Manistee county. It is on federal highway 31 and is served by the Manistee and Northeastern and Pere Marquette railways, lake steamers, bus and truck service. The population was 8,078 in 1930 and 8,694 in 1940. The commerce of the harbour amounted to 1,340,650 tons in 1940. The city has two large salt plants, a paper mill, drop forge, ironworks, three chemical plants and other industries. Orchard Beach state park is two miles north. Manistee was settled in 1841 and chartered as a city in 1869. Since 1914 it has had a city-manager form of government.

MANISTIQUE, a city of the Upper Peninsula of Michigan, U.S.A., on the N. shore of Lake Michigan, at the mouth of the Manistique river; a port of entry and the county seat of Schoolcraft county.

It is on federal highway 2, and is served by the Ann Arbor (by car ferry to Frankfort), the Manistique and Lake Superior and the Soo Line railways and lake steamers.

The population was 5,198 in 1930, and it was 5,399 in 1940. The city has a considerable fishing industry, lime quarries, pulp and paper mills and various other lumber manufactures. It is the centre of a summer resort and fishing region, with many hotels, cottages, camps and private homes roundabout.

In the woods adjoining Indian lake (5 mi. W.) is an enormous spring, Kitch-iti-kippi, "the big spring," worshipped by the ancient Chippewas, a bowl 400 ft. across and 100 ft. deep. Manistique has a city-manager form of government.

MANITOBA, a province of the Dominion of Canada situated almost in the centre of the continent about midway between the Atlantic and Pacific oceans and also about midway between the Gulf of Mexico and the Arctic ocean (area 246,512 sq.mi.). The original boundaries of the province were settled by the Manitoba Act of 1870 (see *History*) as being the parallels of north latitude 49° and 50° 30′ and the meridians of west longitude 96° to 99°, an area of about 14,340 sq.mi. The boundaries were extended later (1881), and finally by a statute of 1912 were settled as the parallels of lat. 49° and 60° N., the meridian 102° W. and, on the east side, the meridian 95° W. from the 49th to the 60th parallel north latitude and thence northeast to a point on Hudson bay midway between the Nelson and Severn rivers. Manitoba thus has a sea coast on the Hudson bay.

Geology, Geography and Climate.—Geologically the province falls into three areas, the Laurentian shield area on the Hudson bay side, developed on Pre-Cambrian rocks; the Red river lowlands (occupied by lakes Winnipeg, Winnipegosis, Lake Manitoba and the Red river itself), where the Pre-Cambrian rocks dip beneath the palaeozoic limestone floor of the region and, on the prairie side, the western plateaus presenting an almost continuous cretaceous scarp overlooking the palaeozoic lowland.

A full account of the geology of the province in its continental relation is found in the general article on CANADA.

Geographically the province may be said to be based on the three large lakes named above, Winnipeg area 9,459 sq.mi., (*cf.* Ontario 7,540), Winnipegosis 2,080 and Manitoba 1,817, into which flow the English and Red rivers from the south and the Saskatchewan from the northwest, the whole system draining by the Nelson river to Hudson bay. The northern part of the province is similarly drained by the Churchill.

The lake area is about 1,000 ft. above the sea, the ground westward rising to about 1,600 ft.

Climate.—Manitoba represents the continental type of climate, as opposed to the littoral, with great extremes of heat and cold. Thus the mean range of the year at Winnipeg is one of 70°, at Victoria, B.C. only 21°. A change of 40° in 24 hours often happens during the Manitoba winter. Winter may be said to last five months, November to March, the ground usually covered with snow from December to March, with an annual fall in the province of from 40 in. to 55 in. Southern Manitoba has a January mean temperature of −5°, northern Manitoba −15°; for July respectively, 65° and 60°. Spring comes rapidly; the mean Manitoba temperature in May is as high as in England. In July and August temperatures of over 100° are on record. The rainfall is usually ample, with annual precipitation recorded from 14 in. to 29 in., but in summer, rain and hail often fall in violent storms, with occasionally dry summers as in 1886 with only 4.23 in. of rain May to August.

Area and Population.—The area of Manitoba is 246,512 sq.mi., including 26,789 of fresh water. The population (1941) was 729,744 (males 378,079); compare population 1871, 25,228; 1881, 60,260; 1901, 255,211; 1921, 610,118; the slackening rate of increase being due to the decline of immigration. In point of racial origin the people of the province are 52% British, nearly 7% French, 5½% Polish, 5% German with a scattering of other races that makes the European portion (other than French) about 38% of the total.

The Indians of the province number over 15,000, their numbers not declining; they are under the care and education of the dominion government, occupying 529,000 acres of reserved land.

Government and Public Finance.—The government of Manitoba rests upon the Imperial British North America act of 1867 and of that of 1871, validating all clauses of the Manitoba act (passed by the Canadian parliament in 1870) on all pre-existing laws and institutions of the Northwest Territory not abolished or altered by these statutes, including the British Common Law and with this, the conventions of the British constitutional system.

Manitoba became part of the dominion July 15, 1870 by virtue of an Imperial Order in Council June 23, 1870 declaring the Manitoba act in force. The statutes quoted provide for provincial representation in the parliament at Ottawa (in 1940, senate 6, house of commons 17). The provincial government at Winnipeg, the capital, consists of a lieutenant-governor, appointed and paid by the dominion government, a prime minister and ministry on British cabinet tenure, and a legislative assembly of 55 members elected for 5 years unless sooner dissolved.

The public revenue of Manitoba in its earlier years was based, like that of all provinces, on dominion subsidies. But within the 20th century the growth of provincial expenditure has gone vastly beyond its original limits (Manitoba, 1881, $226,000; in 1940, $20,000,000). These new expenditures were met from new sources which far exceeded the subsidies—corporation taxes, succession duties, taxes arising from gasoline and licences, and the net revenue from liquor control. The gross public debt of Manitoba in 1940 was $90,000,000.

Municipal government, as throughout Canada, is the creation of the province (B.N.A. Act 1867) and is organized in Manitoba on an elective basis in 4 cities, 37 towns (to include the "Flin Flon municipal district" and 5 suburban municipalities) together with 22 incorporated villages and 111 rural municipalities.

Agriculture and the Forest.—Of the whole land area (219,723 sq.mi.) of the province 50,590 sq.mi. are classed as agricultural, most of which is the treeless alluvial land of the prairies in the southern part of the province; 19,150 sq.mi. are classed as forest land fit for agriculture if cleared, and beyond this is the forest land chiefly in the north; much of it (62,500 sq.mi.) being of scrub and poor growth officially classed as unproductive forest land. This with other waste land of rock and muskeg gives a total of 95,343 sq.mi. in Manitoba (43% of the land) classed as unproductive. The land and natural resources of Manitoba remained at its inception (1870) in the hands of the dominion government but were transferred to provincial control in 1929. Of the forested area, good and bad, 8,500 sq.mi. are privately owned and 84,440 still crown land. Manitoba is predominantly an agricultural country, the net value of agriculture being estimated at 42% of provincial production (*cf.* agriculture in Canada 25%, Saskatchewan 71%, B.C. 13%). Statistics show the acreage under field crops (five years average) as 7,342,100. The main crop is spring wheat 41,130,000 bu. on 2,880,000 ac.; oats 33,-935,000 bu. on 1,427,000 ac., barley 27,178,000 bu. on 1,327,000 ac., hay and clover 445,000 ac., potatoes only 33,000 ac., all these on 5 year average and sugar beets, newly introduced, 18,000 ac. in 1940. In livestock Manitoba raised about 9% of the cows and cattle of Canada, 8% of the swine and 10% of the poultry.

There is practically no commercial fruit growing and no production of tobacco or maple sugar. The Manitoba department of agriculture carries on experimental work, and extension instruction work with assistance to boys' and girls' clubs and agricultural and similar societies (*see* also under CANADA: *Products and Industry,* for detailed statistics and the aid given by the dominion government through mortgage loans, etc.).

Minerals and Mining.—Manitoba has only recently taken its place, even now subordinate, in the production of minerals and metals. Statistics of 1940 show 136 mines and plants in the province as compared with 13,665 in all Canada, 6,406 in Ontario. The discovery of gold and copper in northern Manitoba (Flin Flon, etc.) has brought the production of gold from about $4,000 in 1926 to a value of $5,795,135 reported in 1941, the production of silver from 18 fine oz. in 1926 to $1,033,512, and of copper from a production that was *nil* as late as 1930, to over 70,000,-000 lb. in 1939. Manitoba was not in 1943 a serious producer of iron, nickel or lead but after its beginning in 1930 the production of coal amounted yearly to from 1,000,000 to 4,000,000 short tons. Indications showed that the northern and north-eastern portions of the province long regarded as worthless wilderness are the seat of great mineral deposits of high value.

Manufactures.—Manitoba has practically no manufactures except those which arise in a secondary way in an agricultural and wooded country. Lumber, shingle and other sawmill products represent about 60 to 77 M. ft.b.m. each year, a value in 1940 of $1,736,000. This is less than 3% of the output of British Columbia. The total manufactures of the province employed, in 1940, 26,679 people in 1,171 plants, a scale about one-twelfth that of Ontario. Of 18,765 employed in leading industries before the war in 1939, over 4,000 were in railway shops, 1,700 in meat packing and the rest distributed in dairy and cheese factories, flour mills, clothing factories, etc. But in point of potential power for manufacture Manitoba is well situated, having an available horsepower (24 hr., at ordinary six months flow) of 5,344,500 (*cf.* the other prairie provinces about 1,000,000 each, all Canada 33,000,000). This power was by 1943 only developed (420,000 h.p.) in central electric stations and not applied to pulp and paper or any other industry.

Communications.—Geographically the southern area of Manitoba enjoys a peculiarly advantageous position in east-and-west traffic, since the water and wilderness to the north and the frontier to the south make the Winnipeg area the funnel through which traffic from the east passes to expand all over the west. This is seen in the radiating lines of the two great railroads, the Canadian National railways and the Canadian Pacific. The earliest access was by Hudson bay (see *History* below), now of little importance. But the later opening up of the province was by the Red river from the south (steamboat and stage coach and rail in 1878) and hence traffic lines also have been developed to reach Manitoba via Chicago and St. Paul. Until recently through communication with Manitoba was only by rail but the development of air traffic now makes Winnipeg the central point for the National Trans-Canada system and a general point of aerial departure for the north. Motor highways only reached the province via the United States until the completion of the Trans-Canada highway in 1942 made all-Canada motor traffic possible, even while war conditions still kept it from actuality.

History.—In 1670 the Hudson's Bay company received a charter for territorial rights over the entire watershed of Hudson bay, including what is now Manitoba. Apart from the trading posts of this company and of its rival, the North West Fur company, there was no attempt at settlement till Lord Selkirk in 1811 planted a little colony on land acquired from the company at the junction of the Red and Assiniboine rivers. Opposition from the fur traders culminated in the affray of Seven Oaks, when Governor Semple and his followers were killed by the Métis incited by the North West company in 1816. The settlement was re-established at the close of the year.

Assiniboia, as Lord Selkirk's district was called in the records of the Hudson's Bay company, was re-conveyed to the company in 1835 who then controlled its council until 1870. During the regime of the company, development was slow. There was no output for farm produce, and a large proportion of the small population was French and Métis. In 1869 the imperial government bought and transferred to Canada the territorial rights of the company. The French and Métis of Assiniboia, fearing for their land titles and for their religion, and led by the half-breed Louis J. Riel, rebelled against the impending assumption of government by Canada. In 1870 General Wolseley's expedition was sent to ensure order and the province of Manitoba was created (Manitoba Act of Dom. of Canada, 1870) with a population of some 12,000 people (1,565 white, 558 Indian, 9,840 Métis).

The opening of the era of machine grain-farming (in Minnesota, and in the Dakotas) drew population to the northwest and with the completion of railway connection to Manitoba (1878) led to a rush of settlers, and the expansion of the Winnipeg boom (1881–82). The collapse of the boom was followed in provincial history by the building of the C.P.R. across the prairies, by the Northwest Rebellion of 1885 (occasioned by the settlement-survey of the Saskatchewan valley), transcontinental through traffic (1886), and the struggle in Manitoba against the north-and-south monopoly clause of the C.P.R. The middle years of the '90s witnessed the long-drawn conflict over the provincial abolition of separate (Roman Catholic) schools which occasioned the defeat of the Conservative party in 1896. The advent of the Liberals to power under Sir Wilfrid Laurier was followed by a new and more rapid development of the west which lasted till World War I and witnessed an increase of population in Manitoba from 255,211 in 1901 to 461,304 in 1911. Provincial history in Manitoba in the period between the wars turned on the agrarian question of the conflict between western agricultural and eastern capital and manufacturing interests. It was marked by the rise of the United Farmers, formation of the wheat pools and in Manitoba by the elevation to power (1922) of a Progressive government under John Bracken, later (1942) leader of the Progressive Conservative party of Canada.

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MANITOBA, a lake of Manitoba province, Canada, situated between 50° 11′ and 51° 48′ N. and 97° 56′ and 99° 35′ W., at an altitude of 810 ft. above the sea. It has an average depth of 12 ft.

Its shores are low, and for the most part swampy. It is drained by the Little Saskatchewan river into Lake Winnipeg. It was discovered by De la Verendrye in 1739.

MANITOU, among certain American Indian tribes, a spirit or genius of good or evil; Algonkin, "mystery," "supernatural." It has been regarded as monotheistic in tendency.

Ideas of guardianship, of ethical direction, of cosmic authority are blended in it.

MANITOU SPRINGS, a health resort in Colorado, U.S.A., the starting point of the Pikes Peak cog railway, and with radioactive mineral springs. Resident population (1940) 1,462.

MANITOWOC, a city of eastern Wisconsin, U.S.A., on Lake Michigan, at the mouth of the Manitowoc river, 80 mi. N. of Milwaukee; a port of entry and the county seat of Manitowoc county. It is on federal highways 10, 141 and 151; has a municipal airport; and is served by the Chicago and North Western and the Soo Line railways, and also by ferries of the Ann Arbor and the Pere Marquette railways to Frankfort and Ludington, Mich., and by bus and truck lines. Pop., federal census (1930), 22,963; (1940) 24,404 (92% native white). There is a good harbour, open throughout the year. General vessel traffic amounted in 1939 to 477,581 tons (largely receipts of coal and limestone) and car-ferry traffic to 1,444,493 tons. Shipbuilding, the city's pioneer industry, employs 1,800 men, and plants manufacturing aluminium ware employ about 2,000 men and women. These industries, and the various other manufacturing establishments, have an aggregate annual output valued at $35,000,000. In 1795 Jacques Vieau established a fur-trading post there for the Northwest company. Permanent settlement began about 1836. In 1853 Manitowoc became the county seat, and in 1870 it was chartered as a city. The name is an Indian word meaning "spirit-land."

MANIU, JULIUS (1873–), Rumanian politician, was born at Şimleul-Silvaniei (Transylvania). He studied at the universities of Cluj, Vienna and Budapest, and was for many years professor of law at the theological academy in Blaj. At the age of 26 he joined the National Rumanian party of Transylvania. In spite of the bitter opposition of Count Stephen Tisza, Maniu was elected deputy and sat in the parliament at Budapest from 1906 till 1910. When the World War broke out Maniu was sent to the front and in 1918 was fighting against Italy. When he realized that the collapse of the Central Empire was in sight, he went to Budapest, where a National Rumanian Council was formed, Maniu taking charge of military and foreign affairs. He then went to Vienna and organized the revolt of Hungarian regiments, composed of Rumanians of Transylvania, stationed in Vienna and Prague. On Dec. 1, 1918 the Rumanian National Assembly at Alba-Julia proclaimed the union of Transylvania and the Banat with Rumania and elected Maniu president of the *Consiliul Dirigent* (local government) which took over administrative control throughout Transylvania. In 1919 Maniu was elected president of the National Rumanian party of Transylvania, which in 1925 coalesced with the Nationalist-Democratic party. Maniu became the chief of this new formation, which took the name of the National Rumanian party, and shortly afterwards coalesced with the Peasant or Tsaranist party. From 1928 to 1930 he was premier. (*See* RUMANIA.)

MANIZALES, a city of Colombia and capital of the department of Caldas, 75 m. S. of Medellín, on the old trade route across the Cordillera between Honda, on the Magdalena, and the Cauca Valley. Pop. (1938) 51,025 The city is situated on a plateau of the western slope of the Cordillera, 6,988 ft. above the sea. It is surrounded by rich mineral and agricultural districts. The town suffered heavily from fire in 1925.

MANKATO, a city of southern Minnesota, U.S.A., at the confluence of the Minnesota and the Blue Earth rivers, 84 m. S.W. of St. Paul; the county seat of Blue Earth county. It is on Federal highway 14, and is served by the Chicago Great Western, the Chicago, Milwaukee, St. Paul and Pacific, the Chicago and North Western, the Chicago, St. Paul, Minneapolis and Omaha, and the Minneapolis, Northfield and Southern railways, and by many motor bus lines. Pop. (1920) was 12,469 (86% native white); 1940 federal census 15,654.

The region is a rich farming and dairying country, dotted with many lakes. Mankato is a manufacturing city. It is the seat of a State Teachers college (established 1868); and it has an extensive trade in agricultural and manufactured products and in lime, cement and stone from its fine quarries. The city was founded about 1853 and chartered in 1868. On or near its site had stood a village of the Mankato ("blue earth") band of the Sioux, and in this region occurred the Sioux uprising of 1862. Operations against the Indians were carried on from Mankato, and after their subjugation 38 leaders of the revolt were hanged here in Dec. 1862.

MAN LANGUAGES. The term "Măn" (in Chinese, Southern Barbarian) is applied to languages spoken by hill tribes in Indo-China of whom the Miao and Yao are found in upper Burma. These languages are imperfectly known and must provisionally be regarded as an independent group, with some relationship to Karan.

See *Linguistic Survey of India,* vol. i. (1927) p. 39. *Census of Burma* (1921); *Gazetteer of Upper Burma,* vol. i. part 1.

MANLEY, MARY DE LA RIVIÈRE (*c.* 1663–1724), English writer, daughter of Sir Roger Manley, governor of the Channel Islands, was born on April 7, 1663 in Jersey. She wrote her own biography under the title of *The Adventures of Rivella, or the History of the Author of the Atalantis* by "Sir Charles Lovemore" (1714). In 1709 she achieved her principal triumph as a writer by her *Secret Memoirs . . . of Several Persons of Quality,* a scandalous chronicle "from the New Atalantis, an island in the Mediterranean." She was arrested in the autumn of 1709 as the author of a libellous publication, but was discharged by the court of queen's bench on Feb. 13, 1710. Mrs. Manley sought in this scandalous narrative to expose the private vices of the ministers whom Swift, Bolingbroke and Harley combined to drive from office. Later were published her tragedy *Lucius* (1717); *The Power of Love, in Seven Novels* (1720) and *A Stage Coach Journey to Exeter* (1725).

MANLIUS, the name of a Roman gens, chiefly patrician, but containing plebeian families also.

1. MARCUS MANLIUS CAPITOLINUS, a patrician, consul (392 B.C.). According to tradition, when in 390 B.C. the besieging Gauls were attempting to scale the Capitol, he was roused by the cackling of the sacred geese, rushed to the spot and threw down the foremost assailants (Livy. v. 47; Plutarch, *Camillus,* 27). Several years after, seeing a centurion led to prison for debt, he freed him with his own money, and sold his estate to relieve other debtors. He was charged with aspiring to kingly power, and condemned by the comitia when the assembly had adjourned to a place whence they could no longer see the Capitol which he had saved. His house on the Capitol (the origin of his surname) was razed, and the Manlii resolved that henceforth no patrician Manlius should bear the name of Marcus.

See Livy vi. 14–20, Plutarch, *Camillus,* 36; and Cicero, *De domo,* 38.

2. TITUS MANLIUS IMPERIOSUS TORQUATUS, twice dictator (353, 349 B.C.) and three times consul (347, 344, 340). When his father was brought to trial by the tribune M. Pomponius for abusing his office of dictator, he forced Pomponius to drop the accusation by threatening his life (Livy vii. 3–5). In 360, during a war with the Gauls, he slew one of the enemy, a man of gigantic stature, in single combat, and took from him a *torques* (neck-ornament), whence his surname. When the Latins demanded an equal share in the government of the confederacy, Manlius vowed to kill with his own hand the first Latin he saw in the senate-house. The Latins and Campanians revolted, and Manlius, consul for the third time, gained two great victories in Campania. In this campaign Manlius executed his own son, who had killed an enemy in single combat, and thus disobeyed the express command of the consuls.

See Livy vii. 4, 10, 27, viii. 3; Cicero, *De off.* iii. 31.

MANN, HEINRICH (1871–), German novelist, elder brother of Thomas Mann (*q.v.*), was born at Lübeck on March 27, 1871. Educated in Lübeck and Berlin, he travelled in Italy and Germany and produced a series of novels which, if less remarkable than his brother's, displayed a deep feeling for beauty and much satiric power. *Im Schlaraffenland* (1900) was a mordant account of high finance in Berlin. *Die Göttinnen* (3 vols., 1903) was a romantic and often very beautiful, but fantastic, account of a Dalmatian duchess with political, artistic and erotic aspirations. Later works described and satirized German society. They include *Die Jagd nach der Liebe, Professor Unrat* (1905), *Die kleine Stadt* and *Der Untertan* (1914), which contained a portrait, by reflection, of the emperor William II. so unflattering as to make its publication impossible until following the German revolution. Heinrich Mann left Germany in 1933.

MANN, HORACE (1796–1859), educator and statesman, was born in Franklin, Mass., May 4, 1796. His parents' poverty subjected him to privations, and until he was 15, he never attended school more than eight or ten weeks in a year. He received effective instruction, however, from the able pastor of the village church. In his 20th year he fell in with a good college preparatory teacher. In six months he fitted himself for admission to the sophomore class of Brown university, which he entered in Sept., 1816. He graduated with highest honours in 1819. He then entered a lawyer's office at Wrentham, but was soon called back to the university, where he served for two years as tutor in the Latin and Greek languages and as librarian. On leaving Providence the second time, in 1821, he entered the celebrated law school conducted by Judge Gould, at Litchfield, Conn., where he had a fine record. In 1823 he was admitted to the bar. He continued very successfully in the practice of law for 14 years, until he entered upon an educational career in 1837. At first he made his residence at Dedham, but in 1833 removed to Boston.

About the time that he established himself at Dedham, he began to take an active interest in public affairs. He was elected to the Massachusetts house of representatives in 1827, and was re-elected each year until transferred to the State senate in 1833. Here he served four years, the last two as president of the senate, where he was directly responsible for the enactment of four important measures: (1) a law against the use of alcoholic beverages: (2) against the traffic in lottery tickets; (3) the establishment of State hospitals for the insane; (4) an act creating the State board of education.

For a long period prior to the establishment of a State board of education, there had been in Massachusetts an apparent retrogression of education, due to the increase of local self-government and the decrease of central authority. It was evident that public schools diminished in efficiency. A twofold opposition began some years before 1828, which took, on the one hand, the form of an attempt to remedy the deficiency of public schools by the establishment of academies, and on the other hand, that of a vigorous attack by educational reformers, such as Horace Mann, who sought to replace the district system by a township unit. The establishment of a State board of education and the appointment of Mann as its secretary, therefore, mark an era of return from the extreme of decentralization to the proper union of local and central authority.

Horace Mann was chosen secretary of the new State board of education because an educational statesman was needed rather than a mere schoolman. At a considerable financial sacrifice, Mann accepted the small salary attached to the position. It was a board of limited powers, and its success depended upon the personality of its secretary. It could neither found nor administer schools. Its function was to collect and diffuse information; it could pursuade but could not command. As secretary, Mann's plan of campaign included four leading features: (1) The holding of public meetings and the agency of public addresses; (2) Better training of teachers by a system of county institutes, conducted by the leading educators of Massachusetts and other States, and the founding of normal schools; (3) Ample provision for the collection of statistics; (4) Establishment of a periodical, *The Common School Journal,* to influence the educational public in Massachusetts.

The 12 annual reports prepared by Mann, as secretary, on the condition of education in Massachusetts and elsewhere, including his discussions of the aims, purposes and means of education, occupy a commanding position in American educational history. In May, 1843, Mann went to Europe, where he spent five months in the study of educational conditions. His 7th report embodied the result of this tour abroad, and drew an attack upon him from a group of schoolmasters of Boston. His praise of European schools, and particularly his commendation of oral instruction, the word method in teaching reading, and the abolition of corporal punishment in Germany, wounded the sensibilities of the Boston schoolmasters, and a bitter controversy ensued. He was also assailed by religious sectarians, on the ground that he was secularizing the public schools. His skilful administration as secretary gave him a central position in the history of American educational development. It proved a stimulus to educational progress in Massachusetts and made the Massachusetts system the prototype of other State systems.

In 1848, Mann resigned the secretaryship of the Massachusetts board of education in order to accept a seat in Congress, to which he was elected to fill the place made vacant by the death of John Quincy Adams. In politics Mann was a Whig of moderate anti-slavery views. In the controversy regarding the Compromise of 1850, he became an open critic of Webster's views regarding slavery as stated in his famous speech of March 7. The opposition of the Webster faction caused Mann to lose a renomination to Congress in the Whig convention of 1850. However, he ran as an independent candidate, and was triumphantly re-elected. In 1852, he was the Free-soil candidate for governor of Massachusetts, but was defeated. While in Congress Mann was unable to accomplish anything for education.

In 1853 Mann assumed the presidency of Antioch college, a new institution established at Yellow Springs, O., which was to be non-sectarian and open on equal terms to both sexes. The determining reason which led him westward was the prospect that this new position offered for supplementing his achievement in reorganizing the public schools, by the establishment of his ideals of co-education and non-sectarianism in higher education. While in this position he was harassed by the financial difficulties of the college, and by the opposition of various professors and supporters of the institution who distrusted his religious views. However, staunch friends from time to time supplied him with funds to carry on the college, and he won the loyalty of his students. Worn out by his arduous labours in the administration of the college, Horace Mann died at Yellow Springs on Aug. 2, 1859. His parting words to his students had been delivered in his baccalaureate address in 1859 a few weeks previously: "Be ashamed to die until you have won some victory for humanity."

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MANN, THOMAS (1875–), German writer, was born at Lübeck on June 6, 1875, his father being a senator of an old patrician merchant family. At the age of 19 he moved with his family to Munich, worked in an insurance office (meanwhile devoting himself to literature), then studied the humanities, visited Italy, and worked for a time on the staff of *Simplicissimus.* In 1903 he published *Buddenbrooks: Verfall einer Familie* (English trans. 1924), a very remarkable character and period novel, the scene of which is mostly laid in Lübeck. A series of short stories, *Tristan,* appeared in the same year; a full-length but much slighter novel, *Königliche Hoheit,* in 1915 (English trans. 1925), short stories *Der Tod in Venedig* (1912), *Tonio Kröger* (1914); a political declaration of conservatism, *Betrachtungen einer Unpolitischen* (1918), and a second long novel, *Der Zauberberg* (1925), English trans. *The Magic Mountain* (1926). His characterization and sense of environment are remarkable, his technique unsurpassed. His method is leisurely, fond of lingering among sometimes trivial details with a certain irony; but these are selected with unerring skill, and the sense of tragedy has remarkable force. He was awarded in 1929 the Nobel prize for literature. In 1934 he began his great Joseph series: *Joseph and His Brothers* (1934); *The Young Joseph* (1935); *Joseph in Egypt* (1938). Exiled from Germany, he was appointed lecturer at Princeton university in 1938.

MANNA, a saccharine exudation obtained by making incisions on the trunk of the flowering or manna ash tree, *Fraxinus Ornus.* The manna ash is a small tree found in Italy, and extending to Switzerland, South Tirol, Hungary, Greece, Turkey and Asia Minor. It also grows in the islands of Sicily, Corsica and Sardinia. It blossoms early in summer, producing numerous clusters of whitish flowers. At the present day the manna of commerce is collected exclusively in Sicily from cultivated trees. In the *frassinetti* or plantations the trees are placed about 7 ft. apart, and after they are eight years old, and the trunk at least 3 in. in diameter, the collection of manna is begun. This operation is performed in July or August during the dry weather, by making transverse incisions $1\frac{1}{2}$ to 2 in. long, and about 1 in. apart, through the bark, one cut being made each day, the first at the bottom of the tree, another directly above the first, and so on. In succeeding years the process is repeated on the untouched sides of the trunk, until the tree has been cut all round and exhausted. It is then cut down, and a young plant arising from the same root takes its place. The finest or flaky manna appears to have been allowed to harden on the stem. A very superior kind, obtained by allowing the juice to encrust pieces of wood or straws inserted in the cuts, is called *manna a cannolo.*

Manna of good quality dissolves at ordinary temperatures in about 6 parts of water, forming a clear liquid. Its chief constituent is mannitol or manna sugar, a hexatomic alcohol, $C_6H_8(OH)_6$, which likewise occurs, in much smaller quantity, in certain species of the brown seaweed *Fucus,* and in plants of several widely separated families. The best manna contains 70 to 80%. It crystallizes in shining rhombic prisms from its aqueous solution and as delicate needles from alcohol. Manna possesses mildly laxative properties, and on account of its sweet taste is employed as a mild aperient for children. It is less used in England now than formerly, but is still largely consumed in South America.

The manna of the present day appears to have been unknown before the 15th century, although a mountain in Sicily with the Arabic name Gibelman, *i.e.,* "manna mountain," appears to point to its collection there during the period that the island was held by the Saracens, 827–1070.

Various other kinds of manna are known, but none of these has been found to contain mannitol. Alhagi manna is the produce of *Alhagi maurorum,* a small, spiny, leguminous plant, growing in south-western Asia. This manna occurs in the form of small, roundish, hard, dry tears, varying from the size of a mustard seed to that of a coriander, of a light-brown colour, sweet taste and senna-like odour. Tamarisk manna exudes in June and July from the slender branches of *Tamarix gallica,* var. *mannifera,* in the form of honey-like drops, which, in the cold temperature of the early morning, are found in the solid state. This secretion is caused by the puncture of an insect, *Coccus manniparus.* This kind of manna seems to be alluded to by Herodotus (vii. 31). Under the same name of *gaz-angubīn* there are sold commonly in the Persian bazaars round cakes, of which a chief ingredient is a manna obtained to the south-west of Ispahan, in August, by shaking the branches or scraping the stems of *Astragalus florulentus* and *A. adscendens.*

Oak manna or *Gueze-elefi,* according to Haussknecht, is collected from the twigs of *Quercus Vallonia* and *Q. persica,* on which it is produced by the puncture of an insect during August. A substance collected by the inhabitants of Laristan from *Pyrus glabra* strongly resembles oak manna in appearance. Australian or Eucalyptus manna is found on the leaves of *Eucalyptus viminalis, E. Gunnii,* var. *rubida, E. pulverulenta,* etc. The Lerp manna of Australia is of animal origin. Briançon manna is met with on the leaves of the common larch (*q.v.*), and *bide-khecht* on those of the willow, *Salix fragilis;* and a kind of manna was at one time obtained from the cedar. The manna of the Biblical narrative answers in its description very closely to the tamarisk manna.

See Bentley and Trimen, *Medicinal Plants* (1880); Watt, *Dictionary of Economic Products of India,* under "Manna" (1891); H. W. Youngken, *Text-Book of Pharmacognosy* (1943).

MANNERS, CHARLES (1857–1935), English musician, whose real name was Southcote Mansergh, was born in London, son of Colonel Mansergh, an Irishman. He had a fine bass voice, and studied at the Royal Academy of Music in London. He began singing in opera in 1881, and in 1882 had great success as the sentry in *Iolanthe* at the Savoy, following this with numerous engagements in opera both in England and America. He married the singer Fanny Moody, already a leading soprano on the operatic stage, in 1890; and in 1897 they formed the Moody-Manners opera company, which had a great success in the provinces and undertook seasons in London in 1902, 1903 and 1904.

MANNERS-SUTTON, CHARLES (1755–1828), archbishop of Canterbury, was educated at Charterhouse and Cambridge, where he graduated in 1777. He became dean of Peterborough (1791), bishop of Norwich (1792), dean of Windsor (1794), and archbishop of Canterbury (1805). During his primacy the old archiepiscopal palace at Croydon was sold, and the country palace of Addington bought with the proceeds. For his son Charles *see* CANTERBURY, CHARLES MANNERS-SUTTON.

MANNHEIM, a town of Germany, in the *Land* of Baden, on the Rhine, at its confluence with the Neckar, 39 m. by rail N. of Karlsruhe, 10 m. W. of Heidelberg and 55 m. S. of Frankfort-on-Main. Pop. (1939) 283,801. The name of Mannheim was connected with its present site in the 8th century, when a village of the abbey of Lorsch lay between the Neckar and the Rhine. The history of modern Mannheim begins with the opening of the 17th century, when the elector palatine Frederick IV. founded a town here, peopled chiefly with Protestant refugees from Holland, and built a castle which led to its being much attacked in the Thirty Years' War. In 1688 Mannheim was captured by the French, and in 1689 it was burned down. Ten years later it was rebuilt and fortified. For its subsequent importance it was indebted to the elector Charles Philip, who transferred his residence from Heidelberg to Mannheim in 1720, and it remained the capital of the palatinate for nearly 60 years. In 1795 Mannheim was taken by the Austrians, and in 1803 the town was assigned to the grand duke of Baden, who razed the fortifications. Schiller's plays were performed for the first time at Mannheim towards the end of the 18th century.

Nearly the whole of the south-west side of the town is occupied by the palace (1720–59), formerly the residence of the elector palatine of the Rhine. The left wing was totally destroyed by bombardment in 1795, but was later restored. During World War II, Mannheim's factories, railway yards and docks were targets for frequent and severe British bombing attacks.

Mannheim is the chief commercial town on the upper Rhine, and yields in importance to Cologne alone among the lower Rhenish towns. Barges of 2,000 tons go up the Rhine to Mannheim, but only those not exceeding 1,000 tons go up beyond it to Kehl. Mannheim is thus the chief port of the upper navigation of the Rhine, with about 30 m. of quays. It is the principal emporium for south Germany for cereals, coal, petroleum, timber, sugar and tobacco, with a large trade in hops, wine and other south German produce.

MANNING, HENRY EDWARD (1808–1892), English Roman Catholic cardinal, was born at Totteridge, Hertfordshire, on July 15, 1808[1], being the third and youngest son of William Manning, a West India merchant, who was a director of the Bank of England and governor, 1812–1813, and who sat in Parliament for some thirty years. Manning's boyhood was mainly spent at Coombe Bank, Sundridge, Kent, where he had for companions Charles and Christopher Wordsworth, afterwards bishops of St. Andrews and of Lincoln. He was educated at Harrow, and at Balliol college, Oxford. He made his mark in the Union, where Gladstone succeeded him as president in 1830. He graduated with first-class honours in 1830, and obtained, in 1831, through Viscount Goderich, a post as supernumerary clerk in the colonial office. But he returned to Oxford in 1832, was elected a fellow of Merton College, and was ordained; and in 1833 he was presented to the rectory of Lavington-with-Graffham in Sussex by Mrs. Sargent, whose granddaughter Caroline he married on Nov. 7, 1833. Manning's married life was of brief duration. His young and beautiful wife was of a consumptive family, and died childless (July 24, 1837). This bereavement tended to facilitate his acceptance of the austere teaching of the Oxford Tracts; and though he was never an acknowledged disciple of Newman, it was due to the latter's influence that from this date his theology assumed an increasingly High Church character, and his printed sermon on the "Rule of Faith" was taken as a public profession of his alliance with the Tractarians.

In 1838 Manning took a leading part in the Church education movement, by which diocesan boards were established throughout the country; and he wrote an open letter to his bishop in criticism of the recent appointment of the ecclesiastical commission. In December of that year he paid his first visit to Rome, and called on Dr. Wiseman in company with W. E. Gladstone. In Jan. 1841 Shuttleworth, bishop of Chichester, appointed him archdeacon. In 1842 he published a treatise on *The Unity of the Church,* and in that year he was appointed select

[1]Purcell's assertion that the year of his birth was 1807 rests on no trustworthy evidence.

preacher by his university. Four volumes of his sermons appeared between the years 1842 and 1850, and these had reached the 7th, 4th, 3rd and 2nd editions respectively in 1850, but were not afterwards reprinted.

Newman's secession from the Church of England in 1845 placed Manning in a position of greater responsibility, as one of the High Church leaders, along with Pusey and Keble and Marriott; but it was with Gladstone and James Hope (afterwards Hope-Scott) that he was at this time most closely associated. In the spring of 1847 he was seriously ill, and that autumn and the following winter he spent abroad, chiefly in Rome, where he saw Newman "wearing the Oratorian habit and dead to the world." He had public and private audiences with the pope on April 9 and May 11, 1848, but recorded next to nothing in his diary concerning them, though numerous other entries show an eager interest in everything connected with the Roman Catholic Church, and private papers also indicate that he recognized at this time grave defects in the Church of England and an attraction in Roman Catholicism. Returning to England, he protested, but with moderation, against the appointment of Hampden as bishop of Hereford, and continued to take an active part in the religious education controversy. Through the influence of Samuel Wilberforce he was offered the post of sub-almoner to Queen Victoria, always recognized as a stepping-stone to the episcopal bench, and his refusal of it was honourably consonant with all else in his career as an Anglican dignitary, in which he united pastoral diligence with an asceticism that was then quite exceptional.

In 1850 the decision of the privy council, that the bishop of Exeter was bound to institute the Rev. G. C. Gorham to the benefice of Brampford Speke in spite of the latter's acknowledged disbelief in the doctrine of baptismal regeneration, brought to a crisis the position within the Church of England of those who believed in that Church as a legitimate part of the infallible *Ecclesia docens*. Manning made it clear that he regarded the matter as vital, though he did not act on this conviction until no hope remained of the decision being set aside or practically annulled by joint action of the bishops. In July he addressed to his bishop an open letter on "The Appellate Jurisdiction of the Crown in Matters Spiritual," and he also took part in a meeting in London which protested against the decision. In the autumn of this year (1850) was the great popular outcry against the "Papal aggression" (*see* WISEMAN, NICHOLAS PATRICK STEPHEN), and Manning, feeling himself unable to take part in this protest, resigned, early in December his benefice and his archdeaconry; and writing to Hope-Scott, who a little later became a Roman Catholic with him, stated his conviction that the alternative was "either Rome or licence of thought and will."

He was received into the Roman Catholic Church by Father Brownbill, S.J., at the church in Farm Street, on Passion Sunday, April 6, 1851. On the following Sunday he was confirmed and received to communion by Cardinal Wiseman, who also, within ten weeks of his reception, ordained him priest. Manning thereupon proceeded to Rome to pursue his theological studies, residing at the college known as the "Academy for Noble Ecclesiastics," and attending lectures by Perrone and Passaglia among others. The pope frequently received him in private audience, and in 1854 conferred on him the degree of D.D. In 1857 the pope, *proprio motu,* appointed him provost (or head of the chapter) of Westminster, and the same year he took up his residence in Bayswater as superior of a community known as the "Oblates of St. Charles," an association of secular priests on the same lines as the institute of the Oratory, but with this difference, that they are by their constitution at the beck and call of the bishop in whose diocese they live.

The community was thus of the greatest service to Cardinal Wiseman, whose right-hand man Manning thenceforward became. During the eight years of his life at Bayswater he was most active in all the duties of the priesthood, preaching, hearing confessions, and receiving converts; and he was notably zealous to promote in England all that was specially Roman and papal, thus giving offence to old-fashioned Catholics, both clerical and lay, many of whom were largely influenced by Gallican ideas, and had with difficulty accepted the restoration of the hierarchy in 1850. In 1860 he delivered a course of lectures on the pope's temporal power, at that date seriously threatened, and shortly afterwards he was appointed a papal domestic prelate.

He was now generally recognized as the able and effective leader of the Ultramontane party among English Roman Catholics, acting always, however, in subordination to Cardinal Wiseman; and on the latter's death (Feb. 15, 1865) it was felt that, if Manning should succeed to the vacant archbishopric, the triumph of Ultramontanism would be secured. Such a consummation not being desired by the Westminster chapter, they submitted to the pope three names, and Manning's was not one of them. Pius IX. ignored the nominations, and appointed Manning to the archi-episcopal see. Consecrated at the pro-cathedral at Moorfields (since destroyed) by Dr. Ullathorne, bishop of Birmingham (June 8, 1865), and enthroned there (Nov. 6), after receiving the *pallium* in Rome, Manning began his work as archbishop by devoting himself especially to the religious education of the poor and to the establishment of Catholic industrial and reformatory schools. He steadily opposed whatever might encourage the admission of Catholics to the national universities, and so put his foot down on Newman's project to open a branch house of the Oratory at Oxford with himself as superior. He made an unsuccessful and costly effort to establish a Catholic university at Kensington, and he also made provision for a diocesan seminary of strictly ecclesiastical type. He procured a further condemnation at Rome of the "Association for the Promotion of the Unity of Christendom," which advocated prayers for the accomplishment of a kind of federal union between the Roman, Greek and Anglican Churches, and in a pastoral letter he insisted on the heretical assumption implied in such an undertaking. He also worked for the due recognition of the dignity of the secular or pastoral clergy, whose position seemed to be threatened by the growing ascendancy of the regulars, and especially of the Jesuits, whom, as a practically distinct organization within the Church, he steadily opposed.

In addition to his diocesan synods, he presided in 1873 over the fourth provincial synod of Westminster, which legislated on "acatholic" universities, church music, mixed marriages, and the order of a priest's household, having previously taken part, as theologian, in the provincial synods of 1853 and 1859, with a hand in the preparation of their decrees. But it was chiefly through his strenuous advocacy of the policy of defining papal infallibility at the Vatican council (1869–1870) that Manning's name obtained world-wide renown. In this he was instant in season and out of season. He brought to Rome a petition in its favour from his chapter at Westminster, and during the progress of the council he laboured incessantly to overcome the opposition of the "inopportunists." And he never ceased to regard it as one of the chief privileges of his life that he had been able to take an active part in securing the definition, and in having heard with his own ears that doctrine proclaimed as a part of divine revelation. In 1875 he published a reply to Gladstone's attack on the Vatican decrees; and on March 15 in that year he was created cardinal, with the title of SS. Andrew and Gregory on the Coelian. He was present at the death of Pius IX. (Feb. 7, 1878); and in the subsequent conclave, while some Italian cardinals were prepared to vote for his election to fill the vacant chair, he himself supported Cardinal Pecci, afterwards known as Leo XIII.

With Leo XIII. Manning found less sympathy than with his predecessor, though Manning's advocacy of the claims of labour attracted Leo's attention, and influenced the encyclical which he issued on the subject. After the Vatican council, and more especially after the death of Pius IX., Manning devoted his attention mainly to social questions, and with these his name was popularly associated during the last fifteen years of his life. From 1872 onwards he was a strict teetotaller, not touching alcohol even as a medicine. His example and his zeal profoundly influenced for good the Irish poor forming the majority of his flock; and the "League of the Cross" which he founded, and which held annual demonstrations at the Crystal Palace, numbered nearly

30,000 members in London alone in 1874. He sat on two royal commissions, the one on the housing of the working classes (1884), and the other on primary education (1886); and in each case the report showed evident marks of his influence, which his fellow-commissioners recognized as that of a wise and competent social reformer. In the cause of labour he was active for many years, and in 1872 he set an example to the clergy of all the churches by taking a prominent part in a meeting held in Exeter Hall on behalf of the newly established Agricultural Labourers' Union, Joseph Arch and Charles Bradlaugh being among those who sat with him on the platform.

In later years Manning's strenuous advocacy of the claims of the working classes, and his declaration that "every man has a right to work or to bread" led to his being denounced as a Socialist. That he was such he denied more than once (Lemire, *Le Cardinal Manning et son action sociale,* Paris, 1893, p. 210), nor was he ever a Socialist in principle; but he favoured some of the methods of Socialism, because they alone seemed to him practically to meet the case of that pressing poverty which appealed to his heart. He took a leading part in the settlement of the dockers' strike in the autumn of 1889, and his patient and effectual action on this and on similar occasions secured for him the esteem and affection of great numbers of working men, so that his death on Jan. 14, 1892, and his funeral a week later, were the occasion for a remarkable demonstration. The Cathedral at Westminster is his joint memorial with his predecessor, Cardinal Wiseman.

Preeminently Manning was a devout ecclesiastic, a "great priest"; and his sermons, both Anglican and Catholic, are marked by fervour and dignity, by a conviction of his own authoritative mission as preacher, and by an eloquent insistence on considerations such as warm the heart and bend the will rather than on such as force the intellect to assent. But many of his instincts were those of a statesman, a diplomatist, a man of the world, even of a business man; and herein lay, at least in part, the secret of his influence and success. In the later years of his life especially he showed that he loved righteousness and hated iniquity, and that he realized as clearly as any one that the service of God was incomplete without the service of man.

The publication in 1896 of Manning's *Life,* by Edward Purcell, with its very frank revelation of character was the occasion for some controversy on the ethics of biography. Edward Purcell was a Roman Catholic journalist, to whom Manning, late in life, had entrusted, rather by way of charitable bequest, his private diaries and other confidential papers. It thus came to pass that in Purcell's voluminous biography much that was obviously never intended for the public eye was, perhaps inadvertently, printed, together with a good deal of ungenerous comment. The facts disclosed which mainly attracted attention were: (1) that Manning, while yet formally an Anglican, and while publicly and privately dissuading others from joining the Roman Catholic Church, was yet within a little convinced that it was his own duty and destiny to take that step himself; (2) that he was continually intriguing at the back-stairs of the Vatican for the furtherance of his own views as to what was desirable in matters ecclesiastical; (3) that his relations with Newman were very unfriendly; and (4) that, while for the most part he exhibited towards his own clergy a frigid and masterful demeanour, he held privately very cordial relations with men of diverse religions or of no theological beliefs at all. And certainly Manning does betray in these autobiographical fragments an unheroic sensitiveness to the verdict of posterity on his career. But independent critics (among whom may specially be named François de Pressensé) held that Manning came well through the ordeal, and that Purcell's *Life* had great value as an unintentionally frank revelation of character. *See* also sketches by J. E. C. Bodley, *Cardinal Manning* (and other essays) (1912); Lytton Strachey's *Eminent Victorians* (1918); Shane Leslie's *Henry Edward Manning, His Life and Labours* (1921), in which Purcell is supplemented by correspondence not before used, and the Cardinal's letters are sympathetically interpreted.

(A. W. Hu.; X.)

MANNING, WILLIAM THOMAS (1866–), American Protestant Episcopal divine, was born in Northampton, England on May 12, 1866. He entered the ministry from the diocese of California, being ordained deacon 1889 and priest 1891. He became rector of Trinity church, Redlands (Calif.), 1892, and in 1893 was appointed professor of theology in the University of the South, where in the same year he received the degree of bachelor of divinity. He became successively rector of St. John's, Lansdowne (Pa.), 1896; rector of Christ church, Nashville (Tenn.) 1898; Vicar of St. Agnes's chapel, Trinity parish, New York city, 1903. In 1904 he was appointed assistant rector of Trinity church, New York city, becoming rector in 1908. He was consecrated bishop of New York, May 11, 1921. In 1925 he inaugurated the public movement for the completion of the cathedral of St. John the Divine, New York city.

MANNY, SIR WALTER DE MANNY, Baron de (d. 1372), soldier of fortune and founder of the Charterhouse (*q.v.*), was a native of Hainaut, from whose counts he claimed descent. He was a patron and friend of Froissart, in whose chronicles his exploits have a conspicuous and probably an exaggerated place. He appears to have come to England as an esquire of Queen Philippa in 1327, and he took a distinguished part in the Scottish wars of Edward III. In 1337 he was placed in command of an English fleet, and in the following years proved himself an able military commander. He was summoned to parliament as a baron by writ from Nov. 1347 to Jan. 1371. In 1359 he was made a knight of the Garter, and at various times received extensive lands both in England and in France. He was frequently employed by King Edward in the conduct of diplomatic negotiations as well as in military commands. He was one of those charged with the safe custody of the French king John when a prisoner at Calais in 1360; in 1369 he was second in command under John of Gaunt.

Manny is remembered for his share in the foundation of the Charterhouse in London. In 1349 he bought some land near Smithfield and built a chapel, afterwards sold to the bishop of London, Michael de Northburgh, who died in 1361 and bequeathed a large sum of money to found there a Carthusian convent. It is not clear whether this direction was carried out; for in 1371 Manny obtained letters patent from Edward III. permitting him to found, apparently on the same site, a Carthusian monastery called "La Salutation Mère Dieu," where the monks were to pray for the soul of Northburgh as well as for the soul of Manny himself. The bishop's bequest may have contributed to the building and endowment of the house; or possibly, as seems to be implied by a bull granted by Urban VI., in 1378, there were originally two kindred establishments owing their foundation to Northburgh and Manny respectively. At all events, Manny who died early in 1372 left instructions that he was to be buried in the church of the Carthusian monastery founded by himself. About 1335 he married Margaret, daughter and heiress of Thomas Plantagenet, earl of Norfolk, son of King Edward I.

See *Oeuvres de Froissart, I. Chroniques,* ed. by Baron Kervyn de Lettenhove (Brussels, 1867–77), and the Globe edition of *Froissart's Chronicles* (Eng. trans., 1895); G. F. Beltz, *Memorials of the Most Noble Order of the Garter* (1841); *Chronicon Angliae 1323–1388,* ed. by E. Maunde Thompson (Rolls series 64, 1874); P. Bearcroft, *An Historical Account of Thomas Sutton and of his Foundation in Charterhouse* (1737).

MANNYNG, ROBERT (Robert of Brunne) (*c.* 1264–1340?), English poet, was a native of Brunne, now Bourne, in Lincolnshire. About 6 m. from Bourne was the Gilbertine monastery of Sempringham, founded by Sir Gilbert de Sempringham in 1139. The foundation provided for seven to 13 canons, with a number of lay brothers and a community of nuns. No books were allowed to the lay brothers and nothing could be written in the monastery without the prior's consent. Mannyng entered this house in 1288, when, according to the rules, he must have been at least 24 years of age, if, as is supposed, he was a lay brother. He says he was at Cambridge with Robert de Bruce and his two brothers, Thomas and Alexander, but this does not necessarily imply that he was a fellow-student. There was a Gilbertine monastery at Cambridge, and Mannyng may have been there on business connected with his order. When he wrote *Handlyng Synne* he had been (ll. 63–76) 15 years in the priory, beginning to write in "englysch rime in 1303." Thirty-five years later he began his *Story of Inglande,* and had removed (ll. 139, etc.) to the monastery of Sixille (now Sixhills), near Market Rasen.

Handlyng Synne, a poem of nearly 13,000 lines, is a free translation, with many additions and amplifications, from William of Waddington's *Manuel des Pechiez.* It is a series of metrical homilies on the Ten Commandments, the Seven Deadly Sins and the Seven Sacraments, illustrated by a number of amusing stories from various sources. The *Cursor Mundi* had turned religious history into something not very different from a romance of chivalry, and in the stories of *Handlyng Synne* the influence of the *fabliaux* is not far to seek. Mannyng wrote in the English tongue not for learned but for "lewd" men, "that talys and ryme wyl blethly here," to occupy the leisure hours during which they might otherwise fall into "vylanye, dedly synne or other folye."

Each of his 24 topics has its complement of stories. He tells of the English observance of Saturday afternoon as holy to the Virgin, and has much to say of popular amusements, which become sins when they keep people away from church. Tournaments in particular are fertile occasions of all the deadly sins; and mystery plays, except those of the birth and resurrection of Christ performed in the churches, also lead men into transgression. He inveighs against the oppression of the poor by the rich, reproves those who, weary of matins or mass, spend their time in church "jangling," telling tales, and wondering where they will get the best ale, and revives the legend of the dancers at the church door during mass who were cursed by the priest and went on dancing for a twelvemonth without cessation. He loved music himself, and justified this profane pleasure by the example of Bishop Grosseteste, who lodged his harper in the chamber next his own; but he holds up as a warning to gleemen the fate of the minstrel who sang loud while the bishop said grace, and was miserably killed by a falling stone in consequence. The old monk's keen observation makes the book a far more valuable contribution to history than his professed chronicle. It is a storehouse of quaint stories and out-of-the-way information on manners and customs.

His chronicle, *The Story of Inglande,* was also written for the solace and amusement of the unlearned when they sit together in fellowship (11. 6–10). The earlier half is written in octosyllabic verse, and begins with the story of the Deluge. The genealogy of Locrine, king of Britain, is traced back to Noah, through Aeneas, and the chronicler relates the incidents of the Trojan war as told by Dares the Phrygian. From this point he follows closely the *Brut* of Wace. He loved stories for their own sake, and found fault with Wace for questioning the miraculous elements in the legend of Arthur. In the second half of his chronicle, which is less simple in style, he translates from the French of Pierre de Langtoft. He writes in rhyming alexandrines, and in the latter part of the work uses middle rhymes. Mannyng's *Chronicle* marks a change in national sentiment. Though he regards the Norman domination as a "bondage," he is loud in his praises of Edward I., "Edward of Inglond."

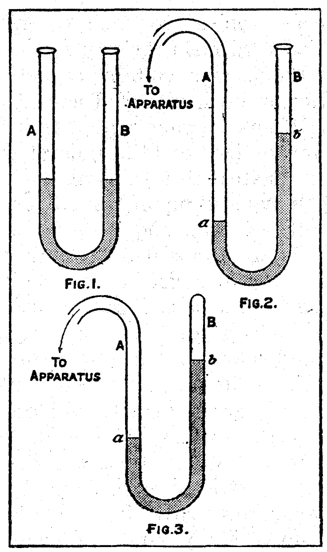
The linguistic importance of Mannyng's work is very great. He used very few of those Teutonic words which, though still in use, were eventually to drop out of the language, and he introduced a great number of French words destined to be permanently adopted in English. Moreover, he employed comparatively few obsolete inflexions, and his work no doubt furthered the adoption of the Midland dialect as the acknowledged literary instrument. T. L. Kington-Oliphant (*Old and Middle English,* 1878) regards his work as the definite starting point of the New English which with slight changes was to form the language of the Book of Common Prayer.

A third work, usually ascribed to Mannyng, chiefly on the ground of its existing side by side with the *Handlyng Synne* in the Harleian and Bodleian mss., is the *Medytacyuns of the Soper of oure lorde Jhesu, And also of hys passyun And eke of the peynes of his swete modyr, Mayden marye,* a free translation of St. Bonaventura's *De coena et passione Domini. . . .*

Robert of Brunne's *Chronicle* exists in two mss.: Petyt ms. 511, written in the Northern dialect, in the Inner Temple library; and Lambeth ms. 131 in a Midland dialect. The first part was edited *The Story of England . . .* (1887) for the Rolls Series, with an introductory essay by F. J. Furnivall; the second part was published by Thomas Hearne as *Peter Langtoft's Chronicle . . .* (1725). Peter Langtoft's French version was edited by Thomas Wright for the "Rolls Series" in 1866. Of *Handlyng Synne* there are complete mss. in the Bodleian library (ms. 415) and in the British Museum (Harleian ms. 1701), and a fragment in the library of Dulwich college (ms. 24). It was edited, with Waddington's text in parallel columns, by F. J. Furnivall for the Roxburghe club (1862), and for the Early English Text Society (1901–03). The *Meditacyun* was edited from the Bodleian and Harleian mss. by J. Meadow Cooper for the same society (1875). *See* also Gerhard Hellmers, *Ueber die Sprache Robert Mannyngs of Brunne und über die Autorschaft der ihm zugeschriebenen Meditations . . .* (Göttingen, 1885), which contains an analysis of the dialectic peculiarities of Mannyng's work; O. Boerner, "Die Sprache Robert Mannyngs" . . . in *Studien zur engl. Philologie* (vol. xii., Halle, 1904) and Oskar Preussner, *Robert Mannyng of Brunne's Übersetzung von Pierre de Langtofts Chronicle* (Breslau, 1891). All accounts of his life are based on his own work.

MANOEL II., ex-king of Portugal (1889–1932), was born at Lisbon on Nov. 15, 1889, the younger son of Carlos I. by his wife Marie Amélie of Orleans. On the assassination of King Carlos and of the crown prince Luis, duke of Braganza, on Feb. 1, 1908, Dom Manoel succeeded to the throne of Portugal, but he only retained it for a short time, as the revolution of Oct. 3, 1910 forced him to flee the country (*see* PORTUGAL). He took refuge with his mother in England, and finally settled at Fulwell Park, Twickenham. He became a familiar and popular figure in English society. On Sept. 4, 1913 he married, at Sigmaringen, Princess Augusta Victoria of Hohenzollern, daughter of Prince Wilhelm of Hohenzollern. Dom Manoel died July 2, 1932.

MANOMETER, an instrument for measuring the pressures exerted by gases or vapours (Gr. μανός, thin or loose; μέτρον, a measure). A form of pressure gauge (*q.v.*). The manometer is simply a **U** tube (fig. 1), containing a liquid: if the pressures on the surfaces of the liquid be equal, then the surfaces will be at the same height. If, on the other hand, the pressure in one limb be greater than the pressure in the other, the surfaces will be at different heights, the difference being directly proportional to the difference of pressures and inversely as the specific gravity of the liquid used. One limb of such a tube (limb A) is connected to the apparatus containing the gas or vapour whose pressure it is desired to determine. The other limb (limb B) may be either open to the air (fig. 2), or closed. In the open-tube type the pressure in one limb is equal to the atmospheric pressure, and in the closed-tube type the experimental pressure is balanced against the liquid column and the pressure of the air compressed into the upper part of a closed limb of the tube (fig. 3). In the "open tube" form (fig. 2) the pressure on the surface a is equal to the pressure on the surface at b (one atmosphere) *plus* the hydrostatic pressure exerted by the liquid column of height ab. The liquid commonly used is mercury. If a scale be placed behind the limbs of the tube, so that the difference ab can be directly determined, then the pressure in a is at once expressible as $P+ab$ in millimetres or inches of mercury, where P is the atmospheric pressure, known from an ordinary barometric observation.



MANOMETERS OF THE OPEN AND CLOSED TUBE TYPE

In the "closed tube" form (fig. 3) the calculation is not so simple, since pressure on the mercury surface in the closed limb will vary with the position of that surface. Suppose the length of the air column in the closed limb be h and its pressure p when the mercury is at the same height in both tubes. Applying pressure at a the mercury column will rise and the air column diminish in the closed limb. Let the length of the air column be h', then its pressure is ph/h'. The difference in height of the mercury columns in the two limbs is $2(h-h')$, hence the pressure in the open limb is equal to that of a column of mercury of length $2(h-h')\ pl+s\frac{ph}{h'}$, and if p is known the pressure applied at a can be determined. A particular case occurs when p is zero—the pressure at a is then equal to the difference in height of the mercury columns. Such instruments are serviceable for measuring pressures less than one atmosphere and are used in the laboratory to measure roughly the degree of vacuum obtained (*see* VACUUM).

MANOR. Any definition of a manor, in land tenure, must take note of two elements—economic and political. The manor has an estate for its basis, although it need not coincide with an estate, but may be wider. It is also a political unit, a district formed for purposes of government, although the political functions made over to it may greatly vary. As a lordship based on land tenure, the manor necessarily comprises a ruler and a population dependent on him, and the characteristic trait of such dependence consists in various forms and degrees of subjection, chiefly regulated by custom. In the sense mentioned the manor is by no means a peculiarly English institution; it occurs in every country where feudalism got a hold. Under other names we find it not only in France, Germany, Italy, Spain, but also, to a certain extent, in the Byzantine empire, Russia, Japan, etc. It is especially representative of an aristocratic stage in the development of European nations. When tribal notions and arrangements ceased to be sufficient for upholding their commonwealths, when social and political life had to be built up on the basis of land-tenure, the type of manorial organization came forward in natural course.

Origin and Development.—One problem common to the entire European world has to be considered from the very beginning. Does the manor date from the Roman empire, or not? Can its chief features be traced in Roman institutions? There can be no doubt that at the end of the Roman period certain traits are noticeable which might, under favourable conditions, develop into a manorial combination. Great estates with political functions, populations subjected to the political lordship of landowners, appear in the closing centuries of the empire, and have to be reckoned with as precursors of mediaeval manorial life. During the last centuries of its existence the Western empire became more and more a conglomerate of barbaric and half-civilized populations. The central power, after claiming an absolute sway over its subjects, is obliged more and more to lean on private forces in order to maintain itself. One of its favourite resources in the 4th and 5th centuries consists in making great landowners responsible for the good behaviour of their tenants and even of their less important neighbours. The *saltus,* the great domain, is occasionally recognized as a separate district exempt from the ordinary administration of the city, subordinated to its owner in respect of taxes and police. Even in ordinary estates (*fundi*) there is a tendency to make the landowner responsible for military conscription, for the presentation of criminals to justice. On the other hand the incumbents of ecclesiastical offices are nominated in accordance with the wishes of patrons among the landowners; in the administration of justice the influence of this same class makes itself felt more and more. Nor are signs of a convergent evolution wanting on the economic side. Slaves are used more and more as small householders provided with rural tenements and burdened with rents and services. Free peasant farmers holding by free agreement get more and more reduced to a status of half-free settlers occupying their tenancies on the strength of custom and traditional ascription to the glebe. Eventually this status is recognized as a distinct class by imperial legislation. Yet there could be no talk of a manorial system as long as the empire and the commercial intercourse protected by it continued to exist.

The fall of the empire hastened the course of evolution. It brought into prominence barbaric tribes who were unable to uphold either the political power or the economic system of the Romans. The Germans had from of old certain manorial features in the constitution of their government and husbandry. The owner of a house had always been possessed of a certain political power within its precincts, as well as within the fenced area surrounding it: the peace of the dwelling and the peace of the hedged-in yard were recognized by the legal customs of all the German tribes. The aristocratic superiority of warriors over all classes engaged in base peaceful work was also deeply engraved in the minds of the fighting and conquering tribes. On the other hand the downfall of complicated forms of civilization and civil intercourse rendered necessary a kind of subjection in which tributary labourers were left to a certain extent to manage their own affairs. The Germanic conqueror was unable to move slaves about like draughts: he had no scope for a complicated administration of capital and work. The natural outcome was to have recourse to serfdom with its convenient system of tribute and services.

But, as in the case of the Roman empire, the formation of regular manors was held back for a time in the early Germanic monarchies by the lingering influence of tribal organization. In the second period of mediaeval development in continental Europe, in the Carolingian epoch, the features of the estate as a political unit are more sharply marked. Notwithstanding the immense efforts of Charles Martel, Pippin and Charlemagne to strengthen the tottering edifice of the Frankish empire, public authority had to compromise with aristocratic forces in order to ensure regular government. As regards military organization this is expressed in the recognition of the power of *seniores,* called upon to lead their vassals in the host; as regards jurisdiction, in the increase of the numbers of commended freemen who seek to interpose the powerful patronage of lay and secular magnates between themselves and the Crown. Great estates arose not only on the lands belonging to the king, but on that of churches and of lay potentates, and the constitution of these estates reminds us forcibly of that of later feudal estates.

The struggle against Northmen, Magyars and Slavs gave a crowning touch to the process of localization of political life and of the aristocratic constitution of society.

France.—In order to describe the full-grown continental manor of the 11th century it is better to take French examples than German, Italian or Spanish. Feudalism in France attained the greatest extension and utmost regularity, while in other European countries it was hampered and intermixed with other institutional features. The expression best corresponding to the English "manor," in the sense of an organized district, was *seigneurie.* *Manoir* is in use but meant strictly "mansion" or chief homestead in France.

The *seigneurie* may be considered from three points of view—as a unit of administration, as an economic unit, and as a union of social classes.

(*a*) In principle the disruption of political life brought about by feudalism ought to have resulted in the complete administrative independence of the manor. *Chaque baron est souverain dans sa baronie* is a proverb meant to express this radical view of manorial separatism. As a matter of fact this separatism was never completely realized, and even at the time of the greatest prevalence of feudalism the little sovereigns of France were combined into a loose federation of independent fiefs. The institutional expression of this aspect of feudalism in the life of the *seigneurie* was the jurisdiction combined with the latter. The principal origin of this jurisdiction was the dismemberment of royal justice, the acquisition by certain landowners of the right of holding royal pleas. The assumption of authority over public tribunals of any kind was naturally considered as equivalent to such a transmission of royal right. But other sources may be noticed also. It was assumed by French feudal law that in all cases when land was granted by a *seigneur* in subinfeudation the recipients would be bound to appear as members of a court of tenants for the settlement of conflicts in regard to land. A third source may be traced in the extension of the patrimonial justice of a person over his serfs and personal dependents to the classes of free and half-free population connected with the *seigneurie* in one way or another. There arose in consequence of these assumptions of jurisdiction a most bewildering confusion of tribunals and judicial rights. A certain order was brought into this feudal chaos by the classification of judiciary functions according to the four categories of high, middle, low and tenurial justice. The scope of the first three subdivisions is sufficiently explained by their names; the fourth concerned cases arising from subinfeudation. As a rule the baron or *seigneur* sat in justice with a court of assessors or peers, but the constitution of such courts varied a great deal.

(*b*) The economic fabric of the French *seigneurie* varied greatly, according to localities. In the north of France it was not unlike that of the English manor. The capital messuage, or castle, and the home-farm of the lord, were surrounded by dependent holdings, *censives,* paying rent, and villein tenements burdened with services. Between these tenancies there were various ties of neighbourhood and economic solidarity recalling the open-field cultivation in England and Germany. When the harvest was removed from the open strips they returned to a state of undivided pasture in which the householders of the village exercised rights of common with their cattle. Wild pasture and woods were used more or less in the same fashion as in England (*droit de pacage de vaine pâture*). The inhabitants often formed courts and held meetings in order to settle the by-laws, and to adjudicate as to trespasses and encroachments (*courts colongères*).

(*c*) The social relations between the manorial lord and his subjects are marked by various forms of the exploitation of the latter by the former. Apart from jurisdictional profits, rents and agricultural services, dues of all kinds are exacted from the rural population. Some of these dues have to be traced to servile origins, although they were evidently gradually extended to groups of people who were not descended from downright serfs but had lapsed into a state of considerable subjection. The *main morte* of rustic tenants meant that they had no goods of their own, but held movable property on sufferance without the right of passing it on to their successors, although after payment of a heavy fine, succession might be permitted. The *formariage* corresponded to the English *merchetum,* and was exacted from rustics on the marriage of their daughters; this payment was considered a badge of serfdom. *Chevage* (*capitagium*) might be exacted as a poll-tax from all the unfree inhabitants of a *seigneurie,* or, more especially, from those who left it to look for sustenance abroad. The power of the lord as a landowner was more particularly expressed in his right of pre-emption (*retrait seigneurial*), and in taxes on alienation (*lods et ventes*). As a person wielding political authority, a kind of sovereignty, the lord enjoyed divers rights which are commonly attributed to the State—the right of coining money, of levying direct taxes and toll (*tallagium, tolneta*) and of instituting monopolies, such as the use of the lord's mill (*moulin banal*), or of his oven (*four banal*) or of his bull (*taureau banal*).

See Fustel de Coulanges, *Histoire des institutions de la France* (1874–92), especially the volumes "L'Alleu et le domaine rural" and "L'Invasion germanique;" Beaudouin, "Les Grands domaines dans l'empire romain" (*Nouvelle revue de droit français et étranger,* 1898); J. Flach, *Les Origines de l'ancienne France,* I., II., III. (1886); P. Viollet, *Histoire des institutions de la France,* I., II. (1890, 1898); A. Luchaire, *Manuel des institutions françaises* (1892); G. Waitz, *Deutsche Verfassungsgeschichte,* I.–VIII. (1865–83); K. T. von Inama-Sternegg, *Deutsche Wirtschaftsgeschichte,* I., II. (1879–91); K. Lamprecht, *Deutsches Wirthschaftsleben,* I.–IV. (1885); A. Meitzen, *Ansiedelungen, Wanderungen und Agrarwesen der Völker Europas,* I.–IV. (1895 *seq.*); W. Wittich, *Die Grundherrschaft in Nordwestdeutschland* (1896); G. F. von Maurer, *Geschichte der Mark-, Dorf- und Hofverfassung in Deutschland;* F. Seebohm, *The English Village Community* (1883); P. Vinogradoff, *Historical Jurisprudence* (2 vols., 1920, 1922).

(P. Vi.)

THE MANOR IN ENGLAND

The typical English Manor, if there be a recognized or definite type, is known to us through the records of the 13th century. There is much valuable material in the somewhat cryptic descriptions in the Domesday survey; there are admirable pictures of the custom and working of a manor in the 12th century extents, surveys, custumals and cartularies, but in the 13th century we find in addition to these, systematic information as to the economic progress of the manor, in the Ministers' accounts, and as to the judicial proceedings of the manorial courts, in the court rolls. By the 14th century we are confronted with a picture of change and decay, emancipation and development.

Topography.—Topographically, a manor is a complex estate, consisting of (*a*) the lord's demesne, scattered in strips in the open fields, or in consolidated blocks of fields; (*b*) the land of the free tenants, who owe the lord small rents in money or in kind, and certain fixed labour-services; (*c*) the land of the villeins, lying for the most part in the open fields, and owing more onerous and uncertain services, as well as rents in money and in kind. The land of the manor is partly arable, partly meadow (very highly valued), partly rough pasture, waste or wood. In central and southern England the arable land was divided into three great fields, arranged for a three year rotation of crops and fallow; the fields were divided into acre or $\frac{1}{2}$-acre strips, grouped in "shots" or furlongs. The lord, the free tenants and the villeins all held more or less defined rights to a share in the meadow and the waste. Much of the communal administrative action of the manorial courts is connected with these rights. In the north and west, and again in Kent and East Anglia the three-field division is hardly to be found, and the whole agrarian system varies sharply from the "normal"; this fact is important in local investigations.

Inhabitants of the Manor.—The inhabitants of the manor have all their separate rights, asserted and defended by the manorial court. The lord at the head of the society, in his hall or manor-house, enjoys his own demesne, holds a certain "superiority" over the lands of the villeins (which, the later lawyers describe as ownership of the freehold of all villein or copyhold land) and possesses rights over the waste paramount to those enjoyed by the other inhabitants. These rights were to some extent limited by the Statute of Merton (1236) and the second Statute of Westminster (1285). The lord's rights of jurisdiction will be better treated in connection with the courts. The free tenant is not yet a modern free-holder; economically he is often hardly distinguishable from a villein, but his status is clearly marked by his power to appeal to the royal courts of justice, even against his lord. Below the free-tenants came the villeins (*nativi, rustici,* bondmen, virgaters, customers, etc.)—customary tenants holding a house, a virgate or half-virgate in acre strips, and a share in the meadows and waste. A virgate was normally about 30 acres—the fourth part of a hide; but it might vary from 10–15 acres up to 60 or 80, while the acre itself varies in different districts. The villein was in certain respects unfree; in the eye of the law he had no rights against his lord, who "was protected from all suits by the *exceptio villenagii";* he might not leave the manor without permission, and he could be reclaimed if he did, by the writ *"de nativo habendo";* he could not, in theory, own any property, and he was subject to certain "base" incidents, such as the payment of *merchet,* and the need to ask permission to put his son to school or to allow him to seek ordination. But in practice the villein bought and sold like other men, after payment of a small fee; he leased, exchanged or sold his land, through the very efficient machinery of the manorial court; he made wills, and at times appears even to have disposed of his villein lands by will—proved in the lord's court. He could, no doubt, be ejected by the lord, but such ejection was very rare, and seemed to require a complete cessation of services, by physical or mental incapacity, before it could be accomplished "according to the custom of the manor." The villein was never exposed to the arbitrary will of the lord, but was always protected by the court, which interpreted the "custom" by the spoken witness of the *villata* (or the *curia,* the *homagium,* the *jurati*) or the written testimony of court roll or custumal. The inevitable confusion which arose between unfree status, and unfree tenure usually reacted to the advantage of the villein by blood, but on some estates (notably monastic lands) there was a determined attempt to impose the whole burden of unfree status upon free men holding villein tenements. Individual villeins, with their *sequela,* or villein brood, were sometimes bought and sold, but they could not be separated from their tenements, and all that is implied by sale is transfer from one lord to another as regards services and jurisdiction. The hardship or prosperity of a villein's lot depended mainly upon his economic position, which would seem to have steadily improved in the 14th century. His rents in money, in kind, and in services were for the most part fixed. The rents of assize (probably a commutation of earlier rents in kind rather than of services) varied considerably on different manors, but as they remained fixed for centuries, the advantage of any fall in the value of money remained with the villein. The dues in kind were gradually almost all commuted, or dropped.

Labour Services.—Although it happened that the villein paid small rents in moneys and in kind, labour dues were the most serious part of a villein's obligations. Two or three days week-work throughout the year might be combined with two or three extra days per week in harvest to make an apparently insupportable burden. It should be noted, however, that a day's work sometimes means, by definition, half a day's work, or a fixed measure of reaping or mowing. Moreover, the labour was due from the virgate, and not from each man; hence a father might send his son to fulfill his obligation. Generally the harvest works (boon-days) survived longest as they were available for emergencies.

One of the most important problems in connection with the manor is the local distribution of labour services, and the varying reasons for their commutation. The history of the manor in the 14th century is the story of the change from typical mediaeval methods to an elementary form of the modern farm worked by hired labour. By the end of the 14th century the class of villeins included men of varied economic status; cottiers or bordars holding a plot of 4 or 5 acres and a cottage at one end of the scale were legally in the same position as men who had laid field to field, virgates and enclosures, until they might hold 100 to 200 acres of land, and require the services of wage-paid men, even while they themselves owed "base" services.

Administration of the Manor.—A very important factor in the development of the manor was the administrative system, the history of which has as yet been imperfectly explored. This aspect of manorial history is, however, useful in correcting over-sweeping generalizations. The lord of a manor might be the king, the duke of Lancaster, a wealthy bishop or monastic house, or, on the other hand the humblest of knights or freemen. Upon his status and the number of his manors depended the character of the administration. The minimum staff would be the lord's bailiff, working with the provost or reeve, who was usually elected by the "homage," and who had under him certain regular servants of the manor—a hay-ward, a reap-reeve, a shepherd, swineherd, bee-keeper, etc. Whenever it happened that the lord held a number of manors, he required a seneschal, or steward, whose office is variously described as agricultural supervision, or as judicial and legal (*cf.* Walter of Henley, etc.). The seneschal was usually assisted by a group of clerks and auditors, and other officials, who were responsible for the final presentation of the manorial accounts. The seneschal and his subordinates were admitted to office by an oath, closely parallel to that of a royal councillor; the whole group of officials tended to develop into a private council, which often contained professional lawyers, described as *utrius jurisperiti.* Rudimentary forms of these private councils may be found in the 12th century, and they were evidently well established by the end of the 13th century (*e.g.,* for the abbey of St. Albans, or the bishoprics of Durham, Worcester and Ely, and the archbishopric of Canterbury).

Manor Court.—The manor court is a complicated structure, though the division court leet, court baron and court customary does not belong to its early history. It originally exercised its criminal, civil, or manorial jurisdiction as one court; its names may differ, the parties before it may be free or unfree, but the court is the same. Its president was the lord's steward; the bailiff was the lord's representative and the public prosecutor; and the tenants of the manor, both free and unfree, attended at the court and gave judgment in the cases brought before it. To modern ears the constitution sounds unfamiliar. The president of the court settled the procedure of the court, carried it out, and gave the final sentence, but over the law of the court he had no power. All that is comprised in the word "judgment" was settled by the body of tenants present at the court. The business of the court may be divided into criminal, manorial and civil. The powers under the first head depended on the franchises enjoyed by the lord in the particular manor; for the most part only petty offences were triable, such as small thefts, breaches of the assize of bread and ale, assaults, and the like; except under special conditions, the justice of great offenses remaining in the king. But offences against the custom of the manor, such as bad ploughing, improper taking of wood from the lord's woods, and the like, were of course the staple business of the court. Under the head of manorial business the court dealt with the choice of manorial officers, and had some power of making regulations for the management of the manor; but its chief function was the recording of the surrenders and admittances of the villein tenants.

It is in this function that we find the origin of copyhold tenure. The manorial court acted as a registry of an active land market, and, provided the fees on transfer were paid, lords evidently made no effort to maintain static conditions. On some estates we find an almost complete replica of the system of royal writs for possessory and even proprietary actions. Litigation became so common that the written record takes the place of the testimony of the old men or of the court. Court rolls were constantly produced in court, as evidence, and from the first half of the 14th century, we find tenants in possession of a copy of court roll. By 1400 the possession of a copy is often enforced, and the existence of the copyholder is thus acknowledged. Besides land questions, the manorial court dealt with any other civil suits that might arise, such as questions of debt, detinue, damages, or contract. In semi-urban manorial courts, which might have to deal with fairs or with industry, these civil cases became of considerable importance. Occasionally, the manor court would appear to encroach upon the province of the courts christian—*e.g.,* in dealing with wills of villeins and copyholders, and in proceedings against usurers.

During the 15th century, the villein slowly developed into a copyholder, and the importance of the manorial court was correspondingly diminished. After ten well-known decisions of Danby, C.J., and Bryan, C.J., in 7 Ed. IV. and 21 Ed. IV., it was established that the courts of law could entertain an action of trespass brought against his lord by a customary tenant. From this time onward, the courts, both of law and of equity, began to intervene, and the records of the courts of Chancery, Star Chamber, and Requests show that in the Tudor period equitable suits brought by tenants against their lords were not infrequent. The few remaining "bondsmen" of the 16th century were constrained to pay heavily for their manumission. Gradually the manor ceased to have any social or economic importance, and its few remaining privileges and peculiarities of tenure were swept away by the Law of Property Acts 1922.

It is clear that the manor court as here described consisted of conflicting elements of very different origin and history. Founded partly on express grants of franchises, partly on the inherent right of a feudal lord to hold a court for his free tenants, partly on the obscure community traceable among the unfree inhabitants of the manor, it is incapable of strict legal definition. All these elements, moreover, contain in themselves reasons for the decay which gradually came over the system. In some cases of urban development, the manorial court was strengthened. But for the most part only a shadow of its former powers survived to control the few remaining copyholders, until the passing of the Law of Property Acts 1922.

Later Legal Theory.—A few words must be given to the legal theories of the 15th century on the manor court. It would seem to have become the law that to the existence of the manor two courts were necessary—a court customary for customary tenants, and a court baron for free tenants. If the freeholders in the manor diminish to less than two, the court baron cannot be held, and the manor perishes. This distinction seems to be without historical justification, as the court of the 13th century was not differentiated in this way; the terms were also very loosely applied, and it is not unusual in the 16th century to find a so-called court baron exercising all the functions of a customary court.

Apart from the change in the court of the manor, the most important thread in its later history is the process, mentioned above, which converted the villein into the copyholder. Although it seems hardly accurate to describe the villein of the 13th century as holding at the will of the lord, yet he could claim no protection from the king's courts. If, however, the villein were a tenant on the king's Ancient Demesne, his condition was distinctly more secure. He was protected by the writs of *monstraverunt* and the little writ of right close from the improper exactions of services and from ejection by the lord. But in ordinary manors there was no such immunity. That ejection was legally possible has already been shown, and it was not until the well-known decision of

Danby, C. J. and Bryan, C. J. in 7 Edw. IV., and 21 Edw. IV., that the courts of law would entertain an action of trespass brought against his lord by a customary tenant. There was nothing, however, to prevent a customary tenant from proceeding by way of petition to the king, and there are cases of such petitions as early as the end of the 14th century.

Moreover, in 1381 royal justice had come to the aid of the lords against their villeins, and it was not unknown that a lord should call in the private aid of a distinguished justice or counsel. In time the process is reversed, and the royal courts begin to help the villein or copyholder against his lord. From the decision of Bryan and Danby onwards, the courts, both of law and of equity, begin to intervene and the records of the courts of Chancery, Star Chamber, and Requests show that in the Tudor period equitable suits brought by tenants against their lords are not infrequent. The 16th century also saw the manumission of the few remaining "bondsmen," who were constrained to pay heavily for their personal freedom. From that period onwards the manor ceased to have any social importance, and survived merely as the nucleus of a peculiar form of land tenure.

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MANOR HOUSE, the house of the lord of the manor, or holder of one of the smaller feudal fiefs, distinguished from a castle by the fact that it did not possess developed towers or a keep, and was not designed to withstand an extended siege. Feudal regulations in regard to which fiefs could possess castles were strict and complex. Early manors were, nevertheless, fortified, and, during the 13th and 14th centuries, the manor house took the form of a rectangular, masonry walled building, frequently with battlements (*q.v.*) and often surrounded by a moat. This central building was itself surrounded by barns, stables and other farm buildings, and the whole group enclosed by a wall. Ruined examples of this type have been studied carefully in France, as the *castera* of S. Médard en Jalle, near Bordeaux (first half 13th century); Camarsac on the banks of the Gironde (early 14th century). Near Southampton, England, the walls of a manor house built by Richard Coeur de Lion in the 12th century still stand and the castle of Stokesay in Shropshire is an example of the English 13th century manor house. All these are noteworthy in that they show a definite attempt to produce, however crudely, carefully thought out living quarters in which the idea of comfort plays an important part. One or more great halls (*see* Hall) was a necessary feature, and in English houses furnished the controlling element in the planning of all manor houses from the 14th century on. As life became more settled and the need of defence less, the single rectangular block became inadequate and various schemes round a court were adopted. In France, the manor house of Xaintrailles near Nérac is a good example of the early 15th century. Ightham Mote, built largely in the reign of Henry VII., is the best preserved English example of the 15th century.

From 1500 on, the need of defence began to disappear and the manor house became a large country house, following in every country the architectural ideals of its period, style and location. Thus, in France, the Renaissance tendency towards classic composition led to the gradual substitution of a rectangular block form for earlier, more informal types. Such a château (*q.v.*) as Azay-le-Rideau (early 16th century) is characteristic of the transition. In Normandy, however, the earlier type continued in use and many Norman farms, to this day, in their enclosing walls, their great courts surrounded by farm buildings, and their rectangular blocks of living quarters, preserve the arrangements of a typical 15th century manor house. The most famous Norman example is the great *manoir d'Ango* at Varengeville near Dieppe, with remarkable, rich, patterned brick work and interesting Francis I. detail.

In England the more informal ideals of the Elizabethan and Jacobean periods controlled 16th and 17th century manor house detail. The most usual plan has a hall in the centre with living quarters at one end and service rooms at the other. Later, as the desire for formality increased and the need for the hall diminished, more symmetrical block treatments became common. The most interesting examples of the earlier type are Great Chalfield manor, South Wraxwell manor (both in Wiltshire) and Ockwell manor in Berkshire, all of the 15th century, and Layer Marney Hall, Essex, and Sutton Place, Surrey, of the 16th century. (*See* also House.)

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MANRESA, a town of Spain, in the province of Barcelona, on the river Cardoner and the Barcelona–Lérida railway. Pop. (1940), 34,075 (mun., 36,381). It is probably the *Munorisa* of the Romans, the capital of the Jacetani or Jaccetani. A large part of the town was burned by the French in 1811. Manresa is the chief town of the highlands watered by the Cardoner and upper Llobregat, which meet below the town, and are also connected by a canal 18 mi. long. Two bridges, one dating from the Roman period, the other constructed in 1804, unite the older part of Manresa with the modern suburbs. The principal buildings are the collegiate church of Santa Maria de la Seo, the Dominican monastery, and the church of San Ignacio, built over the cavern where Ignatius de Loyola spent most of the year 1522 in penitentiary exercises and the composition of his *Exercitia spiritualia.* Manresa has iron-foundries and manufactures of woollen, cotton and linen goods, ribbons, hats, paper, soap, chemicals, spirits and flour. Building stone is quarried nearby. Manresa was captured by insurgents near the close of the civil war of 1936–39.

MANRIQUE, GÓMEZ (1415?–1490?), Spanish poet, soldier, politician and dramatist, took a prominent part in the rebellions of the nobles during the reigns of John II. and Henry IV. His place in the history of Spanish literature is secure as the earliest Spanish dramatist whose name has reached posterity. His *Representación del Nacimiento de Nuestro Señor* and [*Lamentaciones*] *fechas para Semana Santa* and his two *momos,* or interludes, played at court, contain the elements of the religious and secular drama of the future.

MANRIQUE, JORGE (1440?–1479), Spanish poet and soldier, nephew of Gómez Manrique. His love-songs, satires, and acrostic verses are merely ingenious compositions in the taste of his age; he owes his imperishable renown to a single poem, the *Coplas por la muerte de su padre,* an elegy of 40 stanzas on the death of his father. The great sonorous commonplaces on death are vitalized by the intensely personal grief of the poet, who lent a new solemnity and significance to thoughts which had been for centuries the common property of mankind. It was given to Jorge Manrique to have one single moment of sublime expression, and this isolated achievement has won him a fame undimmed by any change of taste during four centuries.

MANSARD, JULES HARDOUIN (1646?–1708), French architect, was born at Paris, probably on April 16, 1646, although this date is contested. He was the son of Raphael (?) Hardouin, painter to the king, and distantly related to François Mansart. For some time he worked under the instruction of Liberal Bruant, with whom he collaborated in the Hôtel de Vendôme; then, having attracted the king's notice, he was commissioned in 1672 to design a château for Madame de Montespan, which was executed later. He was by this time launched upon a brilliant career, under the consistent patronage of Louis XIV. Among his earlier additions to St. Germain were a number of fine private houses, including the Hôtel de Lorges (later Hôtel de Conti), his own residence. After receiving various honours from the king, he was commanded to design and erect the Palace of Versailles. He was working on the great façade, too well known and too noble for description, about 1685, the stables and the Grand Commun being already completed, and Nôtre Dame de Versailles nearly so. At this period of his life he was working, and causing others to work, with almost incredible celerity. In 1685 the foundations of the Pont-Royal were laid, and that year and the following were also occupied with the Institut de St. Cyr. In 1688 he began to work upon the Trianon.

There seemed to be no conception, however magnificent or delightful, of which Mansard was not capable, no branch of construction with which he was not conversant. After making additions to the Palais Royal, and building part of Orleans cathedral, he completed the dome of the Invalides in 1693, and, already ennobled, was further distinguished by the king. Still working with astonishing fertility, he built many country houses in the following years, among which may be mentioned the Château de Lunéville and the Château de Sagonne (his own residence, where he was visited by the king), while still engaged in laying out the gardens of Versailles. He was working on the chapel there when he died in 1708.

MANSARD ROOF, a hipped roof, sloping up on all four sides of a building from a horizontal cornice, in two slopes, of which the lower is more nearly vertical than the other; also a somewhat similar roof in which the upper, more nearly horizontal slope is replaced by a flat roof. *See* MANSART, FRANÇOIS.

MANSART, FRANÇOIS (1598–1666), French architect, was born in Paris on Jan. 23, 1598, and is said to be the descendant of a long line of architects, at one time resident in Italy. He was the son of a carpenter to the king, and for some time studied under Germain Gaulthier, the king's architect. On taking up independent work, of which he was very prolific, he designed and carried out many churches, in whole or in part, and numerous large private houses, while many buildings of uncertain origin have been ascribed to him. Much of his work has since been destroyed. Mansart appears to have interested himself in problems of construction, and is generally considered to be the originator of the so-called "mansard" or curb roof, a modification of contemporary practice which became popular by affording an increased area of floor-space on the top storey of houses. "Mansarde," in modern French a garret or attic chamber, is derived from his name. Among his works may be mentioned the church of the Visitation des Filles de Sainte-Marie, an early work; the Hôtel Carnavalet; Hôtel de la Vrillière (where the bank of France now is), which he did not finish; Château de Maisons at St. Germain-en-Laye; Hôtel Mazarin, part of which has since been used for a time by the Bibliothèque Nationale; several church portals and altars; and many provincial castles, of which La Ferté-Reuilly is a good example. He was commissioned by Colbert to make a design for the Louvres; his plan was approved subject to his undertaking not to alter the design during the construction of the building. This he refused to do, and the Italian, Bertini, was sent for in his stead.

MANSEL, HENRY LONGUEVILLE (1820–1871), English philosopher, was born at Cosgrove, Northamptonshire on Oct. 6, 1820. He was educated at Merchant Taylors' school and St. John's college, Oxford. He took a double first in 1843, and became tutor of his college. He was appointed reader in moral and metaphysical philosophy at Magdalen college in 1855, and Waynflete professor in 1859. He was a great opponent of university reform and of the Hegelianism which was then beginning to take root in Oxford. In 1867 he succeeded A. P. Stanley as professor of ecclesiastical history, and in 1868 he was appointed dean of St. Paul's. He died on July 31, 1871.

Mansel maintained the purely formal character of logic, the duality of consciousness as testifying to both self and the external world, and the limitation of knowledge to the finite and "conditioned." His doctrines were developed in his edition of Aldrich's *Artis logicae rudimenta* (1849)—his chief contribution to the reviving study of Aristotle—and in his *Prolegomena logica: an Inquiry into the Psychological Character of Logical Processes* (1851, 2nd ed. enlarged 1862), in which the limits of logic as the "science of formal thinking" are rigorously determined. In his Bampton lectures on *The Limits of Religious Thought* (1858, 5th ed. 1867; Danish trans. 1888) he applied to Christian theology the metaphysical agnosticism which seemed to result from Kant's criticism, and which had been developed in Hamilton's *Philosophy of the Unconditioned.*

Mansel wrote also *The Philosophy of the Conditioned* (1866) in reply to Mill's criticism of Hamilton; *Letters, Lectures, and Reviews* (ed. Chandler, 1873), and *The Gnostic Heresies* (ed. J. B. Lightfoot, 1875, with a biographical sketch by Lord Carnarvon).

MANSFELD, a German family which took its name from Mansfeld in Saxony, where it was seated from the 11th to the 18th century. One of its earliest members was Hoyer von Mansfeld (d. 1115), a partisan of the emperor Henry V. during his struggles with the Saxons; he fought for Henry at Warnstädt and was killed in his service at Welfesholz. Albert, count of Mansfeld (1480–1560), was an intimate friend of Luther and one of the earliest and staunchest supporters of the Reformation.

With Albert was associated his brother Gebhard, and another member of the family was Johann Gebhard, elector of Cologne from 1558 to 1562. A scion of another branch of the Mansfelds was Peter Ernst, Fürst von Mansfeld (1517–1604), governor of Luxemburg, who, unlike his kinsmen, was loyal to Charles V. He went with the emperor to Tunis and fought for him in France. He served Philip II. at St. Quentin and in the Netherlands, and led a body of troops to aid the king of France against the Huguenots. In this capacity he was present in 1569 at the battle of Moncontour, where another member of his family, Count Wolrad of Mansfeld (d. 1578) was among the Huguenot leaders.

See L. F. Niemann, *Geschichte der Grafen von Mansfeld* (Aschersleben, 1834).

MANSFELD, ERNST, GRAF VON (*c.* 1580–1626), German soldier, was an illegitimate son of Peter Ernst, Fürst von Mansfeld, and passed his early years in his father's palace at Luxemburg. He gained his earliest military experiences in Hungary, where his half-brother Charles (1543–1595) held a high command in the imperial army. He allied himself with the Protestant princes, and was despatched by Charles Emmanuel, duke of Savoy, at the head of about 2,000 men to aid the revolting Bohemians at the outbreak of the Thirty Years' War in 1618. He took Pilsen, but in the summer of 1619 he was defeated at Zablat; after this he offered his services to the emperor Ferdinand II. and remained inactive while the titular king of Bohemia, Frederick V., elector palatine of the Rhine, was driven in headlong rout from Prague. Mansfeld was appointed by Frederick to command his army in Bohemia, and in 1621 he established himself in the Upper Palatinate, successfully resisting the efforts made by Tilly to dislodge him. From the Upper he passed into the Rhenish Palatinate. Here he relieved Frankenthal and took Hagenau; then, joined by his master, the elector Frederick, he defeated Tilly at Wiesloch in April 1622 and plundered Alsace and Hesse. Mansfeld's ravages were ruinous to the districts he was commissioned to defend, and at length Frederick was obliged to dismiss Mansfeld's troops from his service. Joining Christian of Brunswick the count then led his army through Lorraine, devastating the country, and in August 1622 defeating the Spaniards at Fleurus. He next entered the service of the United Provinces. A mercenary and a leader of mercenaries, Mansfeld sold his services to the highest bidder. About 1624 he paid three visits to London, where he was hailed as a hero. James I. was anxious to furnish him with men and money for the recovery of the Palatinate, and in January 1625 Mansfeld and his army of "raw and poor rascals" sailed from Dover to the Netherlands. On the renewal of operations in Germany in the autumn Mansfeld was again engaged. Defeated by Wallenstein at Dessau (1626), he raised another army, and pursued by Wallenstein he pressed forward towards Hungary, where he hoped for aid from Bethlen Gabor, prince of Transylvania. But Gabor made peace with the emperor, and Mansfeld was compelled to disband his troops. He died at Rakowitza Nov. 20, 1626.

See F. Stieve, *Ernst von Mansfeld* (Munich, 1890).

MANSFIELD, KATHERINE (1890–1923), British writer, was born at Wellington, New Zealand, the daughter of Sir H. Beauchamp, and spent most of her girlhood in New Zealand. She published *In a German Pension* (1911), and in 1913 married John Middleton Murry, the critic, with whom she had been associated in the publication of a literary review, *Rhythm*. Her brilliant talent for the short story form was displayed in a collection issued as *Bliss* (1920), and her acute critical powers in frequent contributions to *The Athenaeum,* then edited by her husband. This was followed by *The Garden Party* (1922), but a career of great promise, and small but perfect achievement, was cut short by death, after a long illness, at Fontainebleau, on Jan. 9, 1923. Further stories, *The Doves' Nest,* appeared later in that year, also a volume of *Poems;* in 1924 was published *Something Childish,* tales and fragments of minor interest, and in 1927 the *Journal of Katherine Mansfield* (1914–22). Her *Letters* were published in 1928 (2 vols.).

MANSFIELD, RICHARD (1857–1907), American actor, was born on May 24, 1857, in Berlin, his mother being Madame Rudersdorff (1822–82), the singer, and his father, Maurice Mansfield (d. 1861), a London wine merchant. He first appeared on the stage at St. George's Hall, London, and then drifted into light opera, playing the major-general in *The Pirates of Penzance,* and the lord high executioner in *The Mikado,* both in the English provinces and in America.

In 1883 he joined A. M. Palmer's Union Square theatre company in New York, and made a great hit as Baron Chevrial in *A Parisian Romance*. His rendering (1887) of the doubled title-parts in R. L. Stevenson's *Strange Case of Dr. Jekyll and Mr. Hyde* created a profound impression. By invitation of Sir Henry Irving, he played at the Lyceum theatre in London in 1888. He produced *Richard III.* the next year at the Globe theatre, New York. Among his other chief successes were *Prince Karl, Cyrano de Bergerac* and *Monsieur Beaucaire.*

He was one of the earliest to produce G. Bernard Shaw's plays in America, appearing in 1894 as Bluntschli in *Arms and the Man,* and as Dick Dudgeon in *The Devil's Disciple* in 1897. He died in New London (Conn.), Aug. 30, 1907.

See the lives by Paul Wilstach (1908) and William Winter (1910).

MANSFIELD, WILLIAM MURRAY, 1st Earl of (1705–1793), English judge, was born at Scone in Perthshire, on March 2, 1705, the son of the 5th Viscount Stormont. He was educated at Perth grammar school, Westminster School and Christ Church, Oxford. He was called to the bar at Lincoln's Inn in 1730. He was a good scholar and mixed with the best literary society, being an intimate friend of Alexander Pope. His appearance in some important Scottish appeal cases brought him into notice, and in Scotland at least he acquired an immense reputation by his appearance for the city of Edinburgh when it was threatened with disfranchisement for the affair of the Porteous mob. His English practice had as yet been scanty, but in 1737 a single speech in a jury trial of note placed him at the head of the bar, and from this time he had all he could attend to. In 1738 he married Lady Elizabeth Finch, daughter of the earl of Winchelsea. In 1742 he was appointed solicitor-general.

During the next 14 years Mansfield was one of the most conspicuous figures in the parliamentary history of the time. By birth a Jacobite, by association a Tory, he was nevertheless a Moderate. In the year 1754 he became attorney-general, and for the next two years acted as leader of the House of Commons under the administration of the duke of Newcastle. But in 1756, a vacancy occurred in the chief justiceship of the king's bench, and he claimed the office, being at the same time raised to the peerage as Baron Mansfield.

From this time the chief interest of his career lies in his judicial work, but he did not wholly dissever himself from politics. He became by a singular arrangement, only repeated in the case of Lord Ellenborough, a member of the cabinet, and remained in that position through various changes of administration for nearly fifteen years, and, although he persistently refused the chancellorship, he acted as Speaker of the House of Lords while the Great Seal was in commission. During the time of Pitt's ascendancy he took but little part in politics, but while Lord Bute was in power his influence was very considerable, and seems mostly to have been exerted in favour of a more moderate line of policy. He was a supporter of the prerogative. In 1776 he was created earl of Mansfield. In 1783, although he declined to re-enter the cabinet, he acted as Speaker of the House of Lords during the coalition ministry, and with this his political career may be said to have closed. He continued to act as chief justice until his resignation in June 1788, and died on March 20, 1793.

It is as a judge, however, that Mansfield is chiefly remembered. In the sphere of commercial law he stands alone as having reduced it almost to an exact science, where before it was a chaos of unselected decisions. And the same may be said of the doctrine of quasi-contract, where he found the law again in a chaotic state just fitted for his systematising genius, and left it a coherent body of rules founded on the principle of unjust enrichment. (See *Moses* v. *Macfarland, 2 Burr.* 1005.) But when he had to deal with a body of law already elaborately worked out with settled principles, he went wrong. Thus his attempts to "rationalise by a side wind" our law of seisin (*Taylor and Atkyns* v. *Horde,* 1 *Burr.* 113), and to anticipate the Judicative Act by allowing a plaintiff to set up an equitable title, was bound to fail, as was his more ambitious and very nearly successful attempt to revolutionise the doctrine of consideration by basing contract on moral obligation and reducing consideration to credentiary value only (*Pillans* v. *Van Mierop,* 3 *Burr.* 1663). But while his wide acquaintance with continental jurisprudence sometimes led him astray in matters dependent exclusively on English Common Law the trend of legislation in the 19th century has often followed the lines he tried to lay down.

See Holliday's *Life* (1797); Campbell's *Chief Justices;* Foss's *Judges;* Greville's *Memoirs, passim;* Horace Walpole's *Letters;* and other memoirs and works on the period. And *see* Holdsworth, *History of English Law,* esp. vols. 6, 7 and 8.

MANSFIELD, a market town and municipal borough in the Mansfield parliamentary division of Nottinghamshire, England, on the small river Mann or Maun; the junction of several branches of the Midland railway, by which it is 142 mi. N.N.W. from London. Pop. (1938 est.) 47,420. Area, 11 sq.mi. During the heptarchy Mansfield was occasionally the residence of the Mercian kings, and it was afterwards a resort of Norman sovereigns, since it lay on the western outskirts of Sherwood forest. By Henry VIII the manor was granted to the earl of Surrey. Afterwards it went by exchange to the duke of Newcastle, and thence to the Portland family. The town obtained a fair from Richard II in 1377. It became a municipal borough in 1891. The church of St. Peter is partly Early Norman, and partly Perpendicular. There is a grammar school founded by Queen Elizabeth in 1561, occupying modern buildings. A technical college was opened in 1928. Twelve almshouses were founded by Elizabeth Heath in 1693. Mansfield is in a coal mining area, and its industries are the manufacture of lace, thread, boots and machinery, iron-founding and brewing. In the neighbourhood, there are quarries of limestone, sandstone and freestone.

MANSFIELD, a town of Bristol county, Massachusetts, U.S.A., 24 mi. S. by W. of Boston, on the New York, New Haven and Hartford railroad. The population was 6,530 in 1940 (federal census). It has a large number of greenhouses and a great variety of manufacturing industries. The town was incorporated in 1775.

MANSFIELD, a city of northern Ohio, U.S.A., 75 m. S.W. of Cleveland, on Federal highways 30 and 42; the county seat of Richland county. It has a municipal airport, and is served by the Baltimore and Ohio, the Erie, and the Pennsylvania railways. Pop. was 27,824 in 1920 (88% native white); in 1940, 37,154 by the federal census, with an additional 5,000 in suburbs immediately adjacent. The city occupies 6·4 sq.mi. of rolling ground. It is the highest city in the state with an altitude of

1,154 feet. It is in a rich agricultural region. It is the seat of the State reformatory. There are producing oil wells within 30 mi., and large deposits of sand and blue shale just outside the city. Mansfield has a large wholesale and retail trade, and is an important manufacturing centre. Among its diversity of products are sheet steel, brass goods, stoves, rubber and electrical goods, pumps, motors and generators, bed springs, mattresses and transportation seating.

Bank clearings in 1926 aggregated $108,577,509. From 1920 to 1925 a "child health demonstration" was carried on here under the auspices of the Commonwealth fund, and after the close of the demonstration the special activities for the health of the children of the city and the county were continued by the local health authorities and private organizations.

Mansfield was laid out in 1808 and was named after Lieut.-Col. Jared Mansfield, then U.S. surveyor for Ohio and the North-west Territory. It was incorporated as a village in 1828 and as a city in 1857.

MANSHIP, PAUL (1885–), American sculptor, was born in St. Paul, Minn., on Dec. 25, 1885. He studied at the St. Paul Institute of Art, the Pennsylvania Academy of Fine Arts at Philadelphia, and in New York city. In 1909 he went to Rome, having been awarded a scholarship at the American Academy there, and remained abroad three years. On his return to the United States his works quickly attracted attention by their individuality, and his figures, exhibiting archaic traits skilfully coupled with intensely modern feeling, placed him in the front rank of American sculptors. In 1914 he was awarded the G. F. Widener Memorial Gold Medal at the Pennsylvania Academy of Fine Arts, obtaining also a gold medal at the San Francisco Exposition, 1915. In 1924 he won the medal of the American Numismatic Society, and in 1925 the gold medal of the Philadelphia Art Week. He devoted himself chiefly to classical subjects, but executed two very striking portraits, "John D. Rockefeller" and "Miss Manship," the latter being a study of his daughter, aged three days, which is in the Metropolitan Museum of Art, New York city. Among his other chief works are the J. P. Morgan memorial in the Metropolitan Museum of Art; the "Infant Hercules" fountain in the courtyard of the American Academy at Rome; "Dancing Girl and Fauns" and "Indian and Pronghorn Antelope" in the Art Institute, Chicago; "Yawning" in the St. Paul Institute; "Centaurs" and "Little Brother" (statuette) in the Detroit Museum of Art; "Playfulness" in the Minneapolis Institute of Art; and "Dancer and Gazelles" in the Cleveland museum, also statues in the Luxembourg, Paris, and the Corcoran Gallery of Art, Washington, D.C. In 1920 he made a portrait bust of John Barrymore.

MANSLAUGHTER, a term in English law signifying "unlawful homicide without malice aforethought" (Stephen, *Digest of the Criminal Law*). The distinction between manslaughter and murder and other forms of homicide is treated under HOMICIDE.

MANSON, GEORGE (1850–1876), Scottish water-colour painter, was born in Edinburgh on Dec. 3, 1850. He was apprenticed as wood-engraver with W. and R. Chambers, with whom he remained for over five years, employing his spare hours in the study of water-colour. In 1871 he began to devote himself exclusively to painting. His subjects were derived from humble Scottish life—especially child-life, varied occasionally by portraiture, landscape and views of picturesque architecture. In 1873 he visited Normandy, Belgium and Holland; and in 1875 resided at St. Lô, and in Paris, where he mastered the processes of etching and greatly enlarged the scope of his water-colour work. He died at Lympstone in Devonshire on Feb. 27, 1876.

A volume of photographs from his water-colours and sketches, with a memoir by J. M. Gray, was published in 1880. For an account of Manson's technical method as a wood-engraver *see* P. G. Hamerton's *Graphic Arts*, p. 311.

MANSUR: *see* AL-MANṢŪR.

MANSURA, the capital of the province of Dakahlia, Lower Egypt, near the west side of Lake Menzala, and on the Cairo-Damietta railway. Area, 3 sq.mi. Pop. (1937) 69,036. It dates from 1221, and is famous as the scene of the battle of Mansura, fought on the 8th of February 1250, between the crusaders commanded by the king of France, St. Louis, and the Egyptians. The old fortress of St. Louis is still to be seen. Mansura has several cotton-ginning, cotton, linen and sail-cloth factories.

The Battle of Mansura, Feb. 8, 1250.—This was the disastrous battle in which the Crusade of St. Louis lost its best hope of success. It is of particular historical interest as an illustration of the cumulative military faults which marked the Crusading campaigns in general, with the rare exception of that under Richard Coeur-de-Lion (*see* RICHARD I. and ARSUF). The Crusade of 1249 was aimed at the Islamic power in Egypt, and the landing took place at a favourable moment, for the Sultan was dying and the country consequently in disorder. But King Louis first forfeited the chance for a rapid march on Cairo and then took the worst possible route—from Damietta through the maze of canals and watercourses of the Nile Delta. The French army took four weeks to cover 50m. of such ground and then, on Dec. 19, 1249, reaching the west bank of the Ashmoum canal opposite Mansura, it found the enemy encamped on the far bank. Nearly two months were wasted before the French at last succeeded in crossing. The battle was waged with reckless daring, and, though in a sense a victory, left the French with a gravely depleted army in face of an almost intact adversary, and the knowledge caused a depression which portended the eventual failure of the expedition.

MANTEGNA, ANDREA (1431–1506), Italian painter of the Paduan school, the chief representative of the Early Renaissance in north Italy, was born at Isola di Carturo, near Vicenza, and at an early age went to Padua, where he entered the studio of Francesco Squarcione.

Mantegna was Squarcione's most brilliant pupil and was adopted as his son. At the age of ten he was entered in the guild of painters; at 17 he completed an altar-piece for the church of S. Lucia which established his fame. Reared among fragments of ancient art, in a town overshadowed by a famous university, where the study of the ancient world had become a cult, Mantegna grew up a devotee of antiquity. He had, moreover, the stimulus of seeing the work of Donatello and of Paolo Uccello in Padua, of Andrea Carstagno in Venice, and he learned the lessons which these great representatives of the Florentine school of form could teach. He mastered the newly discovered rules of perspective and he delighted in rendering foreshortened views of the human figure.

In 1454 Mantegna married Nicolasia, the daughter of Jacopo Bellini, the sister of Gentile and Giovanni. His connection with these great initiators of the pictorial tradition of Venice may have contributed to his estrangement from Squarcione. For Mantegna no longer cared to act as an executant of his master's commissions; and he fought and won his case before the tribunals of Padua. Between 1453 and 1459 he completed the cycle of paintings in the Ovetari chapel of S. Agostino degli Eremitani on which Niccolo Pizzolo of Padua, Bono of Ferrara, and Ansuino of Forli had been employed. The frescoes on the left wall representing the "Life of St. James" were executed by Mantegna; "The Martyrdom of St. Christopher," on the opposite wall, is also by him, but is sadly injured. This is his most important early work extant; and by comparing the upper frescoes which were painted first with the later frescoes below we can trace the master's progress to maturity. Other works of this early period are the polyptych representing "St. Luke and other Saints," in the Brera at Milan, and "St. Euphemia," now in the museum at Naples, both dated 1454, and the frescoes of two saints over the entrance porch of the church of S. Antonio, in Padua, dated 1452.

Mantegna's fame spread rapidly beyond Padua and he received various commissions from Verona. He was asked to paint an altar-piece for the church of S. Zeno in that city. This work occupied him from 1457 to 1459 and is one of his masterpieces. It is a triptych representing the "Madonna Enthroned" flanked by saints, with a tripartite predella underneath. The picture was carried off to France in 1797 with many other valuable works, and when restored to Verona in 1814 was found to have been deprived of the predella. Its central portion, representing "the Crucifixion," is in the Louvre; the two side portions, representing "the Agony in the Garden" and "the Resurrection," are in the museum at

Tours. In 1460 Mantegna took service with the Gonzagas, whose court at Mantua was one of the most cultured in Italy. He was at first employed in their castle at Goito on work now destroyed. After a short stay in Florence in May 1466, he settled at Mantua, where he built himself a house. Unfortunately many of his works are no longer extant. A notable exception are the frescoes completed in 1474 in the State room called "Camera degli Sposi." On the walls are the lifelike portraits of the Gonzaga family, perhaps the earliest portrait group of the Italian Renaissance, a powerful work with strongly defined personalities.

He rapidly rose in favour and esteem. In a letter dated July 1487 Cardinal Francesco Gonzaga expressed the wish to have Mantegna with him during his stay in a resort near Bologna that they might enjoy and study a collection of antique bronzes and gems. Lorenzo il Magnifico visited him in his studio and admired his paintings and his antiques. In 1488 he was knighted and repaired to Rome with a recommendation to Pope Innocent VIII., who asked him to decorate a chapel in the Vatican; but although the work was much admired the chapel was destroyed by Pius VI. in order to make room for the enlargement of the Vatican gallery. On his return to Mantua in 1490 Mantegna completed a series of nine tempera paintings which he had begun before his departure for the palace of San Sebastiano. The subject, "the Triumph of Caesar," afforded a welcome opportunity for displaying his admiration of the antique world. The triumphal car is preceded by a rhythmic procession of soldiers, prisoners, elephants, etc., carrying an infinite variety of trophies, including statuary, vases and arms of all kinds. It was considered by Vasari to be Mantegna's best work; it was acquired by Charles I. and is now at Hampton Court greatly damaged by repaintings.

Meanwhile Isabella d'Este had become duchess at Mantua by her marriage with Gian Francesco Gonzaga. She enlisted Mantegna's help for the decoration of her study, a small apartment, in the arrangement of which she took a keen interest prescribing the mythological and allegorical subjects of the five panels which adorned the walls. Two of these, "the Parnassus" and the "Allegory of Virtue and Vice," were painted by Mantegna; the remaining three were done by Pietro Perugino and Lorenzo Costa. The whole set are now in the Louvre. Among Mantegna's last works was the picture which he painted in 1495 for Santa Maria della Vittoria, a church built after his design to commemorate the battle of Fornovo, which Gian Francesco Gonzaga, commander of the Italian forces, found it convenient to celebrate as his victory, though in fact it seems to have been a French victory. This picture is now in the Louvre. Mantegna passed the latter part of his life in poverty; he was in debt and not able to continue in the house he had built, and had to sell his beloved antique bust of Faustina. He died on Sept. 13, 1506, at Mantua, and was buried in a chapel which he had built for himself in S. Andrea, at Mantua. Over his tomb a fine bronze head by an unknown contemporary sculptor presents his strong and austere features. At the time of his death his art seemed surpassed by the rising glory of Titian, of Michelangelo and Raphael.

Besides the paintings described above the following may be mentioned: "The Agony in the Garden," in the National Gallery, London; the portrait of the Cardinal Scarampo, in the Berlin museum; the "Death of the Virgin," in the Prado at Madrid; the "Adoration of the Magi," in the Johnson collection, Philadelphia; the triptych in the Uffizi, Florence, representing "the Adoration of the Magi," "the Circumcision," and "the Ascension," with its delicate and precise finish and its rich decorative effects, is a fine example of the master's power of concentration in works on a small scale. To the same class belong "the Madonna seated in front of a Grotto," in the Uffizi; the "St. George," in the academy at Venice; and the "St. Sebastian," at Vienna. All these are early works. Of a later period are "The Virgin in glory with four Saints" (1497), painted for S. Maria in Organo, at Verona, and now in the collection of Prince Trivulzio at Milan; "the Madonna with John the Baptist and the Magdalen," in the National Gallery, London; "the Triumph of Scipio" (1506) and "Samson and Delilah," in the same gallery, both executed in monochrome; the "Virgin and Child," in the Carrara collection at Bergamo, "the Virgin and Child surrounded by Cherubim," in the Brera at Milan; "Christ upheld by Angels," in the museum at Copenhagen; "The Dead Christ" (1506), at the Brera gallery, Milan, a study of a foreshortened human figure which may be regarded as his last picture.

Mantegna contributed towards the development of the art of engraving; his plates are among the first productions in that medium. By means of delicate shading lines he obtained a chiaroscuro of rich quality. The outline is clear and gemlike; the figures, rhythmically arranged, stand out within their small compass with monumental grandeur. Engraving is here no longer a convenient process for reproducing designs, but a fine art. According to Vasari, Mantegna was prompted to take up engraving during his stay in Rome, but there were artists practising engraving at Mantua as far back as 1475 and the question of the period covered by Mantegna's engravings is not yet solved. Bartsch assigned to Mantegna no fewer than 27 engravings, but present-day criticism acknowledges only seven as original. The earliest is "the Virgin and Child"; then follow "Bacchanalia with Silenus"; "Bacchanalia with a Wine Press"; "The Battle of Sea Gods," in two parts; "The Entombment"; and "the Risen Christ between St. Andrew and Longinus."

See Vasari, *Vite;* Crowe and Cavalcaselle, *History of Painting in North Italy,* edit. by T. Borenius (1912); P. Kristeller, *A. Mantegna* (1901); C. Yriarte, *Mantegna* (1901); F. Knapp, *A. Mantegna* (1910), vol. xvi. of the series *Klassiker der Kunst;* G. Fiocco, *Andrea Mantegna* (Bologna, 1927). V. Lassarini and A. Moschetti, *Documenti relativi-alla pittura padovana del Secolo XV.* (Venice, 1908) is important for documents on Mantegna's early life. *See* also T. Borenius, *Four early Italian Engravers* (1923). (I. A. R.)

MANTELL, GIDEON ALGERNON (1790–1852), English geologist and palaeontologist, born at Lewes, Sussex. Educated for the medical profession, he practised at Lewes, Brighton and Clapham. He studied the palaeontology of the Secondary rocks, particularly in Sussex—a region which he made classical in the history of discovery. His most remarkable discoveries were made in the Wealden formations. He demonstrated the freshwater origin of the strata, and from them he brought to light and described the remarkable Dinosaurian reptiles known as *Iguanodon, Hylaeosaurus, Pelorosaurus* and *Regnosaurus.* He was elected F.R.S. in 1825. He also described the Triassic reptile *Telerpeton elginense.* Towards the end of his life Dr. Mantell retired to London, where he died on Nov. 10, 1852.

His son Walter Mantell (1820–1895) settled in New Zealand, where he discovered remains of *Notornis.*

MANTES-GASSICOURT, a town of northern France in the department of Seine-et-Oise on the Seine, 34 mi. W.N.W. of Paris by rail. Pop. (1936) 13,978. The chief building of the town is the 12th century church of Notre-Dame. The plan, which bears a marked resemblance to that of Notre-Dame at Paris, includes a nave, aisles and choir, but no transepts. Three portals open into the church on the west; the two northernmost date from the 12th century; that to the south is of the 14th century. In the interior are chapels dating from the 13th and 14th centuries. A previous edifice was burned by William the Conqueror together with the rest of the town, at the capture of which he lost his life in 1087. The tower of St. Maclou (14th century), relic of an old church, built from tolls levied on boats, and destroyed during the Revolution, and the hôtel de ville (15th to 17th centuries) are among the older buildings. Modern bridges and a mediaeval bridge unite the town with the town of Limay. Its trade is in cereals and agricultural products. Its industries include the manufacture of musical instruments, baskets, brushes, tiles and hosiery; tanning is also carried on. Mantes was occupied by the English from 1346 to 1364, and from 1416 to 1440. Until 1930 it was called Mantes-sur-Seine.

MANTEUFFEL, EDWIN, Freiherr von (1809–1885), Prussian general field marshal, son of the president of the superior court of Magdeburg, was born at Dresden on Feb. 24, 1809. He was brought up with his cousin, Otto von Manteuffel (1805–1882), the Prussian statesman, and entered the guard cavalry at Berlin in 1827. In 1848 he became aide-de-camp to Frederick William IV., whose confidence he had gained during the revolutionary movement in Berlin. Promoted lieutenant-colonel in 1852, and colonel to command the 5th Uhlans in 1853, he was sent on important diplomatic missions to Vienna and St. Petersburg. In 1857 he became major-general and chief of the military cabinet. He supported the prince regent's plans for the reorganization of the army. He served in the Danish war of 1864, and at its conclusion was appointed civil and military governor of Schleswig. In the Austrian War of 1866 he occupied Holstein and afterwards commanded a division under Vogel von Falkenstein in the Hanoverian campaign, and succeeded him, in July, in command of the Army of the Main (*see* SEVEN WEEKS' WAR). His successful operations ended with the occupation of Würzburg, and he received the order *pour le mérite*. He then went on a diplomatic mission to St. Petersburg, where he was *persona grata,* and succeeded in gaining Russia's assent to the new position in north Germany. In the war of 1870–71 he led the I. corps under Steinmetz, distinguishing himself in the battle of Colombey-Neuilly, and in the repulse of Bazaine at Noisseville (*see* FRANCO-GERMAN WAR; and METZ). He succeeded Steinmetz in October in the command of the I. army, won the battle of Amiens against General Farre, and occupied Rouen, but was less fortunate against Faidherbe at Pont Noyelles and Bapaume. In January 1871 he commanded the newly formed Army of the South, which he led, in spite of hard frost, through the Côte d'Or and over the plateau of Langres, cut off Bourbaki's army of the east (80,000 men), and, after the action of Pontarlier, compelled it to cross the Swiss frontier, where it was disarmed. When the Southern Army was disbanded Manteuffel commanded first the II. army, and, from June 1871 until 1873, the army of occupation left in France, showing great tact in a difficult position. He was rewarded by promotion to the rank of general field marshal and a large grant in money. He was employed on several diplomatic missions, was for a time governor of Berlin, and in 1879 was appointed governor-general of Alsace-Lorraine; and this office he filled until his death at Carlsbad, Bohemia, on June 17, 1885.

See lives by v. Collas (Berlin, 1874), and K. H. Keck (Bielefeld and Leipzig, 1890).

MANTINEIA (MANTINEA), an ancient city of Arcadia, in a long narrow marshy plain (now called after the chief town Tripolitsa) bounded on the W. by Mt. Maenalus, on the E. by Mt. Artemision, and without opening to the coast, the water percolating through underground passages (*katavothra*) to the sea. Tegea (*q.v.*), about 10 m. S. of Mantineia, continually disputed the supremacy of the district.

Mantineia is mentioned in the Homeric catalogue of ships, but in early Greek times was only a cluster of villages, insignificant compared with Tegea, and submissive to Sparta. But soon after the Persian wars, its five constituent villages, at the suggestion of Argos, were merged into one city, whose policy was henceforth guided by three main considerations: its democratic constitution of small freeholders; its ambition to control the Alpheus watershed and Arcadian roads to the Isthmus, and its chronic disputes with Tegea. About 469 B.C. Mantineia alone of Arcadian townships refused to join the league of Tegea and Argos against Sparta. Though formally on the same side in the Peloponnesian War it employed the truce of 423 in fierce but indecisive war with Tegea. Mantineia regained its autonomous position in the Achaean League in 192, and its original name in A.D. 133. Under the later Roman Empire the city dwindled into a mere village (which since the 6th century bore the Slavonic name Goritza) and as a result of malaria and Turkish rule has disappeared.

The site was excavated by the French school at Athens, in 1888. The agora and adjacent buildings, and the walls about $2\frac{1}{2}$ m. in circumference have been investigated. When the city was rebuilt in 370 B.C., the river Ophis, which formerly ran through the town, was divided so as to encircle the walls.

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Battles of Mantineia were fought in the years 418 B.C., 362 B.C. and 207 B.C.

(1). The first battle, in the Peloponnesian War (*q.v.*), is of no strategic importance but of some interest in the evolution of tactics. On the one side were the Spartans and their allies under the Spartan king Agis, while the other was mainly composed of Argives and Mantineans. As the Spartan line advanced, a drift to the right occurred—a common occurrence in ancient battles, due to the natural instinct of each man to hug closely to his neighbour's shield as a protection to his own unguarded, *i.e.,* non-shield bearing, side. Agis, seeing that this drift would cause his left flank to be overlapped by the enemy, sought to prolong his left. This stretching caused a gap in the centre, and the enemy, pouring into the gap, broke up the Spartan left wing. This disaster, however, was offset by the success of the Spartan right. (See *Thucydides* v. 71.)

(2). The second, and more justly famous battle, took place in 362 B.C., and is memorable not only for Epameinondas's further development of the epoch-making tactics which he had introduced at Leuctra (*q.v.*), but also for his death in the moment of victory. He is immortalized by two battles. A year after Leuctra, Epameinondas had led the forces of the newly formed Arcadian League in a march on virgin Sparta itself. The march had been admirably carried out in three converging columns over mountain routes in mid-winter and with deep strategical insight Epameinondas had made an indirect approach to his goal, slipping past Sparta and then moving up from its rear. Strong reinforcements came to Sparta from her allies in the Peloponnesian League, and his own design was thwarted by the dwindling away of his own allies, whose troops preferred easy plunder to the chance of decisive victory. He was thus compelled to retire rather than pay exorbitantly for military success, but only after establishing the new Messenian state as a check on, and counterpoise to, Sparta in southern Greece. And with his subsequent foundation of Megalopolis as a further check his grand strategy had attained the greater political object of definitely overthrowing Sparta's long supremacy in the Peloponnese. But with his subsequent if temporary supersession, Theban democracy forfeited its advantages by short-sighted policy and blundering diplomacy, and enabled its Arcadian allies, repudiating gratitude in growing conceit and ambition, to dispute Theban leadership.

Thus in 362 Thebes was driven to choose between reasserting her authority and sacrificing her prestige. Her move against Arcadia caused Greece to divide afresh into two hostile coalitions. Once more Epameinondas made a surprise spring at Sparta, but he was deprived of the fruits of his night march through a deserter warning the Spartan main army in time for it to hurry back and safeguard the capital. Epameinondas then stood on guard at Tegea while the enemy forces concentrated at Mantineia. The valley in which these places lay is shaped like an hour-glass by the surrounding mountain ranges, and at the mile-wide waist the Spartans and their allies took up a strong position. He determined to seek a decision by battle, but as in his strategy so in his grand tactics showed his art by an indirect approach.

At first Epameinondas marched direct towards the Spartan camp, causing the enemy to form up in battle order facing his line of approach. But when still several miles distant, he suddenly changed direction to the left, turning in beneath a projecting spur. This surprise manoeuvre threatened to take in enfilade the Spartan right, and to dislocate still further the Spartans' battle dispositions he halted his troops and made them ground arms as if to encamp. The deception succeeded; the enemy were induced to relax their battle order, allowing men to fall out and the horses to be unbridled. Meanwhile Epameinondas was actually completing his battle dispositions behind a screen of light troops.

Then, on a signal, the Theban army took up its arms and swept forward. Caught by surprise the enemy made haste to reform, but their cavalry were driven back by the Theban cavalry covering the left flank of the massed column, and this striking the Spartan line "like the prow of a galley" pierced it in two. But in the moment of decision Epameinondas himself was mortally wounded, and with his fall the advance came to a stop and failed to complete the victory already won. (*See* Xenophon, *Hellenica,* vii. 5; *Cambridge Ancient History,* vi. 89-102.)

(3). The third battle for which Mantineia is notable was that of 207 B.C., in which Philopoemen, the commander of the forces of the Achaean League, routed Machanidas, tyrant of Sparta. As Cicero acclaims Epameinondas as "the first man of Greece" —and might justly have acclaimed him, in a time sense, as the first great captain of history—so Plutarch refers to Philopoemen as "the last of the Greeks." As a military artist he was worthy to take a place in the illustrious company of Epameinondas and Xenophon, with Alexander and Pyrrhus. Mantineia was his first battle in chief command, and before beginning operations he had devoted eight months to the preparation and training of his forces. On the approach of Machinadas from Tegea he moved out from Mantineia to accept battle and drew up in order behind a shallow ravine. The interesting feature of his formation was that his phalanx of heavy foot was broken up into small companies with intervals between, and formed in two lines, the rear companies apparently covering the intervals in the front line. This is clearly a modification inspired by Roman practice.

Machinadas advanced in three columns directed on the Achaean right, but on nearing his enemy deployed into line to the right. He then arrayed his catapults for an artillery "preparation," intended to demoralize and disorganize the Achaean ranks, but this move was interrupted by Philopoemen, who launched his light horse. This led to a general engagement of the light troops on both sides in which Machanidas's mercenaries gradually gained the upper hand. The Achaeans on the left wing broke, and Machanidas rashly threw himself into the pursuit, which swept like a tide past the firm rock formed by the Achaean phalanx. Philopoemen thereupon wheeled the forward companies of the phalanx to the left and moved them swiftly to occupy the abandoned flank position, thus cutting off the pursuers and at the same time preventing his flank being turned by the Spartan phalanx, which now advanced. But at the moment when crossing the ravine, and their ranks inevitably becoming disordered, Philopoemen launched his own more flexible phalanx in a decisive riposte. Having dispersed the Spartan phalanx, Philopoemen, while part of his army followed them up, turned with the rest to bar Machanidas's expected return. Thus when the Spartan light troops came in sight of the strongly held ravine they lost heart and melted away, leaving Machanidas himself to fall, according to the reliable Polybius, in personal combat with Philopoemen.

As Rome, on intervening in Greece, recognized the independence of the Achaean League, her generals never had to meet this one accomplished Greek leader. (*See* Polybius, xi. 8–18; Plutarch, *Philopoemen.*) (B. H. L. H.)

MANTIS, an insect belonging to the family *Manteidae* of the order Orthoptera (*q.v.*). Probably no other insect has been the subject of so many and widespread legends and superstitions as the common praying mantis, *Mantis religiosa,* L. of Southern Europe. The ancient Greeks endowed it with supernatural powers (*μάντις,* a diviner); the Turks and Arabs hold that it prays constantly with its face turned towards Mecca, and the Provençals call it *Prega-Diou* (*Prie-Dieu*). Notwithstanding these attributes, mantids are creatures of voracious habits. The front pair of limbs are very peculiarly modified—the coxae being greatly elongated, while the strong third joint or femur bears on its curved underside a channel armed on each edge by strong movable spines. Into this groove the stout tibia is capable of closing like the blade of a penknife, its sharp, serrated edge being adapted to cut and hold. Thus armed, with head raised upon the much-elongated and semi-erect prothorax, and with the half-opened fore-limbs held outwards in the characteristic devotional attitude, it rests motionless upon the four posterior limbs waiting for prey, or occasionally stalks it with slow and silent movements, finally seizing it with its knife-blades and devouring it. These insects destroy great numbers of flies, grasshoppers and caterpillars, and the larger South-American species even attack small frogs, lizards and birds. They are very pugnacious, fencing with their sword-like limbs, the larger frequently devouring the smaller, and the females the males.

Mantis religiosa fixes its somewhat nut-like egg capsules on the stems of plants in September. The young are hatched in early summer, and resemble the adults, but are without wings. The green coloration and shape of the typical mantis are procryptic, serving to conceal the insect alike from its enemies and prey. The passage from leaf to flower simulation has been perfected in certain tropical species of *Manteidae* by the development on the prothorax and raptorial limbs of laminate expansions so coloured on the under side as to resemble papillionaceous or other blossoms, to which the likeness is enhanced by a gentle swaying kept up by the insect in imitation of the effect of a lightly blowing breeze. As instances of this may be cited *Idolum diabolicum,* an African insect, and *Gongylus gongyloides,* which comes from India. Examples of another species (*Empusa egena*) when standing upon the ground deceptively imitate in shape and hue a greenish white anemone tinted at the edges with rose; and Bates records what appears to be a true case of aggressive mimicry practised by a Brazilian species which exactly resembles the white ants it preys upon. More than 800 species of mantids are known and about 20 of these occur in Europe, and a similar number in the United States, but none are found in the British Isles.

PRAYING MANTIS

MANTIS-FLY, the name given to neuropterous insects of the family *Mantispidae,* related to the ant-lions, lace-wing flies, etc., and named from their superficial resemblance to a *Mantis* owing to the length of the prothorax and the shape and prehensorial nature of the anterior legs. The larva, at first campodeiform, makes its way into the egg-case of a spider or the nest of a wasp to feed on the eggs or young. Subsequently it changes into a fat grub with short legs. When full grown it spins a silken cocoon in which the transformation into the pupa is effected. Mantis-flies are widely distributed in both the old and new worlds, but occur chiefly in warm countries.

MAN-TRAPS, mechanical devices for catching poachers and trespassers. They have taken many forms, the most usual being like a large rat-trap, the steel springs being armed with teeth which meet in the victim's leg. Since 1827 they have been illegal in England, except in houses between sunset and sunrise as a defence against burglars.

MANTUA, fortified city, Lombardy (Ital. *Mantova*), Italy, capital of the province of Mantua, see of a bishop and centre of a military district, 25 mi. south-southwest of Verona and 100 mi. east-southeast of Milan by rail. Pop. (1936) 36,489 (town), 40,-467 (commune). It is 88 ft. above the level of the Adriatic on an almost insular site among swampy lagoons of the Mincio. On the west lies Lago Superiore, on the east Lago Inferiore—the boundary between the two being marked by the *Argine del Mulino,* a long mole stretching northward from the northwest angle of the city to the citadel, along which run the road and the railway.

On the highest ground in the city rises the cathedral, the interior of which was built after his death according to the plans of Giulio Romano. The church of St. Andrea after plans by Leon Battista Alberti, has a single, barrel-vaulted nave 338 ft. long by 62 ft. wide (1472–1494 and later); the dome was added in 1732–82. It has a noble façade with a deeply recessed portico, and a brick campanile of 1414. Mantegna is buried here. The immense ducal palace was begun in 1302 for Guido Bonaccolsi, but many of the fine apartments are of much later date, and the internal decorations are largely by Giulio Romano and his pupils. In one of the rooms is a set of tapestries after Raphael's cartoons now at South Kensington Museum. Castello di Corte, the castle of the Gonzagas (1395–1406), erected by Bartolino da Novara, the architect of the castle of Ferrara, now contains the archives, and has some fine frescoes by Mantegna with scenes from the life of Ludovico Gonzaga. Close by are the Piazza dell' Erbe and the Piazza Sordello, with Gothic palaces. Outside the city stands the Palazzo del Te, Giulio's architectural masterpiece, erected for

Frederick Gonzaga in 1523–1535, with numerous fresco-covered rooms. At the villa of Marmiruolo are other works by him. The architecture of Giulio's own house in the town is also good.

Mantua has an academy of arts and sciences (*Accademia Vergiliana*), occupying a fine building erected by Piermarini, containing a theatre designed by Antonio Bibiena (1769), and a museum of antiquities.

Mantua had still a strong Etruscan element in its population during the Roman period. Its main interest is as the birthplace of Virgil (*q.v.*). In 568 the Lombards took Mantua with difficulty; recovered in 590 by the exarch of Ravenna, it was recaptured by Agilulf in 601. The 9th century was the period of episcopal supremacy, and in the 11th the city belonged to Bonifacio, marquis of Canossa. It passed to Geoffrey, duke of Lorraine, and afterwards to the countess Matilda, but was taken by the emperor Henry IV. in 1090. Reduced to obedience by Matilda in 1113, the city on her death instituted a communal government of its own. It afterwards joined the Lombard League. But after internal discords Ludovico Gonzaga attained to power (1328), and was recognized as imperial vicar (1329); and until 1708 the Gonzagas were masters of Mantua (*see* GONZAGA). Under Gian Francesco II., the first marquis, Ludovico III., Gian Francesco III. (whose wife was Isabella d'Este), and Federico II., the first duke of Mantua, the city rose rapidly into importance. It was stormed and sacked by the Austrians in 1630. It was claimed in 1708 as a fief of the empire by Joseph I. Besieged by Napoleon in June 1796, it held out till February 1797. In 1799 it fell to the Austrians; restored to the French by the peace of Lunéville (1801), it became Austrian again (1814–66).

MANU, the Hindu Noah. In post-Vedic myth he is warned by a huge fish to build an ark, and after the deluge his sacrifices bear him a daughter, by whom he becomes the ancestor of mankind. More historically he is the author of the Code of Manu, a compilation of laws reflecting Hindu thought in the Buddhist period, but only preserved in a metrical recension made probably about A.D. 100.

MANUCODE, the name given to the birds of paradise (*q.v.*) comprising the genus *Manucodia* and found in northern Queensland and New Guinea. Four or five species are recognized.

MANUEL I. COMNENUS (*c.* 1120–1180), Byzantine emperor (1143–1180), the fourth son of John II, was born about 1120. Having distinguished himself as a soldier, he was nominated emperor in preference to his elder surviving brother. He endeavoured to restore by force of arms the predominance of the Byzantine empire in the Mediterranean countries. In 1144 he brought back Raymund of Antioch to his allegiance, and in the following year drove the Turks out of Isauria. In 1147 he granted a passage through his dominions to two armies of crusaders under Conrad III. of Germany and Louis VII. of France; but the numerous outbreaks of hostility between the Franks and the Greeks on their line of march, nearly precipitated a conflict between Manuel and his guests. In the same year the emperor made war upon Roger of Sicily, whose fleet captured Corfu and plundered the Greek towns, but in 1148 was defeated with the help of the Venetians. In 1149 Manuel recovered Corfu and prepared to take the offensive against the Normans. With an army mainly composed of mercenary Italians he invaded Sicily and Apulia, and although defeated both on land and sea, Manuel maintained a foothold in southern Italy, which was secured to him by a peace in 1155.

Manuel made treaties with Pisa and Genoa, and supported the free Italian cities with his gold and negotiated with pope Alexander III. In spite of his friendliness towards the Roman church Manuel was refused the title of "Augustus" and he nowhere succeeded in attaching the Italians permanently to his interests. None the less in a war with the Venetians (1172–74), he actually drove his enemies out of the Aegean Sea. On his northern frontier Manuel defeated the rebellious Serbs (1150–52) and made repeated attacks upon the Hungarians. In the wars of 1151–53 and 1163–68 he led his troops into Hungary but failed to maintain himself there; in 1168, however, a decisive victory near Semlin enabled him to conclude a peace by which Dalmatia and other frontier strips were ceded to him. In 1169 he sent a joint expedition with King Amalric of Jerusalem to Egypt, which retired after an ineffectual attempt to capture Damietta. In 1158–59 he fought with success against Raymund of Antioch and the Turks of Iconium. In 1176 he was decisively beaten by them in the pass of Myriocephalum. This disaster, though partly retrieved in the campaign of the following year, had a serious effect upon his vitality; henceforth he declined in health and in 1180 succumbed to a slow fever.

In spite of his military prowess Manuel achieved but in a slight degree his object of restoring the East Roman empire. His victories were counterbalanced by numerous defeats, and his lack of statesmanlike talent prevented his securing the loyalty of his subjects. The expense of keeping up his mercenary establishment put a severe strain upon the financial resources of the state. The subsequent rapid collapse of the Byzantine empire was largely due to his brilliant but unproductive reign. Manuel married, firstly, a sister-in-law of Conrad III of Germany; and secondly, a daughter of Raymund of Antioch. His successor, Alexis II, was a son of the latter.

See John Cinnamus, *History of John and Manuel* (ed. 1836, Bonn); E. Gibbon, *The Decline and Fall of the Roman Empire* (ed. Bury, London, 1896), v. 229 *sqq.*, vi. 214 *sqq.*; G. Finlay, *History of Greece* (ed. 1877, Oxford), iii. 143–197; H. v. Kap-Herr, *Die abendländische Politik Kaiser Manuels* (Strassburg, 1881). (M. C.)

MANUEL II. PALAEOLOGUS (1350–1425), Byzantine emperor from 1391 to 1425, was born in 1350. At the time of his father's death he was a hostage at the court of Bayezid at Brusa, but succeeded in making his escape; he was forthwith besieged in Constantinople, but with some loss, beat off the attack. Manuel subsequently set out in person to seek help from the West, and for this purpose visited Italy, France, Germany and England, but without material success; the defeat of Bayazet at the hands of Timur (1402) gave him a genuine respite from the Ottomans. He stood on friendly terms with Mahommed I., but was again besieged in his capital by Murad II. in 1422. Shortly before his death he was forced to pay tribute to the sultan.

Manuel was the author of numerous works of varied character—theological, rhetorical, poetical and letters. Most of these are printed in Migne, *Patrologia graeca*, clvi.; the letters have been edited by E. Legrand (1893). *See* also C. Krumbacher, *Geschichte der byzantinischen Litteratur* (1897).

MANUEL I. (d. 1263), emperor of Trebizond, was the second son of Alexius I., first emperor of Trebizond, and ruled from 1228 to 1263. He was unable to deliver his empire from vassalage, first to the Seljuks and afterwards to the Mongols. He vainly negotiated for a dynastic alliance with the Franks, by which he hoped to secure the help of Crusaders.

MANUEL II., the descendant of Manuel I., reigned only a few months in 1332–1333. Manuel III. reigned from 1390 to 1417, but the only interest attaching to his name arises from his connection with Timur, whose vassal he became without resistance.

See G. Finlay, *History of Greece* (ed. 1877, Oxford), iv. 338–340, 340–341, 386; Ph. Fallmerayer, *Geschichte des Kaisertums Trapezunt* (Munich, 1827), i. chs. 8, 14, ii. chs. 4, 5; T. E. Evangelides, Ἱστορια τῆς Τραπεζοῦντος (Odessa, 1898), 71–73, 87–88, 126–132.

MANUEL, LOUIS PIERRE (1751–1793), French writer and revolutionary was born at Montargis (Loiret), and became a tutor in Paris. In 1783 he was imprisoned for three months in the Bastille for publishing his *Essais historiques, critiques, littéraires, et philosophiques*. He was one of the leaders of the *émeutes* of June 20 and Aug. 10, 1792, and was made *procureur* of the commune. On Sept. 7, 1792 he was elected one of the deputies from Paris to the Convention and on Nov. 5 made an eloquent speech at the Jacobins club in defence of Robespierre. His missions to the king, however, reconciled him to Louis, and he had to resign from the Convention. He retired to Montargis, where he was arrested, and was guillotined in Paris on Nov. 17, 1793.

His works include *Coup d'oeil philosophique sur le règne de St. Louis* (1786); *L'Année francaise* (1788); *La Bastille dévoilée* (1789); *La Police de Paris dévoilée* (1791); and *Lettres sur la Révolution* (1792).

MANUEL DE MELLO, DOM FRANCISCO (1608–1666), Portuguese writer, a connection on his father's side of the royal house of Braganza, was a native of Lisbon. He studied the Humanities at the Jesuit College of S. Antão, where he showed a precocious talent. The death of his father, Dom Luiz de Mello, drove him early to soldiering, and having joined a contingent for the Flanders war he suffered shipwreck in the Bay of Biscay. At Madrid, he contracted a friendship with Quevedo and earned the favour of the powerful minister Olivares. In 1639 he was appointed colonel of one of the regiments raised for service in Flanders, and in June that year he took a leading part in defending Corunna against a French fleet commanded by the archbishop of Bordeaux. He came safely through the naval defeat in the Channel suffered by the Spaniards at the hands of Van Tromp, and on the outbreak of the Catalan rebellion acted as chief of the staff to the commander-in-chief of the royal forces; his *Historia de la guerra de Cataluña* became a Spanish classic. On the proclamation of Portuguese independence in 1640 he was imprisoned by order of Olivares, and when released hastened to offer his sword to John IV. He travelled to England, where he spent some time at the court of Charles I. and thence passing over to Holland assisted the Portuguese ambassador to equip a fleet in aid of Portugal, and himself brought it safely to Lisbon in Oct. 1641. For the next three years he was employed in various important military commissions. An intrigue with the beautiful countess of Villa Nova, and her husband's jealousy, led to his arrest on Nov. 19, 1644, on a false charge of assassination, and he lay in prison about nine years. Owing perhaps to the intercession of the queen regent of France and other powerful friends, his sentence was finally commuted into one of exile to Brazil. During his long imprisonment he finished and printed his history of the Catalan war, and also wrote other volumes including the *Carta de Guia de Casados* and a *Memorial* in his own defence to the king, which Herculano considered "perhaps the most eloquent piece of reasoning in the language." During his exile in Brazil, whither he sailed on April 17, 1655, he lived at Bahia, where he wrote one of his *Epanaphoras de varia historia* and two parts of his masterpiece, the *Apologos dialogaes*. He returned home in 1659, and in 1663 Alphonso VI. charged him to negotiate with the Curia about the provision of bishops for Portuguese sees. During his stay in Rome he published his *Obras moraes,* dedicated to Queen Catherine, wife of Charles II. of England, and his *Cartas familiares.* On his way back to Portugal he printed his *Obras metricas* at Lyons in May 1665. He died in August of the following year.

Manuel de Mello's early Spanish verses are tainted with Gongorism, but his Portuguese sonnets and *cartas* on moral subjects are notable for their power, sincerity and perfection of form. His *Letters* are written in a conversational style illumined by flashes of wit. His commerce with the best authors appears in the *Hospital das lettras,* a brilliant chapter of criticism forming part of the *Apologos dialogaes.* His comedy in *redondilhas,* the *Auto do Fidalgo Aprendiz,* may be considered an anticipation of Molière's *Le Bourgeois gentilhomme.*

BIBLIOGRAPHY.—There is no uniform edition of Manuel de Mello's works, but a list of them will be found in his *Obras moraes. See* E. Prestage, *Dom Francisco Manuel de Mello, his Life and Writings* (Manchester, 1905); "D. Francisco Manuel de Mello, documentos biographicos" and "D. Francisco Manuel de Mello, obras autographas e ineditas" in *Archivo historico portuguez* for 1909; and *D. Francisco Manuel de Mello, Esboço biografico* (Coimbra, 1914).

(E. P.; A. B.)

MANUFACTURING PRODUCTION: *see* PRODUCTION, CENSUS OF.

MANUL (*Felis manul*), a small desert wild cat, ranging from Tibet to Siberia. The coat is long and soft, of pale silvery grey or light buff, marked with black on the chest and upper parts of the limbs, with transverse stripes on the loins and rings on the tail of the same hue. It preys upon small mammals and birds.

MANURE DISTRIBUTION: *see* TILLAGE MACHINERY.

MANURES AND MANURING: *see* FERTILIZERS.

MANUTIUS, the Latin name of an Italian family (Mannucci, Manuzio), famous in the history of printing as organizers of the Aldine press.

1. ALDUS MANUTIUS (1450–1515). Teobaldo Mannucci, better known as Aldo Manuzio, the founder of the Aldine press, was born at Sermoneta in the Papal States. After studying at Rome and at Ferrara, in 1482 he went to reside at Mirandola with his old friend, the illustrious Giovanni Pico, whose nephew Alberto Pio, prince of Carpi, supplied him with funds for starting his printing press, and gave him lands at Carpi. Settling in Venice in 1490, he gathered Greek scholars and compositors around him, and Greek was the language of his household. He soon published undated editions of the *Hero and Leander* of Musaeus, the *Galeomyomachia,* and the Greek Psalter. During 1495–98 he issued five volumes of Aristotle; in 1498 nine comedies of Aristophanes; Thucydides, Sophocles and Herodotus followed in 1502; Xenophon's *Hellenics* and Euripides in 1503; Demosthenes in 1504; an edition of the minor Greek orators in 1508; and in 1509 the lesser works of Plutarch. During the struggle of Venice with the allied powers of Europe, Aldo's labours were suspended until 1513 when he published his Plato. Pindar, Hesychius, and Athenaeus followed in 1514. Besides these Greek texts, Aldo published the *Asolani* of Bembo, the collected writings of Poliziano, the *Hypnerotomachia Poliphili,* Dante's *Divine Comedy,* Petrarch's poems, a collection of early Latin poets of the Christian era, the letters of the younger Pliny, the poems of Pontanus, Sannazzaro's *Arcadia,* Quintilian, Valerius Maximus, the *Adagia* of Erasmus and many reprints. To promote Greek studies, Aldo founded an academy of Hellenists in 1500 under the title of the New Academy. Its rules were written in Greek; its members were obliged to speak Greek, and their names were Hellenized. The biographies of those enrolled in this academy, including Erasmus and Linacre, are given in Didot's *Alde Manuce.*

2. PAULUS MANUTIUS (1512–1574). After the death of Aldo, his brothers-in-law, the Asolani, carried on the Aldine press, until his youngest son, Paolo, took it over in 1533. The Asolani attempted the duties of editing, and to reserve the honours for themselves, dispensed with the service of competent collaborators. The result was that some of their editions, especially their Aeschylus of 1518, are singularly bad. Paolo determined to restore the glories of the house, and in 1540 separated from his uncles. The field of Greek literature having been well-nigh exhausted, he devoted himself principally to the Latin classics. He was a passionate Ciceronian, and perhaps his chief contributions to scholarship are the corrected editions of Cicero's letters and orations, his own epistles in a Ciceronian style, his Latin version of Demosthenes, and his four treatises on Roman antiquities. Owing to Paolo's financial difficulties, Pius IV. in 1561 invited him to Rome, offering him a yearly stipend of 500 ducats, and undertaking to maintain his press there. The profits on publications were to be divided between Paolo and the Apostolic camera. Paolo accepted the invitation, and spent the larger portion of his life in Rome under three papacies.

3. ALDUS MANUTIUS, JUNIOR (1547–1597), eldest son of Paolo, produced at the age of fourteen a work upon Latin spelling, called *Orthographiae ratio.* Remaining in Venice to superintend the Aldine press after his father's removal to Rome, he published in 1575 his *Epitome orthographiae.* In the same year, in concert with his father-in-law, Giunta, he edited an extensive collection of Italian letters, and in 1576 he published his commentary upon the *Ars poetica* of Horace. About the same time, he was appointed professor of literature to the Cancelleria at Venice. In 1585 Aldo moved to Bologna, but after two years went to Pisa where he made the curious mistake of printing Alberti's comedy *Philodoxius* as a work of the classic Lepidus. Sixtus V. called him in 1588 to Rome. In 1597 he died, leaving children, but none who carried on the Aldine press. Aldo himself, though a precocious student, a scholar of no mean ability, and a publisher of some distinction, was the least remarkable of the three publishers.

See A. Renouard, *Annales de l'imprimerie des Aldes* (3rd ed. Paris, 1834); Didot, *Alde Manuce* (Paris, 1873); Omont's *Catalogue* of Aldine publications (Paris, 1892).

MANWARING, ROBERT (*fl.* 1760), English 18th-century furniture designer and cabinet-maker. The dates of his birth and death are unknown. He was a contemporary, imitator and rival of Chippendale. His work shows the same surprising variations of quality characteristic of that of nearly all the English cabinet-makers of the second half of the 18th century. His best had an undeniable elegance, his worst was squat and ill-proportioned. He introduced the small bracket between the front rail of the seat and the top of the chair leg, or at all events made such constant use of it that it has come to be regarded as characteristic of his work.

Among Manwaring's writings were *The Cabinet and Chair Makers' Real Friend and Companion, or the Whole System of Chairmaking Made Plain and Easy* (1765); *The Carpenters' Compleat Guide to Gothic Railing* (1765); and *The Chair-makers' Guide* (1766).

MANX LANGUAGE AND LITERATURE. Manx is the Celtic speech of the Isle of Man (*q.v.*). The earliest vernacular material is contained in the version of the Book of Common Prayer made in 1610 by Bishop Phillips. The mode of spelling used was not that used in Ireland, but was as phonetic as a language system based on Anglo-Scottish orthography could be. It is therefore very difficult to discover the real sound values attached to the various symbols. Manx is more closely related to Scottish Gaelic than the Irish. A dialectical difference between North and South shows it has not the treatment of short accented vowels before *ll*, *nn*, and *m* and vocalic *s* or *sh* tends to become voiced to *d*. (*See* J. Rhys, *The Outlines of the Phonology of Manx Gaelic* [1895]; H. Jenner, *Transactions* of the London Philological Society [1875].)

Literature.—The literary remains written in the Manx language are considerably slighter than those of any other Celtic dialect. With one small exception nothing pertaining to the saga literature of Ireland has been preserved. The little we possess falls under two heads—original compositions and translations. With regard to the first we must give the place of honour to an Ossianic poem contained in a ms. in the British Museum (written in 1789), which relates how Orree, Finn's enemy, was tormented by the women of Finn's household when the latter was away hunting, how he in revenge set fire to the house, and how Finn had him torn in pieces by wild horses. Most of the literature of native origin consists of ballads and carols, locally called carvels. These used to be sung on Christmas eve in the churches, the members of the congregation each bringing a candle. Any one who pleased could get up and sing one. These carvels deal largely with the end of the world, the judgment-day and the horrors of hell. About 80 of them were published under the title of *Carvalyn Gailckagh* (Douglas, 1891). An attempt has been made in the present century by *Yn Cheshaght Gailckagh* to revive the *Oiel Voirrey* (=Irish *Oidhche Fhéile Mhuire*), "the feast of Mary," as the festival used to be called, and gatherings in the old style have been held in Peel. Apart from the carvels there are other ballads in existence. The earliest is an 18th-century song of Manannan Mac y Lheir, traditionally supposed to have been written in the 16th century, which tells of the conversion of the island by St. Patrick. Then comes *Baase Illiam Dhône* (The Death of Brown William), dealing with the death of William Christian, who was shot as a traitor in 1662. The best-known Manx song is *Mylecharaine* (=Irish *Maolchiarán*). It is directed against a man of this name who was the first to give a dowry to his daughter, the custom having previously been for the bridegroom to pay money to the father of the bride. Others are *Ny Kirree fo Sniaghtey* (The Sheep under the Snow), a song about the loss of the Douglas herring fleet in 1787 (reprinted at Douglas, 1872), and *O Vannin Veg Veen* (Dear little Mona). In 1760 Joseph Bridson wrote a "Short Account of the Isle of Man" in Manx (*Coontey Ghiare jeh Ellan Vannin ayns Gailck*). The translated literature is almost entirely of a religious character. Jenner prints a list of 23 volumes in his article referred to below. The first is the translation of the English Prayer-Book by Bishop Phillips, 1610 (published by A. W. Moore, Oxford, 1895). The *Sermons* of Bishop Wilson (1783). intended to be in 3 vols., of which only one was ever printed, is a very rare work, highly important for our knowledge of Manx prose. A later translation of the Church of England Prayer-Book was printed in 1765, but by far the most important of all is the translation of the Bible. The energetic Bishop Wilson managed to get parts of the Scriptures translated and the Gospel of St. Matthew was printed in 1748. Wilson's successor, Bishop Hildesley, completed the work, and in 1775 the whole Bible appeared. As a curiosity it may be mentioned that *Aesop's Fables* have been translated into the vernacular (Douglas, 1901).

See H. Jenner, "The Manx Language: its Grammar, Literature and Present State," *Transactions of the London Philological Society* (1875), pp. 172 ff.; *Publications of the Manx Society*, vols. xvi., xx., xxi.; L. C. Stern, *Die Kultur d. Gegenwart*, i. xi. 1, pp. 110–11.

MANYCH, a river and depression in S. Russia, stretching between the lower river Don and the Caspian sea, through the North Caucasian area and the autonomous Kalmuck area. During the greater part of the year it is either dry or occupied in part by a string of saline lakes (*limans* or *ilmens*); but in spring when the streams swell which empty into it, the water flows in two opposite directions from the highest point (near Shara-Khulusun). One stream flows westwards with an inclination northwards, until it reaches the Don, though when the latter river is running high, its water penetrates some 60 miles up the Manych. The eastern stream dies away in the sandy steppe about 25 miles from the Caspian, though it is said sometimes to reach the Kuma through the Huiduk, a tributary of the Kuma. Total length of the depression, 330 m. For its significance as a former (geologic) connection between the Sea of Azov and the Caspian sea, *see* CASPIAN SEA.

MANZANARES, a town of Spain, in the province of Ciudad Real, on the River Azuer, a sub-tributary of the Záncara, and on the railways from Madrid to Ciudad Real and Linares. Pop. (1940) 18,182 (mun., 18,451). Manzanares is one of the chief towns of La Mancha, and thus in the centre of the district described by Cervantes in *Don Quixote*. Its citadel was founded as a Christian fortress after the defeat of the Moors at Las Navas de Tolosa (1212). Manzanares manufactures soap and pottery, and has an active trade in wheat, wine and spirits.

MANZANILLO, one of the important ports and trade centres of south-eastern Cuba, located in the Province of Oriente, and a shipping point for sugar, hides, tobacco and hardwood timbers. Pop. (1943) 36,295. Manzanillo lies west and slightly north of Santiago (112 mi.), on the so-called west coast of Cuba, facing Manzanillo bay, although it is south-east of Havana (487 mi.). East and south of the city rises the Sierra Maestra, through which the rivers Cauto (17 mi. N. of Manzanillo) and the Yara and the Buey flow to the sea. The town was founded in 1784, although, like many ports of Cuba, it had long before that time been well known to pirates and buccaneers, who came there to build or repair ships with the fine native woods. The settlement was sacked by the French in 1792, and was fortified the following year. It was opened to foreign ships in 1827, and in 1833 was given its local government. In 1837 it was officially invested with the title Manzanillo el Fiel, or faithful, for its support of the Spanish Constitution.

MANZANILLO, a town and port on the Pacific coast of Mexico, in the State of Colima, 52 mi. by rail W.S.W. of the city of that name. Pop. in 1940 was 6,831. It is situated on a large harbour partly formed and sheltered by a long island extending southwards parallel with the coast. Southward also, and in the vicinity of the town, is the large, stagnant, shallow lagoon of Cuyutlán which renders the town unhealthful. Manzanillo is a commercial town of comparatively recent creation. Manzanillo is connected by the Mexican National railway with Guadalajara and central Mexico. Construction of the harbour works was begun in 1899. These works include a breakwater 1,300 ft. long, with a depth of 12 to 70 ft. and a maximum breadth of 320 ft. at the base and 25 ft. on top, and all the necessary berthing and mechanical facilities for the handling of cargoes. The exports include hides and skins, palm-leaf hats, Indian corn, coffee, palm oil, fruit, lumber and minerals.

MANZANITA, the name given to numerous shrubs of the botanical genus *Arctostaphylos* belonging to the heath family (Ericaceae), comprising about 40 species, confined chiefly to western North America, 25 species being found in California.

They are evergreen shrubs, mostly from 3 to 12 ft. high, with dark red or chocolate-coloured, smooth and polished bark; very crooked, usually stiff branches; small, mostly toothless, often vertical leaves, and handsome white or pink flowers borne in terminal, usually nodding, globose clusters. The fruit, which becomes brownish and berry-like at maturity, is somewhat suggestive when young of a tiny apple, from whence comes the Spanish name *manzanita,* "little apple."

MANZIKERT, BATTLE OF (1071). In the spring of 1071 Romanus Diogenes, the Byzantine emperor, having collected together an army of some 60,000 men marched into Armenia to recover the fortresses of Akhlat and Manzikert which had been captured by Alp Arslan and his Seljūk Turks. His forces were composite, consisting of Byzantine cavalry and infantry, German mercenaries and Franks. At Akhlat he divided his army leaving there a division to besiege the fortress, and with the main body marched on to Manzikert and reduced that place. Hardly had he done so when he fell in with Alp Arslan's advanced guard. The Sultan's army was 100,000 strong, and mainly consisted of horse archers. The tactics which the emperor should have employed were those laid down by Leo the Wise, namely, to maintain an unbroken front, to beware of surprise and never to fight with uncovered flanks or rear.

Romanus was a brave soldier but impetuous. In the advanced guard encounter one of his generals, Basilakes, fell into an ambush losing all his men. The emperor then drew up his army in front of his camp. The right wing was composed of Asiatic cavalry, the left of European and the centre of Byzantine horse. In rear he drew up a strong second line of Germans and Normans under Andronicus Ducas. As he advanced on his enemy, the Turks refused to close, hovering round the two lines and plying them with arrows. In the evening a halt was called, and the emperor fearing that his camp was in danger ordered a retirement. This order was misinterpreted, and confusion resulted, whereupon the Turks closing in compelled the emperor to face about. Andronicus refused to halt and retired to the camp. The loss of the rear line left the rear of the front line open to attack. Eventually this line was overwhelmed and Romanus was decisively defeated and made a prisoner. The result of this defeat was disastrous, Asia Minor was overrun, and by 1080 the old Byzantine army had all but ceased to exist.

See E. Gibbon, *The Decline and Fall of the Roman Empire;* G. Findlay, *History of the Byzantine and Greek Empires;* C. Oman, *A History of the Art of War. The Middle Ages* (1924). (J. F. C. F.)

MANZOLLI, PIER ANGELO, Italian author, was born about the end of the fifteenth century at La Stellata, near Ferrara. His didactic poem, *Zodiacus vitae* (Basel 1543), dedicated to Hercules II. of Ferrara, combines metaphysical speculation with satirical attacks on ecclesiastical hypocrisy, and especially on the Pope and on Luther. It was banned by the Inquisition for its rationalizing tendencies.

MANZONI, ALESSANDRO FRANCESCO TOMMASO ANTONIO (1785–1873), Italian poet and novelist, was born at Milan on March 7, 1785. He was descended on his father's side from the feudal lords of Barzio, in the Valsassina; his mother was the daughter of Cesare Beccaria (*q.v.*). Manzoni was educated at various schools, the last being the Barnabiti School in Milan. In 1805, he accompanied his mother to Paris, where he mixed in the literary set of the so-called "ideologues," and imbibed the negative creed of Voltairianism. The fervent Catholicism which coloured his later life only developed after his marriage. In 1806–07, he published two pieces, one entitled *Urania,* in the classical style, the other an elegy in blank verse, on the death of Count Carlo Imbonati, his mother's lover, who left him considerable property, including the villa of Brusuglio.

He married in 1808 Henriette Blondel, daughter of a Genevese banker, and led for many years a retired life, divided between literature and his farm in Lombardy. To this period belong his *Inni sacri,* a series of sacred lyrics, and a treatise on Catholic morality. In 1818 he had to sell his paternal inheritance, as his affairs had gone to ruin in the hands of a dishonest agent. He cancelled on the spot the record of all sums owing to him by the peasants, and gave them the whole of the coming maize harvest.

In 1819 Manzoni published his first tragedy, *Il Conte di Carmagnola,* which boldly violated all classical conventions, and was severely criticized in the *Quarterly Review,* in an article to which Goethe replied in its defence, "one genius," as Count de Gubernatis remarks, "having divined the other." The Piedmontese revolution of 1821 inspired Manzoni's *Marzo, 1821,* but under Austrian rule the publication of the poem was impossible. It only appeared in 1848. On the death of Napoleon he wrote the famous ode *Il cinque Maggio* (circulated at first in ms. and printed in 1822) which Goethe declared to be the greatest of the many which celebrated that event. Manzoni also wrote at this time the tragedies *Il conte del Carmagnola* (1820) and *Adelchi* (1822), in which he broke loose from the classical convention.

He then turned to the form which gave his genius full scope. Round the episode of the *Innominato,* historically identified with Bernardino Visconti, the romantic novel *I Promessi sposi* began to grow into shape; it was completed in Sept. 1822, published in 1825–27, and at once raised its author to the first rank of literary fame. It was translated into many languages, but it was his last considerable work. Manzoni laboriously revised *I Promessi sposi* in the Tuscan idiom, and in 1840 republished it in that form, with *La Storia della Colonna infame.*

Manzoni's sons took part in the Five Days revolt in Milan in '48. The Austrians did not molest him, but he declined all honours until after the Liberation when he became a senator.

The end of his life was saddened by domestic sorrows. The loss of his wife in 1833 was followed by that of several of his children, and of his mother. In 1837 he married his second wife, Teresa Borri, widow of Count Stampa, whom he also survived, while of nine children born in his two marriages all but two predeceased him. The death of his eldest son, Pier Luigi, on April 28, 1873, was the final blow; he fell ill immediately, and died of cerebral meningitis, on May 22. His remains, after lying in state for some days, were followed to the cemetery of Milan by a vast cortège, including the royal princes and all the great officers of state. But his noblest monument was Verdi's *Requiem,* specially written to honour his memory.

See his *Opere Complete* (7 vols., 1905 *seq.*); his correspondence (ed. G. Sforza 2 vols. 1882–83); further correspondence, *Lettere inedite* (ed. E. Grecchi 2nd ed. 1900); A. Galletti, *A. Manzoni, Il pensatore e il poeta,* 2 vols. (Milan, 1927); A. Piccmati, *La vita et le opere di A. Manzoni* (1886); A. Pellizzari, *Studi Manzoniani* 2 vols. (Naples, 1914); G. Gentile, *Dante e Manzoni* (Florence 1923); F. de Sanctis, *Manzoni* (Bari 1922); A. Stoppani, *I primi e gli ultimi anni di A. Manzoni* (Milan 1923).

MAORI. The Maori come of sea-faring stock. A section of the great Polynesian race which inhabits the far-scattered island groups of the Eastern Pacific, they are the result of an inter-mixture of several distinct waves of canoe-voyagers. The last of these is now established as having come from Tahiti, with Rarotonga as the port of call, about the middle of the fourteenth century. Evidence of this is provided by comparison of the traditions and genealogies most scrupulously preserved by the learned men in each tribe. Prior to this time the country was inhabited by the *tangata whenua,* "the people of the land," some of whom were descended from Toi-kai-rakau, a Polynesian immigrant of about 1150, and others probably from drift-voyagers. With these folk the later arrivals inter-married and fought, ultimately gaining the ascendancy. The visit of Toi was in the nature of a search party for his lost grandson; the later migration, however, was a premeditated colonization, hence the *kumara* (sweet potato), *taro,* yam and other cultivated plants were introduced, as also the native dog.

For general culture the most important element in the Maori population is provided by the fleet of 1350, and on this the present social organization largely depends.

Social Grouping.—The Maori people are divided into a score or more tribes, *iwi,* each with its own well defined lands, and tracing kinship to a common ancestor. Thus all members of Ngati Maru, a tribe around Hauraki, claim descent from Marutuahu, the famous 14th century chief whose name they bear. The principal canoes associated with the fleet are Tainui, Arawa, Matatua, Takitimu, Tokomaru and Aotea, and, generally speaking, the particular group of tribes descended from the captain and crew of each vessel occupy contiguous territory and form a separate unit of a loose political nature, known as a *waka* (canoe). Thus Ngati Maru, together with Waikato and the tribes of the King Country make up the Tainui *waka,* a human "canoe" which extends from Hauraki to Mokau. The tribe is made up of several principal *hapu* or clans, each of which might in olden days number about a thousand fighting men. The *hapu* was not a unilateral group, *i.e.,* a person could belong to it through either his father or his mother, nor was it exogamous, marriage within the group being favoured provided that the parties were not first cousins. Within these major social units were lesser *hapu,* tracing descent to more immediate ancestors, and these in turn were composed of *whanau,* family groups of near relatives who together often occupied a dwelling hut. The individual family of parents and children existed, but, not forming a separate household, did not play a large part in public life. Through all Maori social structure ran this principle of kinship tie by common descent, a bond which linked men together and welded *whanau* to form *hapu,* and *hapu* to form tribe. One *hapu* might fight another but on the approach of a tribal enemy their quarrel was laid aside and their arms were turned against the common foe.

The system of primogeniture played a great part in the social organization. The highest chief of all was the *ariki,* eldest son in a line of first-born men of rank. His *mana* (power) was very great; his word was law. The people of his tribe were his relatives, their rank being broadly represented by the closeness of their kinship to him. Next to him came the chiefs of his own family, then the *rangatira,* "gentlemen," and finally the commonalty (*ware*). But every ordinary man, however undistinguished, could claim some sort of distant connection with his chief and with a noble family. Slaves (*taurekareka*) were mainly prisoners of war, and performed much of the menial labour.

Mode of Life.—The Maori lived in villages (*kainga*), usually with a fort or defended position (*pa*) close at hand. The economic life of the different tribes varied according to the resources at their command. In the north, fertile soil and a warm climate allowed of the cultivation of the *kumara* (sweet potato), but in less favoured districts forest products and the edible rhizome of the bracken (*aruhe, Pteris esculenta*) formed the staple food supply. Birds and the frugivorous native rat were snared and preserved by inland tribes, eels were taken by weirs on the Whanganui river, while around Rotorua and the adjacent lakes crayfish and the fresh water mussel were obtained, while fish was the main food of the dwellers on the sea coast. In these economic pursuits the Maori was very industrious. Advantage was taken of the communal mode of life to secure co-operation in the various tasks, and such labour was lightened by work-songs. Division of labour was practised, though in somewhat rudimentary form. The men did the harder, more exacting work, requiring more initiative and skill, as tree climbing, carving, fishing and fowling and breaking up of ground for crops. The women weeded the soil, collected shellfish, plaited mats and wove garments from the useful *harakeke* (*Phormium tenax,* N. Z. flax) and attended to the cooking of the two daily meals. In each industry there were specialists (*tohunga*) who had received a definite course of training, including knowledge of the magic of the craft.

Warfare was frequent in olden days and each man was trained in the use of weapons. Hand-to-hand fighting was preferred, and ambuscade and stratagem were frequent. In later warfare against Europeans the Maori showed himself extraordinarily proficient in the military art. In time of peace the social side of life was developed, visits were made, and neighbouring tribes were invited to feasts at which dart-throwing, wrestling, top-spinning and posture dancing held the interest of the people. Such receptions were held on the *marae,* the meeting place in the centre of the village. Feasts also took place at *tangi,* the ceremonial wailing for the dead, at which many relatives assembled from long distances.

Religion.—The religion of the Maori was closely bound up with his social and economic life. The ordinary people recognized a number of departmental gods, as Tane-mahuta, guardian deity of the forest, trees and birds, or Tangaroa, the Polynesian Neptune, lord of the sea and fish. The higher priests and chiefs also held belief in Io, a supreme god of rather negative attributes, to whom appeals were made in birth, baptism and marriage ceremonies for people of rank. This knowledge was jealously conserved, being kept from the common people, as also from European ethnographers until recent years. All Maori believed in a host of minor *atua,* rather malignant beings who provided omens, gave force to black magic, and punished breaches of *tapu.* The *tapu* (Polynesian=*taboo*) was one of the strongest forces of law in the Maori community. With the significance of sacred or unclean according to circumstances it conveyed in essential the idea of a prohibition. For instance, the person of a chief, his goods, his place by the fire and the remnants of his meal; all things connected with the gods; a corpse and the surroundings of death were all *tapu,* as were also a cultivated field, or a new house or canoe. Thus things of social importance to the native were protected from improper interference.

According to Maori belief, man was endowed with several spiritual *potentiae,* the *wairua,* the spirit which wanders abroad in dreams, the *mauri* and the *hau,* allied metaphysical concepts representing the vitality of a person, his essential life principle. At death the latter are dissolved, but the *wairua,* the soul, wends its way to Te Reinga, or Te Po, the underworld beneath the sea, a peaceful abode where men pursue their ordinary avocations as in life.

The Modern Maori.—A high degree of intelligence is shown by the Maori, who, on the impact of white civilization, adopted its material symbols eagerly at first, but reacted vigorously when they began to realize its full implications, especially as threatening their tribal land, their greatest treasure.

The majority are farmers. Such men as the late Sir James Carroll, Sir Maui Pomare, Sir Apirana Ngata and Dr. P. H. Buck, have rendered excellent service to the community as doctors, lawyers and Cabinet Ministers. At present the native people number about 54,000, but the percentage of white blood is rapidly increasing, so that ultimately miscegenation may be expected to absorb the Maori into our New Zealand population.

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MAP (or MAPES), **WALTER** (d. *c.* 1208/9), mediaeval ecclesiastic, author and wit, to whose authority the main body of prose Arthurian literature has, at one time or another, been assigned, flourished in the latter part of the 12th and early years of the 13th centuries. He studied at Paris under Girard la Pucelle, who began to teach in or about 1160, but as he states in his book *De nugis curialium* that he was at the court of Henry II. before 1162, his residence at Paris must have been practically comprised in the decade 1150–1160.

Map was clerk of the royal household and justice itinerant; in 1179 he was present at the Lateran council at Rome, on his way thither being entertained by the count of Champagne; at this time he apparently held a plurality of ecclesiastical benefices, being a prebend of St. Paul's, canon and precentor of Lincoln and parson of Westbury, Gloucestershire. There seems to be no record of his ordination, but as he was a candidate for the see of Hereford in 1199 it is most probable that he was in priest's orders. The last reference to him, as living, is in 1208, when an order for payment to him is on record, but Giraldus Cambrensis, in the second edition of his *Hibernica,* redacted in 1210, utters a prayer for his soul, "cujus animae propitietur Deus," a proof that he was no longer alive.

The special interest of Map lies in the perplexing question of his relation to the Arthurian legend and literature. (*See* ARTHURIAN LEGEND.) To him have been attributed the *Lancelot* proper, the *Mort Artus* and the *Queste*. He is constantly referred to as an authority. It seems unlikely that a busy court official could have written the long prose romances attributed to him. But he seems to have been the man who linked up the Arthur legend proper to the cycle of the Holy Grail. His undoubted work is the *De nugis curialium*, and he is reputed to be the author of various witty goliardic verses. Taking all the evidence into consideration it seems more probable that Map had, at a comparatively early date, before he became so important an official, composed a poem on the subject of Lancelot, which was the direct source of the German version, and which Chrétien also knew and followed.

The form in which certain of the references to him are couched favours the above view; the compiler of *Guiron le Cortois* says in his prologue that *"maistre Gautier Map qui fu clers au roi Henry—devisa cil l'estoire de monseigneur Lancelot du Lac, que d'autre chose ne parla il mie gramment en son livre"*; and in another place he refers to Map, *"qui fit lou propre livre de monsoingnour Lancelot dou Lac."* Now only during the early part of his career could Map fairly be referred to as simple *"clers au roi Henry,"* and both extracts emphasize the fact that his work dealt, almost exclusively, with Lancelot. Neither of these passages would fit the prose romance, as we know it, but both might well suit the lost French source of the *Lanzelet;* where we are in a position to compare the German versions of French romances with their originals we find, as a rule, that the translators have followed their source faithfully.

See art. "Map" in *Dict. Nat. Biog. De nugis curialium* and the *Latin Poems attributed to Map* have been edited for the Camden Society by T. Wright (1841). For discussion of his authorship of the *Lancelot* cf. *The Three Days' Tournament*, Grimm Library XV. *See* also under LANCELOT. The passages relating to Map cited above have been frequently quoted by scholars, *e.g.*, Hucher, *Le Grand Saint Graal;* Paulin Paris, *Romans de la Table Ronde;* Alfred Nutt, *Studies in the Legend of the Holy Grail.* (J. L. W.)

MAP, a representation, on a plane and a reduced scale, of part or the whole of the earth's surface. If specially designed to meet the requirements of seamen it is called a chart, if on an exceptionally large scale a plan. A collection of maps is called an atlas, after the figure of Atlas, the Titan, supporting the heavens.

Classification of Maps.—Maps differ greatly, not only as to the scale on which they are drawn, but also with respect to the fullness or the character of the information which they convey. Broadly speaking, they may be divided into two classes, of which the first includes topographical and general maps, the second the great variety designed for special purposes.

Topographical maps and plans are drawn on a scale sufficiently large to show most objects on a scale true to nature.

General maps are either reduced from topographical maps or compiled from such miscellaneous sources as are available. In the former case the cartographer is merely called upon to reduce and generalize the information given by his originals. In the latter case no surveys are available, and the map has to be compiled from a variety of sources. These materials generally include reconnaissance survey of small districts, route surveys and astronomical observations supplied by travellers, and information from native sources. The compiler, in combining these materials, is called upon to examine the various sources of information, and to form an estimate of their value, which he can only do if he have himself some knowledge of surveying and of the methods of determining positions by astronomical observation. A knowledge of the languages of the written accounts and even of native languages, is almost indispensable. Frequently the explorer himself, or the draughtsman employed by him fails to introduce into his map the whole of the information available. Latitudes from the observations of old-time travellers may generally be trusted, but their longitudes should be accepted with caution.

Scale of Maps.—Formerly map-makers contented themselves with placing upon their maps a linear scale of miles. They now usually add the proportion which the units have to nature.

The linear scale of maps can obviously be used only in the case of maps covering a small area, for in the case of maps of greater extension measurements would be vitiated owing to the distortion or exaggeration inherent in all projections.

Map Projections are dealt with separately below. It will suffice therefore to point out that the ordinary needs of the cartographer can be met by conical projections. The indiscriminate use of Mercator's projection, for maps of the world, is to be deprecated owing to the exaggeration of areas in high latitudes.

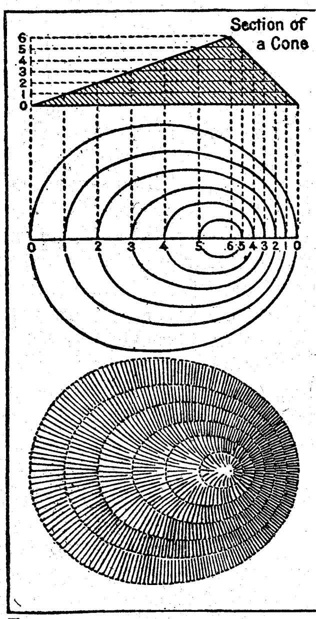


FIG. 1.—DELINEATION OF GROUND SHOWING HORIZONTAL CONTOURS AND HACHURES REGULATED ACCORDING TO INCLINATION OF SLOPE

Delineation of the Ground.—The mole-hills and serrated ridges of mediaeval maps were still in almost general use at the close of the 18th century, and are occasionally met with at the present day, being cheaply produced, readily understood by the unlearned, and in reality preferable to the uncouth and misleading hatchings still to be seen on many maps. Far superior are those scenographic representations which enable a person consulting the map to identify prominent landmarks.

Delineations such as these do not, however, satisfy scientific requirements. This was recognized by J. Picard and other members of the Academy of Science whom Colbert, in 1668, directed to prepare a new map of France, for on David Vivier's map of the environs of Paris (1674, scale 1:86,400) very crude hachures bounding the rivers have been substituted for the scenographic hills of older maps. Towards the close of the 18th century horizontal contours and hachures regulated according to the angle of inclination of all slopes were adopted. These *contours* are the intersections of the surface and horizontal planes (*see* fig. 1). Contours of this kind were first utilized by M. S. Cruquius in his chart of the Merwede (1728); Philip Buache (1737) introduced such contours or isobaths (Gr. ἴσος, equal; βαθύς, deep) upon his chart of the Channel, and intended to introduce smaller contours or isohypses (ὕψος, height) for a representation of the land.

LAYER MAPS

Carl Ritter, in 1806, employed graduated tints, decreasing in depth, from the lowlands to the highlands; while Gen. F. von Hauslab, director of the Austrian Surveys, in 1842, advised that the darkest tints should be allotted to the highlands, so as not to obscure details in the densely peopled plains. C. von Sonklar, in his map of the Hohe Tauern coloured plains and valleys green; mountain slopes in five shades of brown; glaciers blue or white. E. G. Ravenstein's map of Ben Nevis (1887) first employed the spectrum colours, viz., green to brown, in ascending order for the land: blue, indigo and violet for the sea. On the international map of the world, on a scale of 1:1,000,000, which has been undertaken by the leading governments of the world, the ground is shown by contours at intervals of 100m., the strata are in graded tints, viz., blue for the sea, green for lowlands up to 300m., yellow between 300 and 500m., brown up to 2,000m., and reddish tints beyond that height.

Until the 20th century the declivities of the ground were indicated in most topographical maps by a system of strokes or hachures, first devised by L. Chr. Müller (*Plan und Kartenzeichnen,* 1788) and J. G. Lehmann, who directed a survey of Saxony, 1780–1806, and published his *Theorie der Bergzeichnung* in 1799. By this method the slopes are indicated by strokes or hachures crossing the contour lines at right angles, in the direction of flowing water, and varying in thickness according to the degree of declivity they represent. Typical modern topographical maps, on scales from 1:25,000 to 1:250,000, have, generally, contours closely spaced, printed in colours. Hachures may occasionally be found combined with contours, as in the maps of Italy on the 1:100,000 scale.

As to the interval at which the contours should be spaced, a good rule in normal, not mountainous, country is to space them at 50ft. for a scale of 1in. to the mile, and for other scales in proportion. Thus, on a ½in. map the contours would be at 100ft. intervals and so on.

Selection of Names and Orthography.—The nomenclature or "lettering" of maps is a subject deserving special attention. Not only should the names be carefully selected with special reference to the objects which the map is intended to serve, and to prevent overcrowding, but they should also be arranged in such a manner as to be read easily by a person consulting the map. It is an accepted rule now that the spelling of names in countries using the Roman alphabet should be retained, with such exceptions as have been familiarized by long usage. In such cases, however, the correct native form should be added within brackets, as Florence (Firenze), Leghorn (Livorno), Prague (Praha) and so on. At the same time these corrupted forms should be eliminated as far as possible. Names in languages not using the Roman alphabet, or having no written alphabet, should be spelt phonetically, as pronounced on the spot. An elaborate universal alphabet, abounding in diacritical marks, has been devised for the purpose by Prof. Lepsius, and various other systems have been adopted for oriental languages, and by certain missionary societies, adapted to the languages in which they teach. The simple rules laid down by the Royal Geographical Society, will be found sufficient.

The United States Geographic Board acts upon rules practically identical with those indicated, and compiles official lists of place-names, the use of which is binding upon Government departments.

MEASUREMENT ON MAPS

Measurement of Distance.—The shortest distance between two places on the surface of a globe is represented by the arc of a great circle. If the two places are upon the same meridian or upon the equator the exact distance separating them is to be found by reference to a table giving the lengths of arcs of a meridian and of the equator. In all other cases recourse must be had to a map, a globe or mathematical formula. Measurements made on a topographical map yield the most satisfactory results. Even a general map may be trusted, as long as we keep within ten degrees of its centre. In the case of more considerable distances, however, a globe of suitable size should be consulted, or—and this seems preferable—they should be calculated by the rules of spherical trigonometry for the solution of a spherical triangle.

Orthodromic, *i.e.*, great-circle, distances are of course shorter than those measured along a loxodromic line, which intersects all parallels at the same angle. Thus the distance between New York and Oporto, following the former (great-circle sailing), amounts to 3,000m., while following the rhumb, as in Mercator sailing, it would amount to 3,120 miles.

Direct distances may of course differ widely from the distance which it is necessary to travel between two places along a road, down a winding river or a sinuous coast-line. Thus, the direct distance, as the crow flies, between Brig and the hospice of the Simplon amounts to 4·42 geogr. m. (slope nearly 9°), while the distance by road measures 13·85 geogr. m. (slope nearly 3°). Distances such as these can be measured only on a topographical map of a fairly large scale, for on general maps many of the details needed for that purpose can no longer be represented. Space runners for facilitating these measurements have been devised in great variety.

MEASUREMENT OF AREAS

This is easy if the map at our disposal is drawn on an equal area projection. In that case we need simply cover the map with a network of squares—the area of each of which has been determined with reference to the scale of the map—count the squares, and estimate the contents of those only partially enclosed within the boundary, and the result will give the area desired. A planimeter is still quicker.

When dealing with maps not drawn on an equal area projection we substitute quadrilaterals bounded by meridians and parallels, the areas for which are given in the "Smithsonian Geographical Tables" (1894), or similar works.

Models or Relief Maps.—These are intended to present a representation of the ground which shall be absolutely true to nature. The object, however, can be fully attained only if the scale of the map is sufficiently large, if the horizontal and vertical scales are identical, so that there shall be no exaggeration of the heights, and if regard is had, eventually, to the curvature of the earth's surface. Relief maps on a small scale necessitate a generalization of the features of the ground, as in the case of ordinary maps, as likewise an exaggeration of the heights. Thus on a relief on a scale of 1:1,000,000 a mountain like Ben Nevis would only rise to a height of 1·3 millimetres.

The methods of producing reliefs vary according to the scale and the materials available. A simple plan is as follows: draw an outline of the country of which a map is to be produced upon a board; mark all points the altitude of which is known or can be estimated by pins or wires clipped off so as to denote the heights; mark river-courses and suitable profiles by strips of vellum and finally finish your model with the aid of a good map, in clay or wax. A pantograph armed with cutting-files which carve the relief out of plaster of Paris may be used.

Globes.—It is impossible to represent on a plane the whole of the earth's surface, or even a large extent of it, without a considerable amount of distortion. On the other hand a map drawn on the surface of a sphere representing a terrestrial globe will prove true to nature, for it possesses, in combination, the qualities which the ingenuity of no mathematician has hitherto succeeded in imparting to a projection intended for a map of some extent, namely, equivalence of areas, of distances and angles.

It should be observed here that our globes take no account of the oblateness of our sphere; but as the difference in length between the two axes of the earth only amounts to about $\frac{1}{300}$ it could be shown only on a globe of unusual size.

Map Printing.—Maps were first printed in the second half of the 15th century. Those in the *Rudimentum novitiarum* published at Lübeck in 1475 are from woodcuts, while the maps in the first two editions of Ptolemy published in Italy in 1472 are from copper plates. Wood engraving kept its ground for a considerable period, especially in Germany, but copper in the end supplanted it. The art of lithography has greatly affected the production of maps. Owing to the great weight of stones, their cost and their liability of being fractured in the press, zinc plates or aluminium plates, have largely taken the place of stone. The processes of zincography are essentially the same as lithography. Photographic processes are utilized not only in reducing maps to a smaller scale, but also for producing stones and plates from which they may be printed. The manuscript maps intended to be produced by photographic processes upon stone, zinc or aluminium, are drawn on a scale somewhat larger than the scale on which they are to be printed, thus eliminating all those imperfections which are inherent in a pen-drawing. The saving in time and cost by adopting this process is considerable.

For details of the various methods of reproduction *see* LITHOGRAPHY: *Lithography As An Art: The Process.*

HISTORY OF CARTOGRAPHY

A capacity to understand the nature of maps is possessed even by peoples whom we are in the habit of describing as "savages." Wandering tribes naturally enjoy a great advantage in this respect over sedentary ones. Many arctic voyagers have profited from rough maps drawn for them by Eskimos. Specimens of such maps are given in C. F. Hall's *Life with the Esquimaux* (London, 1864). Henry Youle Hind, in his work on the Labrador Peninsula (London, 1863) praises the map which the Montagnais and Nasquapee Indians drew upon bark.

Tupaya, a Tahitian, when on board the "Endeavour," gave an account of his navigations, and having a very complete knowledge of the islands, and having soon mastered the meaning and use of charts, was able to give directions for the construction of a chart showing the islands. Raraka drew a map in chalk of the Paumotu archipelago on the deck of Capt. Wilkes's vessel; Marshall islanders possessed curious cane charts. Far superior were maps found among the semi-civilized Mexicans when the Spaniards invaded their country: cadastral plans of villages and maps of the provinces of the empire of the Aztecs, of towns and the coast. Montezuma presented Cortes with a map, painted on Nequen cloth, of the Gulf coast. Peru, the empire of the Incas, had not only ordinary maps, but also maps in relief, for Pedro Sarmiento da Gamboa (*History of the Incas,* translated by A. R. Markham, 1907) tells us that the 9th Inca (died 1191) ordered such reliefs of certain localities in a district which he had recently conquered and intended to colonize. These were the first relief maps.

The ancient Egyptians were famed as "geometers," and as early as the days of Rameses II. (Sesostris of the Greek, 1333–1300 B.C.) there had been made a cadastral survey of the country showing the rows of pillars which separated the nomes as well as the boundaries of landed estates. It was upon a map based upon such a source that Eratosthenes (276–196 B.C.) measured the distance between Syene and Alexandria which he required for his determination of the length of a degree. Ptolemy, who had access to the famous library of Alexandria was able, no doubt, to use these cadastral plans when compiling his *geography.* Few specimens of ancient Egyptian cartography have survived. In the Turin museum are preserved two papyri with rough drawings of gold mines established by Sesostris in the Nubian desert. These drawings have been commented upon by S. Birch, F. Chabas, R. J. Lauth and other Egyptologists, and have been referred to as the two most ancient maps in existence. They can, however, hardly be described as maps, while in age they are surpassed by several cartographical clay tablets discovered in Babylonia. On another papyrus in the same museum is depicted the victorious return of Seti I. (1366–1333) from Syria, showing the road from Pelusium to Heroopolis, the canal from the Nile with crocodiles, and a lake (mod. Lake Timsah) with fish in it. Apollonius of Rhodes, who succeeded Eratosthenes as chief librarian at Alexandria (196 B.C.), reports in his *Argonautica* (iv. 279) that the inhabitants of Colchis whom, like Herodotus (ii. 104) he looks upon as the descendants of Egyptian colonists, preserved, as heirlooms, certain graven tablets (κύρβεις) on which land and sea, roads and towns were accurately indicated. Eustathius (since 1160 archbishop of Thessalonica), in his commentary on Dionysius Periegetes, mentions route-maps which Sesostris caused to be prepared, while Strabo dwells at length upon the wealth of geographical documents to be found in the library of Alexandria.

A cadastral survey for purposes of taxation was already at work in Babylonia during the age of Sargon of Akkad. In the British Museum may be seen a series of clay tablets, circular in shape and dating back to 2300 or 2100 B.C., which contain surveys of lands. One of these depicts in a rough way lower Babylonia encircled by a "salt water river," Oceanus.

Development of Map-making among the Greeks.—Ionian mercenaries and traders arrived in Egypt, on the invitation of Psammetichus I., about the middle of the 7th century B.C. One of the most distinguished was Thales of Miletus (640–543 B.C.), the founder of the Ionian school of philosophy, whose pupil, Anaximander (611–547 B.C.) is credited by Eratosthenes with having designed the first map of the world. Anaximander looked upon the earth as a section of a cylinder, of considerable thickness, suspended in the centre of the circular vault of the heavens, an idea perhaps from the Babylonians (*see* Job xxvi. 7). Like Homer he looked upon the habitable world (οἰκουμένη) as being circular in outline and bounded by a circumfluent river. The geographical knowledge of Anaximander extended from the Cassiterides or Tin islands in the west to the Caspian in the east, which he conceived to open out into Oceanus. The Aegean sea occupied the centre of the map, while the line where ocean and firmament seemed to meet represented an enlarged horizon.

Anaximenes, a pupil of Anaximander, was the first to reject the view that the earth was a circular plane, but held it to be an oblong rectangle, buoyed up in the midst of the heavens by the compressed air upon which it rested.

The map of the world brought upon the stage in Aristophanes' *The Clouds* (423 B.C.), whereon a disciple of the Sophists points out Athens and other places known to the audience, was probably of the popular circular type, which Herodotus (iv. 36) not many years before had derided and which was discarded by Greek cartographers ever after. Thus Democritus of Abdera (b. *c.* 450, d. after 360), the great philosopher and founder, with Leucippus, of the atomic theory, was also the author of a map of the inhabited world which he supposed to be half as long again from west to east, as it was broad.

Dicaearchus of Messana in Sicily, a pupil of Aristotle (326–296 B.C.), is the author of a topographical account of Hellas, with maps, of which only fragments are preserved; he is credited with having estimated the size of the earth, and, as far as known he was the first to draw a parallel across a map. The map of Dicaearchus resembled that of Democritus.

Scientific geography profited largely from the labours of Eratosthenes of Cyrene, whom Ptolemy Euergetes appointed keeper of the famous library of Alexandria in 247 B.C., and died in that city in 195 B.C. He won fame as having been the first to determine the size of the earth by a scientific method. Having determined the difference of latitude between Alexandria and Syene which he erroneously believed to lie on the same meridian, and obtained the distance of those places from each other from the surveys made by Egyptian geometers, he concluded that a degree of the meridian measured 700 stadia.

Eratosthenes is the author of a treatise which deals systematically with the geographical knowledge of his time, but of which only fragments have been preserved by Strabo and others. This treatise was intended to illustrate and explain his map of the world. In this task he was much helped by the materials collected in his library. His map formed a parallelogram measuring 75,800 stadia from Usisama (Ushant island) or Sacrum Promontorium in the west to the mouth of the Ganges and the land of the Coniaci (Comorin) in the east, and 46,000 stadia from Thule in the north to the supposed southern limit of Libya. Across it were drawn seven parallels, running through Meroe, Syene, Alexandria, Rhodes, Lysimachia on the Hellespont, the mouth of the Borysthenes and Thule, and these were crossed at right angles by seven meridians, drawn at irregular intervals. In his text Eratosthenes ignored the popular division of the world into Europe, Asia and Libya, and substituted for it a northern and southern division, divided by the parallel of Rhodes, each of which he subdivided into *sphragides* or *plinthia*—seals or plinths. The principles on which these divisions were made remain an enigma to the present day. This map of Eratosthenes, notwithstanding its many errors, such as the assumed connection of the Caspian with a northern ocean and the supposition that Carthage, Sicily and Rome lay on the same meridian, enjoyed a high reputation in his day. Even Strabo (*c.* 30 B.C.) adopted its main features.

Hipparchus, the famous astronomer, on the other hand (*c.* 150 B.C.) proved a somewhat captious critic. He justly objected to the arbitrary network of the map of Eratosthenes. The parallels or *climata* drawn through places, of which the longest day is of equal length and the decimation (distance) from the equator is the same, he maintained, ought to have been inserted at equal intervals, say of half an hour, and the meridians inserted on a like principle. In fact, he demanded that maps should be based upon a regular projection, several descriptions of which he had adopted for his star maps. He moreover accuses Eratosthenes (whose determination of a degree he accepts without hesitation) with trusting too much to hypothesis in compiling his map instead of having recourse to latitudes and longitudes deduced by astronomical observations. Such observations, however, were but rarely available at the time. Hipparchus is not known to have compiled a map himself.

About the same time Crates of Mallus (d. 145 B.C.) embodied the views of the Stoic school of philosophy in a globe which has

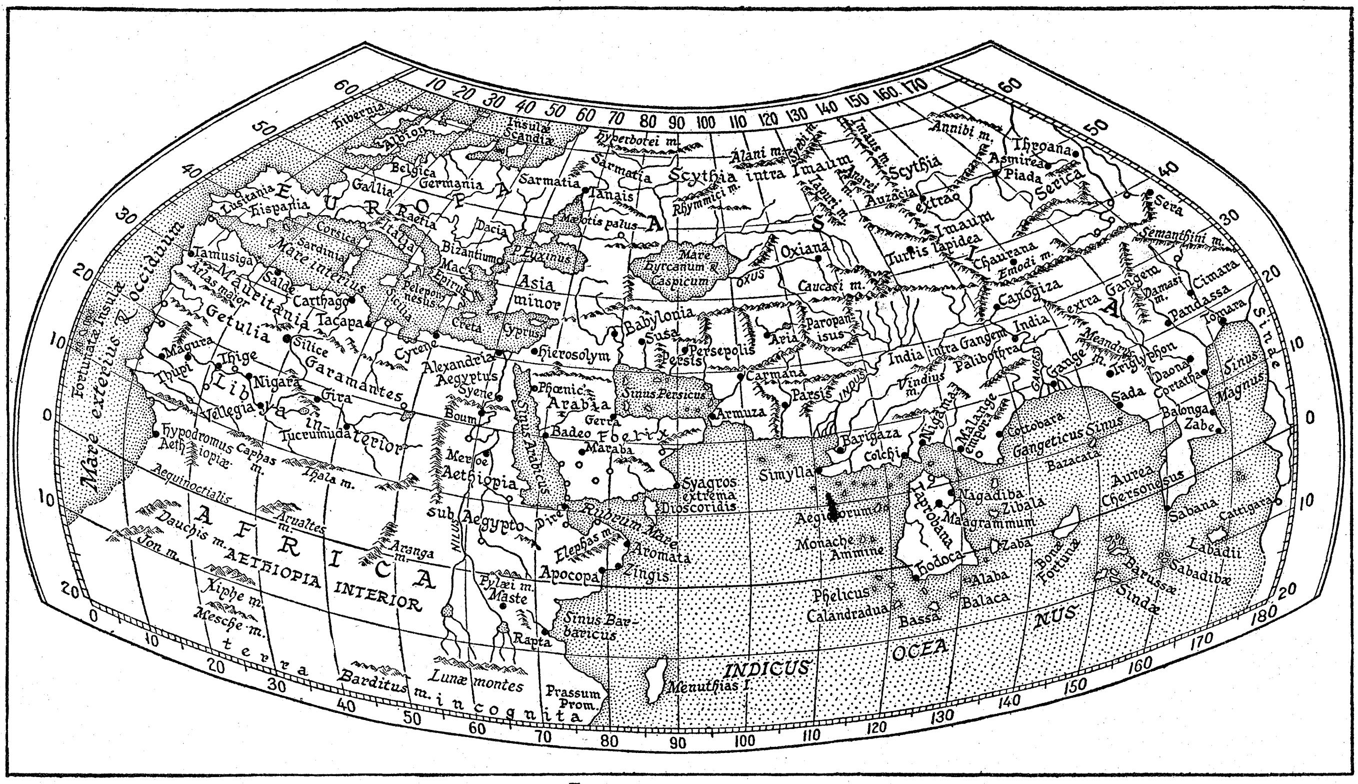


FIG. 2.—PTOLEMY'S MAP

become typical as one of the insignia of royalty. On this globe an equatorial and a meridional ocean divide our earth into four quarters, each inhabited, thus anticipating the discovery of North and South America and Australia.

The period between Eratosthenes and Marinus of Tyre was one of great political importance. Military operations added to our knowledge of the world but scientific cartography was utterly neglected.

Among Greek works written during this period there are several which either give us an idea of the maps available at that time, or furnish information of direct service to the compiler of a map. Among the latter a Periplus or coastal guide of the Erythrean sea, which clearly reveals the peninsular shape of India (A.D. 90) and Arrian's *Periplus Ponti Euxeni* (A.D. 131) which Festus Avienus translated into Latin. Among geographers should be mentioned Posidonius (130–50 B.C.), the head of the Stoic school of Rhodes, who is stated to be responsible for having reduced the length of a degree to 500 stadia; Artemidorus of Ephesus, whose "Geographumena" (*c.* 100 B.C.) are based upon his own travels and a study of itineraries, and above all, Strabo, who adhered to the scientific theories of Eratosthenes.

The credit of having returned to the scientific principles introduced by Eratosthenes and Hipparchus is due to Marinus of Tyre (*c.* A.D. 120). His map and the descriptive accounts which accompanied it have perished, but we learn sufficient concerning them from Ptolemy to be able to appreciate their merits and demerits. Marinus was the first who laid down the position of places on a projection according to their latitude and longitude, but the projection used by him was of the rudest. Parallels and meridians were represented by straight lines intersecting each other at right angles, the relative proportions between degrees of longitude and latitude being retained only along the parallel of Rhodes. The distortion of the countries represented would thus increase with the distance, north and south, from this central parallel. The number of places whose position had been determined by astronomical observation was as yet very small, and the map had thus to be compiled mainly from itineraries furnished by travellers or the dead reckoning of seamen. The errors of distance were still further increased by his assuming a degree to be equal to 500 stadia. There was a list of places arranged according to latitude and longitude. It must have been much in demand, for three editions of it were prepared. Masudi (10th century) saw a copy of it and declared it to be superior to Ptolemy's map.

Ptolemy (*q.v.*) was the author of a *Geography* (*c.* A.D. 150) in eight books. "Geography," in the sense in which he uses the term, signifies the delineation of the known world, in the shape of a map, while chorography carries out the same object in fuller detail, with regard to a particular country. In Book I. he deals with the principles of mathematical geography, map projections and sources of information. Books II. to VII. index the longitudes, and thus it is possible to reconstruct the maps.

Ptolemy's great merit consists in having accepted the views of Hipparchus with respect to a projection suited for a map of the world. Of the two projections proposed by him one is a modified conical projection with curved parallels and straight meridians; in the second projection (*see* fig. 2) both parallels and meridians are curved. The correct relations in the length of degrees of latitude and longitude are maintained in the first case along the latitude of Thule and the equator, in the second along the parallel of Agisymba, the equator and the parallels of Meroe, Syene and Thule. Following Hipparchus he divided the equator into 360° drawing his prime meridian through the Fortunate islands.

As a map compiler Ptolemy does not take a high rank. In the main he copied Marinus whose work he revised and supplemented in some points, but he failed to realize the peninsular shape of India, erroneously exaggerated the size of Taprobane (Ceylon), and suggested that the Indian ocean had no connection with the western ocean, but formed Mare Clausum. Ptolemy knew but of a few latitudes which had been determined by actual observation, while of three longitudes resulting from simultaneous observation of eclipses he unfortunately accepted the least satisfactory, namely, that which placed Arbela 45° to the east of Carthage, while the actual meridian distance only amounts to 34°. An even graver source of error was Ptolemy's acceptance of a degree of 500 stadia (fig. 2). But in spite of his errors the scientific method pursued by Ptolemy was correct, and though he was neglected by the Romans and during the middle ages, once he had become known, in the 15th century, he became the teacher of the modern world.

Map-making Among the Romans.—We learn from Cicero,

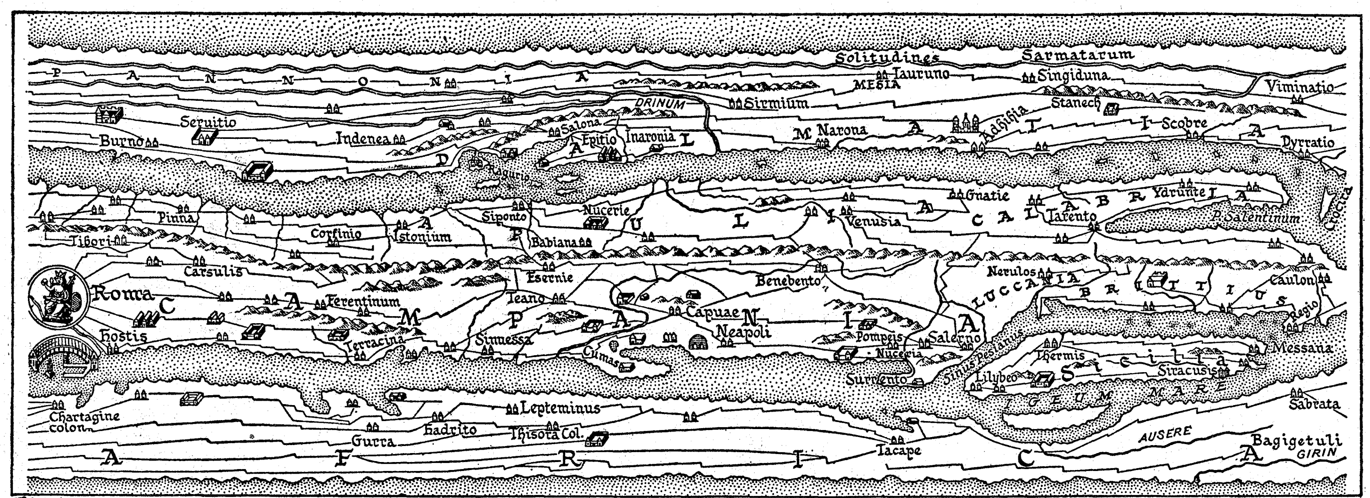


FIG. 3.—A SECTION OF PEUTINGER'S TABULA

Vitruvius, Seneca, Suetonius, Pliny and others, that the Romans had both general and topographical maps. Thus, Varro (*De rustici*) mentions a map of Italy engraved on marble, in the temple of Tellus, Pliny, a map of the seat of war in Armenia, of the time of the emperor Nero, and the more famous map of the Roman empire which was ordered to be prepared for Julius Caesar (44 B.C.), but only completed in the reign of Augustus, who placed a copy of it, engraved in marble, in the Porticus of his sister Octavia (7 B.C.). M. Vipsanius Agrippa, the son-in-law of Augustus (d. 12 B.C.), who superintended the completion of this famous map, also wrote a commentary illustrating it. It must have been a work of superior excellence. A copy of it may possibly have been utilized by Marinus and Ptolemy in their compilations. The Romans have been reproached for having neglected the scientific methods of map-making advocated by Hipparchus. Their maps seem to have met the practical requirements of political administration and of military undertakings.

Only two specimens of Roman cartography have come down to us, viz., parts of a plan of Rome, of the time of the emperor Septimius Severus (A.D. 193–211), now in the Museo Capitolino, and an *itinerarium scriptum,* or road map of the world, compressed within a strip 745mm. in length and 34mm. broad. Of its character the reduced copy of one of its 12 sections (fig. 3) conveys an idea. The map, apparently of the 3rd century, was copied by a monk at Colmar, in 1265, who fortunately contented himself with adding a few scriptural names, and having been acquired by the learned Konrad Peutinger of Augsburg it became known as *Tabula peutingeriana.* The original is now in the State library of Vienna.

Map-making in the Middle Ages.—In scientific matters the early middle ages were marked by stagnation and retrogression. The fathers of the Church did not encourage scientific pursuits. The doctrine of the sphericity of the earth was held by the more learned, but the heads of the Church held it to be unscriptural. Even after Gerbert of Aurillac, who is better known as Pope Sylvester II. (999–1063), Adam of Bremen (1075), Albertus Magnus (d. 1286), Roger Bacon (d. 1294), and indeed all men of leading had accepted as a fact and not a mere hypothesis the geocentric system of the universe and sphericity of the globe, the authors of maps of the world, nearly all of whom were monks, still looked in the main to the Holy Scriptures for guidance in outlining the inhabited world. We have to deal thus with three types of these early maps, viz., an oblong rectangular, a circular and an oval type, the latter being either a compromise between the two former, or an artistic development of the circular type. In every instance the inhabited world is surrounded by the ocean. The authors of rectangular maps look upon the Tabernacle as an image of the world at large. On the other hand there was the expression "circuit of the earth" (Isa. xl. 22), and the statement (Ezek. v. 5) that "God had set Jerusalem in the midst of the nations and countries." In nearly every case the East occupies the top of the map. Neither parallels nor meridians are indicated, nor is there a scale. Paradise is placed in the Far East.

The oldest rectangular map of the world is contained in a most valuable work written by Cosmas, an Alexandrian monk, surnamed Indicopleustes, after returning from a voyage to India (A.D. 535), and entitled *Christian Topography.* According to Cosmas the inhabited earth has the shape of an oblong rectangle surrounded by an ocean in four great gulfs. A small map of the world of the 8th century is found in a codex in the library of Albi, an archiepiscopal seat in the department of Tarn. Its scanty nomenclature is almost wholly derived from the "Historiae adversum paganos" of Paulus Orosius (418). Far greater interest attaches to the so-called Anglo-Saxon map of the world in the British museum (Cotton mss.), where it is bound up in a codex which also contains a copy of the *Periegesis* of Priscianus. Map and Periegesis are copies by the same hand, but no other connection exists between them. More than half the nomenclature of the map is derived from Orosius, an annotated Anglo-Saxon version of which had been produced by King Alfred (848–901). The Anglo-Saxons of the time were of course well acquainted

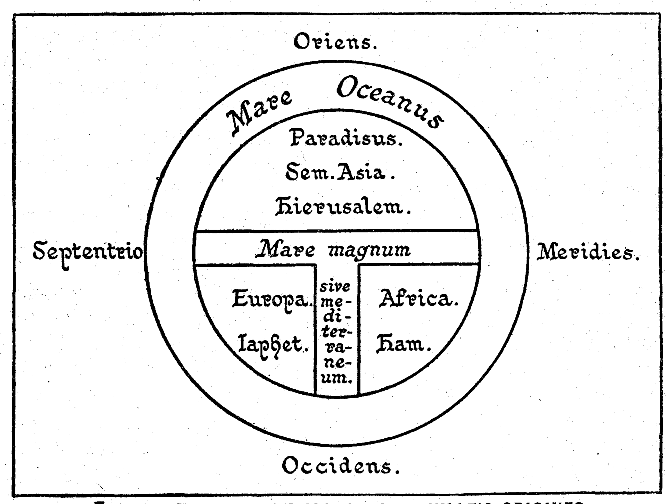


FIG. 4.—T. MAP FROM ISODOR OF SEVILLE'S ORIGINES

with Island (first thus named in 870), Slesvic and Norweci (Norway), and there is no need to have recourse to Adam of Bremen (1076) to account for their presence upon this map. The broad features of the map were derived no doubt from an older document which may likewise have served as the basis for the map of the world engraved on silver for Charlemagne, and which was also consulted by the compilers of the Hereford and Ebstorf maps.

The map or diagram of which Leonardo Dati in his poem on the Sphere (Della Spera) wrote in 1422 "un T dentre a uno O mostra il disegno" (a T within an O shows the design) is one of the most persistent types among the circular or wheel maps of the world. It perpetuates the tripartite division of the world by the ancient Greeks and survives in the Royal Orb. (*See* figs. 9 and 10.)

The map in Hereford cathedral (fig. 5) is the work of Richard of Haldingham, and has a diameter of 134cm. (53 inches). The "survey" ordered by Julius Caesar is referred to in the legend,

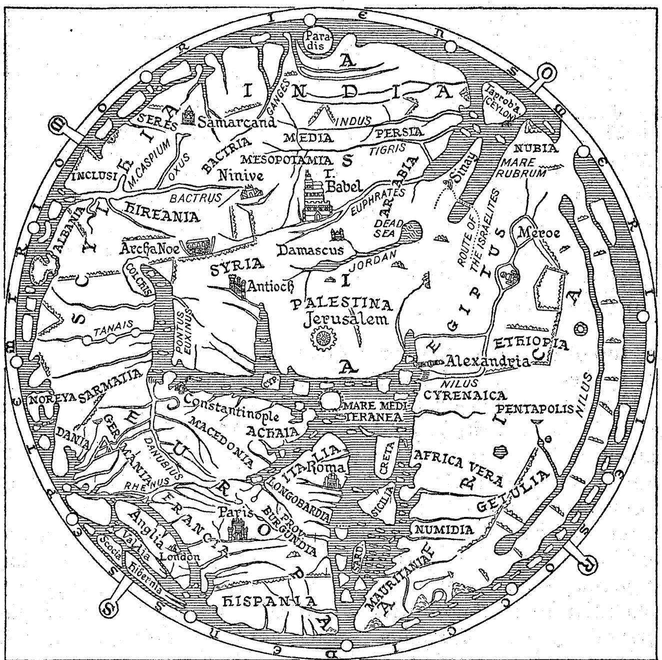


FIG. 5.—THE HEREFORD MAP. (ABOUT 1280)

evidently derived from the Cosmography of Aethicus a work widely read at the time, but this does not prove that the author was able to avail himself of a map based upon that survey. A map essentially identical with that of Hereford, but larger—its diameter is 156cm. (60in.), and consequently fuller of information—was discovered in 1830 in the old monastery of Ebstorf in Hanover. Its date is 1484.

Pomponius Mela tells us that beyond the Ethiopian ocean which sweeps round Africa in the south and the uninhabitable torrid zone, there lies an *alter orbis,* or fourth part of the world inhabited by *Antichthones.* On a diagram illustrating the *Origines* of Isidore of Seville (d. 636) this country is shown, but is described as a *terra inhabitabilis.* It is shown likewise upon a number of maps which illustrate the *Commentaries on the Apocalypse,* by Beatus, a Benedictine monk of the abbey of Valcavado at the foot of the hills of Liebana in Austria (776). There are similar maps illustrating the *Commentaries* existing at St. Sever (1050), Paris (1203) and Tunis; others are rectangular, the oldest being in Lord Ashburnham's library (970). Beatus, too, describes the southern land as *inhabitabilis.* The habitable world is divided among the twelve apostles, whose portraits are given. On the maps illustrating the encyclopaedic *Liber floridus* by Lambert, a canon of St. Omer (1120), this south land "unknown to the sons of Adam," is stated to be inhabited "according to the philosophers" by Antipodes. Lambert, indeed, seems to have believed in the sphericity of the earth. Diagrams illustrating the division of the world into climata are to be found in the *opus majus* of Roger Bacon (d. 1294) and in Cardinal Pierre d'Ailly's *De imagine Mundi* (1410).

Among countries represented on a larger scale on maps, Palestine not unnaturally occupies a prominent place in this age of pilgrimages and crusades (1095–1291). Maps of Palestine accompany St. Jerome's translation of the *Onomasticon* of St. Eusebius (388). The same subject is illustrated by a picture-map in mosaic, portions of which were discovered in 1884 on the floor of the church of Medeba to the east of the Jordan. This is the oldest original of a map in existence, for it dates back to the 6th century and shows the country before the Mohammedan conquest.

There also exist a few special maps of European countries. Of Great Britain we may mention the one of the 12th century, another by Matthew of Paris, the famous historiographer of the monastery of St. Albans (fig. 6) (1236–1259); and the map at the Bodleian Library at Oxford, dated about A.D. 1300. This is a genuine piece of map-making and may perhaps have been used by officials of the king's court.

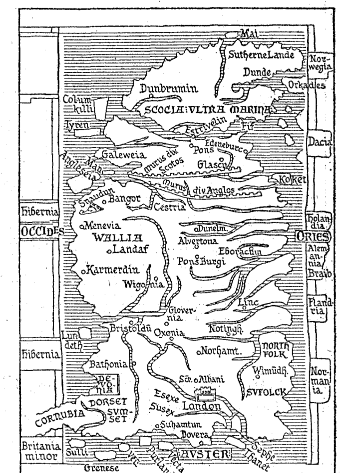


FIG. 6.—MATTHEW OF PARIS (1236–1259)

Celestial globes were known in the time of Bede; they formed part of the educational apparatus of the monastic schools. Gerbert of Aurillac is known to have made such globes (929). Their manufacture is described by Alphonso the Wise (1252), as also in *De sphaera solida* of G. Campanus of Novara (1303). Terrestrial globes, however, are not referred to.

Map-making Among the Arabians and Other Nations of the East.—Baghdad early became a famous seat of learning. Indian astronomers found apt pupils there among the Arabs; the works of Ptolemy were translated into Arabic, and in 827, in the reign of the caliph Abdullah al Mamun, an arc of the meridian was measured in the plain of Mesopotamia. Most famous among these Arabian astronomers were Al Batani (d. 998), Ibn Yunis of Cairo (d. 1008), Zarkala (Azarchel), who determined the meridian distance between his observatory in Toledo and Baghdad to amount to 51° 30′, an error of 3° only, as compared with Ptolemy's error of 18°, and Abul Hassan (1230) who reduced the great axis of the Mediterranean to 44°.

Further materials serviceable to the compilers of maps were supplied by numerous Arabian travellers and geographers, among

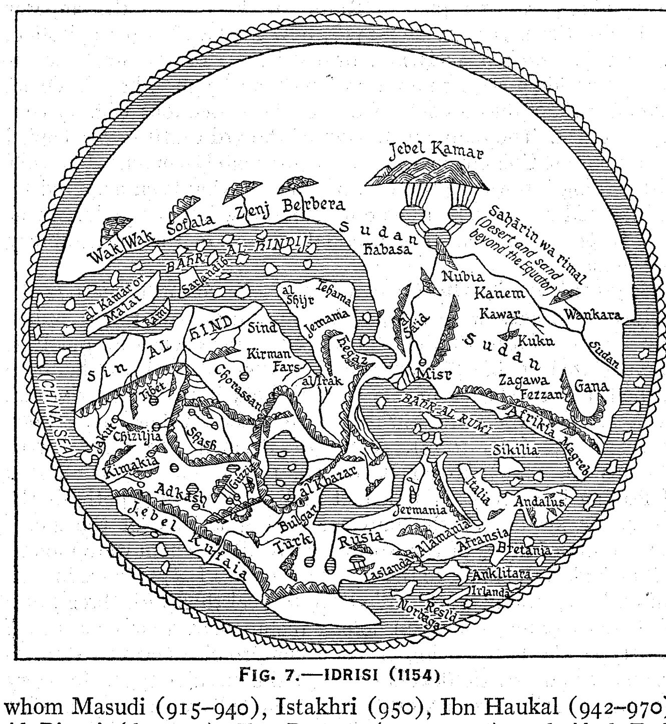


FIG. 7.—IDRISI (1154)

whom Masudi (915–940), Istakhri (950), Ibn Haukal (942–970), Al Biruni (d. 1038), Ibn Batuta (1325–1356) and Abul Feda (1331–1370), occupy a foremost place, yet the few maps which have reached us are crude in the extreme. Neither Idrisi's map of the world (fig. 7), engraved for King Roger of Sicily upon a silver plate, nor the rectangular map in 70 sheets which accompanies his geography (Nushat-ul Mushtat) take rank with Ptolemy's work.

The Arabians are not known to have produced a terrestrial globe, but several of their celestial globes are to be found in our collections. The oldest of these globes was made at Valentia, and is now in the museum of Florence. Another globe (of 1225) is at Velletri; a third by Ibn Hula of Mosul (1275) is the property of the Royal Asiatic Society of London; a fourth (1289) from the observatory of Maragha, in the Dresden museum; two globes of uncertain age at Paris, and another in London. All these globes are of metal (bronze).

The charts in use by the mediaeval navigators of the Indian Ocean—Arabs, Persians or Dravidas—were equal in value if not superior to the charts of the Mediterranean. Marco Polo mentions such charts; Vasco da Gama (1498) found them in the hands of his Indian pilot, and their nature is fully explained in the *Mohit* or encyclopaedia of the sea compiled from ancient sources by the Turkish admiral Sidi Ali Ben Hosein in 1554. These charts are covered with a close network of lines intersecting each other at right angles. The horizontal lines are parallels, depending upon the altitude of the pole star, the Calves of the Little Bear and the Barrow of the Great Bear above the horizon. This altitude was expressed in *isbas* or inches each equivalent to 1° 42′ 50″. Each *isba* was divided into *zams* or eighths. The interval between two parallels thus only amounted to 12′ 51″. These intervals were mistaken by the Portuguese occasionally for degrees, which account for Malacca, which is in lat. 2′ 13″ N., being placed on Cantino's chart (1502) in lat. 14′ S. It may have been a map of this kind which accounts for Ptolemy's moderate exaggerations of the size of Taprobana (Ceylon). A first meridian, separating a leeward from a windward region, passed through Ras Kumhari (Comorin) and was thus nearly identical with the first meridian of the Indian astronomer which passed through the sacred city of Ujjain (Ozere of Ptolemy) or the meridian of Azin of the Arabs. Additional meridians were drawn at intervals of *zams,* supposed to be equal to three hours' sail.

In China, maps in the olden time were engraved on bronze or stone, but after the 10th century they were printed from wood-blocks. Among the more important productions of more recent times may be mentioned a map of the empire, said to be based upon actual surveys by Yhang (721), who also manufactured a celestial globe (an older globe by Ho-shing-tien, 4m. in circumference was produced in 450), and an atlas of the empire on a large scale by Thu-sie-pun (1311–1312) of which new enlarged editions with many maps were published in the 16th century and in 1799. None of these maps was graduated, which is all the more surprising as the Chinese astronomers are credited with having made use of the gnomon as early as 1000 B.C. for determining latitudes.

In the case of Japan, the earliest reference to a map is of 646, in which year the emperor ordered surveys of certain provinces to be made.

Portolano Maps.—During the long period of stagnation in cartography, which we have already dealt with, there survived among the seamen of the Mediterranean charts of remarkable accuracy, illustrating the *Portolani* or sailing directories in use among them. They antedate 1270, and in the eastern part of the Mediterranean embody materials available even in the days before Ptolemy, while the correct delineation of the west seems to be of a later date, and many have been due to Catalan seamen. These charts are based upon estimated bearings and distances between the principal ports or capes, the intervening coast-line being filled in from more detailed surveys. The bearings were dependent upon the seaman's observation of the heavens, for these charts were in use long before the compass had been introduced on board ship (as early as 1205, according to Guiot de Provins). It is therefore misleading to describe them as *Compass or Loxodromic* charts, and they are now known as *Portolano* charts.

None of these charts is graduated, and the horizontal and vertical lines which cross many of them represent neither parallels nor meridians. Their most characteristic feature, and one by which they can most readily be recognized, is presented by groups or systems of rhumb-lines, each group of these lines radiating from a common centre, the central group being generally encircled by eight or 16 satellite groups. Each chart was furnished with a scale of Portolano miles whose length was only 1,233 metres.

On these old charts the Mediterranean is delineated with surprising fidelity. The meridian distance between the Straits of Gibraltar and Beirut in Syria amounts upon them to about 3,000 Portolano miles, equal in lat. 36° N. to 40·9°, as compared with an

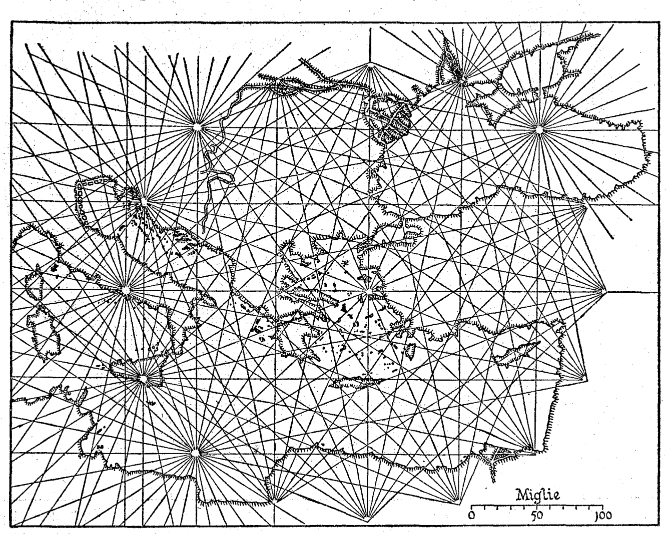


FIG. 8.—THE EASTERN MEDITERRANEAN, BY PETRUS VESCONTE (1311)

actual difference of 41·2°, and a difference of 61° assumed by Ptolemy. There exists, however, a serious error of orientation, due, according to Prof. H. Wagner, to the inexperience of the cartographers who first combined the charts of the separate basins of the Mediterranean so as to produce a chart of the whole. This accounts for Gibraltar and Alexandria being shown as lying due east and west of each other, although there is a difference of 5° of latitude between them, a fact known long before Ptolemy. The oldest of these maps which have been preserved, the so-called "Pisan chart," which belongs probably to the middle of the 13th century, and a set of eight charts, known by the name of its former owner, the Cavaliere Tamar Luxoro, of somewhat later date, are both the work of Genoese artists. Petrus Vesconte, who worked in 1311 and 1327, is the draughtsman of the maps illustrating Marino Sanuto's *Liber secretorum fidelium crucis,* which was to have roused Christendom to engage in another crusade (fig. 8).

The expansions of Portolano maps into maps of the world resemble the wheel maps of an earlier period. This is the character of the map of Petrus Vesconte of 1320, of that of Giovanni Leardo (1448) and of a Catalan map of 1450.

Very different in character is the Catalan map of 1375, for its author, discarding Ptolemy, shows India as a peninsula. On the other hand, an anonymous Genoese would-be reformer of maps (1457), still adheres to the erroneous Ptolemaic delineation of southern Asia, and the very same error is perpetuated by Henricus Marvellus Germanus on a rough map showing the Portuguese discoveries up to 1489. None of these maps is graduated, but if we give the Mediterranean a length of 3,000 Portolano miles, equivalent in 36° N. to 41°, then the longitudinal extent of the old world as measured on the Genoese map of 1457 would be 136° instead of 177° or more as given by Ptolemy.

The Revival of Ptolemy.—Ptolemy's great work became known in western Europe after Jacobus Angelus de Scarparia had translated it into Latin in 1410. This version was first printed in 1475 at Vicenza, but its contents had become known through ms. copies before this, and their study influenced the construction of maps in two respects. They led firstly to the addition of degree lines to maps, and secondly to the compilation of new maps of those countries which had been inadequately represented by Ptolemy. Thus Claudius Clavus Swartha (Niger), who was at Rome in 1424, compiled a map of the world, extending westward as far as Greenland. The learned Cardinal Nicolaus Krebs, of Cusa (Cues) on the Moselle, who died 1464, drew a map of Ger-

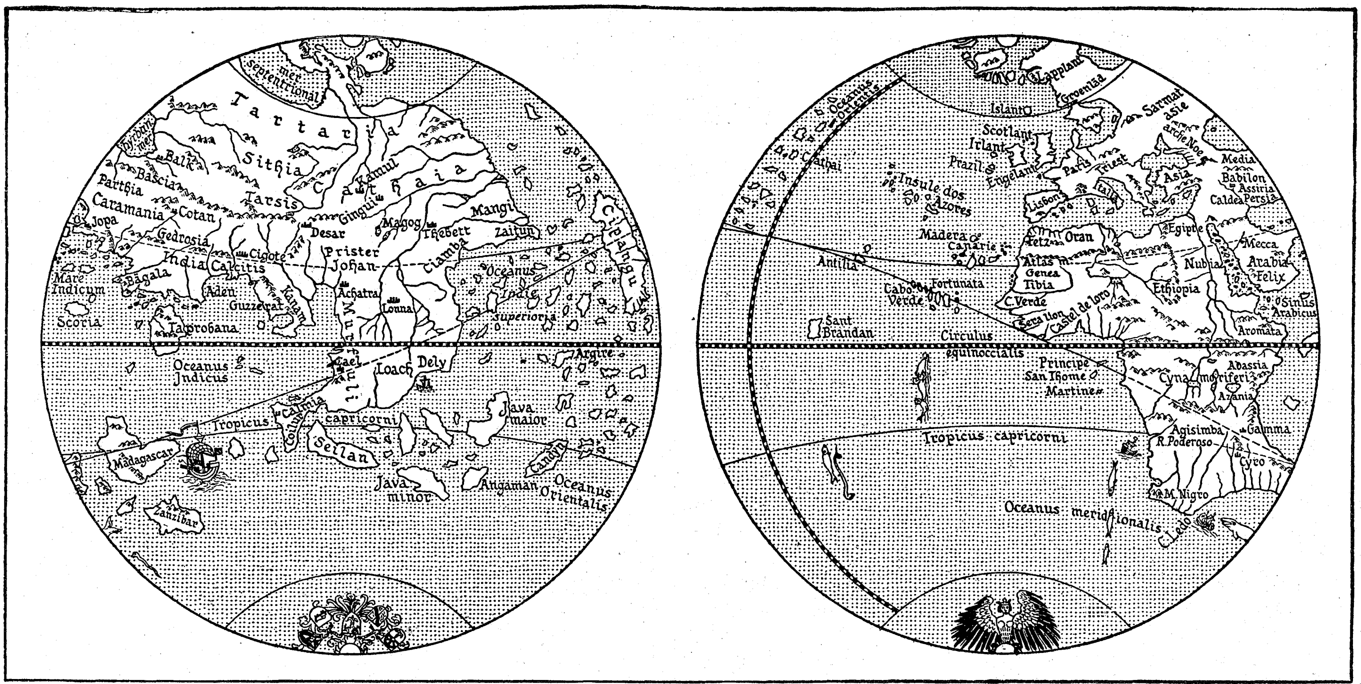


FIG. 9.—BEHAIM'S GLOBE

many which was first published in 1491; D. Nicolaus Germanus, a monk of Reichenbach, in 1466 prepared a set of Ptolemy's maps on a new projection with converging meridians; and Paolo del Pozzo Toscanelli in 1474 compiled a new chart on a rectangular projection, which was to guide the explorer across the western ocean to Cathay and India.

The geographical ideas which prevailed at the time Columbus started in search of Cathay may be most readily gathered from two contemporary globes, the one known as the Laon globe because it was picked up in 1860 at a curiosity shop in that town, the other produced at Nuremberg in 1492 by Martin Behaim. The information which it furnishes, in spite of a legend intended to lead us to believe that it presents us with the results of Portuguese explorations up to the year 1493, is of more ancient date. The Nuremberg globe (fig. 9), a work of a more ambitious order, was undertaken at the suggestion of George Holzschuher, a travelled member of the town council. The work was entrusted to Martin Behaim, who had resided for six years in Portugal and the Azores, and was believed to be a thoroughly qualified cosmographer. The globe is of pasteboard covered with whiting and parchment, and has a diameter of 507mm. (20 inches). The author followed Ptolemy not only in Asia, but also in the Mediterranean. He did not avail himself of the materials available in his day. Not even the coasts of western Africa are laid down correctly, although the author claimed to have taken part in one of the Portuguese expeditions. The ocean separating Europe from Asia is assumed as being only 126° wide, in accordance with Toscanelli's ideas of 1474. Very inadequate use has been made of the travels of Marco Polo, Nicolo de' Conti, and of others in the east.

The maritime discoveries and surveys of that age of great discoveries were laid down upon so-called "plane-charts," that is, charts having merely equidistant parallels indicated upon them, together with the equator, the tropics and polar circles, or, in a more advanced stage, meridians. For his longitude the mariner was dependent upon dead reckoning. Errors of 30° in longitude were by no means rare. It was only after the publication of Kepler's *Rudolphine Table* (1626) that more exact results could be obtained. A further difficulty arose in connection with the variation of the compass, which induced Pedro Reinel to introduce two scales of latitude on his map of the northern Atlantic (1504).

The chart of the world by Juan de la Cosa, the companion of Columbus, is the earliest extant which depicts the discoveries in the New World (1500), and there is the map which Alberto Cantino caused to be drawn at Lisbon for Hercules d'Este of Ferrara (1502), illustrating in addition the recent discoveries of the Portuguese in the East. Other cosmographers of distinction were Pedro Reinel (1504–42), Nuno Garcia de Toreno (1520), to whom we are indebted for 21 charts, illustrating Magellan's voyage, Diogo Ribero (maps of the world 1527, 1529), Alonzo de Santa Cruz, of Seville, whose *Isolario general* includes charts of all parts of the world (1541), John Rotz or Rut (1542), Sebastian Cabot (1544), as also Nicolas Desliens, Pierre Desceliers, G. Breton and V. Vallard, all of Arques, near Dieppe, whose charts were compiled between 1541 and 1554.

The Strasbourg Ptolemy of 1513 has a supplement of as many as 20 modern maps by Martin Waldseemüller or Ilacomilus, several among which are copied from Portuguese originals. Waldseemüller was one of the most distinguished cartographers of his day. He published in 1507 a map of the world, in 12 sheets, together with a small globe of a diameter of 110mm., the segments for which were printed from wood-blocks. On these documents the new world is called America, after Amerigo Vespucci.

Equally interesting with these Ptolemaic supplements are collections like that of Anton Lafreri, which contains reprints of 142 maps of all parts of the world originally published between 1556 and 1572 (*Geografica tavole moderne,* Rome, n.d.), or that of J. F. Camocio, published at Venice in 1576, which contains 88 reprints. The number of cartographers throughout Europe was considerable. Germany is represented by G. Glockendon, the author of an interesting road-map of central Europe (1501), Sebastian Münster (1489–1552), Elias Camerarius, whose map of the mark of Brandenburg won the praise of Mercator; Wolfgang Latz von Lazius, to whom we are indebted for maps of Austria and Hungary (1561), and Philip Apianus, who made a survey of Bavaria (1553–63), which was published 1568 on the reduced scale of 1:144,000, and is fairly described as the topographical masterpiece of the 16th century. For maps of Switzerland we are indebted to Konrad Türst (1495–97), Johann Stumpf (1548) and Aegidius Tschudi (1538). A map of the Netherlands from actual survey was produced by Jacob of Deventer (1536–39). Leonardo da Vinci, the famous artist, while in the service of Cesare Borgia as military engineer, made surveys of several districts in central Italy. New maps of Spain and Portugal appeared in 1560, the former being due to Pedro de Medina, the latter to Fernando Alvarez Secco and Hernando Alvaro. Among the French map-makers of this period may be mentioned Oronce Finé (Finaeus), who in 1525 published a map of France, and Jean Jolivet (*c.* 1560). Gregorio Lilly (1546) and Humphrey

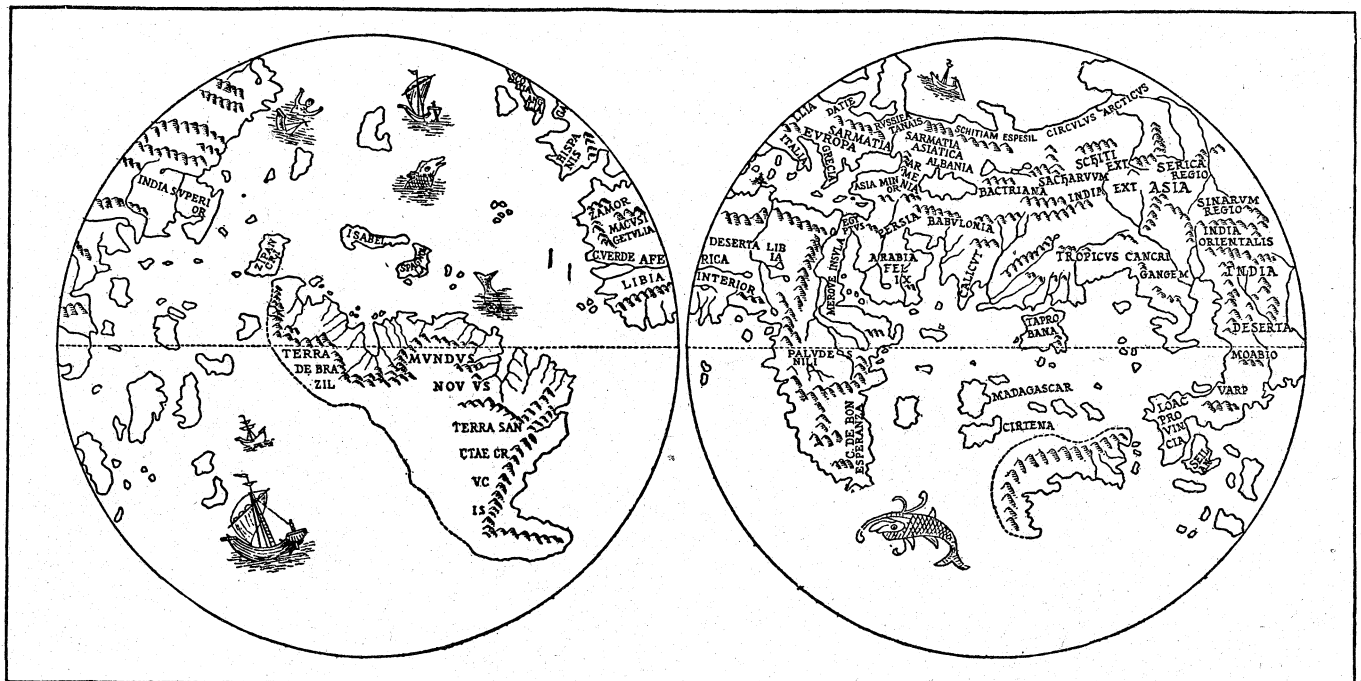


FIG. 10.—LENOX GLOBES (1510)

Lhuyd of Denbigh (d. 1510) furnished maps of the British Isles, Olaus Magnus (1539) of Scandinavia, Anton Wied (1542), Sigismund von Herberstein (1549) and Jenkinson (1562) of Muscovy.

The cylindrical and modified conical projections of Marinus and Ptolemy were still widely used, the stereographical projection of Hipparchus was for the first time employed for terrestrial maps in the 16th century, but new projections were introduced in addition to these. A trapeziform projection with equidistant parallels, by D. Nicolaus Germanus (1466), led to Flamsteed's projection. Joh. Stabius (1502) and his pupil J. Werner (1514) devised three heart-shaped projections, one of which was equal-area. Petrus Apianus (1524) gave his map an elliptical shape. H. Glareanus (1510) first employed an equidistant zenithal polar projection.

No reasonable fault can be found with the marine surveyors of this period, but the scientific cartographers allowed themselves too frequently to be influenced by Ptolemaic traditions. Any cartographer of the period in regions the successful delineation of which depended upon an intelligent interpretation of itineraries, and of information collected by recent travellers, is generally found to fail utterly.

Columbus, trusting to Toscanelli's misleading chart, looked upon the countries discovered by him as belonging to eastern Asia, a view still shared about 1507 by his brother Bartolomeo. Waldseemüller (1507) was the first to separate America and Asia by an ocean of considerable width, but J. Ruysch (1508) returns to the old idea, and even joins Greenland (Gruenlant) to eastern Asia.

Globes, both celestial and terrestrial, were popular after the discovery of America. They were included among the scientific apparatus of ships and of educational establishments. Columbus and Magellan had such globes, those of the latter produced by P. Reinel (1519), and Conrad Celtes tells us that he illustrated his lectures at the University of Vienna with the help of globes (1501). Since 1507, in which year Waldseemüller published a small globe of a diameter of 110mm., covered with printed segments or gores, this cheap and expeditious method has come into general use. Waldseemüller constructed his gores graphically. A. Dürer (1525) and Hen. Loriti Glareanus (1527) were the first who dealt scientifically with the principles of their construction.

Among engraved globes, one of the most interesting is that which was discovered by R. M. Hunt in Paris, and is now in the Lenox Library, New York (fig. 10). Its diameter is only 4½in. (127mm.).

Mercator and His Successors.—Of Gerhard Kremer (1512–94) the earliest works are a map of Palestine (1537), a map of the world on a double heart-shaped projection (1525), and a topographical map of Flanders based upon his own surveys (1540), a pair of globes (1541, diam. 120mm.), and a large map of Europe which has been praised deservedly for its accuracy (1554). He is best known by his marine chart (1569) (fig. 11) and his atlas. The projection of the former may have been suggested by W. Pirkheimer's note in his edition of Ptolemy (1525). Mercator constructed it graphically, the mathematical principles underlying it being first explained by E. Wright (1594). The "Atlas" was only published after Mercator's death, in 1595. It only contained nine maps, but after the plates had been sold to Jodocus (Jesse) Hondius the number of maps was rapidly increased, although Mercator's name was retained. Mercator's maps are carefully engraved on copper. Latin letters are used throughout; the miniatures of older maps are superseded by symbols, and in the better-known countries the maps are fairly correct, but they fail lamentably in regions of imperfect information.

Even before Mercator's death, Antwerp and Amsterdam had become great centres of cartographic activity, and they maintained their pre-eminence until the beginning of the 18th century. Lucas Janszon Waghenaer (Aurigarius) of Enkhuizen published the first edition of his *Spiegel der Zeevaart* (Mariners' Mirror) at Leiden in 1585. It was the first collection of marine maps, lived through many editions, was issued in several languages and became known as *Charettier* and *Waggoner*. Jodocus Hondius was mentioned as purchaser of Mercator's plates. In 1608 Hondius published a map of the world in 12 sheets, on Mercator's projection. Only one copy is known and this is in the possession of the Royal Geographical Society. E. Heawood has written a memoir on this map (1927). The business founded by him about 1602 was continued by his sons, his son-in-law, Jan Janszon (Jansonius) and others. Another map firm was established at Amsterdam in 1612 by Willem Janszon Blaeu (1571–1638), a friend of Tycho Brahe, from 1633 "mapmaker" of the States-General, and a man of scientific culture. He was succeeded by his son Jan (d. 1673) and grandson Cornelius, and before the end of the century turned out a *Zee-Spiegel* of 108 charts (1623).

In France, in the meantime, an arc of the meridian had been measured (1669–70) by Jean Picard, numerous longitudes had been observed between 1672 and 1680 by the same, and by Phil. de Lahire (d. 1719), and these were utilized in a *Carte de France* "as corrected from the observations of the members of the Academy of Sciences" (1666–1699), in a map of the world (1694)

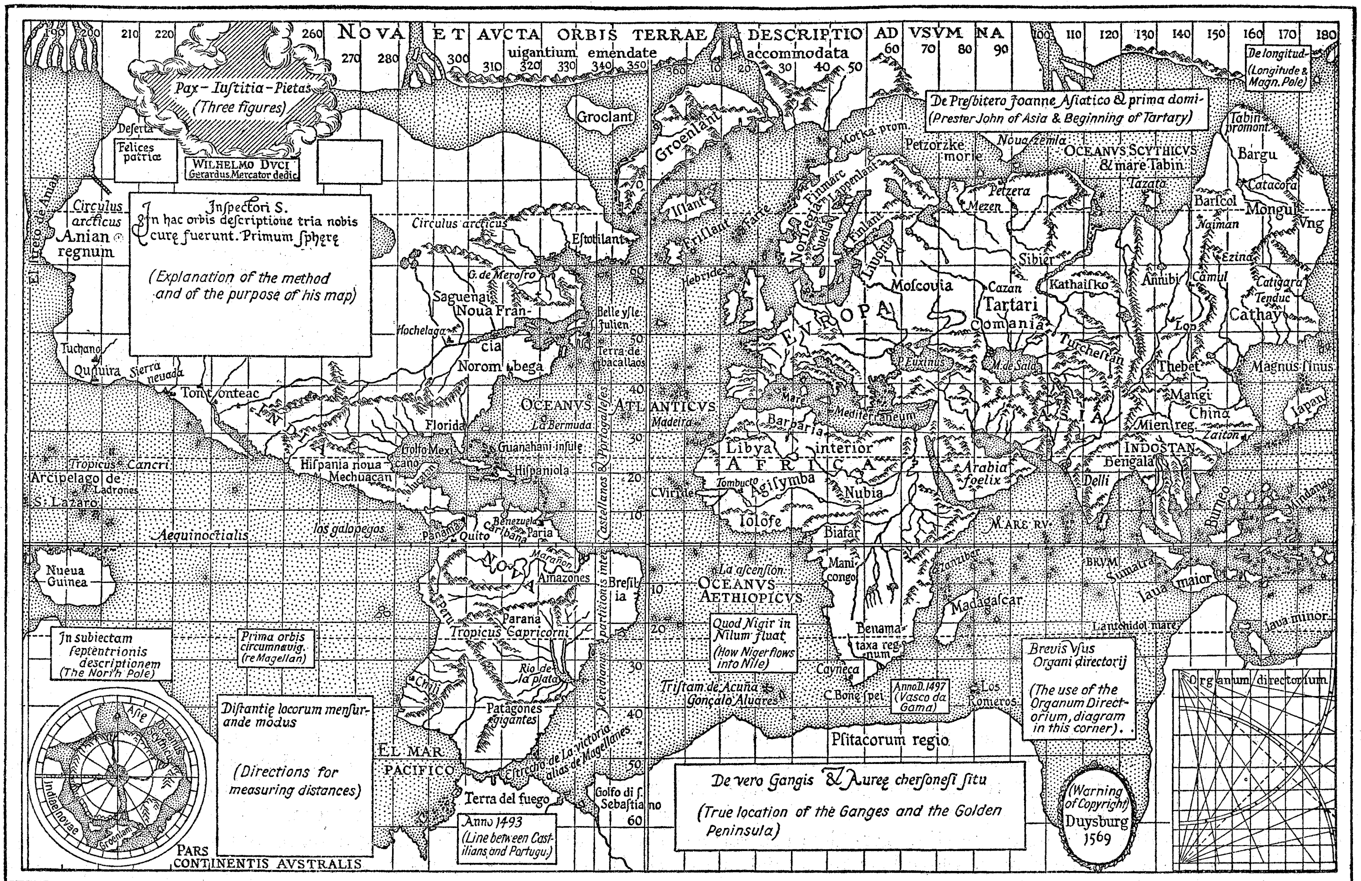


FIG. 11.—MERCATOR'S CHART OF THE WORLD (1569)

by D. Cassini, as also in *Le Neptune François* (1693) with contributions by Pene, D. Cassini and others. These corrected longitudes were not yet available for the maps produced by Nicolas Sanson of Abbeville, since 1627. The cartographical establishment founded by him in that year was carried on after his death in 1667 by his sons, his son-in-law, P. Duval (d. 1683) and his grandson Robert du Vaugondy (d. 1766).

In no other country of Europe was there at the close of the 16th century a geographical establishment capable of competing with the Dutch towns or with Sanson, but the number of those who produced maps, in many instances based upon original surveys, was large.

The first maps illustrating the variation of the compass were published by Chris. Burrus (d. 1632) and Athanasius Kircher (*Magnes,* Rome, 1643), and maps of the ocean and tidal currents by the latter in his *Mundus subterraneus* (1665). Edmund Halley, the astronomer, compiled the first variation chart of scientific value (1683), as also a chart of the winds (1686).

The Eighteenth Century.—It was no mere accident which enabled France to enjoy a pre-eminence in cartographic work during the greater part of the 18th century. Not only had French men of science and scientific travellers done excellent work as explorers in different parts of the world, but France could also boast of two men, Guillaume Delisle and J. B. Bourguignon d'Anville, able to utilize in the compilation of their maps the information they acquired.

Delisle (1675–1726) published 98 maps, and although as works of art they were inferior to the maps of certain contemporaries, they were far superior to them in scientific value. On one of his earliest maps compiled under advice of his father Claude (1700), he gave the Mediterranean its true longitudinal extension of 41°. It was Delisle who assumed the meridian of Ferro, which had been imposed upon French navigators by royal order (1634), to lie exactly 20° to the west of Paris. The work of reform was carried further by B. D'Anville (1697–1782). Altogether he published 211 maps, of which 66 are included in his *Atlas Général* (1737–80); he swept away the fanciful lakes from off the face of Africa, thus forcibly bringing home to us the poverty of our knowledge, delineated the Chinese empire in accordance with the map based on the surveys conducted during the reign of the emperor Kanghi, with the aid of Jesuit missionaries, and published in 1718; boldly refused to believe in the existence of an Antarctic continent covering half the southern hemisphere, and always brought a sound judgment to bear upon the materials which the ever-increasing number of travellers placed at his disposal. Among other French works of importance deserving notice are *Le Neptune oriental* of Mannevillette (1745) and more especially the *Carte géometrique de la France,* which is based upon surveys carried on (1744–83) by César François Cassini de Thury and his son Dominique de Cassini. It is on a transversal cylindrical (rectangular) projection devised by Jacques Cassini (d. 1746). The hills are shown in rough hachures.

England, which had entered upon a career of naval conquest and scientific exploration, had reason to be proud of J. F. W. Desbarres, *Atlantic Neptune* (1774), a North American pilot (1779), who first made known the naval surveys of Capt. Cook and of others; and Tho. Jefferys's *West Indian* and *American Atlases* (1775, 1778). James Rennell (1742–1830), who was surveyor-general of Bengal, published the *Bengal Atlas* (1781). Aaron Arrowsmith, who came to London in 1778, and his successors constitute the glory of the older school of cartographers. His nephew John died in 1873.

In Germany J. B. Homann (d. 1724) founded a geographical establishment in 1702, which depended at first upon copies of British and French maps, but in course of time published also original maps such as J. M. Hase's *Africa* (1727) and Tobias Meyer's *Mappa critica* of Germany (1780), J. T. Güssfeld's map of Brandenburg (1773), John Majer's Württemburg (1710) and J. C. Müller's Bavaria, both based on trigonometrical surveys. Col. Schmettau's excellent survey of the country to the west of the Weser (1767–87) was never published. Switzerland and other European states were worthily represented. Charts illustrating the variation of the compass and of magnetic "dip" were published by E. Dunn (1776) and J. C. Wiffe (1768). Map projections were dealt with by two eminent mathematicians, J. H. Lambert (1772) and Leonh. Euler (1777).

On the maps of Delisle and d'Anville the ground is still represented by "molehills." Hachures of a rude nature first made their appearance on David Vivier's map of the environs of Paris (1674), and on Cassini's *Carte de la France*. Contour lines (isobaths) were introduced for the first time on a chart of the Merwede by M. S. Cruquius (1728), and on a chart of the English Channel by Phil. Buache (1737). J. G. Lehmann (1783) based his hill-shading or hachuring upon these horizontal contours.

Modern Cartography.—The compiler of maps of the present day enjoys many advantages not enjoyed by men similarly occupied a hundred years ago. Topographical surveys are gradually extending, explorers are better trained for their work, and mere outline maps, such as formerly satisfied the public, suffice no longer.

As to atlases, from the middle to the end of the 19th century Germany might be considered as the headquarters of scientific cartography. This was due as much to the inspiriting teachings of Ritter and Humboldt as to the culture and scientific training combined with technical skill commanded by men who devote themselves to this branch of geography. H. Berghaus (1797–1884), H. Kiepert (1818–99) and A. Petermann (1822–78) must occupy a foremost place in the history of cartography. Among the geographical establishments of Germany, that founded by Justus Perthes (1785), at Gotha, occupies the highest rank. To it we are indebted for Petermann's *Mitteilungen*, started in 1855 by A. Petermann. Among other geographical institutes in Germany which deserve mention are the Weimar Institut, founded in 1791; Paul Fleming at Glogau, A. Ravenstein at Frankfort, D. Reimer at Berlin (H. Kiepert, *Handatlas*, 1860); R. Andree (*Hand-Atlas*, 1880) and E. Debes (*Hand-Atlas*, 1894) in Leipzig, and E. Hölzer in Vienna (Vincenz von Haardt's maps).

France is represented by the publishing firms of Ch. Delagrave (Levaseur's maps), Hachette (F. Schrader's *Atlas de géographie moderne*, 1880), and Armand Colin (Vidal de la Blache's *Atlas général*, 1894).

In Great Britain, A. Arrowsmith established himself in London in 1770 (*General Atlas*, 1817), but the cartographical business ceased on the death of John Arrowsmith in 1873. John Cary (1754–1835) produced a very large number of plans, road maps, maps and itineraries. His work is important in the history of British cartography. (*John Cary*, Cambridge University Press, 1925). To John Walker the charts published by the Admiralty were indebted for the perspicuous, firm and yet artistic execution which facilitated their use by the mariner. Among later firms are W. and A. K. Johnston (founded 1825; *Royal Atlas*, 1855); J. Bartholomew, whose publications have had a great effect in popularizing *hypsometrically* coloured maps; Philip and Sons; and E. Stanford.

Amongst recent Continental publications the magnificent *Atlante Internazionale del Touring Club Italiano*, Milan, 1927, deserves mention.

Bibliography.—The history of maps is dealt with ably in Vivien de Saint Martin's *Histoire de la géographie* (Paris, 1875), and in Peschel's *Geschichte der Erdkunde* (2nd ed., Sophus Ruge, Berlin, 1877), as also by W. Wollkenhauer (*Leitfaden zur Geschichte der Kartographie*, Breslau, 1895), and H. Zondervan (*Allgemeine Kartenkunde*, Leipzig, 1901). There are a number of works, beautifully illustrated, which deal fully with particular periods of the subject. Among these may be mentioned Konrad Miller's *Die ältesten Weltkarten* (Stuttgart, 1895–97). The contents of the following collections are more varied in their nature, viz., E. F. Jomard's *Monuments de la géographie* (Paris, 1862), Santarem's *Atlas composé de mappemondes et de portulans*, etc. (Paris, 1842–53, 78 plates), A. E. Nordenskiöld's *Facsimile Atlas* (Stockholm, 1889), Gabriel Marcell, *Choix de cartes et de mappemondes XIV^{e} et XV^{e} siècles* (Paris, 1896), C. H. Coote's *Remarkable Maps of the XVth, XVIth and XVIIth Centuries reproduced in their Original Size* (Amsterdam, 1894–97), and *Bibliotheca lindesiana* (London, 1898) with facsimiles of the Harleian and other Dieppese maps of the 16th century. Nautical charts are dealt with in A. E. Nordenskiöld's *Periplus* (Stockholm, 1869), and Th. Fischer's *Sammlung mittelälterlicher Welt- und Seekarten* (Vienna, 1886). The discovery and mapping of America are illustrated by F. Kunstmann's *Entdeckung Amerikas* (Munich, 1859), K. Kretschmer's *Atlas zur Entdeckung Amerikas* (Berlin, 1892), G. Marcel's *Reproductions de cartes et de globes relatives à la découverte de l'Amerique du XVI^{e} au XVIII^{e} siècle* (Paris, 1893) and E. L. Stevenson's *Maps Illustrating the early Discovery and Exploration of America, 1502–1530* (New Brunswick, N.J., 1906). An important guide to the subject of British cartography is Sir G. Fordham's *Hand-List of Catalogues and Works of Reference relating to Carto-bibliography for Great Britain and Ireland*, Camb. Univ. Press (1928). (E. G. R.; C. F. A. C.)

MODERN MAPS

From the middle of the 18th century to the early part of the 19th was a period which witnessed the beginning of regular topographical surveys in many countries. Thus, in France, Cassini de Thury commenced the first regular topographical map in 1744. The scale of this map was 1:86,400. In 1817 the *Carte de France de l'état major,* on the scale of 1:80,000, was begun, but this was not finished until 1880. These were both engraved on copper.

In Great Britain the Ordnance Survey was founded in 1791; its original purpose was the construction of a map on the scale of 1in. to 1m., or 1:63,360. The survey of Ireland on the scale of 6in. to 1m. was commenced in 1825. Great Britain and Ireland have been mapped on the scale of 1:2,500, or about 25in. to 1m., excepting only waste and mountainous areas. Both the large-scale maps and the small-scale maps of Great Britain (1in., $\frac{1}{2}$in. and $\frac{1}{4}$in. to the mile), are revised periodically.

By the middle of the 19th century topographical maps of the various German States were complete. The Austrian 1:75,000 series was completed in 1889. The famous map of Switzerland, with which is associated the name of Gen. Dufour, was finished in 1865; it is on the scale of 1:100,000. Generally speaking, we may say that during the 19th century all European States except Russia had completed their small-scale mapping, and the sheets were, as a rule, printed from engraved copper plates. In India, Maj. James Rennell commenced the first reliable surveys of Bengal in 1764, and the Survey of India has, since that date, continued to map the Indian empire.

The scales adopted by the United States Geological Survey, which carries out the topographical mapping, are 1:62,500, 1:125,000 and 1:250,000. The continent of Africa is slowly being surveyed on topographical scales, the early topographical surveys being mainly those along the international boundaries, needed for the partition of Africa, which began in 1884.

International Map of the World.—The official title of this international undertaking is *Carte du Monde au Millionième,* and references to it will generally be found under this title. It owes its origin to the initiative of Prof. A. Penck, who put forward the project of a map of the world on a uniform scale at the Geographical Congress held at Berne in 1891. The scale proposed was one-millionth of nature, equivalent to 1km. to 1 millimetre. The scheme and the scale were accepted by the congress, and an international, but unofficial, committee was appointed for the purpose of prosecuting the idea. This committee reported to successive Geographical Congresses held in London in 1895, in Berlin in 1899 and in Washington in 1904, but slight progress was made.

An important step was, however, taken at the Geographical Congress held at Geneva in 1908. At this congress the delegates of the United States made a proposal for the definite standardization of the map and for the drawing-up of fixed rules to govern its production. The geographical section of the British general staff took up the subject and an official conference was effected.

In Nov. 1909 the official conference assembled at the Foreign Office in London. The conference came to unanimous conclusions, and an account of it was published in a report issued by the British Government.

At the Geographical Congress at Rome in 1913 the scheme as formulated in London was accepted generally, but there was a feeling that a more comprehensive official conference was needed in order to put the matter before those countries not hitherto represented officially. An official conference was accordingly held in Paris in Dec. 1913. Thirty-four States sent representatives, and a very thorough examination was made of the London resolutions. In the main they were accepted, and the modifications made were of detail only. The *Carte du Monde au Millionième* is now a world undertaking on lines accepted by practically all civilized countries.

The Paris Conference approved the establishment of a *"bureau permanent,"* comprising a central office at the headquarters of the Ordnance Survey at Southampton, with a branch office at the Royal Geographical Society.

A third Conference was held in London in July, 1928, to decide some points of detail which had arisen since 1913. These were settled unanimously.

MAPS FOR WAR PURPOSES

The Paris Conference concluded on Dec. 18, 1913, but the report was not published when war broke out early in Aug. 1914. The effect of the war on the scheme was twofold. First, it resulted in the immediate cessation of all work on the map so far as the belligerent countries were concerned; but in the second place it led to a demand for maps on, or about, the one-to-a-million scale. In England and France much official cartography was carried out on the million scale. A large series of maps, the initiative of the general staff, were compiled by the Royal Geographical Society.

This important series comprises 90 maps extending from the Persian gulf to the Arctic ocean, and from the western shores of Ireland to beyond the Caspian sea.

The trench warfare of 1914–18 in France and Belgium created a demand for maps on a larger scale than had hitherto been in general use by great armies, and large-scale maps became indispensable for the operations of trench warfare, particularly in connection with the use of artillery. Eventually all the maps of the western front were redrawn from special surveys, the chief scale being 1:20,000.

Bibliography.—Modern Maps: A. R. Hinks, *Maps and Survey* (Cambridge, 1923); C. F. Close and H. Winterbotham, *Text Book of Topographical Surveying* (Stationery Office, London, 1925). A Description of the Large Scale Maps, Ordnance Survey, *idem* for Small Scales; Col. Berthaut, *La Carte de France* 1750–1898, Service Géographique de l'armée; *Catalogue of Maps published by the Geographical Section (British) General Staff* (London); *Carte du Monde au Millionième,* Comptes Rendus des Séances de la Deuxième Conférence Internationale, Service Géographique de l'armée (Paris, 1914). On the reading of maps, particularly the natural features, see *The Interpretation of Topographic Maps,* by R. D. Salisbury and W. W. Atwood, U.S. Geological Survey (Washington, 1908). (C. F. Cl.)

MAP PROJECTIONS

In the construction of maps, one finds the sphere cannot be opened out into a plane like the cone or cylinder; consequently in a plane representation of configurations on a sphere it is impossible to retain throughout the proportions of lines or areas or equality of angles, though we may have in the representation similarity to all very small portions of the original, but at the expense of the areas, which will be quite misrepresented; or we may retain equality of areas if we give up the idea of similarity. A globe of ordinary dimensions serves scarcely any other purpose than to convey a clear conception of the earth's surface as a whole. For this purpose it is absolutely essential. The construction of a map resolves itself into the drawing of two sets of lines, one set to represent meridians, the other to represent parallels.

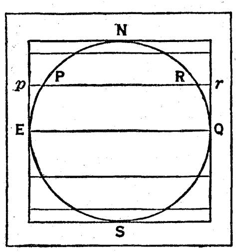


FIG. 12

Cylindrical Equal Area Projection.—Let us suppose a model of the earth to be enveloped by a cylinder in such a way that the cylinder touches the equator, and let the plane of each parallel such as PR be prolonged to intersect the cylinder in the circle *pr* (fig. 12). Now unroll the cylinder and the projection will appear as in fig. 13. The whole world is now represented as a rectangle, each parallel is a straight line, and its total length is the same as that of the equator, the distance of each parallel from the equator is sin l (where l is the latitude and the radius of the model earth is taken as unity). The meridians are parallel straight lines spaced at equal distances.

This projection possesses an important property: each strip of the projection is *equal in area* to the zone on the model which it represents, and that each portion of a strip is equal in area to the corresponding portion of a zone. Any figure, of any shape on the model, is correctly represented as regards area by its corresponding figure on the projection. This is "the cylindrical equal-area projection." It is clear that in this case all meridian lengths are too small and all lengths along the parallels, except the equator, are too large; thus although the areas are preserved the shapes are, especially away from the equator, much distorted. The property of preserving areas is, however, a valuable one when the purpose of the map is to exhibit areas. Mercator's projection commonly used in atlases, preserves local shape at the expense of area.

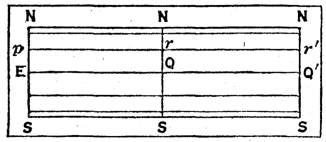


FIG. 13

PERSPECTIVE PROJECTIONS

In perspective drawings of the sphere, the plane on which the representation is actually made may generally be any plane perpendicular to the line joining the centre of the sphere and the point of vision. If V be the point of vision, P any point on the spherical surface, then *p,* the point in which the straight line VP intersects the plane of the representation, is the projection of P.

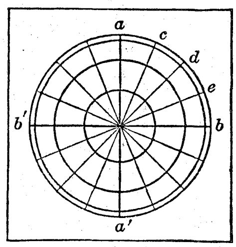


FIG. 14

Orthographic Projection.—In this projection the point of vision is at an infinite distance and the rays consequently parallel; in this case the plane of the drawing may be supposed to pass through the centre of the sphere. Let the circle (fig. 14) represent the plane of the equator on which we propose to make an orthographic representation of meridians and parallels. The centre of this circle is clearly the projection of the pole, and the parallels are projected into circles having the pole for a common centre. The diameters *aa′*, *bb′* being at right angles, let the semicircle *bab′*, be divided into the required number of equal parts; the diameters drawn through these points are the projections of meridians. It is clear that, when the points of division are very close, the parallels will be very much crowded towards the outside of the map; so much so, that this projection is not much used.

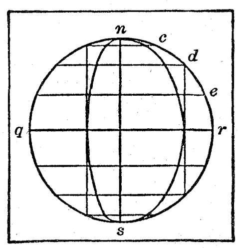


FIG. 15

For an orthographic projection of the globe on a meridian plane let *qnrs* (fig. 15) be the meridian, *ns* the axis of rotation, then *qr* is the projection of the equator. The parallels will be represented by straight lines passing through the points of equal division; these lines are, like the equator, perpendicular to *ns*. The meridians will in this case be ellipses described on *ns* as a common major axis, the distances of *c*, of *d* and of *e* from *ns* being the minor semiaxes.

Fig. 16 shows an orthographic projection of the sphere on the horizon of any place.

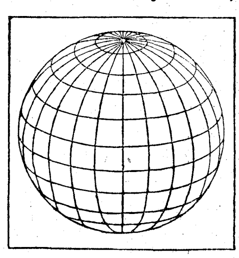


FIG. 16

Stereographic Projection.—In this case the point of vision is on the surface, and the projection is made on the plane of the great circle whose pole is V. Let *kpl*V (fig. 17) be a great circle through the point of vision, and *ors* the trace of the plane of projection. Let *c* be the centre of a small circle whose radius is $cp = cl$.

Since the representation of every infinitely small circle on the surface is itself a circle, it follows that in this projection the representation of small parts is strictly similar. Another inference is that the angle in which two lines on the sphere intersect is represented by the same angle in the projection. In this projection the angles are correctly represented and every small triangle is represented by a similar triangle. Projections having this property are called *orthomorphic* or *conformable.*

External Perspective Projection.—We now come to the general case in which the point of vision has any position outside the sphere. Let *abcd* (fig. 19) be the great circle section of the sphere by a plane passing through *c*, the central point of the portion of surface to be represented, and *V* the point of vision. Let *pj* perpendicular to *Vc* be the plane of representation, join *mV* cutting *pj* in *f*, then *f* is the projection of any point *m* in the circle *abc*, and *ef* is the representation of *cm* (see *Phil. Mag.* 1862).

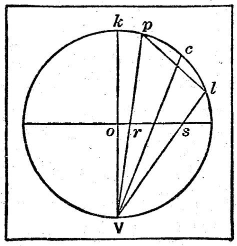


FIG. 17

Clarke's Projection.—The constants *h* and *k* can be determined, so that the total misrepresentation, viz.:

$$M=\int_0^\beta \{(\sigma-1)^2+(\sigma'-1)^2\}\sin u\,du,$$

shall be a minimum, β being the greatest value of *u*, or the spherical radius of the map. Fig. 20 is a map of Asia having the meridians and parallels laid down on this system.

Central or Gnomonic (Perspective) Projection.—In this projection the eye is imagined to be at the centre of the sphere. It is evident that, since the planes of all great circles of the sphere

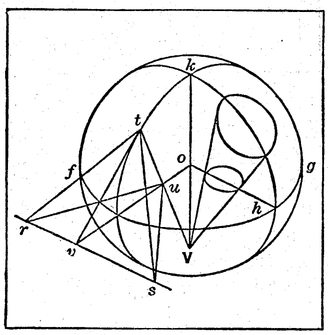


FIG. 18

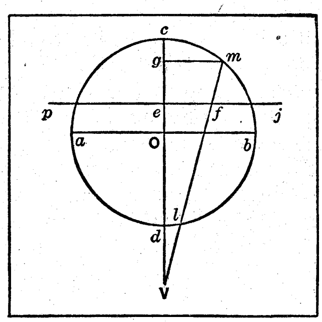


FIG. 19

pass through the centre, the representations of all great circles on this projection will be straight lines, and this is the special property of the *central projection*, that any great circle (*i.e.*, short-

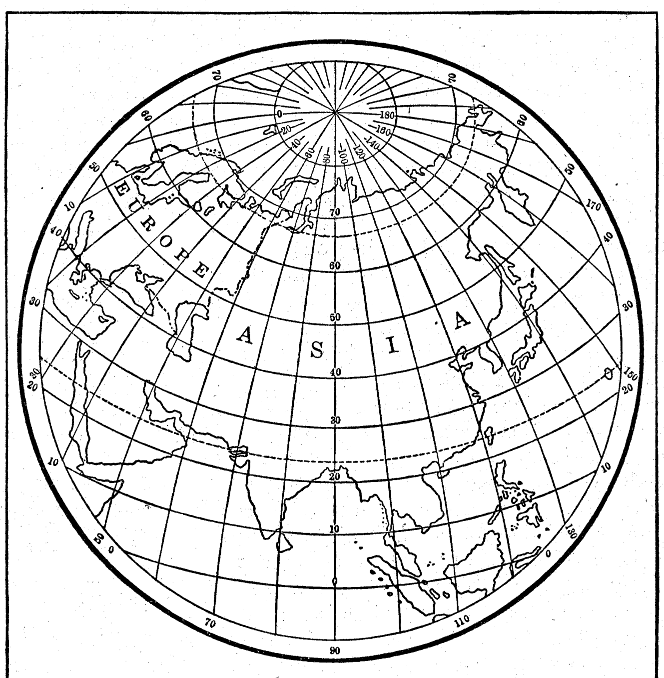


FIG. 20

est line on the spherical surface) is represented by a straight line. The plane of projection may be either parallel to the plane of the equator, in which case the parallels are represented by concentric circles and the meridians by straight lines radiating from the common centre; it may be parallel to the plane of some meridian, the meridians being parallel straight lines and the parallels hyperbolas; or it may be inclined to the axis of the sphere at any angle λ, in which case the central meridian is a straight line at right angles to the equator, which is also a straight line (fig. 10). These three varieties of the central projection are known as polar, meridian or horizontal.

Fig. 22 is an example of a *meridian central projection* of part of the Atlantic ocean. The term *gnomonic* was applied to this projection because the projection of the meridians is a similar problem to that of the graduation of a sun-dial. The gnomonic projection is useful for the study of direct routes by sea and land. The United States hydrographic department has published some charts on this projection. False notions of the direction of shortest lines, which are engendered by a study of maps on Mercator's projection, may be corrected by an inspection of maps drawn on the central projection.

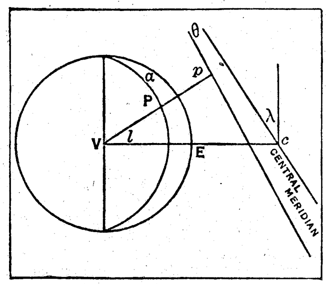
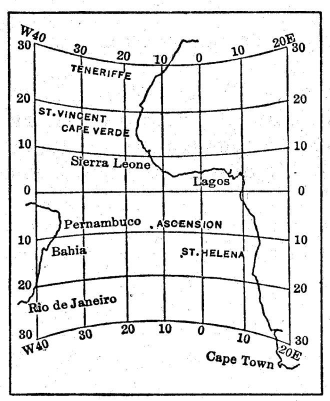


FIG. 21



TEXTBOOK OF TOPOGRAPHICAL SURVEYING BY PERMISSION OF THE CONTROLLER OF H. M. STATIONERY OFFICE
FIG. 22

Until 1922 it was thought that the gnomonic was the only projection which showed the great circles as straight lines, but H. Maurer has shown that, if the projection be compressed uniformly in any direction, the great circles will still be represented as straight lines. He calls this new projection *orthodromic.*

Moreover, there are two points in this projection which have the property that azimuths from them to any other points are correct. This gives a means for plotting ships' positions from bearings sent by wireless from two points (*see Zeitschrift für Vermessungswesen,* 1922.

CONICAL PROJECTIONS

Conical projections are those in which the parallels are represented by concentric circles and the meridians by equally spaced radii. There is no necessary connection between a conical projection and any touching or secant cone. Projections which are derived by geometrical construction from secant cones exhibit large errors, and will not be discussed.

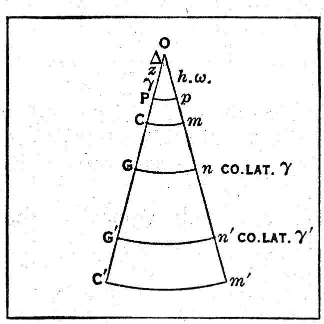


FIG. 23

Conical Projection with Rectified Meridians and Two Standard Parallels.—In some books this has been termed the "secant conical," the use of which term has caused much confusion. Two selected parallels are represented by concentric circular arcs of their true lengths; the meridians are their radii. The degrees along the meridians are represented by their true lengths; and the other parallels are circular arcs through points so determined and are concentric with the chosen parallels.

Thus in fig. 23 two parallels *Gn* and *G'n'* are represented by their true lengths on the sphere; all the distances along the meridians *PGG'*, *pnn'* are the true spherical lengths rectified. Let γ be the co-latitude of *Gn*; γ' that of *Gn'*; ω be the true difference of longitude of *PGG'* and *pnn'*; $h\omega$ be the angle at *O*; and $OP=z$, where *Pp* is the representation of the pole. Then the true length of parallel *Gn* on the sphere is $\omega \sin \gamma$, and this is equal to the length on the projection. The radius of the sphere is assumed to be unity, and z and γ are expressed in circular measure, hence h and z are easily found. It has been assumed that the two errorless parallels have been *selected*, but it is usually desirable to impose some condition which itself will fix the errorless parallels. In fig. 23 let Cm and $C'm'$ represent the extreme parallels of the map, and let the co-latitudes of these parallels be c and c', then any one of the following conditions may be fulfilled:

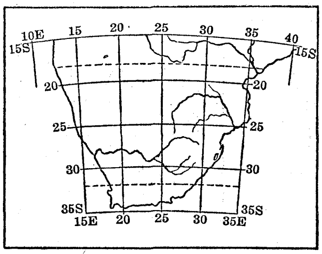


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FIG. 24

(a) The errors of scale of the extreme parallels may be made equal and may be equated to the error of scale of the parallel of maximum error (which is near the mean parallel). This class of projection is accurate, simple and useful.

(b) Or the errors of scale of the extreme parallels may be equated to that of the mean parallel.

(c) Or the absolute errors of the extreme and mean parallels may be equated.

(d) Or in the last the parallel of maximum error may be considered instead of the mean parallel.

(e) Or the mean length of all the parallels may be made correct. This is equivalent to making the total area between the extreme parallels correct, and must be combined with another condition, for example, that the errors of scale on the extreme parallels shall be equal.

Simple Conical Projection.—If in the last group of projections the two selected parallels which are to be errorless approach each other, we get a projection in which all the meridians are of the true rectified lengths and in which one parallel is errorless, the curvature of that parallel being clearly that which would result from the unrolling of a cone touching the sphere along the parallel represented.

Imagine a cone to touch the sphere along any selected parallel, the radius of this parallel on paper (Pp, fig. 25) will be $r \cot \phi$, where r is the radius of the sphere and ϕ is the latitude; or if the spheroidal shape is taken into account, the radius of the parallel on paper will be $\nu \cot \phi$ where ν is the normal terminated by the minor axis (the value ν can be found from ordinary geodetic tables). The meridians are generators of the cone and every parallel such as HH' is a circle, concentric with the selected parallel Pp and distant from it the true rectified length of the meridian arc between them.

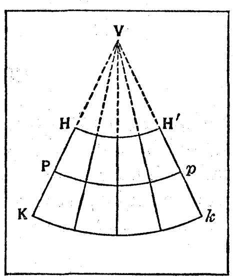

FIG. 25

The errors of scale along the parallels increase rapidly as the selected parallel is departed from, the parallels on paper being always too large. The projection has no merits as compared with the group just described.

Bonne's Projection is derived from the simple conical in the following way: a central meridian is chosen and drawn as a straight line; degrees of latitude spaced at the true rectified distances are marked along this line; the parallels are concentric circular arcs drawn through the proper points on the central meridian, the centre of the arcs being fixed by describing one chosen parallel with a radius of $\nu \cot \phi$; the meridians on each side of the central meridian are drawn through distances at the true lengths along the parallels on sphere or spheroid (fig. 26).

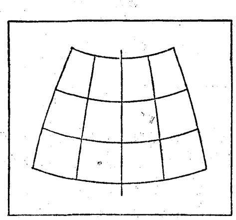

FIG. 26

This system is ill-adapted for countries having great extent in longitude. Where an equal-area projection is required for a country such as France, Scotland or Madagascar, this projection is a good one.

Sinusoidal Equal-area Projection, sometimes known as Sanson's and sometimes incorrectly called Flamsteed's, is a particular case of Bonne's in which the selected parallel is the equator. It is a very suitable projection for an equal-area map of Africa (fig. 27).

POLYCONIC PROJECTIONS

These pseudo-conical projections are valuable not so much for their intrinsic merits as for the fact that they lend themselves to tabulation. There are two forms, the *simple* or *equidistant polyconic*, and the *rectangular polyconic*.

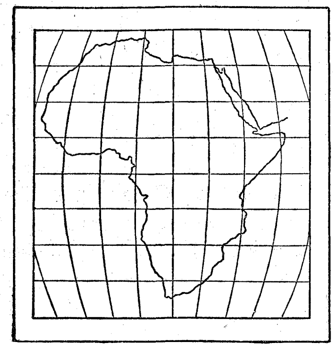

FIG. 27

The Simple Polyconic.—If a cone touches the sphere or spheroid along a parallel of latitude ϕ and is then unrolled, the parallel will on paper have a radius of $\nu \cot \phi$, where ν is the normal terminated by the minor axis. If we imagine a series of cones, each of which touches one of a selected series of parallels, the apex of each cone will lie on the prolonged axis of the spheroid; the generators of each cone lie in meridian planes, and if each cone is unrolled and the generators in any one plane are superposed to form a straight central meridian, we obtain a projection in which the central meridian is a straight line and the parallels are circular arcs each of which has a different centre which lies on the prolongation of the central meridian, the radius of any parallel being $\nu \cot \phi$.

So far the construction is the same for both forms of polyconic. In the *simple polyconic* the meridians are obtained by measuring outwards from the central meridian along each parallel the true lengths of the degrees of longitude. Through corresponding points so found the meridian curves are drawn. The resulting projection is accurate near the central meridian, but, as this is departed from, the parallels increasingly separate from each other, and the parallels and meridians (except along the equator) intersect at angles which increasingly differ from a right angle. The real merit of the projection is that each particular parallel has for every map the same absolute radius, and it is thus easy to construct tables which shall be of universal use. The simple polyconic when used for single sheets and large scales is a sufficiently close approximation to the better forms of conical projection.

Rectangular Polyconic.—In this the central meridian and the parallels are drawn as in the simple polyconic, but the meridians are curves which cut the parallels at right angles.

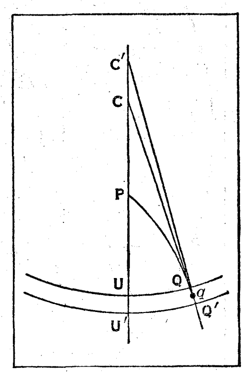

FIG. 28

Let P (fig. 28) be the north pole, CPU the central meridian, U, U' points in that meridian whose co-latitudes are z and $z+dz$. Make $PU=z$, $UC=\tan z$, $U'C'=\tan (z+dz)$; and with CC' as centres describe the arcs UQ, $U'Q'$, which represent the parallels of co-latitude z and $z+dz$. Let PQQ' be part of a meridian curve cutting the parallels at right angles. Join CQ, $C'Q'$; these will be tangents to the curve. Let $UCQ=2\alpha$, $UC'Q'=2(\alpha+d\alpha)$, then the angle between the tangents at QQ', will $=2d\alpha$. Now

$$CC'=\tan (z+dz)-\tan z-dz=\tan^2 z dz.$$

The tangents CQ, CQ' will intersect at q, and in the triangle $CC'q$ the perpendicular from C on $C'q$ is (omitting small quantities of the second order) equal to either side of the equation

$$\tan^2 z dz \sin 2\alpha = -2 \tan z d\alpha.$$
$$-\tan z dz = 2d\alpha / \sin 2\alpha,$$

which is the differential equation of the meridian: the integral is $\tan\alpha = \omega\cos z$, where ω, a constant, determines a particular meridian curve. The distance of Q from the central meridian, $\tan z \sin 2\alpha$, is equal to

$$\frac{2\tan z \tan\alpha}{1+\tan^2\alpha} = \frac{2\omega\sin z}{1+\omega^2\cos^2 z}$$

At the equator this becomes simply 2ω. Let any equatorial point whose actual longitude is 2ω be represented by a point on the developed equator at the distance 2ω from the central meridian, then we have the very simple construction (due to O'Farrell of the Ordnance Survey) (fig. 29).

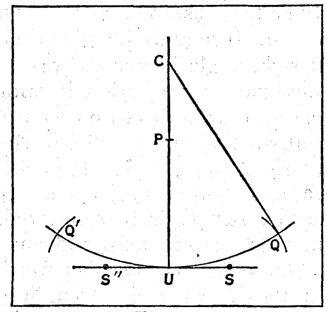

FIG. 29

ZENITHAL PROJECTIONS

Some point on the earth is selected as the central point of the map; great circles radiating from this point are represented by straight lines which are inclined at their true angles at the point of intersection. Distances along the radiating lines vary according to any law outwards from the centre. It follows (on the spherical assumption), that circles of which the selected point is the centre are also circles on the projection. It is obvious that all perspective projections are zenithal.

Equidistant Zenithal Projection.—In this projection, which is commonly called the "equidistant projection," any point on the sphere being taken as the centre of the map, great circles through this point are represented by straight lines of the true rectified lengths, and intersect each other at the true angles.

If z_1 is the co-latitude of the centre of the map, z the co-latitude of any other point, α the difference of longitude of the two points, A the azimuth of the line joining them, and c the spherical length of the line joining them, then the position of the intersection of any meridian with any parallel is given (on the spherical assumption) by the solution of a simple spherical triangle. Thus, let $\tan\theta = \tan z \cos\alpha$, then $\cos c = \cos z \sec\theta \cos(z-\theta)$, and $\sin A = \sin z \sin\alpha \operatorname{cosec} c$.

The most useful case is that in which the central point is the pole; the meridians are straight lines inclined to each other at the true angular differences of longitude, and the parallels are equidistant circles with the pole as centre. This is the best projection to use for maps exhibiting the progress of polar discovery, and is called the *polar equidistant projection*. The errors are smaller than might be supposed. There are no scale errors along the meridians, and along the parallels the scale error is $(z/\sin z) - 1$.

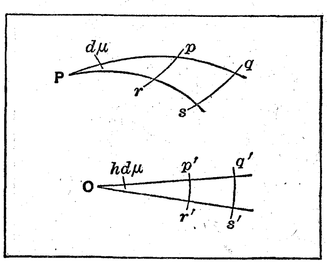

FIG. 30

General Theory of Zenithal Projections.—For the sake of simplicity it will be at first assumed that the pole is the centre of the map, and that the earth is a sphere. The meridians are now straight lines diverging from the pole, and the parallels are represented by circles having the pole as centre, the radius of the parallel whose co-latitude is z being ρ, a function of z determining the nature of the projection.

Let Ppq, Prs (fig. 30) be two contiguous meridians crossed by parallels rp, sq, and $Op'q'$, $Or's'$ the straight lines representing these meridians. If the angle at P is $d\mu$, this also is the value of the angle at O. Let

$$Pp = z,\ Pq = z+dz;\ Op' = \rho,\ Oq' = \rho+d\rho,$$

the circular arcs $p'r'$, $q's'$ representing the parallels pr, qs. If the radius of the sphere be unity,

$$p'q' = d\rho;\quad p'r' = \rho\,d\mu,$$
$$pq = dz;\quad pr = \sin z\,d\mu.$$

Put $\sigma = d\rho/dz$; $\sigma' = \rho/\sin z$,

then $p'q' = \sigma pq$ and $p'r' = \sigma' pr$. That is to say, σ, σ' may be regarded as the relative scales, at co-latitude z, of the representation, σ applying to meridional measurements, σ' to measurements perpendicular to the meridian. A small square situated in co-latitude z, having one side in the direction of the meridian—the length of its side being i—is represented by a rectangle whose sides are $i\sigma$ and $i\sigma'$; its area consequently is $i^2\sigma\sigma'$. If it were possible to make a perfect representation, then we should have $\sigma = 1$, $\sigma' = 1$ throughout. This, however, is impossible.

We may make $\sigma = 1$ throughout by taking $\rho = z$. This is the *Equidistant Projection*, a very simple and effective method of representation.

If we make $\sigma' = 1$ throughout this gives $\rho = \sin z$, a perspective projection, namely, the *Orthographic*.

We may require that areas be strictly represented in the development. This will be effected by making $\sigma\sigma' = 1$, or $\rho\,d\rho = \sin z\,dz$, the integral of which is $\rho = 2\sin\frac{1}{2}z$, which is the *Zenithal Equal-area Projection* of Lambert, sometimes wrongly referred to as *Lorgna's Projection* after Antonio Lorgna (b. 1736). In this system there is misrepresentation of form, but no misrepresentation of areas.

We may require a projection in which all small parts are to be represented in their true forms, *i.e.*, an orthomorphic projection. This condition will be attained by making $\sigma = \sigma'$, or $d\rho/\rho = dz/\sin z$, the integral of which is, c being an arbitrary constant, $\rho = c\tan\frac{1}{2}z$. This, again, is a perspective projection, namely, the *Stereographic*. In this the *whole* is not a similar representation of the original. The scale, $\sigma = \frac{1}{2}c\sec^2\frac{1}{2}z$, at any point, applies to all directions round that point.

These two last projections are, as it were, at the extremes of the scale. We may avoid both extremes by the following considerations. Although we cannot make $\sigma = 1$ and $\sigma' = 1$, so as to have a perfect picture of the spherical surface, yet considering $\sigma - 1$ and $\sigma' - 1$ as the local errors of the representation, we may make $(\sigma-1)^2 + (\sigma'-1)^2$ a minimum over the whole surface to be represented. This projection, known as the *Projection by Balance of Errors*, is due to Sir George Airy (*q.v.*). Airy's investigation was corrected by Clarke (*Phil. Mag.* 1862), and A. E. Young has extended the principle to the conical class generally (see *Some Investigations in the Theory of Map Projections*, 1920).

GENERAL THEORY OF CONICAL PROJECTIONS

Meridians are represented by straight lines drawn through a point, and a difference of longitude ω is represented by an angle $h\omega$. The parallels of latitude are circular arcs, all having as centre the point of divergence of the meridian lines.

Let z be the co-latitude of a parallel, and ρ, a function of z, the radius of the circle representing this parallel. Consider the infinitely small space on the sphere contained by two consecutive meridians, the difference of whose longitude is $d\mu$, and two consecutive parallels whose co-latitudes are z and $z+dz$ (fig. 31). The sides of this rectangle are $pq = dz$, $pr = \sin z\,d\mu$; in the projection $p'q'r's'$ these become $p'q' = d\rho$, and $p'r' = \rho h\,d\mu$.

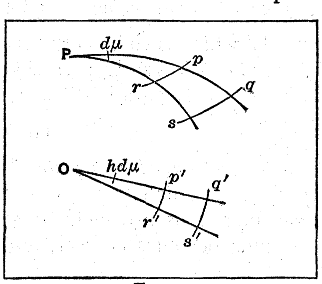

FIG. 31

The scales of the projection as compared with the sphere are $p'q'/pq = d\rho/dz =$ the scale of meridian measurements $= \sigma$, say, and $p'r'/pr = \rho h\,d\mu/\sin z\,d\mu = \rho h/\sin z =$ scale of measurements perpendicular to the meridian $= \sigma'$, say.

Now we may make $\sigma = 1$ throughout, then $\rho = z + \text{const}$. This gives either the group of *conical projections with rectified meridians*, or as a particular case the *equidistant zenithal*.

We may make $\sigma = \sigma'$ throughout, which is the same as requiring that at any point the scale shall be the same in all directions. This gives a group of *orthomorphic projections*.

In this case $d\rho/dz=\rho h/\sin z$, or $d\rho/\rho=hdz/\sin z$.

Integrating, $$\rho=k(\tan\tfrac{1}{2}z)^h, \qquad \text{(i.)}$$

where k is a constant.

Now h is at our disposal and we may give it such a value that two selected parallels are of the correct lengths. Let z_1, z_2 be the co-latitudes of these parallels, then it can be shown that

$$h=\frac{\log\sin z_1-\log\sin z_2}{\log\tan\frac{1}{2}z_1-\log\tan\frac{1}{2}z_2} \qquad \text{(ii.)}$$

This projection, given by equations (i.) and (ii.), is Lambert's orthomorphic projection—commonly called Gauss's projection; its descriptive name is the *orthomorphic conical projection with two standard parallels.*

Mercator's Projection.—This projection retains the characteristic property of orthomorphic projections, viz., similarity of representation of small parts of the surface. The equator is represented by a straight line, which is crossed at right angles at equidistant points by a system of lines representing the meridians. The parallels are straight lines parallel to the equator, and the distance of the parallel of latitude ϕ from the equator is, as we have seen above, $r=a\log_e\tan(45°+\frac{1}{2}\phi)$. In the vicinity of the equator, or indeed within 30° of latitude of the equator, the representation is good, but as we proceed northwards or southwards the exaggeration of area becomes larger, and eventually excessive—the poles being at infinity. This distance of the parallels may be expressed in the form $r=a\,(\sin\phi+\frac{1}{3}\sin{}^3\phi+\frac{1}{5}\sin{}^5\phi+\ldots)$, showing that near the equator r is nearly proportional to the latitude. As a consequence of the similar representation of small parts, a curve drawn on the sphere cutting all meridians at the same angle—the loxodromic curve—is projected into a straight line, and it is this property which renders Mercator's chart so valuable to seamen. The projection of a great circle (being neither a meridian nor the equator) is a curve which cannot be represented by a simple algebraic equation. Mercator's projection although indispensable at sea, is of little value for land maps. The misconceptions arising from this exaggeration of scale may, however, be corrected by the juxtaposition of a map of the world on an equal-area projection.

It is now necessary to revert to the general consideration of conical projections. It has been shown that the scales of the projection (fig. 20) as compared with the sphere are $p'q'/pq=dp/dz=\sigma$ along a meridian, and $p'r'/=ph/\sin z=\sigma'$ at right angles to a meridian. Now if $\sigma\sigma'=1$ the areas are correctly represented, then

$$hpdp=\sin z dz,\ \text{and integrating}\ \tfrac{1}{2}hp^2=C-\cos z; \qquad \text{(i.)}$$

this gives the whole group of *equal-area conical projections.* As a special case let the pole be the centre of the projected parallel, then when

$$z=0,\ p=0,\ \text{and const}=1,\ \text{we have}\ p=2\sin\tfrac{1}{2}z/\delta h \qquad \text{(ii.)}$$

Let z_1 be the co-latitude of some parallel which is to be correctly represented, then $2h\sin\frac{1}{2}z_1/\delta h=\sin z_1$, and $h=\cos^2\frac{1}{2}z_1$; putting this value of h in equation (ii.) the radius of any parallel

$$=p=2\sin\tfrac{1}{2}z\sec\tfrac{1}{2}z_1 \qquad \text{(iii.)}$$

This is Lambert's *conical equal-area projection with one standard parallel,* the pole being the centre of the parallels.

If we put $z_1=\theta$ then $h=1$, and the meridians are inclined at their true angles, also the scale at the pole becomes correct, and equation (iii.) becomes

$$p=2\sin\tfrac{1}{2}z; \qquad \text{(iv.)}$$

this is the *zenithal equal-area projection.*

Reverting to the general expression for *equal-area conical projections,*

$$p=\sqrt{\{2(C-\cos z)/h\}} \qquad \text{(i.)}$$

we can dispose of C and h so that any two selected parallels shall be their true lengths; let their co-latitudes be z_1 and z_2, then

$$2h(C-\cos z_1)=\sin^2 z_1 \qquad \text{(v.)}$$
$$2h(C-\cos z_2)=\sin^2 z_2 \qquad \text{(vi.)}$$

from which C and h are easily found, and the radii are obtained from (i.). This is H. C. Albers' *conical equal-area projection with two standard parallels.* The pole is not the centre of the parallels.

PROJECTION BY RECTANGULAR SPHEROIDAL CO-ORDINATES

If in the simple conical projection the selected parallel is the equator, this and the other parallels become parallel straight lines and the meridians are straight lines spaced at equatorial distances, cutting the parallels at right angles; the parallels are their true distances apart. This projection is the *simple cylindrical.* If now we imagine the touching cylinder turned through a right-angle in such a way as to touch the sphere along any meridian, a projection is obtained exactly similar to the last, except that in this case we represent, not parallels and meridians, but small circles parallel to the given meridian and great circles at right angles to it. It is clear that the projection is a special case of conical projection. The position of any point on the earth's surface is thus referred, on this projection, to a selected meridian as one axis, and any great circle at right angles to it as the other. Or, in other words, any point is fixed by the length of the perpendicular from it on to the fixed meridian and the distance of the foot of the perpendicular from some fixed point on the meridian, these spherical or spheroidal co-ordinates being plotted as plane rectangular co-ordinates.

The perpendicular is really a plane section of the surface through the given point at right angles to the chosen meridian, and may be briefly called a great circle. Such a great circle clearly diverges from the parallel; the difference in latitude and longitude between the point and the foot of the perpendicular can be at once obtained by ordinary geodetic formulae, putting the azimuth $=90°$. Approximately the difference of latitude in seconds is $x^2\tan\phi\operatorname{cosec}1''/2p\nu$ where x is the length of the perpendicular, p that of the radius of curvature to the meridian, ν that of the normal terminated by the minor axis, ϕ the latitude of the foot of the perpendicular. The difference of longitude in seconds is approximately $x\sec p\operatorname{cosec}1''/\nu$. The resulting error consists principally of an exaggeration of scale north and south and is approximately equal to $\sec x$ (expressing x in arc); it is practically independent of the extent in latitude.

It is on this projection that the 1:2,500 ordnance maps and the 6in. ordnance maps of the United Kingdom are plotted, a meridian being chosen for a group of counties. This projection is only suitable for cadastral plans. As regards errors, a range of 100 miles each side of the central meridian will give a maximum error in scale in a north and south direction of about 1/3000.

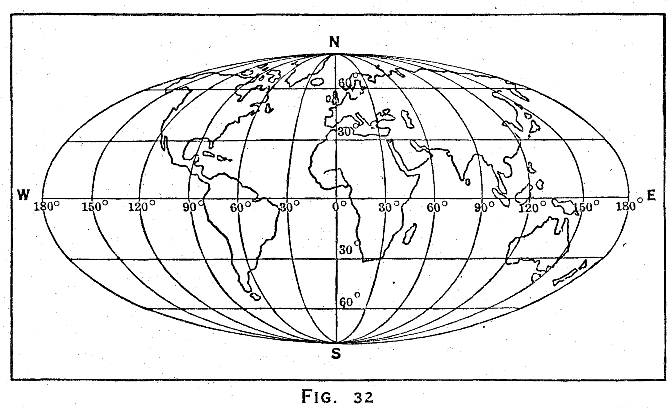

FIG. 32

ELLIPTICAL EQUAL-AREA PROJECTION

In this projection (fig. 32), also called Mollweide's projection, the parallels are parallel straight lines and the meridians are ellipses, the central meridian being a straight line at right angles to the equator, which is equally divided.

If we imagine the poles moved so that the major axis of the ellipse now represents a meridian, we obtain the *Transverse Elliptical Equal-area Projection* as shown in fig. 33 (see *Ordnance Survey Professional Paper,* 1927).

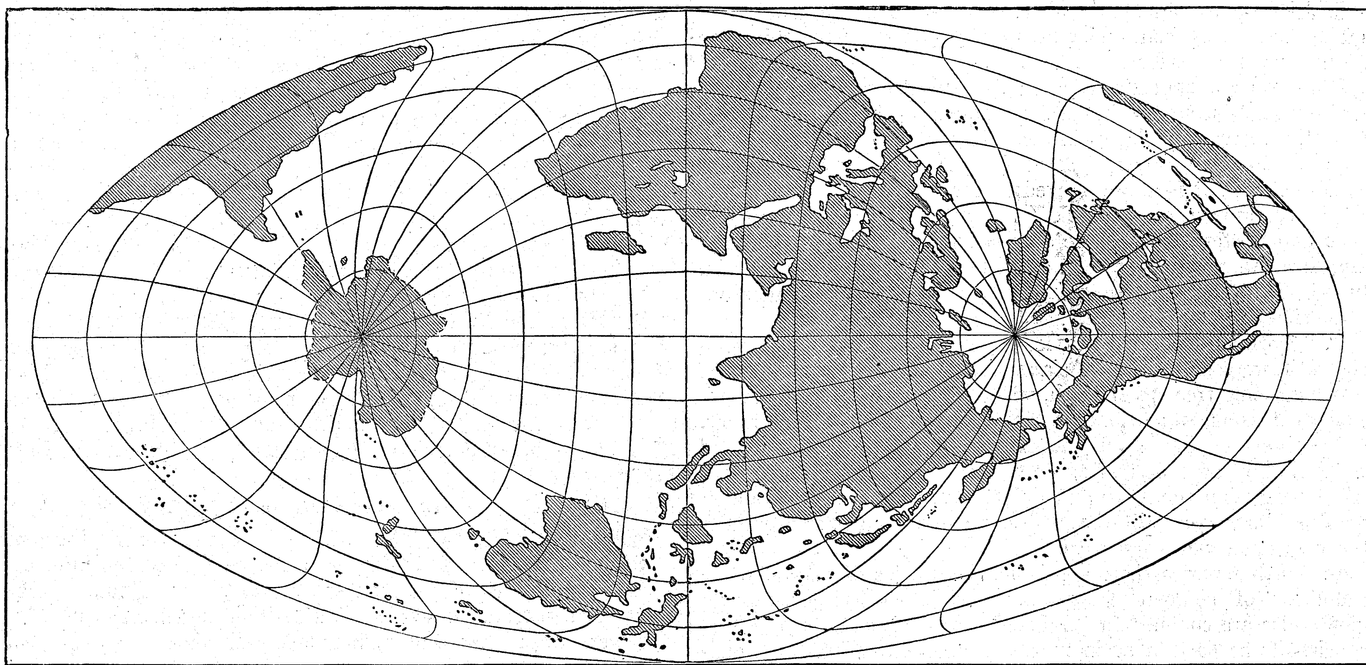

FIG. 33

SPECIAL PURPOSE PROJECTIONS

These projections are devised for simplicity of drawing and not for any special properties. The most useful projection of this class is the *globular projection.* This is a conventional representation of a hemisphere in which the equator and central meridian are two equal straight lines at right angles, their intersection being the centre of the circular boundary. The meridians divide the equator into equal parts and are arcs of circles passing through points so determined and the poles. The parallels are arcs of circles which divide the central and extreme meridians into equal parts. This is a simple and effective projection, well suited for conveying ideas of the general shape and position of the chief land masses.

Field sheets for topographical surveys should be on conical projections with rectified meridians; these projections for small areas and ordinary topographical scales—not less than 1:500,000—are sensibly errorless. But to save labour it is customary to employ for this purpose either form of polyconic projection, in which the errors for such scales are also negligible. In some surveys, to avoid the difficulty of plotting the flat arcs required for the parallels, the arcs are replaced by polygons, each side being the length of the portion of the arc it replaces. This method is especially suitable for scales of 1:125,000 and larger, but it is also sometimes used for smaller scales.

Among projections which have not been described may be mentioned the circular orthomorphic (Lagrange's) and the rectilinear equal-area (Collignon's) and a considerable number of conventional projections, which latter are for the most part of little value.

The choice of a projection depends on the function which the map is intended to fulfil. If the map is intended for statistical purposes to show areas, density of population, incidence of rainfall, of disease, distribution of wealth, etc., an *equal-area* projection should be chosen. In such a case an area scale should be given. At sea, *Mercator's* is practically the only projection used except when it is desired to determine graphically great circle courses in great oceans, when the *central* projection must be employed. For conveying general ideas of the shape and distribution of the surface features of continents or of a hemisphere *Clarke's perspective* projection is a good one. For exhibiting the progress of polar exploration the *polar equidistant* projection should be selected. For special maps for general use on scales of 1:1,000,000 and smaller, and for a series of which the sheets are to fit together, the *conical, with rectified meridians and two standard parallels,* is a good projection. For topographical maps, in which each sheet is plotted independently and the scale is not smaller than 1:500,000, either form of *polyconic* is very convenient.

Projections may be devised to fulfil a special purpose. Thus, Mr. J. T. Craig invented a projection the special property of which is that, from every point on the map, the true bearing of Mecca can be accurately measured. He called this the Mecca *Azimuthal Projection* (*see* J. T. Craig, *Map Projections,* Survey of Egypt publication, Cairo, 1909). Another example of a projection which was devised to be used for a special purpose is the *Two Point Equidistant Projection.* In this projection, having chosen two points on the sphere (or spheroid), the distances on the map from these two points, to all other points, are true to scale. So that, if the chosen points are the beginning and ending points of a journey, such a projection will enable the traveller to ascertain accurately, by direct measurement the distances that he is from his starting point or his goal (*Ordnance Survey Professional Paper* no. 5).

The Projection of the International Map of the World on the 1:1,000,000 scale is a slightly modified form of simple polyconic. Each sheet is 4° in latitude by 6° in longitude, and each sheet is plotted independently. The upper and lower parallels have the radius ν cot lat., where ν in each case is the normal terminated by the minor axis. Instead of the central meridian (which is a straight line) being exactly to scale, the meridians 2° to the east and west of it are true to scale; the object of this device is to reduce the maximum error. Along the limiting parallels the degrees of longitude are marked off in their true lengths to scale, and the meridians are straight lines joining the appropriate points on the limiting parallels. The meridians themselves are divided equally, and the inner parallels join the appropriate points on the meridians. The largest scale error is about 1/1270 (*La Carte du Monde au Millionième,* Association Française pour l'Avancement des Sciences, 1911).

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(C. F. CL.; A. R. C.)

MAPLE, the name given to trees of the botanical genus *Acer* (fam. Aceraceae), comprising about 115 species native chiefly to north temperate regions.

Maples have opposite, long-stalked, mostly palmately lobed leaves. The flowers are in fascicles appearing before the leaves, as in the Norway maple; or in corymbs with the leaves, as in the sugar maple; or in racemes after the leaves, as in the sycamore maple. The fruit is a two-winged samara.

The common or small maple (*A. campestre*), of northern Europe and western Asia, is the only species native to Great Britain. It grows usually less than 20 ft. high, with leaves about 2 in. broad. The compact, fine-grained wood has been used since ancient times for making tables.

The sycamore or great maple (*A. pseudoplatanus*), native to central Europe and western Asia and naturalized in Great Britain, is a handsome tree, 70 ft. high, with leaves 4 in. to 8 in. broad. The hard wood, which takes a high polish, is valued in turnery.

The Norway maple (*A. platanoides*), native to Europe and western Asia and introduced into Great Britain in 1683, is a lofty tree, sometimes 100 ft. high, resembling the sycamore maple. Many ornamental varieties are in cultivation, especially the handsome var. *schwedleri*.

In North America there are 13 native species of maple; 9 are found east of the great plains, 2 occur in the Rocky mountain region and 2 are confined to the Pacific coast. The eastern maples consist of the hard or sugar maples, the soft maples, the mountain maples and the boxelder.

The sugar, hard or rock maple (*A. saccharum*), highly valued as a timber and shade tree and the chief source of maple sugar (*q.v.*), grows from Newfoundland to South Dakota and southward to South Carolina and Texas, sometimes attaining a height of 120 ft. and a trunk diameter of 4 ft. The heavy, hard, very strong wood is extensively utilized, the varieties known as *bird's-eye*, *curly* and *wavy* maple being highly prized for cabinet work and finishings.

The very similar black maple (*A. nigrum*), of more restricted range, is likewise very valuable. The southern sugar maple (*A. floridanum*) and the whitebark maple (*A. leucoderme*) are small trees of the southern states.

The soft maples include the white or silver maple (*A. saccharinum*), with the leaves white below, and the red or swamp maple (*A. rubrum*), with dull red flowers in spring and flame-red foliage in autumn. Both are common trees, similar in size to the sugar maple and of nearly the same geographical range. They furnish a softer lumber than the sugar and black maples and are widely planted for ornament.

The mountain maple (*A. spicatum*) and the striped maple or moosewood (*A. pennsylvanicum*) are small late-flowering trees of northern range but extending southerly in the mountains. The boxelder or ash-leaved maple (*A. negundo*), a small tree with leaves of three to five leaflets, grows along streams from Vermont to Alberta and south to Florida and Arizona. The California boxelder (var. *californicum*), with leaves of three leaflets, occurs in the Sacramento valley and southward.

The bigtooth maple (*A. grandidentatum*) and the dwarf maple (*A. glabrum*) are small trees of the Rocky mountain region, the latter extending to northern California and Oregon and its variety (var. *douglasii*) to Alaska. The bigleaf maple (*A. macrophyllum*), a valuable timber tree, sometimes 100 ft. high, with leaves 4 in. to 10 in. broad, occurs near the coast from southern California to Alaska.

The highly ornamental vine maple (*A. circinatum*), usually a small tree, but sometimes vine-like or prostrate, is found from northern California to British Columbia.

In 1940 the total cut of maple lumber was 462,947,000 bd.ft., valued at approximately $15,000,000.

See C. S. Sargent, *Manual of the Trees of North America* (1905, 2nd ed. 1922); G. B. Sudworth, "Check List of the Forest Trees of the United States," *U.S. Dept. Agric. Misc. Cir. 92* (1927); L. H. Bailey, *Standard Cyclopedia of Horticulture* (1914–27) and *Manual of Cultivated Plants* (1924). (E. S. Hr.)

MAPLE SUGAR, a sugar of characteristic flavour obtained by evaporating the sap of various species of maple, but principally the sugar maple (*see* Maple), found chiefly in the north-eastern United States and in Canada. The States of Vermont, New York, and Ohio and the Province of Quebec contribute over three-fourths of the total production. From 1926 to 1935 the average annual production of sugar and syrup, calculated as sugar, was over 24,000,000lb. in the United States and over 25,000,000lb. in Canada. (*See* Sugar.) (H. G. K.)

MAPLEWOOD, a residential suburb of Saint Louis, Missouri, U.S.A., in St. Louis county, on federal highway 50 and the Missouri Pacific railroad, 7 mi. from the Union station. Pop. 7,431 in 1920 (90% native white); in 1930, 12,657; in 1940, 12,875, by federal census.

MAPU, ABRAHAM (1808–1867), Hebrew novelist. His most famous books were the *Love of Zion* and the *Transgression of Samaria*. Besides their intrinsic merits, these novels stand high among the works which produced the romantic movement in modern Hebrew literature. An English translation of the *Love of Zion* bears the title *Amnon, Prince and Peasant*, by F. Jaffe (1887).

See N. Slouschz, *The Renascence of Hebrew Literature* (1909), ch. v.

MAR, EARLDOM OF. Mar, one of the ancient divisions of Scotland, comprised the larger portion of Aberdeenshire, extending from north of the Don southward to the Mounth. Like other such districts, it was in Celtic times under the rule of a *mormaer*. In the 12th century his place was taken by an earl, but no definite succession of earls appears till the 13th century. Earl Gratney (*fl. c.* 1300) married a sister of (King) Robert Bruce, who brought him the lordship of Garioch and castle of Kildrummy, which she held against the earl of Athole, an ally of the English (1335). Their son Donald was made regent in July 1332, but was defeated and slain at Dupplin next month. His daughter and eventual heir, Margaret, brought the earldom to her husband, William, earl of Douglas, and on the accession of her daughter Isabel a troublous time followed. While she was living as a widow at her castle of Kildrummy, it was stormed by Alexander Stewart, a bastard, who forced her to execute a charter (Aug. 1404) settling the reversion to the earldom on himself and his heirs. This act she revoked by a charter of September 1404, but on marrying him in December, she granted him the earldom for life, the king confirming this in June 1405. After her death in 1408 the earl commanded the royal forces at the battle of Harlaw, when the Lord of the Isles was defeated in 1411, and afterwards acted as warden of the Marches.

In 1426 he resigned the earldom to the Crown, the king granting it by a fresh creation to him and certain heirs, with reversion to the Crown. In the following centuries the earldom had a complicated and chequered history, the title eventually remaining in the Erskine family. As a result of the attainder of the 11th earl, John (1675–1732), a prominent Jacobite (*see* below), the earldom remained under forfeiture for 108 years.

Alloa and other Erskine estates of the attainted earl were repurchased for the family, and descended to John Francis Erskine (1741–1825), his heir-male, who was also his heir of line through his daughter. To him, in his 83rd year, as grandson and lineal representative of the attainted earl, the earldom was restored by act of parliament. His grandson, who succeeded him in 1828, inherited the earldom of Kellie (1619) and other Erskine dignities by decision of 1835. At his death in 1866, his earldom of Mar was the subject of rival claims, and the right to the succession was not determined till 1875. For the prolonged proceedings for the settlement of this case, in which the decision of the House of Lords (Feb. 25, 1875), in favour of the late earl's cousin and heir-male, was reversed by a special act, the Earldom of Mar Restitution act in 1885, in favour of the son of the late earl's cousin, J. F. E. Goodeve (Erskine), *see* the authorities quoted below.

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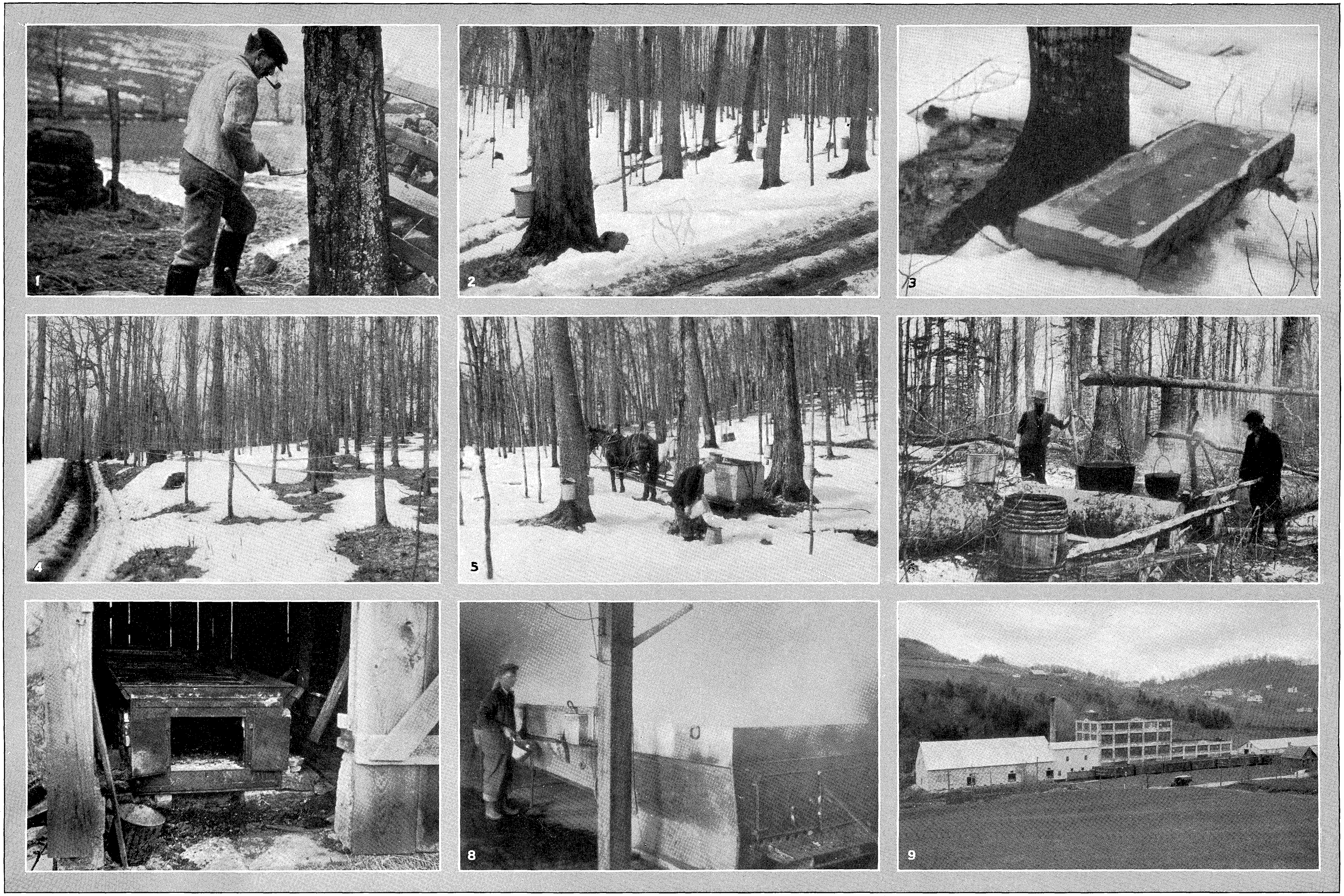


BY COURTESY OF (1, 6, 7) THE AMERICAN MUSEUM OF NATURAL HISTORY, (2, 3, 4, 5, 8, 9) THE CARY MAPLE SUGAR COMPANY

GATHERING SAP AND MAKING MAPLE SUGAR

1. Tapping a sugar maple for sap. 2. Covered pails attached to sugar maple trees to collect the running sap. 3. The Indian method of collecting sap in a hollowed log. 4. Sugar maples piped for sap gathering in the modern way. 5. A horse-drawn rig carrying a gathering tank for maple sap. 6. Primitive method of making maple syrup in a kettle. 7. Modern evaporating pan and furnace used in the evaporation of sap. 8. Sap being boiled into sugar in a typical evaporating apparatus. 9. General view of a maple sugar factory in Vermont

Collectanea genealogica, and "The later Earldom of Mar" in Walford's *Antiquarian Magazine,* vol. ii.; also his *Studies in Peerage and Family History.*

MAR, JOHN ERSKINE, 1st or 6th Earl of (d. 1572), regent of Scotland, was a son of John, 5th Lord Erskine (d. 1552), who was guardian of King James V., and afterwards of Mary Queen of Scots. The custody of Edinburgh castle was in his hands, and during the struggle between the regent, Mary of Lorraine, and the lords of the Congregation he appears to have acted consistently in the interests of peace. When Mary Stuart returned to Scotland in 1561 Lord Erskine was a member of her council, and favoured her marriage with Lord Darnley. In 1565 Erskine was granted the earldom of Mar (*see* p. 852). As guardian of James, afterwards King James VI., he prevented the young prince from falling into the hands of Bothwell, and when the Scottish nobles rose against Mary and Bothwell, Mar was one of their leaders. He took part in the government of Scotland during Mary's imprisonment at Lochleven, and also after her subsequent abdication. In 1571 he was chosen regent of Scotland, but he was overshadowed by the earl of Morton. He died at Stirling on Oct. 29, 1572.

MAR, JOHN ERSKINE, 2nd or 7th Earl of (*c.* 1558–1634), Scottish politician, was the only son of the preceding. He was nominally the guardian of the young king James VI., who lived with him at Stirling; but he was in reality a puppet in the hands of the regent, the earl of Morton; and he lost power when Morton was imprisoned. He was concerned in the seizure of James VI. in 1582; but when James escaped the earl fled into the west of Scotland. Leaving his hiding-place Mar seized Stirling castle, whereupon James marched against him, and he took refuge in England. Queen Elizabeth interceded for him in vain, and Mar and his friends gathered an army, entered the presence of the king at Stirling, and were soon in authority (1585). Mar was restored to his lands and titles. He became governor of Edinburgh castle and tutor to James's son, Prince Henry, and for his second wife he married Mary, daughter of Esmé Stewart, duke of Lennox. In 1601 the earl was sent as envoy to London; here Elizabeth assured him that James should be her successor, and his mission was conducted with tact and prudence. Mar was created Lord Cardross in 1610; he was a member of the Court of High Commission and was lord high treasurer of Scotland from 1615 to 1630. He died at Stirling on Dec. 14, 1634.

MAR, JOHN ERSKINE, 6th or 11th Earl of (1675–1732), Scottish Jacobite, was the eldest son of Charles, the 5th earl (1650–89). He was associated with the party favourable to the English Government; he was one of the commissioners for the Union, and was made a Scottish secretary of State, becoming after the Union of 1707 a representative peer for Scotland, keeper of the signet and a privy councillor. In 1713 Mar was made an English secretary of State by the Tories, but under George I. he was deprived of his office, and in 1715 he went in disguise to Scotland and placed himself at the head of the adherents of James Edward, the Old Pretender. Meeting many Highland chieftains at Aboyne he avowed a desire for the independence of Scotland, and at Braemar in Sept. 1715 he proclaimed James VIII. king of Scotland, England, France and Ireland. At Sheriffmuir, in Nov. 1715, Mar's forces were defeated by those of his opponent, Archibald Campbell, afterwards 3rd duke of Argyll. Mar then met James Edward at Fetteresso; he fled with him to France. In the course of time he became thoroughly distrusted by the Jacobites. In 1721 he accepted a pension of £3,500 a year from George I., and in 1724 he left the Pretender's service. His later years were spent in Paris and at Aix-la-Chapelle, where he died in May, 1732. He had been attainted in 1716, and his only son, Thomas, Lord Erskine, died childless in March 1766.

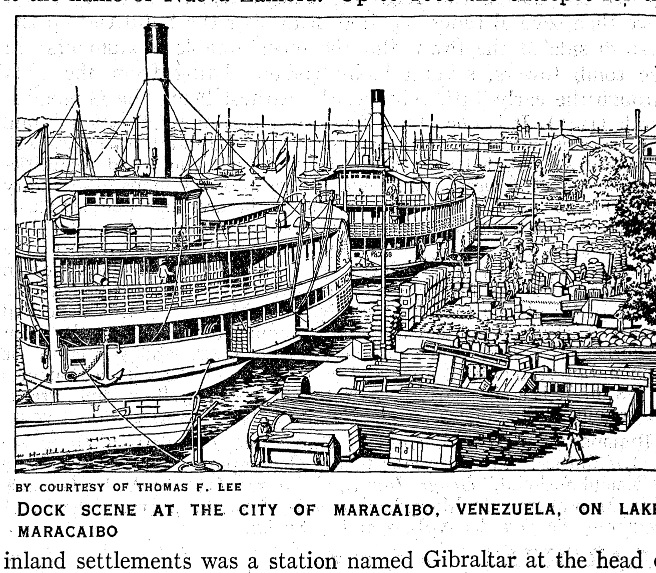
See the *Journal of the Earl of Mar* (1716); R. Patten, *History of the late Rebellion* (1717); and A. Lang, *History of Scotland,* vol. iv. (1907).

MARABOUT, in Islam a hermit or devotee (Fr. from Arab *murābit,* "one who pickets his horse on a hostile frontier"). The word is derived from *ribāt,* a fortified frontier station, which, later, came to mean a religious house or hospice (*zāwiya*). In North Africa the marabouts enjoy extraordinary influence, being esteemed as living saints and mediators. They are liberally supported by alms, direct all popular assemblies, and have a decisive voice in intertribal quarrels and all matters of consequence. On their death their sanctity is transferred to their tombs (also called marabouts), where chapels are erected at, and gifts and prayers offered to, their tombs.

See Dervish.

MARACAIBO, a city and seaport of Venezuela and capital of the State of Zulia, is situated on the west shore of the broad channel which connects Lake Maracaibo with the Gulf of Venezuela, or Maracaibo, about 25m. from the mouth of the channel opening into the latter. Pop. (1905), 49,817; (1941), 112,519; there is a considerable foreign element in the vicinity, largely engaged in petroleum operations. The best residential suburb, Haticos, extends along the lake shore toward the south. The city is provided with tramways, telephone service and electric lighting, but the water supply and drainage are inferior. The most important buildings are the executive's residence, the legislative chambers, the municipal hall, the prison, the market, a hospital and six churches. The city also has a school of arts, a public library and public gardens. Within the past few years the development of petroleum around the shore of Maracaibo lake has greatly promoted business activity in the city. In colonial times Maracaibo had a famous Jesuits' college (now gone) and was one of the educational centres of Spanish America; the city now has a national college and a nautical school. The industries include shipbuilding, and the manufacture of saddlery and other leather products, bricks and tile, rum, beer, chocolate and coconut oil. Maracaibo has become one of the most important petroleum export centres in Latin America. Some oil is also refined here. The bar at the entrance to Maracaibo channel does not admit vessels drawing more than 12ft., but there is a depth of 30ft. inside and near the city. Steam communication is maintained on the Catatumbo and Zulia rivers to Villamizar, and on the Escalante to Santa Cruz. The principal exports from Maracaibo are petroleum, coffee, hides and skins, cabinet and dyewoods, cocoa and mangrove bark, to which may be added dividivi, sugar, copaiba, gamela and hemp straw for paper-making, and fruits.

Maracaibo was founded in 1571 by Alonso Pacheco, who gave it the name of Nueva Zamora. Up to 1668 the entrepôt for the



BY COURTESY OF THOMAS F. LEE

Dock scene at the city of Maracaibo, Venezuela, on Lake Maracaibo

inland settlements was a station named Gibraltar at the head of the lake, but the destruction of that station by pirates in that year transferred this valuable trade to Maracaibo. The city did not figure actively in the War of Independence until 1821 (Jan. 28), when the province declared its independence and sought an alliance with Colombia. This brought to an end the armistice between Bolívar and Morillo, and thenceforward the city experienced all the changing fortunes of war until its final capture by the revolutionists in 1823.

MARACAIBO, a large lake of western Venezuela, extending southward from the Gulf of Venezuela, into which it opens through a long neck, or strait, obstructed at its mouth by islands and bars. The lake is roughly quadrangular in shape, and extends from the 9th to the 11th parallel of S. lat. and from the 71st to the 72nd meridian. It opens into the Gulf through 13 channels, the depth on the bar in the main channel ranging from 7ft. at low water to 12ft. at high water. Inside the bar the depth is about 30ft., and the lake is navigable for vessels of large size. It receives the waters of many rivers, principally on its west and south sides, the largest of which are the Catatumbo and Zulia, Escalante, Chanudo, Ceniza, Santa Ana, Negro, Apan and Palmar. The first three have navigable channels for river steamers. There are a number of small lakes near Lake Maracaibo's southern and western margins, the largest of which is the Laguna de Zulia. The heavy rainfall on the eastern slopes of the Eastern Cordillera, which is said to exceed 86in. per annum, is responsible for the great volume of water discharged into the lake. The average annual precipitation over the whole basin is said to be 70 inches. In the upper half of the lake the water is sweet, but below that, where the tidal influence is stronger, it becomes brackish. The most important port on the lake is Maracaibo, but there are ports of lesser trade at its upper end which are in direct communication with the inland cities of Trujillo, Mérida and San Cristóbal. The Catatumbo river, which enters from the west near the north end of the lake, and its principal tributary, the Zulia, are navigable as far as Villamizar, in Colombia, and afford an excellent transportation route for the coffee and other products of Santander. During the last few years petroleum exploitation around the shore of Lake Maracaibo has been active under the direction of various European, United States and native companies. Population of Maracaibo city in 1936 census was 110,010; all lines of business have expanded. There are several refineries, some within the gulf area and others on Curaçao and nearby islands of the Caribbean.

MARAGHA, a town of Iran in the province of Azerbaijan, on the Safi river, in 37° 23′ N., 46° 16′ E., 80 mi. from Tabriz. Pop. about 35,000. It is pleasantly situated in a narrow valley running nearly north and south at the eastern extremity of a well-cultivated plain opening toward Lake Urmia, which lies 18 mi. to the west. Two stone bridges in good condition, said to have been constructed during the reign of Hulagu Khan (1256–65), and since then several times repaired, lead over the Safid rud on the western side of the town. But the most notable monuments are five tomb towers, several badly ruined, dating from the 12th through the early 14th century, the earliest being the Gunbad-i-Surkh (1147). It is one of the finest examples of brickwork in Iran. The place is surrounded by extensive vineyards and orchards, well watered by canals led from the river, and producing great quantities of fruit. On a hill west of the town are traces of a famous observatory (*rasad*) constructed under the direction of the great astronomer Nasr-ud-Din of Tus. The building, which no doubt served as a citadel as well, enclosed a space of 380 yd. by 150, and the foundations of the walls were 4½ to 5 ft. in thickness. The marble, which is known throughout Iran as Maragha marble, is a travertine obtained at the village of Dashkesen (about 30 mi. N.W. of Maragha). It is deposited from water, which bubbles up from a number of springs, in the form of horizontal layers, which at first are thin crusts and can easily be broken, but gradually solidify and harden into blocks with a thickness of 7–8 in. It is a singularly beautiful substance, of yellow, pink, greenish or milk-white colour, streaked with reddish, copper-coloured veins.

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MARANHÃO, a northern State of Brazil, bounded N. by the Atlantic, E. and S.E. by Piauí, S.W. and W. by Goiaz and Pará. Having an area of 133,674 sq.mi., its pop. in 1940 was 1,242,-721. The coastal zone and the northwest corner of the state belong to the Amazon valley region, being a heavily forested plain traversed by numerous rivers. The eastern and southern parts, however, belong to the lower terraces of the great Brazilian plateau, broken by eroded river-courses between which are high open plains. There are no true mountain ranges in Maranhão, those indicated on the maps being only plateau escarpments marking either its northern margin or the outlines of river valleys. The climate is hot, and the year is divided into a wet and dry season, extreme humidity being characteristic of the former but no part of the year is rainless. The heat, however, is greatly modified on the coast by the south-east trade winds, and the climate is generally considered healthful, though beri-beri and eruptive diseases are common in some places.

The coast itself is broken and dangerous, there being many small indentations, which are usually masked by islands or shoals. The largest of these are the Bay of Turiassú, facing which is the island of Tocansa, and several others of small size and the contiguous bays of São Marcos and São José, between which is the large island of São Luiz. The rivers of the state all flow northward to the Atlantic, and a majority of them have navigable channels. The Parnaíba forms the eastern boundary while the Tocantins and the Gurupí bound the state on the west. The principal rivers are the Maracassumé and Turiassú, the Mearim and its larger tributaries (the Pindaré, Grajaú, Flores and Corda) which discharge into the Bay of São Marcos, and the Itapecurú and Monim which discharge into the Bay of São José.

The principal industries of Maranhão are agricultural, the river valleys and coastal zone being highly fertile and being devoted to the cultivation of sugar-cane, cotton, rice, coffee, tobacco, mandioca and a great variety of fruits. The southern highlands, however, are devoted to stockraising, which was once an important industry. Troublesome insects, vampire bats and the failure to introduce new blood into the degenerated herds are responsible for its decline. A railway, 250 mi. long, crosses the eastern part of the state connecting São Luiz on the coast with Teresina, the capital of Piauí. São Luiz, capital (pop. of the *município* 86,546 in 1940); other principal towns, with the population of their municipal districts in 1940, are: Caxias 78,327; Pedreiras 43,437; Barra do Corda 35,818 and Viana 29,287.

The coast of Maranhão was first discovered by Pinzón in 1500, but it was included in the Portuguese grant of captaincies in 1534. The first European settlement was made by a French trading expedition under Jacques Riffault, of Dieppe, in 1594, who left a part of his men when he returned home. Subsequently Daniel de la Rivardière, commissioned by the French crown, founded a colony on the island in 1612. The French were expelled by the Portuguese in 1615 and the Dutch held the island from 1641 to 1644. In 1621 Ceará, Maranhão and Pará were united and called the "Estado do Maranhão," which was made independent of the southern captaincies. Ceará was later detached, but the "State" of Maranhão remained independent until 1774, when it became subject to the colonial administration of Brazil. Maranhão did not join in the declaration of independence of 1822, but in 1823 the Portuguese were driven out by Admiral Lord Cochrane, and the province became a part of the empire of Brazil.

MARANTACEAE, the arrowroot family, monocotyledonous perennials, comprising 26 genera and 300 species, all tropical and mainly American. The West Indian *Maranta arundinacea* is the source of arrowroot (*q.v.*). Various species of *Calathea* are cultivated for their ornamental foliage. For a monographic treatment *see* K. Schumann, "Marantaceae," *Pflanzenreich* 11 (iv 48); 1–184, fig. 1–23 (1902).

MARASH or Maraş, a city in Turkey, east of the Jihan river at the foot of Mt. Taurus; pop. (1940) 27,744, and capital of the vilayet of the same name. The American mission has a college here and the Americans and Jesuits, churches and schools. The climate for the greater part of the year is good. A railway connects Marash with the Istanbul-Baghdad line.

History.—Marash was anciently a Hittite town and several Hittite monuments have been discovered including an inscribed lion and several stelae. As Marasi it appears in Assyrian records, but little or nothing is known of the town at that period. It reappears in history in the 2nd century A.D. with the name Germanicia. The identification of Germanicia with Marash has been questioned without any real justification. Nor is the attempt by Honigmann to distinguish two Germanicias in fairly close proximity likely to meet with favour. The Armenians have called Marash Kermanig since the 12th century at least. Heraclius visited the town in A.D. 640. Before 700 it had passed into Muslim hands. The Khalif Muʿāwiya rebuilt it and it figured in the struggles with the Byzantines; after 770, however, it remained definitely in Muslim hands. Hārūn al-Rashēd (786–809) strengthened its fortifications. The crusaders captured the town (1097), as did the Seljuks half a century later. It became part of the Turkish empire in the 16th century. In 1832 the Egyptian army in its march towards Constantinople stayed its advance there at the bidding of the Powers. Marash was brought within the sphere of military operations consequent on the Franco-Turkish dispute of 1920–21.

See G. Le Strange, *Palestine under the Moslems* (1890), 37 *seq.*, 502 *seq.* (for Arab texts); F. Cumont, *Études Syriennes* (1917) 169 *seq.*; E. Honigmann, *Historische Topographie von Nord Syrien im Altertum* (1923), Nos. 192, 193. (E. Ro.; X.)

MARAT, JEAN PAUL (1743–1793), French revolutionary leader, son of Jean Paul Marat, a designer of Cagliari in Sardinia, and Louise Cabrol of Geneva, was born at Boudry, Neuchâtel, on May 24, 1743. On his mother's death in 1759 Marat set out on his travels, and studied medicine for two years at Bordeaux, whence he moved to Paris, where he made use of his knowledge of optics and electricity to subdue an obstinate disease of the eyes. After some years in Paris he went to Holland, and then to London, where he practised medicine. In 1773 he published a *Philosophical Essay on Man.* The book directly attacks Helvétius, who had in his *De l'esprit* declared a knowledge of science unnecessary for a philosopher. Marat declares that physiology alone can solve the problems of the connection between soul and body, and proposes the existence of a nervous fluid as the true solution. In 1774 he published *The Chains of Slavery,* which was intended to influence constituencies to return popular members, and reject the king's friends. In 1775 he published in London his *Essay on Gleets,* and in Amsterdam a French translation of the first two volumes of his *Essay on Man.* In this year he visited Edinburgh, and was made an M.D. of St. Andrews. On his return to London he published an *Enquiry into the Nature, Cause, and Cure of a Singular Disease of the Eyes,* with a dedication to the Royal Society. In the same year there appeared the third volume of the French edition of the *Philosophical Essay on Man,* which exasperated Voltaire, whose attack made the young author more conspicuous. His fame as a doctor was now great, and on June 24, 1777, the comte d'Artois, afterwards Charles X. of France, made him physician to his guards with 2,000 livres a year and allowances.

Marat soon had an aristocratic practice. He presented memoirs on heat, light and electricity to the Académie des Sciences, but the academicians were horrified at his temerity in differing from Newton and would not receive him. In 1780 he had published at Neuchâtel a *Plan de législation criminelle,* founded on the principles of Beccaria. In April 1786 he resigned his court appointment. The results of his leisure were in 1787 a new translation of Newton's *Optics,* and in 1788 his *Mémoires académiques, ou nouvelles découvertes sur la lumière.*

In the notoriety of the political life which was now to begin, his scientific and philosophical knowledge was to be forgotten, the high position he had given up denied, and he himself scoffed at as an ignorant charlatan, who had sold quack medicines about the streets of Paris, and been glad to earn a few sous in the stables of the comte d'Artois. In 1788 the elections for the States-general were the cause of a flood of pamphlets, of which Marat's *Offrande à la patrie* dwelt on much the same points as the famous brochure of the Abbé Siéyès: *Qu'est-ce que le tiers état?* In June 1789 he published a supplement to his *Offrande,* followed in July by *La constitution,* in which he embodies his idea of a constitution for France, and in September by his *Tableau des vices de la constitution d'Angleterre,* which he presented to the Assembly. The latter alone deserves remark. The Assembly was at this time full of anglomaniacs, who desired to establish in France a constitution similar to that of England. Marat had seen that England was at this time being ruled by an oligarchy using the forms of liberty, which, while pretending to represent the country, was really being gradually mastered by the royal power. His heart was now all in politics; and he decided to start a paper. At first appeared a single number of the *Moniteur patriote,* followed on Sept. 12 by the first number of the *Publiciste parisien,* which on Sept. 16 took the title of *L'Ami du peuple* and which he edited, with some interruptions, until Sept. 21, 1792.

The life of Marat now becomes part of the history of the French Revolution. From the beginning to the end he stood alone. He was never attached to any party; the tone of his mind was to suspect whoever was in power. About his paper, the incarnation of himself, the first thing to be said is that the man always meant what he said; no poverty, no misery or persecution, could keep him quiet; he was perpetually crying, "Nous sommes trahis." Whoever suspected any one had only to denounce him to the *Ami du peuple,* and the denounced was never let alone till he was proved innocent or guilty. Marat began by attacking the most powerful bodies in Paris—the Constituent Assembly, the ministers, the corps municipal, and the court of the Châtelet. Denounced and arrested, he was imprisoned from Oct. 8 to Nov. 5, 1789. A second time, owing to his violent campaign against Lafayette, he narrowly escaped arrest and had to flee to London (Jan. 1790). There he wrote his *Dénonciation contre Necker,* and in May dared to return to Paris and continue the *Ami du peuple.* He was embittered by persecution, and continued his vehement attacks against all in power, and at last, after the day of the Champs du Mars (July 17, 1790), against the king himself. All this time he was in hiding in cellars and sewers, where he was attacked by a horrible skin disease, tended only by the woman Simonne Evrard, who remained true to him. The end of the Constituent Assembly he heard of with joy and with bright hopes for the future, soon dashed by the behaviour of the Legislative Assembly. When almost despairing, in December 1791, he fled once more to London, where he wrote his *Ecole du citoyen.* In April 1792, summoned again by the Cordeliers' Club, he returned to Paris, and published No. 627 of the *Ami.*

The war was now the question, and Marat saw clearly that it was to serve the purposes of the Royalists and the Girondins, who thought of themselves alone. Again denounced, Marat had to remain in hiding until Aug. 10. The proclamation of the duke of Brunswick excited all hearts; who could go to save France on the frontiers and leave Paris in the hands of his enemies? Marat, like Danton, foresaw the massacres of September. After the events of Aug. 10 he took his seat at the commune, and demanded a tribunal to try the Royalists in prison. No tribunal was formed, and the massacres in the prisons were the inevitable result. In the elections to the Convention, Marat was elected seventh out of the twenty-four deputies for Paris, and for the first time took his seat in an assembly of the nation. At the declaration of the republic, he closed his *Ami du peuple,* and commenced, on the 25th, a new paper, the *Journal de la république française,* which was to contain his sentiments as its predecessor had done, and to be always on the watch. In the Assembly Marat had no party; he would always suspect and oppose the powerful, refuse power for himself. After the battle of Valmy, Dumouriez was the greatest man in France; he could almost have restored the monarchy; yet Marat did not fear to denounce him in placards as a traitor.

His unpopularity in the Assembly was extreme, yet he insisted on speaking on the question of the king's trial, declared it unfair to accuse Louis for anything anterior to his acceptance of the constitution, and though implacable towards the king, as *the* one man who must die for the people's good, he would not allow Malesherbes, the king's counsel, to be attacked in his paper, and speaks of him as a "sage et respectable vieillard." The king dead, the months from January to May 1793 were spent in an unrelenting struggle between Marat and the Girondins. Marat despised the ruling party because they had suffered nothing for the republic, because they talked too much of their feelings and their antique virtue, because they had for their own virtues plunged the country into war; while the Girondins hated Marat as representative of that rough red republicanism which would not yield itself to a Roman republic, with themselves for tribunes, orators and generals.

The Girondins conquered at first in the Convention, and ordered that Marat should be tried before the Revolutionary Tribunal. But their victory ruined them, for on April 24 Marat was acquitted, and returned to the Convention with the people at his back. The fall of the Girondins on May 31 was a triumph for Marat. But it was his last. The skin disease he had contracted in the subterranean haunts was rapidly closing his life; he could only ease his pain by sitting in a warm bath, where he wrote his journal, and accused the Girondins, who were trying to raise France against Paris. Sitting thus on July 13, he heard in the evening a young woman begging to be admitted to see him, saying that she brought news from Caen, where the escaped Girondins were trying to rouse Normandy. He ordered her to be admitted, asked her the names of the deputies then at Caen, and, after writing their names, said, "They shall soon be guillotined," when the young girl, whose name was Charlotte Corday (*q.v.*), stabbed him to the heart.

The Convention attended his funeral, and placed his bust in the hall where it held its sessions. Louis David painted "Marat Assassinated," and a veritable cult was rendered to the Friend of the People, whose ashes were transferred to the Panthéon with great pomp on Sept. 21, 1794—to be cast out again in virtue of the decree of Feb. 8, 1795. (R. An.)

Besides the works mentioned above, Marat wrote: *Recherches physiques sur l'électricité*, etc. (1782); *Recherches sur l'électricité médicale* (1783); *Notions élémentaires d'optique* (1764); *Lettres de l'observateur Bon Sens à M. de M. . . . sur la fatale catastrophe des infortunés Pilatre de Rozier et Romain, les aéronautes et l'aérostation* (1785); *Observations de M. l'amateur Avec à M. l'abbé Sans . . .* etc. (1785); *Éloge de Montesquieu* (1785), published 1883 by M. de Bresetz; *Les Charlatans modernes, ou lettres sur le charlatanisme académique* (1791); *Les Aventures du comte Potowski* (published in 1847 by Paul Lacroix, the "bibliophile Jacob"); *Lettres polonaises* (unpublished). Marat's works were published by A. Vermorel, *Oeuvres de J. P. Marat, l'ami du peuple, recueillies et annotées* (1869). Two of his tracts, (1) *On Gleets,* (2) *A Disease of the Eyes,* were reprinted, ed. J. B. Bailey, in 1891.

See A. Vermorel, *Jean Paul Marat* (1880); François Chèvremont, *Marat: esprit politique, accomp. de sa vie* (2 vols., 1880); Auguste Cabanès, *Marat inconnu* (1891); A. Bougeart, *Marat, l'ami du peuple* (2 vols., 1865); M. Tourneux, *Bibliographie de l'histoire de Paris pendant la révolution française* (vol. ii., 1894; vol. iv., 1906), and E. B. Bax, *J. P. Marat* (1900). The *Correspondance de Marat* has been edited with notes by C. Villay (1908); L. R. Gottschalk, *Jean Paul Marat* (1927).

MARATHI (properly *Marāthī*), the name of an important Indo-Aryan language spoken in western and central India. The name is sometimes spelt *Mahrāthī,* with an *h* before the *r,* but, according to a phonetic law of the Aryan languages of western India, this is incorrect. The original *h* in "Māhārāṣṭrī," from which the word is derived, is elided between two vowels.

Marathi occupies an irregular triangular area of approximately 100,000 sq.m., having its apex about the district of Balaghat in the Central Provinces, and for its base the western coast of the peninsula from Daman on the Gulf of Cambay in the north to Karwar on the open Arabian Sea in the south. It covers parts of two provinces of British India—Bombay and the Central Provinces (including Berar)—with numerous settlers in Central India and Madras, and is also the principal language of Portuguese India and of the north-western portion of His Highness the Nizam's dominions. The standard form of speech is that of Poona in Bombay, and in its various dialects it covers the larger part of that province.

Dialects.—Besides the standard form of speech, there is only one real dialect of Marathi, viz., Konkani (Kōnkaṇī), spoken in the country near Goa. There are also several local varieties, and we may conveniently distinguish between the Marathi of the Deccan, that of the Central Provinces (including Berar), and that of the northern and central Konkan. In the southern part of the district of Ratnagiri this latter Konkani variety of Marathi gradually merges into the true Konkani dialect through a number of intermediate forms of speech. There are also several broken jargons, based upon Marathi, employed by aboriginal tribes surviving in the hill country.

Relations with other Indo-Aryan Languages.—Marathi has to its north, in order from west to east, Gujarati, Rajasthani, Western Hindi and Eastern Hindi. To its east and south it has the Dravidian languages, Gondi, Telugu and Kanarese. Marathi does not merge into any of the cognate neighbouring forms of speech, but possesses a distinct linguistic frontier. This isolated character of Marathi is partly due to the barrier of the Vindhya range which lies to its north, and partly to the fact that none of the northern languages belongs now to the Outer Band, but they are in more or less close relationship to the language of the Midland. Eastern Hindi is more closely related to Marathi than the others, and in its case, in its bordering dialects, we do find a few traces of the influence of Marathi.

Written character.—Marathi books are generally printed in the Nagari character (*see* Sanskrit Language and Literature), and this is also used in private transactions and correspondence. In the Maratha country it is known as the *Bālbōdh* ("teachable to children," *i.e.,* "easy") character. A cursive form of Nagari called *Mōḍī,* or "twisted," is also employed as a handwriting. It is said to have been invented in the 17th century by Balaji Avaji, the secretary of the celebrated Sivaji. Each word can be written as a whole without lifting the pen from the paper.

Origin of the Language.—The word "Marāthī" signifies the language of the Maratha country. It is the modern form of the Sanskrit *Māhārāṣṭrī,* just as "Marāthā" represents the old *Māhārāṣṭra,* or Great Kingdom. *Māhārāṣṭrī* was the name given by Sanskrit writers to the Prakrit spoken in Mahārāṣṭra, the great Aryan kingdom extending southwards from the Vindhya range to the Kistna, broadly corresponding to the southern part of the Bombay Presidency and to the state of Hyderabad. This Māhārāṣṭrī became the form of Prakrit employed as the language of lyric poetry and of the formal epic (*kāvya*). Dramatic works were composed in it, and it was the vehicle of the non-canonical scriptures of the Jaina religion. The oldest work in the language is the *Sattasaī,* or Seven Centuries of verses, compiled at Pratiṣṭhāna, on the Gōdāvarī, the capital of King Hāla, at some time between the 3rd and 7th centuries A.D.

General Character of the Language.—The Prakrits fall into two well-defined groups, an Inner, Śaurasēnī, and its connected dialects on the one hand, and an Outer, Māhārāṣṭrī, Ardhamāgadhī, and Māgadhī with their connected dialects on the other. These two groups differed in their phonetic laws, in their systems of declension and conjugation, in vocabulary, and in general character. Meaningless suffixes such as *-alla, -illa, -ulla,* etc. can be added, almost *ad libitum* to any noun, adjective or particle in Māhārāṣṭrī and Ardhamāgadhī, but are hardly ever met in Śaurasēnī. These give rise to numerous secondary forms of words, which give a distinct flavour to the whole language.

Vocabulary.—Māhārāṣṭrī Prakrit, the most independent of the Outer languages, was distinguished by the large proportion of *dēśyas* (*see* Indo-Aryan Languages) found in its vocabulary, and the same is consequently the case in Marathi, although the proportion of *tatsamas* to *tadbhavas* in the language is fairly high. The proportion of Persian and, through Persian, of Arabic words in the Marathi vocabulary is comparatively low.

Phonetics.—In the standard dialect the vowels are the same as in Sanskrit, but *ṛ* and *l* only appear in words borrowed directly from that language (*tatsamas*). Final short vowels (*a, i* and *u*) have all disappeared in prose pronunciation, except in a few local dialects, and final *i* and *u* are not even written. After an accented syllable a medial *a* is pronounced very lightly, even when the accent is not the main accent of the word. Almost the only compound consonants which survived in the Prakrit stage were double letters, and in M. these are usually simplified, the preceding vowel being lengthened in compensation. It is not usual to lengthen the vowel in compensation in Konkani, which appears to contain many relics of the old Prakrit (Saurāṣṭrī) spoken in the Gujarat country before the invasion from the Midland.

On the whole, the consonantal system is much the same as in other Indian languages. Nasalization of long vowels is very common, especially in Konkani. The palatals are pronounced as in Skr. in words borrowed from that language or from Hindustani, and also in Marathi *tadbhavas* before *i, ī, ē* or *y.* In other cases they are pronounced *ts, tsh, dz, dzh* respectively. There are two *s*-sounds in the standard dialect which are very similarly distinguished, *ś*, pronounced like an English *sh*, is used before *i, ī, ē* or *y;* and *s*, as in English "sin," elsewhere. In the dialects *s* is practically the only sibilant used, and that is changed by the vulgar speakers of Konkani to *h* (again as in north-western India). Aspirated letters show a tendency to lose their aspiration, especially in Konkani. Generally speaking Marathi closely follows Māhārāṣṭrī when that differs from the Prakrits of other parts of India. There is similarly both in Marathi and Māhārāṣṭrī a laxness in distinguishing between cerebral and dental letters.

Declension.—Marathi retains the three genders, masculine, feminine and neuter. In Marathi the neuter denotes both inanimate things and animate beings when both sexes are included, or when the sex is left undecided. In the Konkani the neuter gender is further employed to denote females below the age of puberty. Numerous masculine and feminine words, however, denote inanimate objects. The rules for distinguishing the gender of such nouns must be learned from the grammars. For the most part, but not always, words follow the genders of the Skt. originals. Strong bases in *ā*—and these do not include *tatsamas*—are masculine, and the corresponding feminine and neuter words end in *ī* and *ẽ* respectively. Sex is usually distinguished by the use of the masculine and feminine genders, and large and powerful inanimate objects are generally masculine, while small, delicate things are generally feminine. In the case of some animals sex is distinguished by the use of different words.

A pleonastic suffix of -(*a*)*ka*-(masc. and neut.), could in Sanskrit be added to any noun, whatever the termination of the base might be. Modern forms made with this pleonastic suffix, and ending in *ā, ī* or *ẽ* are called "strong forms," while all those made without it are called "weak forms." As a rule the fact that a noun is in a weak or strong form does not affect its meaning, but sometimes the use of a masculine strong form indicates clumsiness or hugeness. Other pleonastic suffixes are employed in Marathi, usually with specific senses. Thus the suffix-*illa*-generally forms adjectives, while -*ḍa-ka* implies contempt.

The synthetic declension of Sanskrit and Prakrit has been preserved in Marathi more completely than in any other Indo-Aryan language. In the formation of the plural the Prakrit declensions are very closely followed by Marathi.

The usual post-positions are:—

Instrumental: *nẽ*, plural *nĩ*, by. Dative: *lā*, plural also *nā*, to or for. Ablative: *hūn, ūn*, from. Genitive: *tsā*, of. Locative: *āt*, in.

The accusative is usually the same as the nominative, but when definiteness is required the dative is employed instead. The termination *nẽ*, with its plural *nĩ*, is really the oblique form, by origin a locative, of the *nā* or *nō*. The suffix *nā* of the dative plural is derived from the same word. The post-position *lā* is probably a corruption of the Sanskrit *lābhē*, for the benefit (of). The locative termination *ā̃t* is a contraction of the Pr. *antō*, Skt. *antar*, within. The genitive *gharātsā* is really an adjective meaning "belonging to the house," and agrees in gender, number and case with the noun which is possessed. The suffix *tsā, cī, cẽ*, is derived from the Sanskrit suffix *tyakas*, Pr. *caō*, which is used in much the same sense.

Strong adjectives, including genitives, can be declined like substantives, and agree with the qualified noun in gender, number and case. When the substantive is in an oblique case, the adjective is put into the general oblique form without any defining post-position, which is added to the substantive alone. Weak adjectives are not inflected in modern prose, but are inflected in poetry. Comparison is effected by putting the noun with which comparison is made in the ablative case.

The pronouns closely follow the Prakrit originals. There is no pronoun of the third person, its place being supplied by the demonstratives. In all the plural is employed honorifically instead of the singular.

Conjugation.—Marathi has two conjugations. The first as a rule consists of intransitive verbs, and the second, corresponding to the *e*-or causal-class, of transitive verbs, but there are numerous exceptions.

In Marathi the present has lost its original meaning and is now a habitual past. It is also the base of the Marathi future, which is formed by adding *l*, or in the first person singular *n*, to the old present. In the second person singular the *l* has been added to a form derived from the Pr. *uṭ ṭhasi*, which is also the origin of the old present *uṭhēs*. The remaining tenses are modern forms derived from the participles. The conjunctive participle is derived from the Apabhramśa form *uṭṭhiu*, to which the dative suffix *n*. (old Marathi *ni, niyā*) has been added.

Various tenses are formed by adding personal suffixes to the present, past or future passive participle. When the subject of the verb is in the nominative the tense so formed agrees with it in gender, number and person. In the present, the terminations are relics of the verb substantive, and in the other tenses of the personal pronouns.

The present tense is formed by compounding the present participle with the verb substantive. Further tenses are similarly made by suffixing, without compounding, various tenses of the verb substantive to the various participles.

Literature.—The modern vernacular literature of the Maratha country arose under the influence of the religious reformation inaugurated by Rāmānuja early in the 12th century. The earliest writer is Nāmdēv (13th century), whose hymns in honour of Vithoba, a personal form of Vishnu, are found in the Sikh *Ādi Granth*. Dnyānōbā, a younger contemporary, wrote a paraphrase of the Sanskrit *Bhagavad Gītā*, which is still much admired. Sivaji was a disciple of Rāmdās, (1608–1681), who exercised great influence over him, and whose *Dāsbōdh*, a work on religious duty, is a classic. Contemporary with Rāmdās and Sivaji was Tukārām (1608–1649), a Śudra by caste, the greatest writer in the language. Being unsuccessful both in his business and in his family relations, he abandoned the world and became a wandering ascetic. His *Abhangs* or "unbroken" hymns are famous in the country of his birth, but do not rise to any great height as poetry. Other Marathi poets are Srīdhar (1678–1728), who translated the *Bhāgavata Purāṇa*, and the learned Mayūra or Mōrōpant (1729–94). Mahīpati (1715–90) was an imitator of Tukārām, who collected the popular traditions about national saints. *Lāvaṇīs*, or erotic lyrics, by various writers, are popular, but are often more passionate than decent. The *Pawaḍas* or war-ballads, mostly by nameless poets, are sung everywhere throughout the country. There is a small prose literature consisting of narratives of historical events (the so-called *Bakhars*), moral maxims and popular tales.

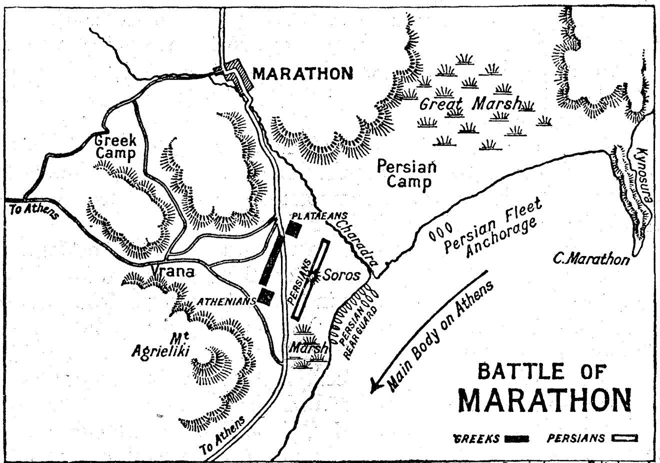
Konkani once had a literature of its own, which is said to have been destroyed by the Inquisition at Goa. Temples and manuscripts were burnt wholesale. Under Roman Catholic auspices a new literature arose, the earliest writer being an Englishman, Thomas Stephens (Thomaz Esteyão), who came to Goa in 1579, wrote the first Konkani grammar, and died there in 1619. Amongst other works, he was the author of a Konkani paraphrase of the New Testament in metrical form.

BIBLIOGRAPHY.—Marathi is fortunate in possessing the best dictionary of any modern Indian language, J. T. Molesworth's (1857). For learners Navalkar's (1894) and R. B. Joshi's (Poona, 1900) are the best grammars, while in J. Bloch's *La Formation de la Langue Marathe* (1914) we have an admirable history of the language, and of its present conditions, written by a trained philologist. *See* also *Grammatica da lingua Concani no dialecto do norte* by J. F. da Cunha Rivara (1858). For Konkani proper *see* A. F. X. Maffei's *Grammar* (Mangalore, 1882) and *Dictionaries* (*ibid.*, 1883) (in English). Monsenhor S. R. Dalgado is the author of a *Konkan-Portuguese Dictionary* (1893). A full account of Marathi, given in great detail, will be found in vol. vii. of the *Linguistic Survey of India* (1905).

MARATHON, a plain about 5m. long by 2m. wide on the east coast of Attica 24m. N.E. of Athens. There is a large marsh at the northern end from which extremity the Kynosura promontory a mile long ending in Cape Marathon forms an anchorage sheltered from the north and east. From the village of Marathon the Charadra brook bisects the plain and a small marsh lies at the southern end. Here (490 B.C.) 9,000 Athenian and 1,000 Plataean heavy infantry defeated part of a Persian army under Datis and Artaphernes. During the Ionian revolt the Athenians and Eretrians had aided the rebels in the attack on Sardis. The Persian king, Darius, ordered his generals to "enslave Athens and Eretria and bring the slaves into his presence." (Herodotus vi. 94.)

Eretria, after a siege, was surrendered by treachery. The city was destroyed and the inhabitants enslaved. The Persian host, guided by Hippias, the former tyrant of Athens, landed at Marathon "thinking to do the same to the Athenians." (Herodotus vi. 102.)

When news of the fall of Eretria reached Athens a courier, Pheidippides, was sent to Sparta for aid. Miltiades, with knowledge



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of war and of the Persians, was selected as one of the Athenian generals under the Polemarch, Callimachus, and seems to have dominated the war council and dictated the plan of campaign. The Athenians marched on Marathon to delay the Persian advance in the passes leading to Athens and to enable the Plataeans and Spartans to join. On the march the Plataeans came up. The passes were found unoccupied and the Greeks took up a position in the Avlona valley covering the direct roads to Athens and flanking the southern road. The result was to pin down the Persians. Against the Greek position in a narrow valley with both flanks secured by hills they could not use their cavalry. To advance by the southern road would commit their column to a defile between the mountains and the sea and enable the Greeks to fall upon their rear while the main body would be unable to come up. To re-embark would expose part of their army to almost certain disaster. In spite of the Spartan delay on account of a religious festival, time fought for the Athenians.

While the Spartans were on the Isthmus of Corinth the Persians embarked their cavalry and part of their infantry to make a dash on Athens by sea. A rear guard, probably about 20,000 strong, was drawn up on the southern part of the plain parallel with the beach. Callimachus, probably on the advice of Miltiades, decided to attack—the date was probably Sept. 21. A mile from the Persian line the Greeks were marshalled, the centre thinned so as to extend the line to equal that of the Persians and to strengthen the Athenian right under Callimachus and the Plataeans on the left. Down the sloping plain moved the bronze-clad Greeks. When the ranks came within range of the Persian missiles they broke into a charge. The weak Athenian centre recoiled; but the shock of the heavy Greek wings crushed in and rolled up the Persian flanks. The victorious Persian centre was then dealt with. The hostile rear guard was destroyed losing 6,400 killed. The Greeks lost 192. The Athenians then marched back to Athens and arrived in time to forestall a landing by the Persian main body.

The failure of the Persians was due to neglect of security measures and lack of aggressive action which resulted in failure to make use of superior numbers, and finally to a division of forces. The Greeks were prompt in action and sought to unite their strength for the decisive battle, and bring it to bear against a part of the Persian army. Tactically, the successful double envelopment of the hostile flanks foreshadowed the design of Cannae. If at Marathon the situation is unlikely to have been created intentionally, the opportunity at least was ably exploited. (*See* GRAECO-PERSIAN WARS.)

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MARATHON RACE, a race run over a distance of 26m. 385yds., which still commemorates the epic feat of Pheidippides in 490 B.C. News had reached the Athenians that Darius the Mede was crossing the Aegean sea to conquer the Greek States. Pheidippides, an Olympic champion runner, was despatched to enlist the aid of the Spartans. For two days and two nights he travelled, swimming the rivers and climbing the mountains in his path. Then he returned with the news that the Spartan army would start at the full moon. Meanwhile the Persians had landed and the Athenians, accompanied by Pheidippides, bearing his long spear and heavy shield, set out to meet the invaders in battle at Marathon. That encounter resulted in a victory for the Greeks and, forthwith, Pheidippides set out to bear the news to the capital. Unencumbered by his weapons he ran the 22 miles from Marathon to Athens, only to fall dead on the outskirts of the city as he gasped (in Greek), "Rejoice, we conquer!"

When the Olympic games were reinstated at Athens in 1896 a marathon race was included in the programme and, most appropriately, won by Loues, a Greek peasant, who covered the course in 2 hours 55mins. 20secs. The scenes which signallized the success of Loues were remarkable. When he entered the stadium at the end of the race, the Greek spectators rose as one man to celebrate their countryman's victory, women tore off their jewellery to fling it at his feet, a hotel proprietor gave him an order for 365 free meals, and even a street urchin pressed forward with the promise to black his boots for nothing for the rest of his life. Another memorable marathon race was that of 1908, run from Windsor Castle to the Olympic stadium at Shepherd's Bush, London. In that year the 2,000-year-old tragedy of Pheidippides was very nearly repeated. Dorando Pietri, 23 years of age and a restaurant waiter by calling, was entered as the chief representative of Italy. The race was run in exceptionally hot weather and the British representatives set up a pace at the start which was largely responsible for the terrible condition of the leading runners at the finish. Many of the 75 competitors who had started from Windsor collapsed by the way. Dorando, who ran pluckily throughout, was forced to abate his pace to a crawl when approaching the Stadium and collapsed, for the first time, at the entrance to the track; first aid was rendered and he rose to totter on around the arena. Fifty yards further and he went down again, and was again helped up. He fell for the third time and was afterwards almost carried past the winning post. Not unnaturally, protests were lodged by J. J. Hayes, U.S.A., and C. Hefferon, South Africa, who had finished second and third respectively, and Dorando Pietri, who could never have reached the tape without assistance, was disqualified. Her Majesty, the late Queen Alexandra, however, presented the plucky little Italian with a gold cup.

The event is now regarded as the blue-ribbon of the Olympic games and is honoured as a championship in all countries. Of the Olympic victors the United States, Finland, and France have each produced two, the other victors coming singly from Greece, South Africa, Argentina, and Japan.

It is impossible to assess truly either the world's or Olympic records on account of the varying conditions in different countries.

The fastest time recorded is that of K. Son, Japan, who won the Olympic Marathon Race, 1936, in 2 hrs. 29 mins. 19.2 secs., beating E. Harper, Great Britain, by 2 mins. 4 secs. In 1932 S. Ferris, Great Britain, was second to J. Zabala, Argentina.

Great Britain has been unfortunate in this event. In 1932 J. Zabala was forced to make a new Olympic record of 2 hrs. 31 mins. 36 secs. to beat S. Ferris; and although Harper beat this in 1936 by 12.8 secs., a badly blistered foot prevented him from keeping on terms with K. Son of Japan.

Marathon racing is far more strenuous than any form of track or cross-country running, since it is all road-work. The runner who aspires to marathon fame must go through a period of at least three months' rigorous training to make himself sound in wind and limb, so that he may gradually, and by constant practice, bring his muscles and sinews to the highest pitch of endurance. In this form of racing it is the pace and not the distance that kills. Style counts for little over this trying course. Tall, heavy runners are not well suited to the event. Small, light men, with powerful legs and plenty of lung and heart room, are the most likely to develop into long-distance champions, and to this class belong Dorando Pietri, J. J. Hayes and the Finnish Olympic champions, Hannes Kolehmainen and A. O. Stenross. It is unwise for young and immature athletes to attempt the marathon distance; it has, indeed, been proved that men of over 30 years are generally best fitted for this endurance race—witness the repeated success of Paavo Nurmi, Finland, in the Boston marathon.

See S. A. Mussabini, *The Complete Athletic Trainer* (1923); Alec Nelson, *Practical Athletics* (1924). (F. A. M. W.)

MARATTA (Maratti), **CARLO** (1625–1713), Italian painter of the Roman school. He was born at Camerano between Loreto and Ancona on May 13, 1625, and went early to Rome where he worked under Andrea Sacchi. He formed his style by studying the paintings of the Caracci and of Raphael. After the deaths of his master and of Pietro da Cortona he was for nearly half a century the most eminent painter in Rome. Six successive popes honoured him with their patronage. Innocent II. made him curator of the apartments in the Vatican and in the years 1702–03 he restored by order of Clement XI. the frescoes of Raphael in the Vatican and the Farnesina. For this service he was given the knighthood of the order of Christ. Louis XIV. nominated him a court painter. He died in Rome on Dec. 15, 1713. Maratta was an ardent admirer of Raphael, whose style, modified by the eclectic influence of the Caracci, he followed in opposition to the then prevailing Baroque style of Pietro da Cortona. His chief works, which are very numerous, are easel pictures in oil. His conceptions are graceful and lacking in vigour. There are several etchings by this painter. His life has been described by his intimate friend G. P. Bellori in *La Vita di Carlo Maratta* (1731).

MARAZION, a small seaport of Cornwall, England, on the shore of Mount's bay, 2 m. E. of Penzance. Pop. (1931) 1,126. A causeway of boulders and pebbles, thrown up by the sea and passable at low tide, unites Marazion with the insular St. Michael's Mount (*q.v.*). The charter attributed to Robert, count of Mortain, granting lands and liberties to St. Michael's Mount, opposite Marazion, included a market on Thursdays. This appears to have been held from the first on the mainland. From it is probably derived the Marghasbigan (*Parvum Forum*) of the earlier and the Marghasyewe or Marketjew (*Forum Tovis*) of the later charters. Richard, king of the Romans, provided that the three fairs, on the two feasts of St. Michael and at Mid-Lent, and the three markets which had hitherto been held by the priors of St. Michael's Mount on land not their own at Marghasbigan, should in future be held on their own land at Marchadyou. To remedy the loss incurred by this measure Ralph Bloyou in 1331 procured for himself and his heirs a market on Mondays and a fair on the vigil, feast and morrow of St. Andrew at Marghasyon. In 1595 Queen Elizabeth granted to Marazion a charter of incorporation. This ratified the grant of St. Andrew's fair, provided for another on the Feast of St. Barnabas and established a market on Saturdays. In 1883 the old corporation ceased to function, and its property was vested in the charity commissioners. Of the fairs only the Michaelmas fair has survived and all the markets have gone. Remains of an ancient bronze furnace, discovered near the town, tend to prove that tin-smelting was practised here at an early period. Marazion was once a flourishing town, and owed its prosperity to the throng of pilgrims who came to visit St. Michael's Mount. During the first half of the 16th century it was twice plundered; first by the French, and later by the Cornish rebels. The rise and progress of the neighbouring borough of Penzance in the 17th century seriously affected Marazion.

The church of St. Hilary, destroyed by fire in 1853, had a very fine spire, which has been reproduced in the restored building. The inscribed stones in the churchyard date from the 4th century, one being in honour of Constantine the Great. Another has Cornish lettering, which can no longer be deciphered; and there are British and Roman crosses. Market gardening is extensively carried on, and there is a fishing industry.

MARBLE, a term applied to any limestone or dolomite which is sufficiently close in texture to admit of being polished (from Lat. *marmor*, Gr. *μάρμαρος* shining stone). Many other ornamental stones—such as serpentine, alabaster and even granite—are sometimes loosely designated marble, but by accurate writers the term is invariably restricted to those crystalline and compact varieties of carbonate of lime (occasionally with carbonate of magnesia) which, when polished, are decorative. The crystalline structure is typically shown in statuary marble. A fractured surface of this stone displays a multitude of sparkling facets, which are the rhombohedral cleavage-planes of the component grains. The beautiful lustre of polished statuary marble is due to the light penetrating for a short distance into the rock and then suffering reflection at the surfaces of the deeper-lying crystals. The durability of marble in a dry atmosphere or when protected from rain renders it a valuable building stone; on the other hand, when exposed to the weather or the acid atmosphere of large cities, its surface readily crumbles.

Statuary and Economic Marbles.—Among statuary marbles the first place may be assigned to the famous Pentelic marble, the material in which Pheidias, Praxiteles and other Greek sculptors executed their principal works; it came from the quarries of Mount Pentelicus in Attica, and its characteristics are well seen in the Elgin marbles from the Parthenon at Athens now at the British Museum. Parian marble, another stone much used by Greek sculptors and architects, was quarried in the isle of Paros, chiefly at Mount Marpessa. It is called by ancient writers *lychnites* (Gr. *λύχνος*, a lamp) in allusion to the fact that the quarries were worked by the light of lamps. The Venus de' Medici is a notable example of work in this material. Carrara marble is better known than any of the Greek marbles, inasmuch as it constitutes the stone invariably employed by the best sculptors of the present day; it occurs abundantly in the Apuan Alps, an offshoot of the Apennines, and is largely worked in the neighbourhood of Carrara, Massa and Serravezza. Stone from this district was employed in Rome for architectural purposes in the time of Augustus, but the finer varieties, adapted to the needs of the sculptor, were not discovered until some time later. It is in Carrara marble that the finest works of Michelangelo and of Canova are executed; the purest varieties are snow-white and are of fine saccharoidal texture. Silica is disseminated through some of the marble, becoming a source of annoyance to the workman; while occasionally it separates as beautifully pellucid crystals of quartz known as "Carrara diamonds."

Other Varieties of Marble.—Certain calcareous metamorphic rocks frequently form stones which are sufficiently beautiful to be used for ornamental purposes, and are generally classed as marbles. Such serpentinous limestones are included by petrologists under the term *ophicalcite*. The famous *verde antico* is a rock of this character.

Many marbles which are prized for the variegated patterns they display owe these patterns to their formation in concentric zones—such marbles being in fact stalagmitic deposits of carbonate of lime, sometimes consisting of aragonite. One of the most beautiful stalagmitic rocks is the so-called onyx marble of Algeria. This was largely used in the buildings of Carthage and Rome, but the quarries which yielded it were rediscovered near Oued-Abdallah only in 1849. The stone is a beautifully translucent material, delicately clouded with yellow and brown, and is greatly prized by French workmen. Large deposits of a very fine onyx-like marble, similar to the Algerian stone, have been worked at Técali, about 35 m. from the city of Mexico. Among other stalagmitic marbles, mention may be made of the well-known Gibraltar stone, which is often worked into models of cannon and other ornamental objects. This stalagmite is much deeper in colour and less translucent than the onyx marbles of Algeria and Mexico. A richly tinted stalagmitic stone worked in California is known as Californian marble. It is worth noting that the "alabaster" of the ancients was stalagmitic carbonate of lime, and that this stone is therefore called by mineralogists "Oriental alabaster" in order to distinguish it from our modern "alabaster," which is a sulphate, and not a carbonate, of lime. Gypsum capable of taking a polish is found at Fauld in Staffordshire and in Italy and Spain.

The brown and yellow colours which stalagmitic marbles usually present are due to the presence of oxide of iron. This colouring matter gives special characters to certain stones, such as the *giallo antico,* or antique yellow marble of the Italian antiquaries. Siena marble is a reddish mottled stone obtained from the neighbourhood of Siena in Tuscany; and a somewhat similar stone is found in King's county, Ireland. True red marble is by no means common, but it does occur, of bright and uniform colour, though in very small quantity, in the Carboniferous limestone of Derbyshire and north-east Staffordshire. The red marble called *rosso antico* is often confounded with the *porfido rosso antico,* which is really a mica-hornblende-porphyrite owing its red colour to the mineral withamite.

Fire marble is a brown shelly limestone containing ammonites and other fossil shells, which present a brilliant display of iridescent colours, like those of precious opal. It occurs in rocks of Liassic age at the lead-mines of Bleiberg in Carinthia, and is worked into small ornamental objects.

Occurrence in Great Britain.—Although crystalline marbles fit for statuary work are not found to any extent in Great Britain, the limestones of the Palaeozoic formations yield a great variety of marbles well suited for architectural purposes. The Devonian rocks of south Devon are rich in handsome marbles, presenting great diversity of tint and pattern. Plymouth, Torquay, Ipplepen, Babbacombe and Chudleigh may be named as the principal localities. Many of these limestones owe their beauty to the fossil corals which they contain, and are hence known as "madrepore marbles." Of far greater importance, however, are the marbles from the Carboniferous or Mountain Limestone, whence British marbles are mainly derived. Marbles of this age are worked in Derbyshire and Yorkshire, in the neighbourhood of Bristol, in North Wales, in the Isle of Man, and in various parts of Ireland; one of the most beautiful is the "encrinital marble," a material which owes its peculiarities to the presence of numerous encrinites, or stone-lilies, fossils which, when cut in various directions, give a characteristic pattern to the stone. The joints of the stems and arms are known from their shape as "wheel-stones," and the rock itself has been called "entrochal marble." The most beautiful varieties are those in which the calcareous fossils appear as white markings on a ground of grey limestone. In Belgium a black marble with small sections of crinoid stems is known as *petit granit,* while in Derbyshire a similar rock, crowded with fragments of minute encrinites, is termed "bird's-eye marble."

Perhaps the most generally useful marbles yielded by the Carboniferous system are the black varieties, which are largely employed for chimney-pieces, vases, etc. The colour of most black limestone is due to the presence of bituminous matter. Such limestone commonly emits a fetid odour when struck; and the colour, being of organic origin, is discharged on calcination.

British limestones of Mesozoic and Tertiary age are not generally compact enough to be used as marbles, but some of the shelly beds are employed to a limited extent for decorative purposes. The most important Mesozoic marbles are the shelly limestones of the Purbeck formation, which were a favourite material with mediaeval architects for slender clustered columns and sepulchral monuments. It consists of a mass of the shells of a freshwater snail, *Paludina carinifera,* embedded in a blue, grey or greenish limestone, and is found in the Upper Purbeck beds of Swanage. Excellent examples of its use may be seen in Westminster Abbey and in the Temple Church, as well as in the cathedrals of Salisbury, Winchester, Worcester and Lincoln. Sussex marble is very similar, occurring in thin beds in the Weald clay and consisting largely of the shells of *Paludina,* principally *P. sussexiensis* and *P. fluviorum.* The altar stones and the episcopal chair in the cathedral at Canterbury are made of this material.

Marble in the United States.—America possesses some valuable deposits which, in the eastern States, have been extensively worked. The crystalline limestones of western New England furnish an abundance of white and grey marble, while a beautiful material fit for statuary has been quarried near Rutland, Vt. A grey bird's-eye marble is obtained from central New York, and the greyish clouded limestones of Thomaston, Me., have been extensively quarried. Of the variegated and coloured marbles, perhaps the most beautiful are those from the northern part of Vermont, in the neighbourhood of lake Champlain. A fine brecciated marble is found on the Maryland side of the Potomac, below Point of Rocks. Among the principal localities for black marble may be mentioned Shoreham, Vt., and Glens Falls, N.Y. In 1937 the production of dimension marble in the United States was valued at $5,134,721, of which $3,336,545 was building marble and $1,798,176 monumental marble. Production by leading States in 1937 was Vermont, $1,539,571; Tennessee, $1,384,961; Georgia, $1,030,407; Missouri, $445,114; Alabama, $313,663; Arkansas, $22,902; all other States, $398,103.

In Canada the crystalline limestones of the pre-Cambrian series yield beautiful marbles.

Marble in Other Countries.—The quarries of France, Belgium, Italy and Spain, not to mention less important localities, yield a great diversity of marbles, and almost every stone bears a distinctive name, often of trivial meaning; but in this article it is impossible to enumerate the local names used by marble-workers in different countries. In India we find important quarries at Makrana in Rajputana—a locality which is said to have yielded the marble for the famous Taj Mahal at Agra. In the valley of the Nerbudda, near Jabalpur, there is a large development of marble. The white marble which is used for the delicately pierced screens called *jalee* work is obtained from near Raialo, in Ulwar. (F. W. R.; X.)

Petrography.—Marbles are uniformly crystalline, and hence have no bedding or schistosity which would tend to make them fissile, but are entirely massive and free from grain. The microstructure of pure marble is comparatively simple. Thin sections are seen to be built up of somewhat rounded grains of calcite, fitting closely together in a mosaic; very rarely do any grains show traces of crystalline form. They are colourless and transparent, and are usually traversed by a lattice-work of sharply defined cleavage cracks, which correspond to the rhombohedral faces. In polarized light the colours are pinkish or greenish white, or in very thin sections iridescent because the mineral has a very strong double refraction. They may also be crossed by bars or stripes, each of which indicates a twin plate, for the crystals are usually polysynthetic. This twinning may be produced by pressure acting either during the crystallization of the rock or at a later period.

The purest marbles generally contain some accessory minerals, and in many they form a considerable proportion of the mass. The commonest are quartz in small rounded grains, scales of colourless or pale yellow mica (muscovite and phlogopite), dark shining flakes of graphite and small crystals of pyrites or iron oxides. Even fine Carrara marble leaves a residue of this sort when dissolved in acid. Many marbles contain other minerals which are usually silicates of lime or magnesia. The list of these accessories is a very large one. Diopside is very frequent and may be white or pale green; hornblende occurs as white bladed tremolite or pale green actinolite; feldspars may be present also, such as orthoclase, or more frequently some plagioclase such as albite, labradorite and anorthite, scapolite (or wernerite); various kinds of garnet; vesuvianite, spinel, forsterite, periclase, brucite, talc, zoisite and epidote, chondrodite, biotite, datolite, sphene and apatite may be mentioned as typical accessory minerals. The presence of metalliferous minerals such as galena,

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VARIETIES OF ORNAMENTAL MARBLES

1. Forest green (serpentine), Italy
2. Campan mélange vert (sawn across the bed), France
3. Royal Jersey green (serpentine), Phillipsburg, N. J.
4. Campan mélange rouge (sawn with the bed), France
5. Morocco red flamme (sawn with the bed), Algeria
6. Roman breche, France
7. Monte skyrose, South America
8. Famosa violet "W," Germany
9. Benou jaune, France

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VARIETIES OF ORNAMENTAL MARBLES

1. Breche rose, Italy
2. Campan Griotte, France
3. Lumachelle, France
4. Loredo chiaro, Italy
5. Sienna Travertine, Germany
6. Escalette, France
7. Piastraccia veined, Italy
8. French grand antique, France
9. Napoleon grey, Central United States

grey or red silver ores, zinc blende, antimonite, chalcopyrite, molybdenite, cassiterite, usually indicates impregnation by ore-bearing solutions, especially if these substances occur in workable quantities. The rubies of Burma are found in crystalline limestones and are constantly accompanied by precious spinel (or balasruby).

These minerals represent impurities in the original limestone which crystallized at the time that the marble became crystalline. The silicates derive their silica mainly from sand or infiltrated siliceous deposits; the alumina represents an admixture of clay; the iron came from limonite or hematite in the original state of the rock. Where the silicates bulk largely because the original limestone was highly impure, all the carbonic acid may be driven out and replaced by silica during the process of recrystallization. The rock is then a calc-silicate rock, hard, tough, flinty and no longer readily soluble in acids. They are sometimes fine-grained hornstones (known as calc-silicate hornfelses). Where white minerals predominate (wollastonite, tremolite, feldspar) these rocks may have a close resemblance to marbles, but often they are green from the abundance of green pyroxenes and amphiboles, or brown (when garnet and vesuvianite are present in quantity) or yellow (with epidote, chondrodite or sphene). Decomposition induces further changes in colour owing to the formation of green or yellow serpentine, pale green talc, red hematite, and brown limonite. Most of the coloured or variegated crystalline marbles have originated in this manner. Often bands of calc-silicate rock alternate with bands of marble, and they may be folded or bent; in other cases, nodules and patches of silicates occur in a matrix of pure marble. Earth movements may shatter the rocks, producing fissures afterwards filled with veins of calcite; in this way the beautiful brecciated or veined marbles are produced. Sometimes the broken fragments are rolled and rounded by the flow of the marble under pressure and pseudo-conglomerates or "crush conglomerates" result. In other cases the banding of the marble indicates the original bedding of the calcareous sediments. Crystalline limestones which contain much mica may be called cipollins; in them quartz, garnet and hornblende often also occur. The *ophicalcites* are marbles containing much serpentine, which has been formed by the decomposition of forsterite or diopside. The much-discussed *Eozoon,* at one time supposed to be the earliest known fossil and found in Archaean limestones in Canada, is now known to be inorganic and to belong to the ophicalcites.

Many marbles, probably all, are metamorphosed limestones. The passage of limestones rich in fossils into true marbles as they approach great crystalline intrusions of granite is a phenomenon seen in many parts of the world; occasionally the recrystallization of the rock has not completely obliterated the organic structures (*e.g.,* at Carrara and at Bergen in Norway). The agencies which have induced the metamorphism are heat and pressure, the heat arising from the granite and the pressure from overlying masses of rock, for these changes took place before the granite cooled and while it was still deeply buried beneath the surface. As rocks which have undergone changes of this kind are commonest in the oldest and deepest layers of the earth's crust, most marbles are Palaeozoic or pre-Cambrian. They occur very often with mica schists, phyllites, etc., which were beds of clay alternating with the original limestone. In regions where the sedimentary rocks have been converted into schists, gneisses and granulites, the limestones are represented by calc schists, cipollins and marbles. Often no granite or other intrusive rock is present which may be regarded as the cause of the metamorphism. The marbles are often banded or schistose, and under the microscope show crushing and deformation of the component crystals, such as would have been produced by the earth pressures which accompany rock-folding. These crush structures have been obtained experimentally in marbles subjected to great pressures in steel cylinders. In the recrystallization of these limestones the direct heating action of igneous intrusions may have played no part, but the rise of temperature and increase of pressure due to the folding of great rock masses have probably been the operating causes.

(J. S. F.)

MARBLEHEAD, a town of Essex county, Massachusetts, U.S.A., on Massachusetts bay, 16 m. N.E. of Boston. It is served by the Boston and Maine railroad. The population was 10,856 in 1940 federal census. It is a quaint old town, occupying a rocky promontory about 4 sq.m. in area. Among the older buildings are the Lee Mansion (1768), which houses the Marblehead Historical Society, St. Michael's Church (Protestant Episcopal; 1714), the old Town Hall (1727), the Old Brig, and the Gerry house, where Elbridge Gerry was born. The harbour, formed by a rocky peninsula known as Marblehead Neck, is now a yachting centre. Along the picturesque rocky coast are the modern hotels, cottages and club-houses of the summer colony. The principal industries of the town are the manufacture of children's shoes, yacht and launch building and fishing. Marblehead was settled about 1629, and was set off from Salem and incorporated in 1649. In the early 17th century it received many colonists from the Channel islands. In the colonial period it was an important commercial, fishing and shipbuilding port, and at one period was one of the largest communities in Massachusetts. After the passage of the Boston Port Bill (1774) it was made the port of entry in place of Boston, but its merchants patriotically put their wharves and warehouses at the disposition of the Boston merchants and refused to profit by the opportunity. During the Revolution many vessels set out from this port, including the "Lee," which in Nov., 1775 captured the "Nancy," with military stores valued at £20,541. The sea fight between the "Chesapeake" and the "Shannon" (June 1, 1813) took place off the adjacent coast. Marblehead claims to be the birthplace of the American Navy, as the schooner "Hannah," manned and fitted here, was the first American warship regularly commissioned (Sept. 2, 1775, by General Washington) by authority derived from the United Colonies.

MARBOT, JEAN BAPTISTE ANTOINE MARCELIN, Baron de (1782–1854), French soldier, son of General Jean Antoine de Marbot (1754–1800), who died in the defence of Genoa under Masséna, was born at La Rivière (Corrèze) on Aug. 18, 1782. He joined the republican army as a volunteer in 1799. He was aide-de-camp to Marshal Augereau, commanding the VII. corps, in the war against Prussia and Russia in 1806–7. After this he served in the Peninsular War under Lannes and Masséna, in the Russian War of 1812 and the German campaign of the following year. After a slow recovery from the wounds he had received at Leipzig and Hanau, he was promoted general of brigade by Napoleon during the Hundred Days, and took part in, and was wounded at, the battle of Waterloo. He was exiled at the second restoration and only returned to France in 1819. His intimacy with the duke of Orleans secured him important military positions. Under the July monarchy he was present at the siege of Antwerp in 1832. He was promoted lieutenant-general in 1836. From 1835 to 1840 he served in various Algerian expeditions, and in 1845 he was made a member of the Chamber of Peers. Three years later, at the fall of Louis Philippe, he retired into private life. He died at Paris on Nov. 16, 1854. Marbot's fame rests on the fascinating *Memoirs of his Life and Campaigns* (1891; Eng. trans., 1902).

His elder brother, Antoine Adolphe Marcelin de Marbot (1781–1844), served in Napoleon's campaigns of 1808 to 1812, and again in the Hundred Days. He returned to the army after 1830.

MARBURG, a university town in the Prussian province of Hesse-Nassau, Germany, on the right bank of the Lahn, 60 mi. by rail N. of Frankfort-on-Main, on the main line to Cassel. Pop. (1939) 29,010. Marburg is first historically mentioned in a document of the beginning of the 13th century, and received its municipal charter from the landgrave Louis of Thuringia in 1227. By 1247 Marburg had already become the second town of Hesse, and in the 15th and 16th centuries it alternated with Cassel as the seat of the landgraves. In 1529 the famous conference between Luther and Zwingli on the subject of Transubstantiation took place there in the Rittersaal of the Schloss. The hill on which the town lies is crowned by the Schloss, a Gothic building, the most noteworthy parts of which are the Rittersaal, dating from 1277–1312, and the little chapel. This Schloss is now the repository of the archives of Hesse. The Elizabethenkirche, in the purest Early Gothic style, was erected by the grand master of the Teutonic Order in 1235–83, to contain the tomb of St. Elizabeth of Hungary, who was the wife of the landgrave Louis. She built a hospital here, and died in 1231, worn out with works of charity. In 1235 she was canonized at the instance of the Teutonic Knights who were zealous in promoting her cult. Her rich silver-gilt sarcophagus may still be seen, but the Protestant zeal of Landgrave Philip the Generous caused him to remove the body to some unknown spot in the church. The Lutheran church is another Gothic edifice, mainly 15th century. The town hall, built in 1512, and several houses in the Renaissance style, also deserve mention. The university of Marburg, founded in 1527, was the first university established without papal privileges, and acquired a great reputation throughout Protestant Europe. Marburg is the seat of a district court. Marburg pottery is renowned; and soap, iron wares and surgical instruments are also manufactured there.

MARBURG, COLLOQUY OF, the name given to a conference of divines held in 1529 in the interests of the unity of Protestant Germany. The circumstances in which it was held, the influence of the men who conducted its deliberations, and the result of its proceedings, combine to render it of no small importance for the history of the Reformation in Germany.

The measures taken by the Catholic party to resist the progress of the Reformation, especially by resolutions at Speyer (1526 and 1529), would be met only by the united force of all the princes and states subscribing to the Evangelical teaching; and this unity was wanting. The feud which raged round the doctrine of the Lord's Supper had already broken out before the first diet of Spires, and had aroused great and immediate excitement. At a very early period, however, efforts were made to allay the dissension. Strassburg pronounced for conciliation: but the most powerful and zealous champion of peace was to be found in the landgrave Philip of Hesse, who recognized the absolute necessity—from a political standpoint—of the union of all German Protestants. It was obvious that a permanent coalition could not be expected unless some definite understanding on the debated point could be attained; and the landgrave succeeded in bringing about a conference or "colloquy" at Marburg, in October 1529.

The proceedings opened on the 1st of October with conferences between Luther and Oecolampadius, and Melanchthon and Zwingli: then on the two following days the discussion proper—confined almost entirely to Luther and Zwingli—was held before the landgrave and his guest Duke Ulrich of Württemberg, in the presence of more than fifty persons. As regards the main point of contention, *i.e.,* the doctrine of the Lord's Supper, no agreement was found practicable; and the private conversations on the 4th of October, which formed the sequel of the debate, carried matters no farther. Since the landgrave, however, was reluctant to see the colloquy brought to an absolutely fruitless close, he requested Luther to draw up a list of the most important points of doctrine on which it might yet be possible to arrive at some degree of unanimity. This was done on the 4th of October; and a few alterations were introduced to meet the wishes of the Swiss deputies. The *Articles of Marburg,* which thus came into being, contain the doctrine of the Trinity, of the personality of Christ, of faith and justification, of the Scriptures, of baptism, of good works, of confession, of government, of tradition and of infant baptism. The fifteenth article, treating of the Lord's Supper, defines the ground common to both parties even in this debatable region, recognizing the necessity of participation in both kinds, and rejecting the sacrifice of the Mass. It then proceeds to fix the point of difference in the fact that no agreement had been reached on the question "whether the true body and blood of Christ are corporeally present in the bread and wine."

See T. Kolde, *s.v.* "Marburger Religionsgespräch," in *Realencyklopädie f. protestant. Theologie,* 3rd ed. xii. 248 *seq.*

MARC, FRANZ (1880–1916), German painter, was born at Munich on July 4, 1880, the son of the painter, Wilhelm Marc. He studied at Munich under Hackl and W. von Dietz. The decisive impulse came only when he got into touch with the group of painters including Kandinsky, Jawlenski and Macke who founded the "Blue Knight" (*Blauer Reiter*) in 1911. One of his most famous pictures entitled "Tierschicksale" (Destinies of Beasts) is characteristic of his whole work, which is singularly compact, not merely in choice of motive, but also in pictorial composition. A leaning towards metaphysics, towards abstraction from the world of reality, gives many of his pictures a problematic character. Marc was killed near Verdun on March 4, 1916.

MARCA, PIERRE DE (1594–1662), French prelate and historian, born at Gan, near Pau, on Jan. 24, 1594, attracted the notice of Richelieu by his support of the Catholic cause in the south during the wars of religion. Richelieu brought him to Paris as counsellor of State in 1640. He defended the "Gallican liberties" in the famous treatise, *De concordia sacerdotii et imperii, seu de libertatibus ecclesiae gallicanae* (1641). He was governor of Catalonia during the French occupation and, after holding various ecclesiastical preferments, was nominated archbishop of Paris in succession to De Retz in February 1662. He died on June 29 of the same year.

Marca made a minute study of the archives of Béarn and of the history of Catalonia. His *Histoire de Béarn* (1640) is valuable for the number of charters and other documents which it contains. *Marca hispanica* (1688), left unfinished at his death, was completed by his friend Baluze.

See the article "Marca" in Bayle's *Dictionnaire historique et critique.*

MARCANTONIO [MARCANTONIO RAIMONDI] (*c.* 1480–*c.* 1530), the chief Italian master of the art of engraving of the Renaissance, and the first who practised it in order to reproduce, not designs of his own invention, as earlier craftsmen had commonly done, but those of other artists almost exclusively. He was born probably about 1480 at Bologna. As early as 1504 he is mentioned as an artist of repute in G. P. Achillini's *Viridario.* His earliest dated plate, illustrating the story of Pyramus and Thisbe, is ascribed to the year 1505. Marcantonio received his training in the workshop of the famous goldsmith and painter, Francesco Raibolini, called Francia. "Having more aptitude in design," says Vasari, "than his master, and managing the graver with facility and grace, he made waist-buckles and many other things in niello, such being then greatly in fashion, and made them most beautifully, as being in truth most excellent in that craft."

The real fame, however, of Marcantonio was destined to be founded on his attainments in that particular development of the goldsmith's art which consists of engraving designs on metal plates for reproduction by the printing press. About eighty engravings can be referred to the first five or six years of his career (1505–1511). Their subjects are very various, including many of pagan mythology, and some of obscure allegory, along with those of Christian devotion. The types of figures and drapery, and the general character of the compositions, bespeak for the most part the inspiration, and sometimes the direct authorship, of Francia. But the influence of German example is very perceptible also, particularly in the landscape backgrounds, and in the endeavour to express form by means of light and shadow with greater freedom than had been hitherto the practice of the Italian schools.

It may have been for the sake of commercial profit or for the sake of improving his style that he by-and-by produced a series of direct counterfeits on copper from Albrecht Dürer's woodcuts. These facsimiles are sixty-nine in number, including seventeen of Dürer's "Life of the Virgin," thirty-seven of his "Little Passion," on wood, and a number of single pieces. The "Life of the Virgin" was copied in 1506 and signed with Dürer's signature. Dürer who visited Italy in that year complained to the Venetian Senate of this action of Marcantonio, who then added his own signature to the copies which he subsequently made and completed in 1510 of Dürer's "Little Passion." The Bolognese engraver profited greatly by the study of the energetic line work and the method of modelling by cross-hatching of the Nuremberg master. He was soon to come under a totally different influence, and to turn the experience he had gained to account in interpreting the work of a master of a quite other stamp. Up till the year 1510 Marcantonio had lived entirely at Bologna, with the exception, it would appear, of a visit or visits to Venice. A few of his early engravings are from drawings of the school of Giorgione.

Very soon afterwards he was attracted, for good and all, into the circle which surrounded Raphael at Rome. Where or when he had first made Raphael's acquaintance is uncertain. His passage to Rome by way of Florence has been supposed to be marked by an engraving, dated 1510, and known as "The Climbers," *Les Grimpeurs* (Bartsch, 487), in which he has reproduced a portion of the design of Michelangelo's cartoon of the soldiers surprised bathing, and has added behind the figures a landscape imitated from the then young Dutch engraver Lucas of Leiden. Contemporary or somewhat earlier than this is a large engraving done by him from a design by Baldassare Peruzzi, a Sienese artist drawn about the same time into the Raphael circle. The piece in which he is recorded to have first tried his hand after Raphael himself is the Lucretia (Bartsch, 192). From that time until he disappears in the catastrophe of 1527, Marcantonio was almost exclusively engaged in reproducing by means of engraving the designs of Raphael or of his immediate pupils. Raphael, the story goes, was so delighted with the print of the Lucretia that he personally trained and helped Marcantonio afterwards.

A printing establishment was set up under the charge of Raphael's colour-grinder, Il Baviera, and the profits, in the early stage of the business, were shared between the engraver and the printer. The sale soon became very great; pupils gathered round about Marcantonio, of whom the two most distinguished were Marco Dente, known as Marco da Ravenna, and Agostino de' Musi, known as Agostino Veneziano; and he and they, during the last ten years of Raphael's life, and for several years following his death, gave forth a great profusion of engravings after the master's work—not copying, in most instances, his finished paintings, but working up, with the addition of simple backgrounds and accessories, his first sketches and trials, which often give the composition in a different form from the finished work, and are all the more interesting on that account.

Marcantonio's best engravings were done during the first few years after he had attached himself to Raphael. In them he enters into the genius of his master, and loses little of the chastened science and rhythmical purity of Raphael's contours, or of the inspired and winning sentiment of his faces; while in the parts where he is left to himself—the rounding and shading, the background and landscape—he manages his burin with all the skill and freedom which he had gained by the imitation of northern models, but puts away the northern emphasis and redundance of detail. His work, however, does not long remain at the height marked by pieces like the Lucretia, the Dido, the Judgment of Paris, the Poetry, the Philosophy, or the first Massacre of the Innocents. Marcantonio's engravings after the works of Raphael's later years are cold, ostentatious, and soulless by comparison. Still more so, as is natural, were those which he and his pupils produced after the designs of the followers of Raphael and Michelangelo, of a Giulio Romano, a Polidoro, or a Bandinelli.

Marcantonio's association with Giulio Romano was the cause of his first great disaster in life. He engraved a series of obscene designs by that painter in illustration of the *Sonnetti lussuriosi* of Pietro Aretino, which caused his temporary banishment from Rome. Marcantonio's ruin was completed by the calamities attendant on the sack of Rome in 1527. He had to pay a heavy ransom in order to escape from the hands of the Spaniards, and fled from Rome, in the words of Vasari, "all but a beggar." It is said that he took refuge in his native city, Bologna; but he never again emerges from obscurity, and all we know with certainty is that in 1534 he was dead.

See H. Delaborde, *Marcantonio Raimondi* (1887); H. Hirth, *Marcanton und sein Styl* (Munich, 1898); Wickhoff, *Jahrbuch* (Vienna, xx. 181, 1899); P. Kristeller, *Kupferstich u. Holzschnitt* (1905); A. M. Hind, *Great Engravers* (1912); and *History of Engraving and Etching* (1923).

MARCASITE, a mineral with the same chemical composition as pyrite, being iron disulphide FeS_2, but crystallizing in the orthorhombic instead of in the cubic system. The name is of Arabic origin and was long applied to crystallized pyrites in general. It was known to G. Agricola in 1546 as *Wasserkies* or *Weisserkies* and *Leberkies*, and it has been variously known as white pyrites, hepatic pyrites, lamellar pyrites, radiated pyrites (German *Strahlkies*) and prismatic pyrites.

The crystals are isomorphous with mispickel (*q.v.*), but only rarely are they distinctly developed and simple. Often they are twinned on a prism plane producing pentagonal stellate groups of five crystals. This frequent twinning gives rise to characteristic forms, with many re-entrant angles, to which the names "spear pyrites" and "cockscomb pyrites" are applied. The commonest state of aggregation is that of radially arranged fibres, the external surface of the mass being globular, nodular or stalactitic in form.

Apart from crystalline form, the external characters of marcasite are very similar to those of pyrite, and when distinct crystals are not available the two species cannot always be easily distinguished. The colour is usually pale bronze-yellow, often rather lighter than that of pyrite; on freshly fractured surfaces of pure marcasite the colour is tin-white, but this rapidly tarnishes on exposure to air. The lustre is metallic and brilliant, the streak greyish or brownish-black. The hardness (6–6½) is the same as that of pyrite, and the specific gravity (4·8–4·9) as a rule rather less. It readily oxidizes on exposure to moist air, with the production of sulphuric acid and a white fibrous efflorescence of ferrous sulphate, and in course of time specimens in collections often become completely disintegrated. In nature it is frequently altered to limonite. Marcasite is thus the less stable of the two modifications of iron disulphide. Many experiments have been made with a view to determining the difference in chemical constitution of marcasite and pyrite, but with no very definite results. Marcasite has been prepared artificially from acid solutions, whilst pyrite is formed only from slightly acid or neutral solutions.

Marcasite occurs under the same conditions as pyrite, but is much less common. While pyrite is found abundantly in the older crystalline rocks and slates, marcasite is more abundant in clays, and has often been formed as a concretion around organic remains. It is abundant, for example, in the plastic clay of the brown coal formation at Littmitz, near Carlsbad, where it has been extensively mined for the manufacture of sulphur and ferrous sulphate. In the chalk of the south-east of England nodules of marcasite with a fibrous radiated structure are abundant (these bodies being often mistaken for "thunderbolts" or meteorites), and in the chalk marl between Dover and Folkestone fine twinned groups of "spear pyrites" are common. The mineral is also met with in metalliferous veins; for example the "cockscomb pyrites" of the lead mines of Derbyshire and Cumberland.

MARCEAU, FRANÇOIS SEVERIN DESGRAVIERS (1769–1796), French general, was born at Chartres on March 1, 1769. He studied law, but joined the army in 1785. He joined in the attack on the Bastille (July 14, 1789), and then took his discharge from the regular army. Later he joined the National Guard, and in March 1792 became lieutenant-colonel of a battalion of the Eure-et-Loire, taking part in the defence of Verdun in 1792. He was re-employed as captain in the regular service, but in 1793 was imprisoned for some time with other officers as a "suspect." On his release he fought at Saumur against the Vendéen royalists, and rescued Bourbotte (June 10, 1793) from the insurgents. Marceau became general of division (Nov. 10), and with Kléber, who became his personal friend, won important victories near Le Mans (Dec. 12–13) and Savenay (Dec. 21), but after their retirement from the war they were only saved from arrest and execution by the intervention of Bourbotte. After spending the winter of 1793–94 in Paris, Marceau took command in the army under Jourdan in which Kléber also served, and distinguished himself in the campaigns of 1794 and 1795. In the campaign of 1796 Marceau's men covered Jourdan's retreat over the Rhine. He fought the desperate actions on the Lahn (Sept. 16 and 18), and at Altenkirchen on Sept. 19 received a mortal wound, of which he died on the 21st. His body was burned, and his ashes, which at the time were placed under a pyramid designed by Kléber, were transferred in 1889 to the Pantheon at Paris.

See Maze, *Le Général Marceau* (1888); Parfait, *Le Général Marceau* (1892); and T. C. Johnson, *Marceau* (London, 1896).

MARCEL, ÉTIENNE (d. 1358), provost of the merchants of Paris under King John II., is mentioned as provost of the Grande-Confrérie of Notre Dame in 1350, and in 1354 he succeeded Jean de Pacy as provost of the Parisian merchants. His political career began in 1356, when John was made prisoner after the battle of Poitiers. In conjunction with Robert le Coq, bishop of Laon, he played a leading part in the states-general called together by the dauphin Charles on Oct. 17. A committee of eighty members, constituted on their initiative, pressed their demands with such insistence that the dauphin prorogued the states-general; but financial straits obliged him to summon them once more on Feb. 3, 1357, and the promulgation of an edict of reform was the consequence. John the Good forbade its being put into effect, whereupon a conflict began between Marcel and the dauphin, Marcel endeavouring to set up Charles the Bad, king of Navarre, in opposition to him. The states-general assembled again on Jan. 13, 1358, and on Feb. 22, the populace of Paris, led by Marcel, invaded the palace and murdered the marshals of Champagne and Normandy before the prince's eyes. Thenceforward Marcel was in open hostility to the throne. After vainly hoping that the insurrection of the Jacquerie might turn to his advantage, he next supported the king of Navarre, whose armed bands infested the neighbourhood of Paris. On the night of July 31 Marcel was about to open the gates of the capital to them, but Jean Maillart prevented the execution of this design, and killed him before the Porte Saint-Antoine.

See F. T. Perrens, *Étienne Marcel et le gouvernement de la bourgeoisie au xiv*e *siècle* (1860); P. Frémaux, *La Famille d'Étienne Marcel*, in the *Mémoires* of the *Société de l'histoire de Paris et de l'Île de France* (1903), vol. xxx.; and Hon. R. D. Denman, *Étienne Marcel* (1898).

MARCELLINUS, ST., according to the Liberian catalogue, became bishop of Rome on June 30, 296; his predecessor was Caius or Gaius. He is not mentioned in the *Martyrologium hieronymianum*, or in the *Depositio episcoporum*, or in the *Depositio martyrum*. The *Liber pontificalis*, basing itself on the Acts of St. Marcellinus, the text of which is lost, relates that during Diocletian's persecution Marcellinus was called upon to sacrifice, and offered incense to idols, but that, repenting shortly afterwards, he confessed the faith of Christ and suffered martyrdom with several companions. According to the *Liber pontificalis*, Marcellinus was buried, on April 26, 304, in the cemetery of Priscilla, on the Via Salaria, 25 days after his martyrdom; the Liberian catalogue gives as the date Oct. 25. After a considerable interregnum he was succeeded by Marcellus, with whom he has sometimes been confounded.

See L. Duchesne, *Liber pontificalis*, I. lxxiii.–lxxiv. 162–163, and II. 563.

MARCELLO, BENEDETTO (1686–1739), Italian musical composer, was a pupil of Lotti and Gasparini, but was intended by his father for the law. In 1711 he was a member of the Council of Forty, and in 1730 went to Pola as Provveditore. He retired after eight years to Brescia in the capacity of *camerlengo*, and died there on July 24, 1739.

Marcello is best remembered by his *Estro poetico-armonico* (Venice, 1724–1727), a musical setting for voices and strings of the first fifty Psalms, as paraphrased in Italian by G. Giustiniani. Charles Avison and John Garth brought out an edition with English words (London, 1757). His other works are chiefly cantatas.

A catalogue of his works is given in *Monatshefte für Musikgeschichte*, vol. xxiii. (1891).

MARCELLUS, the name of two popes.

MARCELLUS I. succeeded Marcellinus, after a considerable interval, most probably in May 308, under Maxentius. He was banished from Rome in 309 on account of the tumult caused by the severity of the penances he had imposed on Christians who had lapsed under the recent persecution. He died the same year, being succeeded by Eusebius. He is commemorated on Jan. 16.

MARCELLUS II. (Marcello Cervini), the successor of Julius III., was born on May 6, 1501, and was elected pope on April 9, 1555. As president of the Council of Trent he had incurred the anger of the emperor by his jealous defence of papal prerogative. He died on April 30, 1555. He was followed by Paul IV.

Contemporary lives are to be found in Panvinio, continuator of Platina, *De vitis pontiff. rom.*; and Ciaconius, *Vitae et res gestae summorum pontiff. rom.* (Rome, 1601–02). P. Polidoro, *De gestis, vita et moribus Marcelli II.* (Rome, 1744), makes use of an unpublished biography of the pope by his brother, Alessandro Cervini. *See* also Brilli, *Intorno alla vita e alle azioni di Marcello II.* (Montepulciano, 1846); Ranke, *Popes* (Eng. trans., Austin), i. 284 *seq.*; A. von Reumont, *Gesch. der Stadt Rom*), iii. 2, 512, *seq.*

MARCELLUS, a Roman plebeian family belonging to the Claudian gens. Its most distinguished members were the following:—

1. MARCUS CLAUDIUS MARCELLUS (*c.* 268–208 B.C.), one of the Roman generals during the Second Punic War and conqueror of Syracuse. He first served against Hamilcar in Sicily. In his first consulship (222) he was engaged, with Cn. Cornelius Scipio as colleague, in war against the Insubrian Gauls, and won the *spolia opima* for the third and last time in Roman history by slaying their chief Viridomarus or Virdumarus (Polybius ii. 34; Propertius v. 10, 39). In 216, after Cannae, he took command of the remnant of the army at Canusium, and although he was unable to prevent Capua going over to Hannibal, he saved Nola and southern Campania. In 214 he was in Sicily as consul at the time of the revolt of Syracuse; he stormed Leontini and besieged Syracuse, but the skill of Archimedes repelled his attacks. He took it after a two years' siege, and set the example of carrying away the art treasures of a captured city. Consul again in 210, he took Salapia in Apulia, which had revolted to Hannibal, and put to death the Numidian garrison. Proconsul in 209, he attacked Hannibal near Venusia, into which he retired after a desperate battle. In his last consulship (208), he and his colleague, while reconnoitring near Venusia, were unexpectedly attacked, and Marcellus was killed. His successes have been exaggerated by Livy, but the name often given to him, the "sword of Rome," was well deserved.

Livy xxiii. 14–17, 41–46; xxiv. 27–32, 35–39; xxv. 5–7, 23–31; xxvi. 26, 29–32; xxvii. 1–5, 21–28; Polybius viii. 5–9, x. 32; Appian, *Hannib.* 50; Florus ii. 6.

2. M. CLAUDIUS MARCELLUS, an inveterate opponent of Julius Caesar. During his consulship (51 B.C.) he proposed to remove Caesar from his army in March 49, but was outmanoeuvred by Curio. In January 49 he tried to put off declaring war against Caesar till an army could be got ready, but his advice was not taken. He followed Pompey when he left for Italy, and after Pharsalus retired to Mytilene, where he practised rhetoric and studied philosophy. In 46 the senate successfully appealed to Caesar to pardon him, this being the occasion of the speech *Pro Marcello* attributed to Cicero. Marcellus left for Italy, but was murdered in May by one of his own attendants, P. Magius Chilo, in the Peiraeus. Marcellus was a thorough aristocrat. He was an eloquent speaker (Cicero, *Brutus*, 71), and a man of firm character, although not free from avarice.

See Cicero, *Ad fam.* iv. 4, 7, 10, and *Ad Att.* v. 11 (ed. Tyrrell and Purser); Caesar, *B. C.* i. 2; Suetonius, *Caesar*, 29; G. Boissier, *Cicero and his Friends* (Eng. trans., 1897).

3. M. CLAUDIUS MARCELLUS (*c.* 43–23 B.C.), son of C. Marcellus and Octavia, sister of Augustus. In 25 he was adopted by the emperor and married to his daughter Julia. This seemed to mark him out as the heir to the throne. In 23 Marcellus, then curule aedile, died at Baiae. Great hopes had been built on the youth, and he was celebrated by many writers, especially by Virgil in a famous passage (*Aeneid*, vi. 860). He was buried in the Campus Martius, and Augustus himself pronounced the funeral oration. The Theatrum Marcelli (remains of which can still be seen) was afterwards dedicated in his honour.

See Horace, *Odes*, i. 12; Propertius iii. 18; Dio Cassius liii. 28, 30; Tacitus, *Annals*, ii. 41; Suetonius, *Augustus*, 63; Vell. Pat. ii. 93.

MARCH, AUZIAS (1379–1459), Catalan poet, was born at Valencia. An undisguised follower of Petrarch, he carries the imitation to such a point that he addresses his *Cants d'amor* to a lady whom he professes to have seen first in church on Good Friday; so far as the difference of language allows, he reproduces the rhythmical cadences of his model, and in the *Cants de mort* touches a note of brooding sentiment peculiar to himself. The success of his metrical innovation no doubt encouraged Boscán (*q.v.*) to introduce the Italian metres into Castilian.

MARCH, EARLS OF, title derived from the "marches" or boundaries (1) between England and Wales, and (2) England and Scotland, and held severally by great feudal families possessed of lands in those border districts. The earls of March on the Welsh borders were descended from Roger de Mortemer (so called from his castle of Mortemer in Normandy), who was connected by marriage with the dukes of Normandy. His son Ralph (d. *c.* 1104) figures in Domesday as the holder of vast estates in Shropshire, Herefordshire and other parts of England, especially in the west; and his grandson Hugh de Mortimer, founder of the priory of Wigmore, Herefordshire, was one of the most powerful of the barons reduced to submission by Henry II. The Mortimers, however, continued to exercise almost undisputed sway, as lords of Wigmore, over the western counties and the Welsh marches.

I. **Welsh Marches.**—Roger de Mortimer (*c.* 1286–1330), 8th baron of Wigmore and 1st earl of March, being an infant at the death of his father, Edmund, was placed by Edward I. under the guardianship of Piers Gaveston, and was knighted by Edward in 1306. Through his marriage with Joan de Joinville, or Genevill, Roger acquired increased possessions on the Welsh marches, including the important castle of Ludlow, and extensive estates in Ireland, whither he went in 1308 to enforce his authority. This brought him into conflict with the De Lacys, who turned for support to Edward Bruce, brother of Robert Bruce, king of Scotland. Mortimer was appointed lord-lieutenant of Ireland by Edward II. in 1316, and at the head of a large army drove Bruce to Carrickfergus, and the De Lacys into Connaught. About 1318 he began to interest himself in the growing opposition to Edward II. and his favourites, the Despensers; and he supported Humphrey de Bohun, earl of Hereford, in refusing to obey the king's summons to appear before him in 1321. Forced to surrender to the king at Shrewsbury in 1322, Mortimer was consigned to the Tower of London, whence he escaped to France in Aug. 1324. At the French court Queen Isabella found Roger Mortimer; she became his mistress and refused to return to England so long as the Despensers retained power as the king's favourites. Isabella's relations with Mortimer compelled them to withdraw to Flanders, where they obtained assistance for an invasion of England. Landing in England in 1326, they were joined by Henry, earl of Lancaster; London rose in support of the queen; and Edward took flight to the west, where he was captured in November, and compelled to abdicate in favour of his son. The country was now ruled by Mortimer and Isabella, who procured the murder of Edward II. in the following September. In 1328 Mortimer was created earl of March. The jealousy of Lancaster having been excited by March's arrogance, Lancaster prevailed upon the young Edward III., to throw off the yoke of his mother's paramour. March was arrested and conveyed to the Tower. Accused of assuming royal power and of various other high misdemeanours, he was condemned without trial and hanged on Nov. 29, 1330, his vast estates being forfeited to the Crown. His eldest son, Edmund, was father of Roger Mortimer (*c.* 1328–60), who was knighted by Edward III. in 1346, and restored to his grandfather's title as 2nd earl of March.

Edmund de Mortimer (1351–1381), 3rd earl of March, was son of Roger, 2nd earl of March, by his wife Philippa, daughter of William Montacute, 1st earl of Salisbury. Being an infant at the death of his father, Edmund, as a ward of the Crown, was placed by Edward III. under the care of William of Wykeham and Richard Fitzalan, earl of Arundel. The young earl married in 1368 Philippa, only daughter of Lionel, duke of Clarence, and of Elizabeth, daughter and heiress of William de Burgh, 6th lord of Connaught and 3rd earl of Ulster. The earl of March, therefore, not only became the representative of one of the chief Anglo-Norman lordships in Ireland in right of his wife Philippa, but the latter, on the death of her father shortly after her marriage, stood next in succession to the crown after the Black Prince and his sickly son, afterwards King Richard II. This marriage had, therefore, far-reaching consequences in the history of England, giving rise to the claim of the house of York to the crown of England, contested in the Wars of the Roses. He died at Cork in 1381. The earl had two sons and two daughters, the elder of whom, Elizabeth, married Henry Percy (Hotspur), son of the earl of Northumberland. His eldest son Roger succeeded him as 4th earl of March and Ulster.

Roger de Mortimer, 4th earl of March and Ulster (1374–98), succeeded to the titles and estates of his family when a child of seven, and a month afterwards he was appointed lord-lieutenant of Ireland. March's daughter Anne married Richard earl of Cambridge, son of Edmund duke of York, fifth son of Edward III.; their son Richard, duke of York, was father of King Edward IV., who thus derived his title to the crown and acquired the estates of the house of Mortimer.

Edmund de Mortimer (1391–1425), 5th earl of March and Ulster, son of the 4th earl, succeeded to his father's claim to the crown as well as to his title and estates. When Richard II. was deposed and the crown seized by Henry of Lancaster in 1399, the young earl of March and his brother Roger were kept in custody by Henry IV., who, however, treated them honourably, until March 1405, when they were carried off by the opponents of the Lancastrian dynasty, of whom their uncle Sir Edmund Mortimer and his brother-in-law Henry Percy (Hotspur) were leaders in league with Owen Glendower. The boys were recaptured, and in 1409 were committed to the care of the prince of Wales. On the accession of the latter as Henry V., in 1413, the earl of March was restored to his estates, his brother Roger having died some years previously; and he continued to enjoy the favour of the king in spite of a conspiracy in 1415 to place him on the throne. March accompanied Henry V. throughout his wars in France, and on the king's death in 1422 became a member of the council of regency. He died in Ireland in 1425, and as he left no issue the earldom of March in the house of Mortimer became extinct, the estates passing to the last earl's nephew Richard, who in 1435 was officially styled duke of York, earl of March and Ulster, and baron of Wigmore. Richard's son Edward having ascended the throne in 1461 as Edward IV., the earldom of March became merged in the crown.

See T. Rymer, *Foedera,* etc. (1704–32); T. F. Tout, *The Political History of England,* vol. iii., ed. by W. Hunt and R. L. Poole (1905); W. Dugdale, *Monasticon anglicanum* (3 vols., 1655–73); W. Stubbs, *Constitutional History of England* (1874–78), vol. ii.

II. **Scottish Marches.**—The Scottish earls of March were descended from Crinan, whose son Maldred married Algitha, daughter of Ughtred, earl of Northumberland, by Elgiva, daughter of the Saxon king Aethelred. Maldred's son Cospatric, or Gospatric, was made earl of Northumberland by William the Conqueror; but being soon afterwards deprived of this position he fled to Scotland, where Malcolm Canmore, king of Scotland, granted him Dunbar and adjoining lands. Two generations of Cospatrics followed in lineal succession, bearing the title of earl, but without territorial designation. Cospatric II witnessed the charter of Alexander I founding the abbey of Scone in 1115. The 3rd earl, also named Cospatric, a liberal benefactor of Melrose abbey, died in 1166, leaving two sons, the younger of whom was the ancestor of the earls of Home. The elder son, Waltheof, was the first of the family to be styled "comes de Dunbar," about 1174. He was one of the hostages for the performance of the Treaty of Falaise for the liberation of William the Lion in 1175. Waltheof's son Patrick Dunbar (the name Dunbar, derived from the family estates, now becoming an hereditary surname), styled 5th earl of Dunbar, although his father had been the first to adopt the territorial designation, was keeper of Berwick castle, and married Ada, natural daughter of William the Lion. His grandson Patrick, 7th earl, headed the party that liberated King Alexander III. in 1255 from the Comyns, and in the same year was nominated guardian of the king and queen by the Treaty of Roxburgh. He signed the Treaty of Perth (July 6, 1266) by which Magnus VI. of Norway ceded the Isle of Man and the Hebrides to Scotland. His wife was Christian, daughter of Robert Bruce.

Patrick Dunbar, 8th earl of Dunbar and 1st earl of March, claimed the crown of Scotland in 1291 as descendant of Ada, daughter of William the Lion. He was one of the "seven earls of Scotland," a distinct body separate from the other estates of the realm, who claimed the right to elect a king in cases of disputed succession. He was the first of the earls of Dunbar to appear in the records as "comes de Marchia," or earl of March. He was favourable to the English interest in Scottish affairs, and he did homage to Edward I. In 1298 he was appointed the English king's lieutenant in Scotland.

Patrick Dunbar (1285–1369), 9th earl of Dunbar and 2nd earl of March, son of the preceding, gave refuge to Edward II. after Bannockburn, and contrived his escape by sea to England. Later, he made peace with Robert Bruce, and by him was appointed governor of Berwick castle, which he held against Edward III. until the defeat of the Scots at Halidon Hill (July 19, 1333). His countess, known in Scottish history and romance as "Black Agnes," daughter of Thomas Randolph, earl of Moray (Murray), and grandniece of Robert Bruce, is famous for her defence of Dunbar castle against the English under the earl of Salisbury in 1338. This lady succeeded to the estates and titles of her brother, John Randolph, 3rd earl of Moray. The earldom of Moray passed after her death to her second son, John Dunbar, who married Marjory, daughter of King Robert II.

George Dunbar (d. 1420), 10th earl of Dunbar and 3rd earl of March, great-nephew of the 8th earl and warden of the marches, accompanied Douglas in his foray into England in 1388, and commanded the Scots after Otterburn. He afterwards quarrelled with the Douglases, and when his lands were seized, fled to England, where he was welcomed by Henry IV. He fought on the English side at Homildon Hill; and, having revealed to Henry the defection of the Percies, who were in league with Douglas and Owen Glendower, he fought against those allies at Shrewsbury (July 23, 1403). Becoming reconciled with Douglas, he returned to Scotland in 1409, and was restored to his earldom by the regent Albany.

George Dunbar, 11th earl of Dunbar and 4th earl of March, was one of the negotiators for the release of James I. of Scotland in 1423 from his captivity in England, and was knighted at that king's coronation. In 1434, however, on the ground that the regent had had no power to reverse his father's forfeiture for treason, March was imprisoned and his castle of Dunbar seized by the king; and the parliament at Perth declared his lands and titles forfeited to the Crown.

The earldom of March in the house of Dunbar having thus been forfeited to the Crown, James II. in 1455 conferred the title, together with that of warden of the marches, on his second son Alexander, duke of Albany; but this prince entered into treasonable correspondence with Edward IV. of England, and in 1487 the earldom of March and the barony and castle of Dunbar were again annexed to the crown of Scotland.

The title of earl of March was next held by the house of Lennox. (*See* Richmond, Earls and Dukes of; and Lennox.)

The title of earl of March in the peerage of Scotland, by another creation, was conferred in 1697 on William Douglas, second son of William, 1st duke of Queensberry. (*See* Queensberry, Earls, Marquises and Dukes of.)

See Andrew Lang, *History of Scotland* (4 vols., 1900–07); Sir Bernard Burke, *A Genealogical History of Dormant and Extinct Peerages* (1866); Sir Robert Douglas, *The Peerage of Scotland* (2 vols., 1813); Lady Elizabeth Cust, *Some Account of the Stuarts of Aubigny in France* (1891).

MARCH, FRANCIS ANDREW (1825–1911), American philologist and educationist, was born on Oct. 25, 1825, in Millbury, Mass. He graduated in 1845 at Amherst, where his attention was turned to the study of Anglo-Saxon by Noah Webster. After teaching in secondary schools and at Amherst, he went in 1855 as a tutor to Lafayette college, where he became in 1857 professor of English language and comparative philology—the first chair of the kind established. In 1907 he became professor emeritus, and he died in Easton, Pa., on Sept. 9, 1911. In 1865 he published *Method of Philological Study of the English Language,* and in 1870 *A Comparative Grammar of the Anglo-Saxon Language,* a monumental work, and *An Anglo-Saxon Reader,* both marking a new era in the study of English in America. To the "Douglass Series of Christian Greek and Latin Classics," which he edited, he contributed *Latin Hymns* (1874). He was consulting editor of the *Standard Dictionary* (1890–95) and in 1879–82 was director of the American readers for the Philological Society's *New English Dictionary.* Among American linguistic scholars March ranks with Whitney, Child and Gildersleeve. His article "On Recent Discussions of Grimm's Law" in the *Transactions and Proceedings* of the American Philological Association for 1873 in large part anticipated Verner's law. With his son, Francis Andrew March, jr., also a professor at Lafayette, he edited *A Thesaurus Dictionary of the English Language* (1903).

See *Addresses in Honor of Professor Francis A. March, LL.D., L.H.D.* (1895), and J. W. Bright's tribute in Modern Language Association, *Publications* (vol. xxix., 1914).

MARCH, PEYTON CONWAY (1864–), American soldier, was born at Easton, Pa., on Dec. 27, 1864. He graduated from Lafayette college in 1884 and four years later from the U.S. Military academy. He graduated from the artillery school in 1898, and on the outbreak of the Spanish-American War went to the Philippines, remaining there three years and rising to the grade of lieutenant-colonel of volunteers. After honourable discharge from the volunteers in 1901 he was appointed captain of artillery in the regular army. From 1903–07 he was a member of the general staff and in 1904, during the Russo-Japanese War, was with the Japanese army in Manchuria as observer. He was promoted major in 1907, lieutenant-colonel in 1912 and colonel in 1916. Soon after America's entrance into the World War in 1917 he was made a brigadier-general, U.S.A., and later major-general of the national army and in Sept. 1917, major-general of the regular army. In 1917 he was with the A.E.F. in France in charge of the American artillery forces. In March 1918 he was appointed acting chief of staff, and the following May chief of staff with the rank of general. On June 30, 1920, his rank reverted to that of major-general, and at his own request he was retired from active service Nov. 1, 1921. As chief of staff of the army, he reorganized the war department, consolidated the regular army, National Guard and national army divisions into a single army—the U.S. army—and initiated and carried into execution a programme which landed in France, by the time of the Armistice, 2,000,000 men.

MARCH, a town in Isle of Ely, England, 30 mi. N.W. of Cambridge. Pop. of urban district (1938) 12,290. Area, 30.9 sq.mi. It lies in the flat fen country, on the old course of the river Nene. It is an important junction on the L.N.E.R. and the starting-point of a line to Lincoln and Doncaster. The church of St. Wendreda (Early English and later) has a Perpendicular timber roof. Agriculture is the chief industry.

MARCH, the third month of the modern calendar, containing 31 days. It was the Romans' first month until the adoption of the Julian calendar, 46 B.C., and it continued to be the beginning of the legal year in England until the 18th century. In France it was reckoned the first month of the year until 1564, when, by an edict of Charles IX., January was decreed to be thenceforth the first month. Scotland followed the example of France in 1599; but in England the change did not take place before 1752. The Romans called the month *Martius,* from Mars, the god of war. The Anglo-Saxons called March *Hlyd-monath,* "loud or stormy month," or *Lencten-monath,* "lengthening month," in allusion to the fact that the days then rapidly become longer. There is an old saying, common to both England and Scotland, representing March as borrowing three days from April; the last three days of March being called the "borrowing" or the "borrowed days."

In music, the march is the familiar type of composition used to accompany and stimulate the marching of soldiers. For this purpose it is naturally strongly rhythmic in character, being generally written in common time, with the principal accents vigorously marked by the drum. The pace may be either brisk, as in a quick march, or slow, as in a funeral march. In the matter of structure, a trio, or alternative section in a more melodious vein, is generally provided by way of contrast to the main tune. Apart from actual military marches, the form has had attraction in all times for eminent composers, who have left many memorable examples. Such are the Dead March in *Saul* (Handel), Beethoven's funeral marches (pianoforte sonata in A flat and Eroicasymphony), many by Schubert, Mendelssohn's Wedding March (*Midsummer Night's Dream* music), Chopin's Marche Funèbre (B flat minor sonata), several by Wagner (*Tannhäuser, Lohengrin, Huldigungsmarsch* and *Kaisermarsch*), Elgar's *Pomp and Circumstance* series, many by the "March King" among bandmasters, John P. Sousa, *e.g.*, Stars and Stripes Forever, etc.

MARCHAND, JEAN (1883–1941), French painter, was born in Paris on Nov. 22, 1883. He studied with Bonnat and Merson (1902–6), but deserted conventional teaching, and exhibited at the Salon des Indépendants in 1908. He visited Russia and England on several occasions. Though Marchand came under the influence of cubism between 1910 and 1912, his work was not greatly affected by it. His human forms are treated with power and discretion, while his landscapes and still life are tinged with an intense melancholy. His death in Paris was reported Oct. 10, 1941.

MARCHAND, JEAN BAPTISTE (1863–1934), French general and African explorer, was born at Thoissey (Ain) on Nov. 22, 1863. After four years' service in the ranks, he was, in 1887, appointed a sub-lieutenant. In 1889 he was on active service in Senegal, was twice wounded, and made a chevalier of the Legion of Honour. In 1898 he carried out his historic occupation of Fashoda and for this he was promoted to commander in the Legion of Honour. In 1902 he was made colonel and shortly after the outbreak of war in 1914 he was appointed to command the Colonial Brigade of the XIV Corps, and in 1915 was promoted a temporary-general of brigade. A few months later he assumed command of the 10th (Colonial) Division and was wounded in Sept. 1915. On April 4, 1917 he was promoted general of division. He retired in 1919, and received the grand cross of the Legion of Honour in 1920. Gen. Marchand died Jan. 14, 1934.

MARCHE or **LA MARCHE,** one of the former provinces of France. It owes its name to its position, it having been in the 10th century a march or border district between the duchy of Aquitaine and the domains of the Frankish kings in central France. Sometimes it was called the *Marche Limousine,* and originally it was a small district cut partly from Limousin and partly from Poitou. Its area was increased during the 13th century, after which, however, it remained unaltered until the time of the Revolution. It was bounded on the north by Berry; on the east by Bourbonnais and Auvergne; on the south by Limousin; and on the west by Poitou. It embraced the greater part of the modern department of Creuse, a considerable part of Haute Vienne, and a fragment of Indre. Its area was about 1,900 sq. mi.; its capital was Charroux and later Guéret, and among its other principal towns were Dorat, Bellac and Confolens.

Marche first appears as a separate fief about the middle of the 10th century when William III., duke of Aquitaine, gave it to one of his vassals named Boso, who took the title of count. In the 12th century it passed to the counts of Limousin, and this house retained it until the death of the childless Count Hugh in 1303, when it was seized by the French king, Philip IV. In 1316 it was made a duchy for Prince Charles, afterwards King Charles IV., and a few years later (1327) it passed into the hands of the family of Bourbon. The family of Armagnac held it from 1435 to 1477, when it reverted to the Bourbons, and in 1527 it was seized by Francis I. and became part of the domains of the French crown. It was divided into Haute Marche and Basse Marche, the estates of the former being in existence until the 17th century. From 1470 until the Revolution the province was under the jurisdiction of the parlement of Paris.

See A. Thomas, *Les États provinciaux de la France centrale* (1879).

MARCHES, THE (It. *Le Marche*), a territorial division (region) of Italy, embracing from north to south the provinces of Pesaro and Urbino, Ancona, Macerata, and Ascoli Piceno, with a population of 1,278,071 in 1936, a rise of 189,358 since 1901. It is bounded by Emilia on the north, the Adriatic on the east, the Abruzzi on the south, and Umbria and Tuscany on the west. The chief rivers, all of which run into the Adriatic eastwards and northeastwards, are the Metauro (anc. *Metaurus, q.v.*) and the Tronto (anc. *Truentus*), the latter forming the southern boundary of the Marches for some distance. Except for the river valleys and the coast strip (often very narrow), the general level is more than 500 ft. above the sea. The lower hills are very largely composed of loose, clayey, unstable earth, while the Appenines are of limestone. The province of Pesaro and Urbino falls within the boundaries of the ancient Umbria (*q.v.*), while the territory of the other three belonged to Picenum (*q.v.*). The railway from Bologna to Brindisi runs along the coast-line of the entire territory.

At Fano there is a branch to Fermignano, on the line from Fabriano to Urbino; at Falconara, near Ancona it is joined by the main line from Foligno and Rome; at Porto Civitanova is a branch to Macerata, San Severino and Fabriano (a station on the line from Ancona to Rome and the junction for Urbino); at Porto S. Giorgio is a branch to Fermo and Amandola, and, at Porto d'Ascoli, a branch to Ascoli Piceno.

Agriculture and Industry.—Owing largely to the *mezzadria* or *metayer* system the soil is fairly highly cultivated.

The silk industries, making of strawplait and straw hats, rearing of silk-worms and cocoons, with sugar-refining, tobacco, terra-cotta manufacture, brickworks and ironworks, furnish the chief occupations of the people of the Marches next after agriculture and pastoral pursuits.

The chief agricultural products in 1938 were:

	Acres under cultivation	Production in tons
Wheat	652,591	497,900
Maize	159,874	82,600
Barley	19,027	10,100
Oats	6,324	4,200
Garden produce	. .	86,500
Sugar beet	. .	14,200
Flax	8,401	1,800
Tobacco	. .	900
Potatoes	32,617	89,500
Beans	94,145	13,700
Vines	924,895	60,660,300 gal. (wine)
Olives	402,032	369,900 gal. (olive oil)
Forage	1,269,847	1,797,100
Fruits	. .	25,200

Another important branch of activity is the paper industry, especially at Fabriano. Limestone quarries and sulphur mines supply building stone and sulphur to the regions of central Italy; chalk and petroleum are also found. Ancona is the only really good harbour.

Fishing is carried on along the entire coast.

History.—For the early history of the territory of the Marches, *see* PICENUM. From the Carolingian period onwards the name Marca begins to appear—first the Marca Fermana for the mountainous part of Picenum, the Marca Camerinese for the district farther north, including a part of Umbria, and the Marca Anconitana for the former Pentapolis. In 1080 the Marca Anconitana was given in investiture to Robert Guiscard by Gregory VII., to whom the countess Matilda ceded the Marches of Camerino and of Fermo. In 1105 we find the emperor Henry IV. investing Werner with the whole territory of the three marches under the name of March of Ancona. It was afterwards once more recovered by the Church and governed by papal legates. It became part of the kingdom of Italy in 1860. The pictorial art of the Marches from the 13th century onwards has become the object of considerable interest.

See L. Serra, *Le Gallerie Comunali delle Marche* (1926); *L'Arte nelle Marche* (Pesaro, 1927).

MARCHESI, MATHILDE (née Mathilde Graumann) (1826–1913), German singer and teacher, was born at Frankfort-on-Main on March 26, 1826. She made her début as a singer in 1844, but in 1849 began her teaching career, speedily earning a wide reputation at the conservatories of Vienna and Cologne, as well as in London and Paris. In 1852 she married Salvatore Marchesi, Cavaliere de Castrone (d. 1908), a well-known singer and teacher. Among Madame Marchesi's pupils were Emma Calvé, Emma Eames, Melba, Emma Nevada, Gabrielle Kraus and Etelka Gerster. She published various works on the technique of singing, and in 1897 a volume of reminiscences, *Marchesi and Music*. She died in London on Nov. 17, 1913.

Her daughter, Blanche Marchesi (1863–1940), was also a famous singer and teacher.

MARCHMONT, EARLS OF. The 1st earl of Marchmont was Sir Patrick Hume or Home (1641–1724), son of Sir Patrick Hume, bart. (d. 1648), of Polwarth, Berwickshire. He became a member of the Scottish parliament in 1665, and opposed the harsh policy of the earl of Lauderdale towards the Covenanters, and for his contumacy he was imprisoned. After his release he went to London, where he associated himself with the duke of Monmouth. Suspected of complicity in the Rye House plot, he crossed to the Netherlands, where he took part in the deliberations of Monmouth, the earl of Argyll and other exiles about the projected invasion of Great Britain. Polwarth sailed to Scotland with Argyll in 1685, and after the failure of the rising escaped to Utrecht. He accompanied William of Orange to England, and in 1689 he was again a member of the Scottish parliament. In 1690 he was made a peer as Lord Polwarth; in 1696 he became lord high chancellor of Scotland, and in 1697 was created earl of Marchmont. When Anne became queen in 1702 he was deprived of the chancellorship. He died on Aug. 2, 1724.

His son Alexander, the 2nd earl (1676–1740), took the name of Campbell instead of Hume after his marriage in 1697 with Margaret, daughter and heiress of Sir George Campbell of Cessnock, Ayrshire. The earldom became dormant on the death of the 3rd earl in 1794.

See *The Marchmont Papers,* ed. Sir G. H. Rose (1831).

MARCIAN (*c.* 390–457), emperor of the East (450–457), was born of humble parentage in Thrace, and entered the army at an early age. Eventually through the influence of Aspar and Ardaburius he became a captain of the guards, and later tribune and senator. On the death of Theodosius II. he was chosen as consort by the latter's sister and successor, Pulcheria. Marcian repudiated the payment of tribute to Attila; and reformed the finances. He repelled attacks upon Syria and Egypt (452), and quelled disturbances on the Armenian frontier (456). The other notable event of his reign is the Council of Chalcedon (451).

See Gibbon, *The Decline and Fall of the Roman Empire* (ed. Bury, London, 1896), iii. 384, iv. 444–445; J. Bury, *The Later Roman Empire* (London, 1889), i. 135–136.

MARCIANUS (*c.* A.D. 400), Greek geographer, was born at Heraclea in Pontus. Two of his works have been preserved in a more or less mutilated condition. In the first, the *Periplus of the Outer Sea,* in two books, in which he proposed to give a complete description of the coasts of the eastern and western oceans, his chief authority is Ptolemy; the distances from one point to another are given in stades, with the object of rendering the work easier for the ordinary student. The second, the *Periplus of the Inner Sea* (the Mediterranean), is a meagre epitome of a similar work by Menippus of Pergamum, who lived during the times of Augustus and Tiberius. It contains a description of the southern coast of the Euxine from the Thracian Bosporus to the river Iris in Pontus. A few fragments remain of an epitome by Marcianus of the 11 books of the *Geographumena* of Artemidorus of Ephesus.

See J. Hudson, *Geographia veteris scriptores graeci minores,* vol. i. (1698), with Dodwell's dissertation; C. W. Müller, *Geographici graeci minores,* vol. i., pp. cxxix., 515–573; E. Miller, *Périple de Marcien d'Héraclée* (1839); S. F. G. Hoffmann, *Marciani Periplus* (1841); E. H. Bunbury, *Hist. of Ancient Geography* (1879), ii. 660; A. Forbiger, *Handbuch der alten Geographie,* vol. i. (1842).

MARCION and **THE MARCIONITE CHURCHES.** Among the Christian organisations of the middle period of the second century the most important, next to Catholicism, was the Marcionite community. It admitted all believers without distinction of age, sex, rank or culture. It was no mere school for the learned, disclosed no mysteries for the privileged, but sought to lay the foundation of the Christian community on the pure and authentic gospel of Christ. The pure gospel, however, Marcion found to be everywhere more or less corrupted and mutilated in the Christian circles of his time. His undertaking thus resolved itself into a reformation of Christendom. This reformation was to deliver Christendom from false Jewish doctrines by restoring the Pauline conception of the gospel—Paul being, according to Marcion, the only apostle who had rightly understood the new message of salvation as delivered by Christ. In Marcion's own view, therefore, the founding of his church—to which he was first driven by opposition—amounts to a reformation of Christendom through a return to the gospel of Christ and to Paul; nothing was to be accepted beyond that. This of itself shows that it is a mistake to reckon Marcion among the Gnostics. For he ascribed salvation, not to "knowledge" but to "faith"; he appealed openly to the whole Christian world; and he nowhere consciously added foreign elements to the revelation given through Christ. It is true that in many features his Christian system resembles the so-called Gnostic systems; but the first duty of the historian is to point out what Marcion plainly aimed at; only in the second place have we to inquire how far the result corresponded with those purposes.

Marcion was a wealthy shipowner, belonging to Sinope in Pontus. He appears to have been a convert from Paganism to Christianity. About A.D. 140 he arrived in Rome as a Christian, and made himself known to the local church. Even then, however, the leading features of his peculiar system must have been already thought out. At Rome he tried to gain acceptance for them in the college of presbyters and in the church; but he now encountered such determined opposition from the majority of the congregation that he found it necessary to withdraw from the great church and establish in Rome a community of his own. This was about the year 144. The new society increased in the two following decades; and very soon numerous sister-churches were flourishing in the east and west of the empire. Marcion took up his residence permanently in Rome, but still undertook journeys for the propagation of his opinions; and he seems never to have abandoned his design of gaining over the whole Church to his gospel.

The distinctive teaching of Marcion originated in a comparison of the Old Testament with the gospel of Christ and the theology of the apostle Paul. Its motive was not metaphysical, but religious and historical. In the gospel he found a God revealed who is goodness and love, and who desires faith and love from men. This God he could not discover in the Old Testament; on the contrary, he saw there the revelation of a just, stern, jealous, wrathful and variable God, who requires from his servants blind obedience, fear and outward righteousness. Overpowered by the majesty and novelty of the Christian message of salvation, too conscientious to rest satisfied with the ordinary attempts at the solution of difficulties, while prevented by the limitations of his time from reaching an historical insight into the relation of Christianity to the Old Testament and to Judaism, he believed that he expressed Paul's view by the hypothesis of two Gods: the just God of the law (the God of the Jews, who is also the Creator of the world), and the good God, the Father of Jesus Christ. Paradoxes in the history of religion and revelation which Paul draws out, and which Marcion's contemporaries passed by as utterly incomprehensible, are here made the foundation of a dualistic conception of history and of religion. It may be said that in the 2nd century only one Christian—Marcion—took the trouble to understand Paul; but it must be added that he misunderstood him. The profound reflections of the apostle on the radical antithesis of law and gospel, works and faith, were not appreciated in the 2nd century. Marcion alone perceived their decisive religious importance, and with them confronted the legalizing, and in this sense judaizing, tendencies of his Christian contemporaries. But the Pauline ideas lost their truth under his treatment; for, when it is denied that the God of redemption is at the same time the almighty Lord of heaven and earth, the gospel is turned upside down.

DUALISTIC THEORY

The general outlines of his teaching are as follows. Man is, in spirit, soul and body, a creature of the just and wrathful god. This god created man from ὕλη (matter), and imposed on him a strict law. Since no one could keep this law, the whole human race fell under the curse, temporal and eternal, of the Demiurge. Then a higher God, hitherto unknown, and concealed even from the Demiurge, took pity on the wretched, condemned race of men.

He sent his Son (whom Marcion probably regarded as a manifestation of the supreme God Himself) down to this earth in order to redeem men. Clothed in a visionary body, in the likeness of a man of thirty years old, the Son made his appearance in the fifteenth year of Tiberius, and preached in the synagogue at Capernaum. But none of the Jewish people understood him. Even the disciples whom he chose did not recognize his true nature, but mistook him for the Messiah promised by the Demiurge through the prophets, who as warrior and king was to come and set up the Jewish empire. The Demiurge himself did not suspect who the stranger was; nevertheless he became angry with him, and, although Jesus had punctually fulfilled his law, caused him to be nailed to the cross. By that act, however, he pronounced his own doom. For the risen Christ appeared before him in his glory, and charged him with having acted contrary to his own law. To make amends for this crime, the Demiurge had now to deliver up to the good God the souls of those who were to be redeemed; they are, as it were, purchased from him by the death of Christ. Christ then proceeded to the underworld to deliver the spirits of the departed. Then, to gain the living, Christ raised up Paul as his apostle. He alone understood the gospel, and recognized the difference between the just God and the good. Accordingly, he opposed the original apostles with their Judaistic doctrines, and founded small congregations of true Christians. But the preaching of the false Jewish Christians gained the upper hand; nay, they even falsified the evangelical oracles and the letters of Paul. Marcion himself was the next raised up by the good God, to proclaim once more the true gospel. This he did by setting aside the spurious gospels, purging the real gospel (the Gospel of Luke) from supposed judaizing interpolations, and restoring the true text of the Pauline epistles. Marcion was the earliest critical student of the New Testament canon and text. It is noteworthy that he refused to admit the genuineness of the Pastoral Epistles and said that the letter to the Ephesians was really addressed to the Laodiceans.

On the basis of these writings Marcion proclaimed the true Christianity, and founded churches. He taught that all who put their trust in the good God, and his crucified Son, renounce their allegiance to the Demiurge, and approve themselves by good works of love, shall be saved. But he taught further—and here we trace the influence of the current gnosticism on Marcion—that only the spirit of man is saved by the good God; the body, because material, perishes. Accordingly his ethics also were thoroughly dualistic. By the "works of the Demiurge," which the Christian is to flee, he meant the whole "service of the perishable." The Christian must shun everything sensual, and especially marriage, and free himself from the body by strict asceticism. The golden age of the Marcionite churches falls between the years 150 and 250. During that time they were really dangerous to the great Church; for in fact they maintained certain genuine Christian ideas, which the Catholic Church had forgotten. The earliest inscription (A.D. 318) on a Christian place of worship is Marcionite, and was found on a stone which had stood over the doorway of a house in a Syrian village. From the beginning of the 4th century they began to die out in the West, or rather they fell a prey to Manichaeism. In the East also many Marcionites went over to the Manichaeans; but there they survived much longer. They can be traced down to the 7th century, and then they seem to vanish. But it was unquestionably from Marcionite impulses that the new sects of the Paulicians and Bogomils arose; and in so far as the western Cathari, and the antinomian and anticlerical sects of the 13th century are connected with these, they also may be included in the history of Marcionitism.

Bibliography.—*See* A. Harnack, *History of Dogma,* i. 266, 286; F. Loofs, *Dogmengeschichte* pp. 111–114; N. McLean, art. "Marcionism" in Hastings *Encyclopaedia of Religion and Ethics;* G. Krüger, *Early Christian Literature,* and art. in Herzog-Hauck's *Realencyklopädie für prot. Theol. und Kirche,* xii.; F. J. Foakes Jackson's *Christian Difficulties of the Second and Twentieth Centuries,* is a study of Marcion and his relation to modern thought.

MARCOMANNI, the name of a Suevic tribe "men of the mark, or border." They were often in conflict with the Roman empire, and gave their name to the Marcomannic war, a struggle waged by the emperor Marcus Aurelius against them. The Marcomanni disappeared from history during the 4th century, being probably merged in the Baiouarii, the later Bavarians.

See Suebi; and E. Devrient, "Hermunduren und Markomannen" in *Neues Jahrb. f. das klassische Altertum* (1901), 51.

MARCONI, MARCHESE GUGLIELMO (1874–1937), Italian inventor who put wireless telegraphy on a commercial basis, was born at Bologna on April 25, 1874, the younger son of an Italian father and an Irish mother. He was educated privately at Bologna, Florence and Leghorn. As a boy he took a keen interest in physical and electrical science. In 1895 the idea became firmly rooted in his mind that a system of telegraphy through space could be provided by means of electromagnetic waves, the existence of which had been foreseen mathematically by Clerk Maxwell in 1864 and later investigated experimentally by Heinrich Hertz, Oliver Lodge, Righi and others. Interesting scientific experiments had been carried out in London and elsewhere with these electric waves, but Marconi was the first to devise the practical means by which they could be made to provide a new and revolutionary method of telegraphic communication. In the early summer of 1895, Marconi conducted a number of experiments at his father's country house at Pontecchio, near Bologna. These experiments, made with crude and inefficient apparatus, soon began to give results which appeared to Marconi to be remarkable, communication being established in that year over distances in excess of a mile. He was created a Marchese in 1929.

In 1896 Marconi came to England, and on June 2 of that year took out the first patent ever granted for wireless telegraphy based on the use of electric waves. He continued his experiments in London, and in the same year demonstrated his invention before officials of the Post Office and other representatives of British and Foreign Government departments. These demonstrations were first carried out on the roof of the General Post Office, St. Martin's-le-Grand, London. Later experiments for the Post Office were carried out on Salisbury plain and across the Bristol channel from Penarth to Brean down, near Weston-super-Mare, ranges first of two, then of four, and afterwards of nine miles were obtained. In June 1897, at the invitation of the Italian Government, Marconi went to Spezia, where a land station was erected and communication with Italian warships was established up to a distance of 12 miles. He was then invited to demonstrate his apparatus in Rome, where successful tests were carried out in the presence of the late King Humbert and Queen Margherita. Other tests also took place at the Italian Chamber of Deputies.

The time was now almost ripe for wireless telegraphy to be applied to commercial and utilitarian purposes, and in July 1897 a company was formed in London to acquire the Marconi patents in all countries except Italy. This company was called the Wireless Telegraph and Signal Company, Limited, which in 1900 changed its name to that of Marconi's Wireless Telegraph Company, Limited (*q.v.*). For some time the company's efforts were confined to furthering Marconi's pioneer work. A number of interesting tests and demonstrations were undertaken round the coasts of the British Isles and abroad. Permanent stations were erected at Alum bay in the Isle of Wight and at Bournemouth, this station being subsequently removed to Poole.

In 1898 wireless telegraphy was first employed as a means of communication between lightships and the shore by installations on the East Goodwin lightship and the South Foreland lighthouse, separated by a distance of about 12 miles. The utility of wireless in saving life at sea was demonstrated for the first time when, on March 3, 1899, that lightship was run down by a steamer. The accident was at once reported by wireless to the South Foreland, enabling life-boats to be promptly sent to the assistance of the light vessel. In March 1898 Marconi established communication across the English Channel between England and France. During this year wireless was also first utilised in the naval manoeuvres for communication between warships over distances of 74 miles. The first military application of wireless took place during the South African War.

In Oct. 1900 the erection of a long distance wireless telegraph station in Cornwall was commenced by Marconi and preliminary tests were carried out up to a distance of about 200 miles. On

Dec. 12, 1901, Marconi, on his first attempt, succeeded in transmitting and receiving signals across the Atlantic Ocean from Poldhu in Cornwall to St. John's, Newfoundland.

In 1902 Marconi, during a voyage on the American liner S.S. "Philadelphia," received messages up to a distance of 700 miles by day and 2,000 miles by night, thus first discovering the now well-known fact that wireless signals can usually be received over much greater distances at night than during the hours of daylight.

In 1902 he patented a magnetic detector, and in 1905 he took out his patents for the horizontal directional aerial. In 1910 Marconi, assisted by Mr. H. J. Round, received signals and messages at Buenos Aires from Clifden (Ireland) over a distance of about 6,000 miles. In 1912 he introduced "the timed spark system" for generating continuous waves. This system was employed for several years at many important long distance stations and by its means Marconi sent the first messages ever transmitted by wireless from England to Australia on Sept. 22, 1918.

In 1916, during the World War, experiments were commenced by Marconi in Italy with very short waves, with the object of devising a directive, or beam system, of wireless telegraphy for war purposes. Later, in England, with the assistance of Mr. G. S. Franklin, important results were obtained by the use of 15-metre waves between London and Birmingham. Short waves have proved themselves capable, even when used with a minimum of power, of carrying out communications by night as well as by day over any distance, even to the antipodes. They are much more amenable to control than long waves. (*See* WIRELESS TELEGRAPHY.)

During the World War Marconi served in both the Italian army and navy. He also visited America as a member of the Italian war mission to the United States Government. In 1919 the King of Italy appointed him plenipotentiary delegate to the Peace Conference in Paris, and in that capacity he attended the meetings of that conference and signed on behalf of Italy the peace treaties with Austria and Bulgaria. He also attended in the same capacity the meetings of the commission on mandates held in Paris and in London. Marconi was awarded the Nobel Prize for physics in 1909, the Albert Medal of the Royal Society of Arts, and, in the United States, the Franklin and the John Fritz Medals. In the same year he was nominated by the King of Italy to be a member of the Italian Senate. He died on July 20, 1937 at Rome.

MARCONI'S WIRELESS TELEGRAPH CO., LTD. In 1896 Guglielmo Marconi, then a young and unknown Italian inventor, came to England and took out the first patent for wireless telegraphy by means of Hertzian waves. On July 20, 1897, the Wireless Telegraph and Signal Co., Ltd., was formed to acquire Marconi's patents and develop them commercially. In 1900 the name of the company was changed to Marconi's Wireless Telegraph Co., Ltd., under which name it has remained registered. In 1899 Marconi succeeded in establishing communication between England and France. This was followed by the transmission of signals across the Atlantic, an achievement which laid the foundations of world-wide wireless communication. These successes led to a considerable extension of the commercial activities of the Marconi company. The Marconi International Marine Communication company was formed in 1900 to develop marine wireless, and, as time went on, wireless companies were formed by the Marconi company in the British Dominions and in other countries throughout the world.

The invention of the thermionic valve has revolutionized the design of wireless apparatus. The Marconi company rapidly evolved new apparatus using thermionic valves, various types of which now cover the requirements of many fields of communication. This development opened the way for the practical transmission of music and speech, and between Feb. 23 and March 6, 1920, the first broadcasting of musical items in England took place from the Marconi company's works at Chelmsford. Regular broadcasting of music and speech was instituted from Marconi stations at Writtle, Chelmsford, in 1921, and Marconi house, London, in 1922 before the establishment of the British Broadcasting company, now the British Broadcasting Corporation (B.B.C.), which began its activities in 1922.

One of the latest developments in wireless telegraphy is the short-wave *beam system* which has revolutionized long distance wireless communication. During 1926 and 1927 beam stations for communicating between Great Britain and Canada, Australia, South Africa and India, U.S.A. and South America were built. Beam stations have also been built in other countries, and this system is fast replacing the long-wave high-power system for long distance communication. The beam system has made it possible to transmit wireless telephone messages over great distances at much lower cost. (L. C. M.)

MARCOS DE NIZA (*c.* 1495–1558), a Franciscan friar born in Nice about 1495. He went to America in 1531, and after serving in Peru, Guatemala and Mexico, was chosen to explore the country north of Sonora. Preceded by Estevanico, the negro companion of Cabeza de Vaca and the "Black Mexican" of Zuñi traditions, Fray Marcos left Culiacan in March 1539, and penetrated to Zuñi or the "Seven Cities of Cibola," which he described as equal in size to the city of Mexico. He embodied much mere hearsay in his report, the *Descubrimiento de las siete ciudades,* which led F. V. de Coronado to make his expedition next year to Zuñi, of which Fray Marcos was the guide; and the realities proved a great disappointment. Fray Marcos was made Provincial of his order for Mexico before the second trip to Zuñi, and returned in 1541 to the capital, where he died on March 25, 1558.

The *Descubrimiento* is one of the world's famous narratives of travel. It may be found in J. F. Pacheco's *Documentos* (vol. iii.) and Hakluyt's *Voyages* (vol. iii.); also in G. Ramusio, *Navigazione* (vol. iii.) and H. Ternaux-Compans, *Voyages* (vol. iii.). *See* A. F. A. Bandelier, *The Gilded Man (El Dorado)* (1893); H. H. Bancroft, *Arizona and New Mexico* (San Francisco, 1888), and, for critical opinions, G. P. Winship, "The Coronado Expedition," in *U.S. Bureau of Ethnology, Fourteenth Annual Report* (for 1892–93, 1896).

MARCUS AURELIUS ANTONINUS (121–180), Roman emperor and Stoic philosopher, was born in Rome A.D. 121, the date of his birth being variously stated as April 6, 21 and 26. His original name was Marcus Annius Verus. His father Annius Verus (prefect of the city and thrice consul), who came of Spanish stock, had received patrician rank from Vespasian. Marcus was three months old when his father died, and was thereupon adopted by his grandfather. Hadrian adopted, as his successor, Titus Antoninus Pius (uncle of Marcus), on condition that he in turn adopt both Marcus (then 17) and Lucius Ceionius Commodus, the son of Aelius Caesar, who had originally been intended by Hadrian as his successor, but had died before him. Marcus had been, at the age of 15, betrothed to Fabia, the sister of Commodus; the engagement was broken off by Antoninus Pius, and he was betrothed to Faustina, the daughter of the latter. In 139 the title of Caesar was conferred upon him and he dropped the name of Verus. The full name he then bore was Marcus Aelius Aurelius Antoninus, Aelius coming from Hadrian's family, and Aurelius being the original name of Antoninus Pius. In 140 he was made consul. He was educated, not at school, but by tutors, Herodes Atticus and M. Cornelius Fronto (*q.v.*) in the usual curriculum of rhetoric and poetry; but Stoicism attracted him from the first, and at 25 he definitely abandoned Fronto, whose training was wholly literary, to learn philosophy under Rusticus the Stoic, and law under L. Volusius Moecianus. A Stoic he remained in practice, but retained the humanity of his disposition.

Emperor.—Antoninus Pius died in 161, having recommended as his successor Aurelius, then 40 years of age, without mentioning Commodus, his other adopted son, commonly called Lucius Verus. It is believed that the senate urged Aurelius to take the sole administration. But he admitted Verus as his partner, giving him the tribunician and proconsular powers, and the titles Caesar and Augustus. In the first year of his reign Faustina gave birth to twins, one of whom became the emperor Commodus.

Aurelius' reign was largely occupied in defending the empire against attacks from all sides. First of all the Parthians under Vologeses III. broke into Syria. Verus went out in nominal command of the war against them, which was really conducted by Avidius Cassius. The war was concluded in 165, but the returning army brought a pestilence with them that spread over the whole empire. Aurelius accompanied Verus in wars in Pannonia and Noricum in 167–8, and peace was made with the Marcomanni in 168. Early in 169 Verus died, leaving Aurelius sole emperor. In the autumn of 169 war again broke out on the Rhine-Danube frontier, and Marcus Aurelius lived almost entirely at Carnuntum for three years. The Marcomanni were eventually driven out of Pannonia and almost annihilated, and in 174 Aurelius won over the Quadi the celebrated victory of the "thundering legion," commemorated on the column of Antonina.

Germany.—Aurelius next marched to Germany. There news reached him that Avidius Cassius, the commander of the Roman troops in Asia, had revolted and proclaimed himself emperor (175). But after three months Cassius was assassinated, and his head was brought to Aurelius, who with characteristic magnanimity, persuaded the senate to pardon all the family of Cassius.

During his journey of pacification, Faustina, who had borne him 11 children, died. Aurelius trusted her while she lived, and mourned her loss.

After the death of Faustina and the pacification of Syria, Aurelius proceeded, on his return to Italy, through Athens, and was initiated in the Eleusinian mysteries. He gave large sums of money for the endowment of chairs in philosophy and rhetoric, with a view to making the schools the resort of students from all parts of the empire. Along with his son Commodus he entered Rome in 176, and obtained a triumph for victories in Germany. In 177 occurred that persecution of Christians, the share of Aurelius in which has been the subject of so much controversy. Meanwhile the German War continued, and the two Quintilii, who had been left in command, begged Aurelius once more to take the field.

Death.—In this campaign Aurelius, after a series of successes, was attacked, according to some authorities, by an infectious disease, of which he died after a week's illness, either in his camp at Sirmium (Mitrovitz), on the Save, in Lower Pannonia, or at Vindobona (Vienna), on March 17, 180, in the fifty-ninth year of his age. Other accounts are: (1) that he was poisoned in the interests of Commodus (Dio. Cass. lxxi. 33, 4), (2) that he died of a chronic stomachic disease; the latter is perhaps the most likely. His ashes (according to some authorities, his body) were taken to Rome. By common consent he was deified and all those who could afford the cost obtained his statue or bust; for a long time his statues held a place among the penates of the Romans. Commodus, who was with his father when he died, erected to his memory the Antonine column (now in the Piazza Colonna at Rome), round the shaft of which are sculptures in relief commemorating the miracle of the thundering legion and the various victories of Aurelius over the Quadi and the Marcomanni. A bronze equestrian statue was set up in the Forum, now on the Capitol.

Aurelius was consistently hostile to Christianity, and persecution, unknown or forbidden under earlier reigns, was systematically pursued under his directions. His attitude was logical enough. The State religion was to him an essential part of the imperial system, and the Christians, particularly in their opposition to emperor-worship, were a danger to the established order.

In his work on the internal administration Marcus Aurelius was equally untiring. His reign is especially notable for legal reforms, and an attempt to arrest the fall in the legitimate birth-rate. His provincial administration was not made easier by the drain on the Treasury caused by the defence of the empire. Against his will he had to increase taxation, and he risked alienating his soldiers by refusing an increase of pay. Last of a line of emperors who all seemed to come little short of the Stoic ideal of the philosopher king, Marcus Aurelius was the best of them all.

Philosophy.—The book which contains the philosophy of Aurelius is known by the title of his *Reflections,* or *Meditations,* although that is not the name which he gave to it himself (Τὰ εἰς ἑαυτόν). Of the genuineness of the work no doubts are now entertained. It is believed that he wrote also an autobiography, which has perished. The *Meditations* were written, it is evident, as occasion offered—in the midst of public business, and on the eve of battles on which the fate of the empire depended—hence their fragmentary appearance, but hence also much of their practical value and even of their charm.

Throughout his life he was a practising, but he was not strictly an orthodox, Stoic. In his hands Stoicism is a practical rule of life, not a philosophy of quietism. In the *Meditations* are no speculations on the absolute nature of the deity, and no clear expressions of opinion as to a future state. He is, above all things, a practical moralist. The goal in life to be aimed at, according to him, is not happiness, but tranquillity, or equanimity. This condition of mind can be obtained only by "living conformably to nature," that is to say, one's whole nature, and as a means to that man must cultivate the four chief virtues, each of which has its distinct sphere—wisdom, or the knowledge of good and evil; justice, or the giving to every man his due; fortitude, or the enduring of labour and pain; and temperance, or moderation in all things. It is no "fugitive and cloistered virtue" that Aurelius seeks to encourage; on the contrary, man must lead the "life of the social animal." While he held that the prime principle in man is the social, "the next in order is not to yield to the persuasions of the body, when they are not conformable to the rational principle which must govern." This divinity "within a man," this "legislating faculty," which, looked at from one point of view, is conscience, and from another is reason, must be implicitly obeyed. He who thus obeys it will attain tranquillity of mind.

What gives the sentences of Marcus Aurelius their enduring value and fascination, and renders them superior to the utterances of Epictetus and Seneca, is that they are the gospel of his life. His precepts are simply the records of his practice. To the saintliness of the cloister he added the wisdom of the man of the world; he was constant in misfortune, not elated by prosperity, never "carrying things to the sweating-point," but preserving, in a time of universal corruption, unreality and self-indulgence, a nature sweet, pure, self-denying, unaffected.

Bibliography.—P. B. Watson's *M. Aurelius Antoninus* (1884) contains a general account—life, character, philosophy, relations with Christianity—as well as a bibliography; see also art. in Pauly-Wissowa, *Realencyclopädie, s.v.* "Annius" (No. 94), col. 2279, and H. D. Sedgwick, *Marcus Aurelius* (New Haven, 1921). For special points see: (1) *Historical:* Authorities under Rome: *Ancient History;* S. Dill, *Roman Society from Nero to M. Aurelius* (1904); M. Rostovtzev, *Social and Economic History of the Roman Empire* (1926). (2) *Relations to Christianity:* Sir W. M. Ramsay, *The Church in the Roman Empire* (1898); W. Möller, *History of the Christian Church, A.D. 1–600* (Eng. trans., A. Rutherford, 1892); W. E. Addis, *Christianity and the Roman Empire* (1893); E. G. Hardy, *Christianity and the Roman Government* (1894), pp. 145 *sqq.,* and Leonard Alston, *Stoic and Christian of the 2nd century* (1906); J. Dartigue-Peyrou, *Marc-Aurèle dans ses rapports avec le christianisme* (1897). (3) *Philosophical:* Besides article Stoics, E. Renan, *Marc. Antoninus et la fin du monde antique* (1882); Eng. trans., W. Hutchinson (1904); W. Pater, *Marius the Epicurean* (1888); Matthew Arnold's *Essays;* C. H. W. Davis, *Greek and Roman Stoicism* (1903); editions of the *Meditations* (5, below); F. W. Bussell, *Marcus Aurelius and the Later Stoics* (Edinboro, 1910). (4) *Military:* E. Napp, *De rebus imperat. M. Aurel. Anton. in oriente gestis* (Bonn, 1879); Conrad, *Mark Aurels Markomannenkrieg* (1889); Th. Mommsen, *Provinces of the Roman Empire* (Eng. trans., W. P. Dickson, London, 1886); for the Aurelius column, E. Petersen, A. von Domaszewski, and G. Calderini, *Die Marcussäule* (Munich, 1896), with historical introduction by Th. Mommsen. (5) The *Meditations* were published by Xylander in 1558; the best critical edition is that of J. Stich in the Teubner series (Leipzig, 1882; 2nd ed., 1903). Translations exist in almost every language; that of George Long (1862, re-edited 1900) has been superseded by those of G. H. Rendall (1898, with valuable introduction) and J. Jackson (1906, with introduction by Charles Bigg). (6) For the correspondence of Aurelius and Fronto, *see* Robinson Ellis, *Correspondence of Fronto and M. Aurelius* and *Class Rev.* vol. 34 p. 14 (1904).

MARCUS HOOK, a borough of Delaware county, Pennsylvania, U.S.A., on the Delaware river and the Pennsylvania railroad, 19 mi. S.W. of Philadelphia. Pop. in 1930, 4,867; in 1940, 4,123, federal census. It has a considerable shipping trade, oil refineries and factories making synthetic fibres, chemicals, barrels and congoleum. Settlement dates from 1640. The streets were laid out by William Penn, who granted a charter to the borough in 1701.

MARCY, WILLIAM LEARNED (1786–1857), American statesman, was born in Southbridge, Mass., on Dec. 12, 1786. He graduated at Brown university in 1808, studied law, was admitted to the bar in Troy, N.Y., and began practice there in 1810. During the War of 1812 he served as a captain of volunteers, and Oct.

22, 1812 took part in the storming of the British post at St. Regis, Canada. In 1816 he became recorder of Troy, but he was removed from office in 1818 by his political opponents. As editor of the Troy *Budget* he was a vigorous supporter of Martin Van Buren, and when Van Buren's followers acquired control of the legislature in 1821 Marcy was made adjutant-general of the New York militia. From 1823 to 1829 Marcy was comptroller of the State, an office then especially important on account of the large expenditures for internal improvements, and during this period he became the leading member of the famous "Albany regency" (*q.v.*), a group of able Democratic politicians who exerted a powerful influence throughout the State by their control of the party patronage and machinery. He was one of the associate justices of the New York supreme court from 1829 to 1831, presiding over the trial of the alleged murderers of William Morgan and in other important cases; and was a member of the United States Senate from Dec. 1831 to July 1832, when he resigned to become governor of New York. In a speech in the Senate defending Van Buren against an attack by Henry Clay, Marcy made the unfortunate remark that "to the victors belong the spoils of the enemy," and thereby became widely known as a champion of the proscription of political opponents. He served as governor of New York for six years (1833–38 inclusive). As governor he secured the enactment, in 1838, of a general banking law, which abolished the monopoly features incident to the old banking system. In 1844–45 he was recognized as one of the leaders of the "Hunkers," or regular Democrats in New York, and an active opponent of the "Barnburners." He was secretary of war under President Polk from 1845 to 1849, and as such discharged with ability the especially onerous duties incident to the conduct of the Mexican War.

From 1853 to 1857 he served the term as secretary of State in the cabinet of President Pierce. Few cabinet officers in time of peace have had more engrossing duties. His circular in 1853 to American diplomatic agents abroad, recommending that, whenever practicable, they should "appear in the simple dress of an American citizen," created much discussion in Europe; in 1867 his recommendation was enacted into a law of Congress.

In 1853 Marcy secured the negotiation of the Gadsden Treaty (*see* GADSDEN, JAMES), by which the boundary dispute between Mexico and the United States was adjusted and a large area was added to the Federal domain. The expedition of William Walker (*q.v.*) to Nicaragua in 1855 further complicated the Central American situation. The diplomatic relations of the United States and Spain growing out of the noted "Black Warrior Case" furnished, perhaps, the most perplexing of Marcy's problems, and it was largely due to his influence that war was averted. However, he was not averse to increasing his popularity and his chances for the presidency by obtaining Cuba in an honourable manner, and it was at his suggestion that James Buchanan, J. Y. Mason and Pierre Soulé, the ministers respectively to Great Britain, France and Spain, met at Ostend and Aix-la-Chapelle in Oct. 1854 to discuss the Cuban question. But the remarkable "Ostend Manifesto" (*q.v.*), the outcome of their conference, was quite unexpected, and Marcy promptly disavowed the document. In domestic affairs Marcy was a shrewd, but honest partisan; in diplomacy he exhibited the qualities of a broadminded, patriotic statesman, endowed, however, with vigour, rather than brilliancy, of intellect. He died at Ballston Spa, N.Y., on July 4, 1857.

For his early career, consult J. S. Jenkins, *Lives of the Governors of New York* (Auburn, N.Y., 1851); and for his work as secretary of State, *see* James Ford Rhodes, *History of the United States* (vols. i. and ii., 1892), and an article by Sidney Webster, "Mr. Marcy, the Cuban Question, and the Ostend Manifesto" (in vol. viii. of the *Political Science Quarterly*, 1893); J. B. Moore, "A Great Secretary of State," *Pol. Sci. Quart.* (vol. xxx., P. 377–396, Lancaster, Pa., 1915); "Diary and Memoranda of William L. Marcy, 1849–51," *American Hist. Rev.* (vol. xxiv., P. 444–462, 641–653, Lancaster, Pa., 1919); De Alva S. Alexander, *A Political History of the State of New York* (1906–1923).

MARDI GRAS: *see* SHROVE TUESDAY.

MARDIN, a town in a vilayet of the same name in Kurdistan, Turkey, and *c.* 30 m. north-west of Nisibin, on the line of the Baghdad railway. The town is of some importance on the caravan route between the east and west. From Mardin one road leads west to Urfah and so to Aleppo or Aintab. A second runs north-west to Diarbekr. South-east runs the road to the Tigris and so to Mosul and Baghdad. The town is the centre of a rich agricultural district, the principal products being wheat, barley and sesame. A certain amount of wool is produced and there is a small cotton and woollen weaving industry. The population is very mixed and is 23,270 for the city and 252,505 for the vilayet. It includes Arabs, Armenians, Jacobites, Kurds and a medley of Asiatics.

MARDONIUS (*fl.* 479 B.C.), Persian general, was the son of Gobryas, one of the conspirators against Smerdis the Magian. He married Artazostra, daughter of Darius Hystaspis, and in 492 was sent to succeed Artaphernes in the settlement of Ionia with a special commission to attack Athens and Eretria. Contrary to the usual Persian policy, he restored democracies in Ionia, and then crossed the Hellespont and invaded Thrace and Macedonia. His fleet was wrecked off Athos with enormous loss, and Mardonius abandoned further progress and came back to Aria; he was superseded in 490. On the accession of Xerxes Mardonius was one of the chief instigators in the invasion of Greece. After Salamis he persuaded Xerxes to return, and himself stayed behind with a large army. He was defeated by Pausanius and killed at Plataea in September 479.

See Herodotus: Books vi.–ix.; *Diod.* xi., i. 28–31.

MARDUK, a late name for the god of the city of Babylon, who appears regularly in the classical Sumerian liturgies under the titles *Asar-lu-dug* and *Enbilulu*. The original title is *Asaru,* which occurs in the old pantheon at Fara, *c.* 3200 B.C., and so far as known, long before the city of Babylon was founded. *Asaru, Asar-ri,* is a title of this, originally inferior, deity of the cult of Enki at Eridu, as son of the water god, a deity of lustration. His connection with Babylon, which is first mentioned as a small city by Sargon in the 28th century B.C., may be original and very old. The title *Marduk* lays special emphasis upon his solar aspect. It is certain that all the older titles of this god, Asaru, Asar-alim, Asar-alim-nun-na, Asarludug, describe him as an inferior deity of the water cult of Eridu, and how he came to be transferred to Babylon is at present inexplicable. *Alim* means the mythical fish ram, symbol of his father, the water god of Eridu, and *Asaru* was the god of lustration at Habur in Eridu. Asarludug means "Asaru who restores man to happiness," and describes his original activity as agent of Enki in all magical rituals of the water cult against demons. Marduk is pre-eminently the god of the magicians in Babylonian and Assyrian religion, and this was his sole sphere in the original Sumerian pantheon.

With the rapid rise of Babylon under the 11 kings of the 1st dynasty (2169–1870), the priests of the local cult looked for some means of increasing the respect due to the god of the great capital and a theological reason for it. Inasmuch as the Sumerian pantheon had been universally accepted by the Accadians, and had now a firm hold upon the religious beliefs of the Semites in Assyria, Cappadocia and the Amoritic western country, it was impossible to make *Asaru* one of the three heads of the trinity; these were securely held by Anu, Enlil and Enki. But the old war and sun god Ninurta, Zamama, son of Enlil, was largely drawn upon to make Asaru also a sun god, and more especially the god of the spring sun. This addition to his original character as a god of lustration and magic was brought about by rewriting the Sumerian legend of Creation in which Ninurta championed the gods against the dragon of Chaos, the storm demon Zû, and then created the world. The new Semitic version in six books attributed this victory of the gods to Marduk. The name itself was introduced at this time, *amar-udu, amar-utu,* and means "young bull, the sun," becoming, after the regular rule of Sumerian loan-words, *Marutukku, Marudukku, Má-rû-tu-*[*uk-ku*], *Maruduk, Marduku, Marduk*. (*See* S. Langdon, *Oxford Editions of Cuneiform Texts*, vol. vi. 99, 113, and *Cuneiform Texts* . . in the British Museum, vol. xxv. 34, ii. 17.) The Hebrew transcription is Merodak, and the Greek, *Maradouchos, Mardakos, Mardokos, Maradach.*

In the Semitic version of the Epic, Marduk's birth and education are described. The old theological view, that he was the son of Enki or Ea of Eridu, is preserved, except in the Assyrian editions, where he is displaced by Ashur, son of Lahmu. The legend of how he was unanimously raised to the rank of a great god (in the convocation of the gods), because of his magical power to cause objects to vanish and reappear, and for his promise to go forth to battle with Tiamat, Kingu and the dragons of darkness, is one of the principal episodes of the epic. After Tiamat was slain and the dragons bound, Marduk created heaven and earth, the constellations and planets, and fixed their movements. Finally, he ordered man to be created on the advice of his father, Ea. Kingu was then slain and from his blood "mankind" was created. This was the Eridu legend of the creation of man, but in the rival Nippurian school his creation is said to have been by the mother goddess, Aruru, from clay. Undoubtedly the Hebrew legend of the creation of Adam from clay combines the legend of Marduk and Aruru.

Upon the epic of Creation and the myth of the conquest of light over darkness is based the Babylonian new year festival, described in the article BABYLONIAN AND ASSYRIAN RELIGION. For the later identification of Marduk with Tammuz and the Resurrection of Bêl, *see* TAMMUZ. So completely did Marduk finally dominate the religion of Babylonia that he is chiefly known to Greek and Roman writers as "lord," Bêlos, *see* BÊL. A text proves that in the late period theological speculation went so far as to assimilate all the important deities to Marduk, but this advance toward real monotheism was obviously confined to priests at Babylon. (*See* Jensen, *Keilinschriftliche Bibliothek,* vi. pt. 2, p. 118.) Unlike other great and older deities, Marduk had no temples and shrines outside his own city. The Sumerian cities of the south never admitted his new rôle in the pantheon, but only his original names and character as an inferior water deity of Eridu. At Babylon his temple, Esagila, and his stage tower, Etemenanki, were the largest of the kind in Babylonia and Assyria. To Esagila, at least in the late period, all the statues of the great gods of Babylonia were brought in ships and wagons to assemble in the hall of convocation (Dukug) and fix the fates of men for the coming year at the Nisan festival.

Marduk's principal rôle in astronomy was as the planet Jupiter; as such he was known as Shulpaé, a title of a deity which originally had no connection with Asaru or Marduk. The title belongs originally to Enlil, the ancient *Bêl* of Nippur, and is found in the oldest inscriptions. The planet must have been known as *mul Shulpaé,* and identified with Enlil before the 22nd century, otherwise the name would not have been chosen for Marduk when the theologians assigned to him the largest of the planets.

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MARE, the female of any animal of the family *Equidae,* particularly of the horse. It is also used of the camel. To find a "mare's nest" is an old saying for a purely imaginary discovery. In "night-mare," an oppressive or terrifying dream, the termination is a word for a goblin, supposed to cause these dreams: *cf.* ELF.

MARE CLAUSUM and **MARE LIBERUM** (Lat. for "closed sea" and "free sea") in international law, terms associated with the historic controversy which arose out of demands on the part of different States to assert exclusive dominion over areas of the open or high sea. Thus Spain and Portugal laid claim to exclusive dominion over whole oceans, Great Britain to the narrow seas, and so on. These claims gave rise to vigorous opposition by other powers and led to the publication of Grotius's work *Mare liberum* (1608). In *Mare clausum,* written in 1617–18 and published in 1635, Selden asserted "that the sea by the law of nature or nations is not common to all men but capable of private dominion or property as well as the land."

A formula was found by Bynkershoek in his *De dominio maris* (1702) for the restriction of dominion over the sea to the actual distance to which cannon range, *i.e.,* three marine miles, could protect it (*see* WATERS, TERRITORIAL).

See Grotius, *The Freedom of the Seas* (tr. by R. van D. Magoffin, 1916); Sir J. Boroughs, *The Sovereignty of the British Seas* (ed. Wade, 1920).

MAREE, LOCH, a fresh-water lake in the county of Ross and Cromarty, Scotland. Its name commemorates St. Maelrubha, who, in 671 founded a monastery at Applecross and a chapel (now in ruins) on Isle Maree. The lake is $13\frac{1}{2}$ m. long from Kinlochewe at the head of the dam erected in the 16th century (or earlier) by the iron-smelters of the Ceardach Ruardh, or Red Smiddy, on the river Ewe by which it drains to the sea. Its greatest breadth is just over 2 m. at Slattadale, and the greatest depth 367 ft. There are over 30 islands, covering an area of nearly 1 sq.m. and lying mostly north and east of Slattadale. The largest is Eilean Subhainn, or St. Swithin's Isle, which contains two small lakes. For two-thirds of its length the loch is flanked by mountains. On the north-east the principal heights are Ben Slioch (3,217 ft.), Ben Lair and Ben Airidh-a-Char, and, on the south-west, the peaks of Ben Eay, four of which exceed 3,000 ft. Sea trout and salmon are taken in the loch.

MARÉES, HANS VON (1837–1887), German painter, was born at Elberfeld on Dec. 24, 1837. In 1853 he went to Berlin, where he studied for two years under Steffeck. For the next eight years he worked chiefly in Munich, coming under the influence of the historical school, and in 1864 he went to Rome. He also travelled in Spain and France and spent some time in Berlin. In 1873 he received his most important commission, the painting of frescoes in the library of the Zoological museum at Naples. Although ambitious, Marées lacked self-confidence, and in the latter part of his life ceased to exhibit his work. He died in Rome on June 5, 1887, a disappointed and practically unknown man. When his works were collected at the Munich exhibition in 1891, their real value became apparent.

See Meier-Gräfe, *Hans von Marées* (vol. iii., 1909); Conrad Fiedler, *H. v. Marées,* 2 vols., one of illustrations (Munich, 1889); Hans von Marées, *Briefe* (Munich, 1920); Meier-Gräfe, *Der Zeichner Hans von Marées* (Munich, 1925).

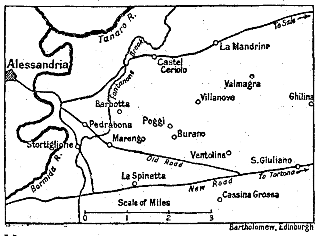
MAREMMA, a marshy region of Tuscany, Italy, from the mouth of the Cecina to Orbetello, 15 to 20 m. broad. In Etruscan and Roman times the Maremma was a populous and fertile coast plain, with considerable towns situated on the hills—Populonia, Rusdellae, Cosa, etc.—and was drained by subterranean canals, which were brought to light when excavations were in progress for the building of railways. The decline of agriculture at the end of the Republic led to a conversion of the land to pasture, and the fall of the Empire resulted in neglect of watercourses. Leopold II. of Tuscany (1822–1844) made the first successful efforts to counteract malaria by drainage, filling up of swamps, and establishment of new farms, and since his time continuous efforts have been made with considerable success.

See C. Nicolosi, *Il Litorale Maremmano; La Montagna Maremmana* (Bergamo, Arti Grafiche, 1911), well illustrated.

MARENGO, a village of north Italy, on the road between Alessandria and Tortona, and $4\frac{3}{4}$m. E.S.E. of the gates of the former. It is situated on the Fontanone brook, a small affluent of the Tanaro which marks the western edge of the plain of Marengo, the scene of the great victory won by Napoleon Bonaparte over the Austrians under Baron Melas (1729–1806) on June 14, 1800. The antecedents of the battle are described under FRENCH REVOLUTIONARY WARS.

The French army, uncertain of its opponent's position, had advanced westward from the Scrivia towards Alessandria on the 12th, and its outposts had reached the Bormida on the evening of the 13th. But contact with the main Austrian army was not obtained, and on the assumption that it was moving towards either Valenza or Genoa Bonaparte weakened his army by considerable detachments sent out right and left to find the enemy and to delay his progress. Unknown, however, to Bonaparte Melas's army was still at Alessandria, and on the morning of June 14 it filed out of the fortress and began its advance into the great plain of Marengo, one of the few favourable cavalry battle-grounds in north Italy.

Gen. Victor had not carried out Bonaparte's evening order to destroy the bridges over the Bormida, and the dispersion of the French army allowed only a fragmentary, though most energetic, resistance to be offered to the Austrian onset. The latter, considerably delayed at first by the crossing of the river Bormida, broke up into two columns,[1] advanced, the right by the main road on Marengo, the left on Castel Ceriolo. The former, personally commanded by Melas, was 20,000 strong, and Gen. Victor, its immediate opponent, about 10,000, or including some 5,000 of Lannes' corps who fought on his right, about 15,000 strong; the Austrians were, moreover, greatly superior in guns (in all 192 to 14) and cavalry. The French disputed every yard of ground, holding their first line until they had by fire and counter-attack forced practically the whole of the Austrian right to deploy, and two hours passed before the Austrians managed to reach the Fontanone brook. But Victor's troops, being disorganized and short of ammunition, had then to retire more rapidly across the plain. The retreat was orderly, according to Victor's report, and made in échelon from the centre, and it is certain that at any rate the regiments held together, for the 6,000 Austrian sabres found no opportunity to charge home. Many guns and wagons were, however, abandoned.



MAP OF MARENGO, THE SCENE OF NAPOLEON'S VICTORY OVER THE AUSTRIANS, JUNE 14, 1800

On the French right, opposed to the column of Lieut.-Field-Marshal Ott, was Lannes, with some 4,000 men (excluding Watrin's division which was with Victor) against 7,500. He too was after a time forced to retire, with heavy losses. Thus, about 11 A.M., Bonaparte, who was at some distance from the field, became convinced that he had to deal with Melas's army. At once he sent out his staff officers to bring back his detachments, and pushed forward his only reserve, Monnier's division, to support Lannes and Victor. But before this help arrived Lannes had been driven out of Castel Ceriolo, and Victor and Watrin forced back almost to San Giuliano. A little after 2 P.M. Monnier's division (3,500) came into action, and its impetuous advance drove the Austrians out of Castel Ceriolo. But after an hour it was forced back in its turn, and by 3 P.M., therefore, the 20,000 French troops, disordered and exhausted, and in one line without reserves,[2] held a ragged line of battle to the right and left of San Giuliano. The best that could be expected was a prolongation of the struggle till nightfall and a fairly orderly retreat. Melas, slightly wounded and believing that the battle was won, returned to Alessandria, leaving a younger man, his chief of staff Zach, to organize the pursuit.

Then followed one of the most dramatic events in military history. Of the two detachments sent away by Napoleon in search of the enemy, one only received its orders of recall. This was Boudet's division of Desaix's corps, away to the south at Rivalta and at noon heading for Pozzolo-Formigaro on the Alessandria-Genoa road. At 1 P.M. a brief message, "Revenez, au nom de Dieu!" altered the direction of the column, and between 4 and 5, after a forced march, the division, headed by Desaix, came on to the battle-field. It was deployed as a unit and moved forward at the word of command along the main road Alessandria-Tortona, the sight of their closed line giving fresh courage to the men of Lannes and Victor. Then, while on the other side Zach was arraying a deep column of troops to pursue along the main road, Napoleon and Desaix, themselves under fire, hastily framed a plan of attack. All arms were combined. First, Marmont with eight of Boudet's guns and ten others (the rest had been abandoned in the retirement) came into action on the right of the road, replying to the fire of the Austrian guns and checking their advanced infantry; close in rear of the artillery was Desaix's infantry with the remnants of Lannes' and Victor's troops rallying on its right and left; on Lannes' right, still facing Ott's column, was Monnier, supported by the Consular Guard of horse and foot; lastly 400 sabres of Kellermann's cavalry brigade, which had already been engaged several times and had lost heavily, formed up on the right of Desaix. About 5 P.M. Desaix advanced against the head of the Austrian main column formed by Zach. He himself fell in the attack, but the onset of his intact troops drove back the leading Austrians upon their supports, and at the critical moment when the attack of Boudet's single weak division had almost spent its force, Kellermann with his 400 sabres sallied out of the French line. Marmont had brought up two guns to assist the infantry, and as he fired his last round of case-shot the cavalry raced past him to the front, wheeled inwards against the flank of the great column, and rode through and through it. Zach was taken prisoner with more than 2,000 men, and Kellermann, rallying some of his troopers, flung himself upon the astonished Austrian cavalry and with the assistance of the Consular Guard cavalry defeated it. The "will to conquer" spread along the whole French line, while the surprise of the Austrians suddenly and strangely became mere panic. Lannes, Victor and Monnier advanced afresh, pushing the Austrians back on Marengo. A few Austrian battalions made a gallant stand at that place, while Melas himself, as night came on, rallied the fugitives beyond. Next day the completely exhausted, but victorious, French army extorted from the dazed Austrians a convention by which all Italy up to the Mincio was evacuated by them. The respective losses were: French about 4,000, Austrians 9,500.

See the French official *Campagne de l'armée de réserve,* vol. ii., by C. de Cugnac.

[1]A third column was sent out to the extreme right (3,000 under O'Reilly). This destroyed a small French detachment on the extreme left, but took little or no part in the main battle.

[2]The Austrians, too, fighting in "linear" formation had few reserves. About one-third only of the imperial forces in Italy was actually engaged in the battle.

MARENZIO, LUCA (before 1560–1599), Italian composer, was born probably at Coccaglia in the Bergamask before 1560. According to some accounts he was descended from a noble family of Bergamo. He was a pupil of Giovanni Contini, organist of Brescia, and began to publish books of madrigals at an early age. In 1581 he was in Venice and from 1582 to 1585 in Rome, where he was at one period chapel-master to the Cardinal d'Este. For two years he held a handsome appointment at the court of Poland, but 1595 found him back in Rome with an appointment at the Papal chapel. In Rome he became a warm friend of Cardinal Aldobrandino, the pope's nephew. He died in Rome on Aug. 22, 1599. Marenzio's most important compositions consist of the 16 books of madrigals, 5 books of vilanelles and airs, 2 books of motets and 1 mass. (The complete list is in Eitner's *Quellen-lexikon.*) The 5-part and 6-part madrigals in two books are in the British Museum. The *Musica transalpina* (1588) contains some of his works, and several motets are included in Proske's *Musica divina* (1853).

See also "Marenzio" in Grove *Dictionary of Music and Musicians.*

MAREOTIS, the most westerly of the lakes in the Delta of Egypt (Arab. *Mariut*). On the narrow strip of land separating the lake from the Mediterranean the city of Alexandria is built. (*See* EGYPT and ALEXANDRIA.) In classical times its shores were a region of great fertility, and in the middle ages the lake was practically dry. During the siege of Alexandria in 1801 the British cut the ridge of dunes at Aboukir and flooded the area with sea water. Now, by means of pumps, the water-level of the lake is kept about 8 ft. below sea-level, and cultivation has been largeiy restored.

MARE'S-TAIL, the popular name for an aquatic herb known botanically as *Hippuris vulgaris* (water-milfoil family Hippuridaceae). Mare's-tail grows on margins of lakes, ponds and similar localities, and has a submerged stout creeping rootstock from which spring many-jointed cylindrical stems bearing numerous narrow leaves close-set in whorls. The minute greenish flowers are borne in the leaf-axils. Like many freshwater plants it has a wide distribution, occurring in arctic and temperate regions in the northern hemisphere. It reappears in Antarctic South America.

MARET, HUGUES-BERNARD, Duc de Bassano (1763–1839), French statesman and publicist, was born at Dijon. After receiving a sound education, he entered the legal profession and became advocate at the King's Council at Paris. The interest aroused by the debates of the first National Assembly suggested to him the idea of publishing them, conjointly with Méjean, in the *Bulletin de l'Assemblée.* The publicist Charles Joseph Panckoucke (1736–1798), owner of the *Mercure de France* and publisher of the famous *Encyclopédie* (1781), persuaded him to merge this in a larger paper, the *Moniteur universel,* which gained a wide repute for correctness and impartiality. He was a member of the moderate club, the Feuillants; but after the overthrow of the monarchy on Aug. 10, 1792 he accepted an office in the ministry of foreign affairs, where he sometimes exercised a steadying influence. On the withdrawal of the British legation from Paris Maret went on a mission to London, where he had a favourable interview with Pitt on Dec. 2, 1792. All hope of an accommodation was, however, in vain. After the execution of Louis XVI. (Jan. 21, 1793), the chief French diplomatic agent, Chauvelin, was ordered to leave England, while the French Convention declared war (Feb. 1, 1793). These events precluded the possibility of success attending a second mission of Maret to London in January. He was sent to Naples as ambassador of the French Republic; but he was captured by the Austrians, and was only released in 1795 when the duchess of Angoulême was set free. Maret took part in the negotiations with Great Britain at Lille during the summer of 1797, until the *coup d'état* of Fructidor frustrated any peace. On the return of Bonaparte from Egypt in 1799 Maret joined the general's party which came to power with the *coup d'état* of Brumaire (Nov. 9–10, 1799).

Maret now became one of the First Consul's secretaries and shortly afterwards secretary of state. The *Moniteur,* which became the official journal of the state in 1800, was placed under his control. In 1804 he became minister; in 1807 he was named count, and in 1809 he received the title of duc de Bassano. His personal devotion to the emperor was of that absolute unwavering kind which Napoleon highly valued. Maret accompanied Napoleon through most of his campaigns, including that of 1809; and in the spring of 1811 he replaced Champagny, duc de Cadore, as minister of Foreign Affairs. In this capacity he concluded the treaties between France and Austria and France and Prussia, which preceded the French invasion of Russia in 1812. He was with Napoleon through the greater part of that campaign; and after its disastrous conclusion helped to prepare the new forces with which Napoleon waged the equally disastrous campaign of 1813. But in November 1813 Napoleon replaced him by Caulaincourt, duc de Vicence.

Maret, however, as private secretary of the emperor, remained with his master through the campaign of 1814, as also during that of 1815. After the second restoration of the Bourbons he was exiled, and retired to Grätz where he occupied himself with literary work. In 1820 he was allowed to return to France, and after the Revolution of 1830, Louis Philippe, king of the French, made him a peer of France; he also held two high offices for a few days. He died at Paris in 1839. He shares with Daru the honour of being the hardest worker and most devoted supported in Napoleon's service; but it has generally been considered that he carried devotion to the length of servility, and thus often compromised the real interests of France. This view has been contested by Baron Ernouf in his work *Maret, duc de Bassano,* which is the best biography.

For Maret's mission to England in 1792 and his work at Lille in 1797, *see* Augustus W. Miles, *Letters on the French Revolution.*

MARGARET, a female proper name, which became very popular in all Christian countries as that of Saint Margaret (*q.v.*). (Fr. *Marguerite,* It. *Margherita,* Ger. *Margareta,* fr. Lat., *margarita,* Gr. *μαργαρίτης,* a pearl.)

MARGARET, ST. (Sancta Margarita), virgin and martyr, is celebrated by the Church of Rome on July 20. According to the legend, she was a native of Antioch, daughter of a pagan priest named Aedesius. She was scorned by her father for her Christian faith, and lived in the country with a foster mother keeping sheep. Olybrius, the "praeses orientis," offered her marriage as the price of her renunciation of Christianity. Her refusal led to her being cruelly tortured, and after various miraculous incidents, she was put to death. Among the Greeks she is known as Marina, and her festival is on the 17th of July. She has been identified with St. Pelagia (*q.v.*)—Marina being the Latin equivalent of Pelagia—who, according to a legend, was also called Margarito. The cult of St. Margaret was very widespread in England, where more than 250 churches are dedicated to her.

See *Acta sanctorum,* July, v. 24–45; *Bibliotheca hagiographica, Latina* (Brussels, 1899), n. 5303–13; Frances Arnold-Forster, *Studies in Church Dedications* (London, 1899), i. 131–133 and iii. 19.

MARGARET, ST. (*c.* 1045–1093), queen of Malcolm III. Canmore king of Scotland, was the daughter of the English prince Edward, son of Edmund Ironside, and sister of Edgar Aetheling. In 1067 the widow and children of Edward fled from Northumberland and sought the protection of the Scottish king. The marriage of Malcolm and Margaret was followed by several invasions of Northumberland by the Scottish king, probably in support of the claims of his brother-in-law Edgar. A considerable portion of the old Northumbrian kingdom had been reduced by the Scottish kings in the previous century, but up to this time the English population had little influence upon the ruling element of the kingdom. Malcolm's marriage undoubtedly improved the condition of the English, and under Margaret's sons, Edgar, Alexander I. and David I., the Scottish court practically became Anglicized. Margaret died on Nov. 17, 1093, four days after her husband and her eldest son Edward, who were slain in an invasion of Northumberland. She rebuilt the monastery of Iona, and was canonized in 1251 on account of her benefactions to the Church.

MARGARET (1353–1412), queen of Denmark, Norway and Sweden, the daughter of Valdemar IV. of Denmark, was born in 1353 and married ten years later to King Haakon VI. of Norway. Her first act, after her father's death (1375), was to procure the election of her infant son Olaf as king of Denmark. Olaf died in 1387, having in 1380 also succeeded his father; and in the following year Margaret, who had ruled both kingdoms in his name, was chosen regent of Norway and Denmark. She now turned to Sweden, where the nobles were in arms against their unpopular king, Albert of Mecklenburg.

At a conference held at Dalaborg castle, in March 1388, the Swedes were compelled to accept all Margaret's conditions, elected her "Sovereign Lady and Ruler," and engaged to accept from her any king she chose to appoint. On Feb. 24, 1389, Albert, who had returned from Mecklenburg with an army of mercenaries, was routed and taken prisoner at Aasle near Falköping, and Margaret was now the omnipotent mistress of three kingdoms. Stockholm, then almost entirely a German city, still held out; fear of Margaret induced both the Mecklenburg princes and the Wendish towns to hasten to its assistance; and the Baltic and the North Sea speedily swarmed with the privateers of the *Viktualien brödre* or *Vitalianer,* so called because their professed object was to revictual Stockholm. Finally the Hansa intervened, and by the compact of Lindholm (1395) Albert was released by Margaret on promising to pay 60,000 marks within three years, the Hansa in the meantime to hold Stockholm in pawn. Albert failing to pay his ransom within the stipulated time, the Hansa surrendered Stockholm to Margaret in September 1398, in exchange for very considerable commercial privileges.

It had been understood that Margaret should, at the first convenient opportunity, provide the three kingdoms with a king who was to be her nearest kinsman, and in 1389 she proclaimed her infant cousin, Eric of Pomerania, king of Norway. In 1396 homage was rendered to him in Denmark and Sweden likewise, Margaret reserving to herself the office of regent during his minority. To weld the united kingdoms still more closely together, Margaret summoned a congress of the three councils of state to Kalmar in June 1397; and on Trinity Sunday, June 17, Eric was crowned king of Denmark, Norway and Sweden. The proposed act of union divided the three *Rigsraads,* but the actual deed embodying the terms of the union never got beyond the stage of an unratified draft. Margaret revolted at the clauses which insisted that each country should retain its own laws and customs, and be administered by its own dignitaries, as tending to prevent amalgamation, but she avoided every appearance of an open rupture.

A few years after the union of Kalmar, Eric, now in his eighteenth year, was declared of age and homage was rendered to him in all his three kingdoms, but during her lifetime Margaret was the real ruler of Scandinavia. So long as the union was insecure, Margaret had tolerated the presence near the throne of "good men" from all three realms (the *Rigsraad,* or council of state, as these councillors now began to be called); but their influence was always insignificant. In every direction the royal authority remained supreme. The offices of high constable and earl marshal were left vacant; the *Danehoffer* or national assemblies fell into desuetude, and the great queen, an ideal despot, ruled through her court officials acting as superior clerks. Margaret also recovered for the Crown all the landed property which had been alienated during the troublous days of Valdemar IV. This so-called "reduktion," or land-recovery, was carried out with the utmost rigour, and hundreds of estates fell to the Crown. Margaret also reformed the Danish currency. In foreign politics she maintained a strict system of neutrality. On the other hand she spared no pains to recover lost Danish territory. Gotland she purchased from its actual possessors, Albert of Mecklenburg and the Livonian Order, and the greater part of Schleswig was regained in the same way. Margaret died suddenly on board her ship in Flensborg harbour on Oct. 28, 1412.

See *Danmarks riges historie, den senere Middelalder,* pp. 358–412 (Copenhagen, 1897–1905); Erslev, *Danmarks historie under dronning Margrethe* (Copenhagen, 1882–1901); Hill, *Margaret of Denmark* (London, 1898). (R. N. B.)

MARGARET (1489–1541), queen of Scotland, eldest daughter of Henry VII., king of England, by his wife Elizabeth, daughter of Edward IV., was born at Westminster on Nov. 29, 1489. She married James IV. of Scotland on Aug. 8, 1503, but the scanty dowry given by her avaricious father embittered the relations between the two kingdoms, which the marriage, although accompanied by a treaty of perpetual peace, did nothing to heal. The whole of Margaret's life after her marriage was an unending series of intrigues, first with one political faction then with another; her conduct being mainly influenced by considerations affecting her pocket.

Margaret was crowned at Edinburgh in March 1504. Between 1507 and 1510 two sons and a daughter were born, all of whom died in infancy; in 1512 she gave birth to a son who succeeded his father as James V.; in 1514 she bore a posthumous son, Alexander, created duke of Ross, who died in the following year. A dispute with her brother Henry VIII. over a legacy was a contributory cause of the war which ended at Flodden, where James IV. was killed in Sept. 1513, having by his will appointed Margaret sole guardian of her infant son, now James V. Scotland was divided mainly into two parties, one in favour of alliance with England, and the other with France. The leader of the latter was John Stewart, duke of Albany, next heir to the crown of Scotland after Margaret's sons; Margaret herself for the most part inclined to the English faction; and when Albany returned to Scotland from France on the invitation of the Scottish parliament in the spring of 1514, the conflict grew almost to civil war. Her marriage to Archibald Douglas, earl of Angus, on Aug. 6, 1514 alienated many of the nobility, especially the earls of Arran and Home, and made her entirely dependent on the house of Douglas. It also furnished the council with a pretext for removing her from the regency and guardianship of the king in favour of Albany in July 1515. She fled to England in September, where a month later she bore to Angus a daughter, Margaret, who afterwards became countess of Lennox, mother of Lord Darnley and grandmother of James I. of England.

In 1516 Margaret went to her brother's court in London, while Angus, much to his wife's displeasure, returned to Scotland, where he made peace with Albany and was restored to his estates. The rivalry between the French and English factions in Scotland was complicated by private feuds of the Hamiltons and Douglases, the respective heads of which houses, Arran and Angus, were contending for the supreme power in the absence of Albany in France, where at the instance of Henry VIII. he was detained by Francis I. Margaret, quarrelling with her husband over money matters, sided at first with Arran and began to agitate for a divorce from Angus. In this she was probably aided by Albany, who found an unexpected ally in the queen-mother, Margaret being temporarily alienated from the English party by her brother Henry's opposition to her divorce. When Albany returned to Scotland in 1521 his association with Margaret gave rise to the accusation that it was with the intention of marrying her that he favoured her divorce from Angus. As Albany was strongly supported by the Scottish parliament, Angus found it necessary to withdraw to France till 1524. During these years there was constant warfare between the English and the Scots on the border, but in May 1524 Albany was obliged to retire to France. Henry VIII. continually aimed at securing the person of his nephew, the king of Scots, but he was proclaimed a reigning sovereign in July 1524. The queen-mother married Henry Stewart, second son of Lord Avondale, immediately after her divorce from Angus in 1527. Margaret and her new husband, who was created Lord Methven, now became for a time the ruling influence in the counsels of James V. But when her desire to arrange a meeting between James and Henry VIII. in 1534 was frustrated by the clergy and the council, Margaret in her disappointment revealed certain secrets to Henry which led to her being accused by her son of betraying him for money and of acting as an English spy. She died at Methven Castle on Oct. 18, 1541.

See A. Lang, *History of Scotland,* vol. i. (1900); M. A. E. Green, *Lives of the Princesses of England* (6 vols., 1849–55); *The Hamilton Papers,* ed. by J. Bain (2 vols., Edinburgh, 1890); John Leslie, *History of Scotland,* ed. by T. Thompson (4 vols., Edinburgh, 1830); Sir H. Ellis, *Original Letters Illustrative of English History* (1825–46).

MARGARET (1283–1290), titular queen of Scotland, and generally known as the "maid of Norway," was the daughter of Eric II., king of Norway, and Margaret, daughter of Alexander III., king of Scotland. Her mother died soon after Margaret's birth, and in 1284 the estates of Scotland decided that if Alexander died childless the crown should pass to his granddaughter. In March 1286 Alexander was killed and Margaret became queen. The English king Edward I. was watching affairs in Scotland, and in 1289 a marriage was arranged between the infant queen and Edward's son, afterwards Edward II. Margaret sailed from Norway and reached the Orkneys, where she died in Sept. 1290. Some mystery surrounded her death, and about 1300 a woman from Leipzig declared she was Queen Margaret. The impostor, if she were such, was burned as a witch at Bergen.

See A. Lang, *History of Scotland,* vol. i. (Edinburgh, 1904); A. O. Anderson, *Early Sources of Scottish History,* A.D. *500–1286,* vol. 2 (1922).

MARGARET MAULTASCH (1318–1369), countess of Tirol, nicknamed Maultasch (pocket-mouth) on account of the shape of her mouth, was the daughter and heiress of Henry, duke of Carinthia and count of Tirol. When Henry died in 1335 Carinthia passed to Albert II., duke of Austria; but Tirol was inherited by Margaret and her young husband, John Henry, son of John, king of Bohemia, whom she had married in 1330. This union was not a happy one, and the Tirolese disliked the government of Charles, afterwards the emperor Charles IV., who ruled the county for his brother. Margaret combined with the Estates and expelled her husband, being supported by the Emperor Louis IV., who, declaring her marriage null and void, married her in 1342 to his own son Louis, margrave of Brandenburg, whom Margaret then pronounced Count of Tirol. The local nobles were, however, soon discontented with their new rulers. Supported by the Pope, who placed the Emperor and his son under the ban, they attacked Margaret, who defended herself bravely until her husband put down the rebellion. Louis died in 1361 and Margaret's only son, Meinhard, in 1363. On Sept. 29, 1363, Margaret handed over Tirol to Rudolph IV., duke of Austria, and retired to Vienna, where she died on Oct. 3, 1369. She lived long in the memory of the people of Carinthia, who regarded her as an amazon, and called her the *Wicked Gretl*.

See A. Huber, *Geschichte der Vereinigung Tirols mit Oesterreich* (Innsbruck, 1864). Her story is the subject of Lion Feuchtwanger's novel *The Ugly Duchess*.

MARGARET OF ANJOU (1430–1482), queen of England, daughter of René of Anjou, titular king of Naples and Jerusalem, was born on March 23, 1430. She married Henry VI. king of England on April 23, 1445. Her marriage had been negotiated by William de la Pole, duke of Suffolk, and when she came to England, Suffolk and his wife were her only friends. Naturally she fell under his influence, and supported his policy. This, added to her French origin and sympathies, made her unpopular. Her active share in politics began after Suffolk's fall in 1450. She not only supported Edmund Beaufort, duke of Somerset, in his opposition to Richard of York, but concerned herself also in the details of government, seeking pecuniary benefits for herself and her friends. As a childless queen her influence was limited; and when her only son, Edward, was born on Oct. 13, 1453, her husband, was stricken with insanity. From this time she was the ardent champion of her husband's and son's rights; to her energy the cause of Lancaster owed its endurance, but her implacable spirit contributed to its failure.

When York's protectorate was ended by Henry's recovery in January 1455, Margaret, not content with the restoration of Somerset and her other friends to liberty and office, pushed her politics to extremes. The result was the defeat of the Lancastrians at St. Albans, and for a year Margaret had to acquiesce in York's power. Ultimately, in October 1456 at Coventry, she procured some change in the government. Though formally reconciled to York in March 1458, she continued to intrigue with her partisans in England, and even with friends in France. After the Yorkist failure at Ludlow in 1459, Margaret embittered the struggle by a wholesale proscription of her opponents in the parliament at Coventry. She was not present with her husband at Northampton on July 10, 1460. She made her way to Scotland, and from Mary of Gelderland, the queen regent, purchased the promise of help at the price of surrendering Berwick. Margaret was still in Scotland at the date of Wakefield, so was not, as alleged by hostile writers, responsible for the barbarous treatment of York's body. But she was with the northern army which defeated Warwick at St. Albans on Feb. 17, 1461; for the executions which followed she must bear the blame. After Towton Margaret with her husband and son once more took refuge in Scotland.

A year later she went to France, and with help from her father and Louis XI. equipped an expedition which landed in Northumberland in October, and achieved some slight success; but on the way to seek further help from Scotland the fleet was overwhelmed in a storm. In the spring she was again trying to raid Northumberland. In August 1463 she crossed to Sluys in Flanders. She was almost destitute, but was courteously treated by Charles the Bold, then count of Charolais, and joined her father in France. Margaret never lost her hopes of her son's restoration. But when at last the quarrel between Warwick and Edward IV. brought her the opportunity, it was with difficulty that she could consent to be reconciled to so bitter an enemy. After Warwick's success and Henry's restoration Margaret still remained in France. On the day of Warwick's defeat at Barnet (April 14) Margaret and Edward landed at Weymouth. Three weeks later the Lancastrians were defeated at Tewkesbury, and Edward was killed. Margaret was captured a few days after, and brought to London where for five years she remained a prisoner. Finally Louis XI. ransomed her under the Treaty of Pecquigny, and she returned to France in January 1476. Margaret lived for six years in Bar and Anjou, in poverty and dependent for a pension on Louis, who made her surrender in return her claims to her father's inheritance. She died on April 25, 1482 and was buried at Angers cathedral.

BIBLIOGRAPHY.—For contemporary English authorities *see* under HENRY VI. French authorities and especially the *Chroniques* of George de Chastellain, and the *Mémoires* of Philippes de Comines contain much that is of value. The *Letters of Margaret of Anjou* (Camden Soc., 1863) have small historical importance. There have been numerous biographies, the chief is Mrs. Hookham's *Life of Margaret of Anjou* (1872).

MARGARET OF AUSTRIA (1522–1586), duchess of Parma and regent of the Netherlands from 1559 to 1567, was a natural daughter of Charles V. Her mother, Margaret van Ghent, was a Fleming. She was brought up by her aunts Margaret of Austria and Maria of Hungary, who were successively regents of the Netherlands from 1507 to 1530 and from 1530 to 1555. In 1533 she was married to Alexander de' Medici, duke of Florence, who was assassinated in 1537, after which she became the wife of Ottavio Farnese, duke of Parma, in 1542. The union proved an unhappy one. Like her aunts, who had trained her, she was a woman of masculine abilities, and Philip II., when he left the Netherlands in 1559 for Spain, acted wisely in appointing her regent. In ordinary times she would probably have proved as successful a ruler as her two predecessors in that post, but her task was very different from theirs. She had to face the rising storm of discontent against the Inquisition and Spanish despotism, and Philip left her but nominal authority. He was determined to pursue his own arbitrary course, and the issue was the revolt of the Netherlands. In 1567 Margaret resigned her post into the hands of the duke of Alva and retired to Italy. She died at Ortona in 1586.

See L. P. Gachard, *Correspondance de Marguérite d'Autriche avec Phillippe II. 1554–1568* (Brussels, 1867–87); R. Fruin, *Het voorspel van den tachtig jarigen vorlog* (Amsterdam, 1856); E. Rachfahl, *Margaretha von Parma, Statthalterin der Niederlande, 1559–1567* (Munich, 1895); also bibliography in *Cambridge Modern History*, iii. 795–809 (1904).

MARGARET OF AUSTRIA (1480–1530), duchess of Savoy and regent of the Netherlands from 1507 to 1530, daughter of the archduke Maximilian of Austria, afterwards the emperor Maximilian I., was born at Brussels on Jan. 10, 1480. In April 1497 she was married at Burgos to the Infant John, heir to the throne of Castile and Aragon. She was left a widow, however, a few months later. In 1501 Margaret became the wife of Philibert II., duke of Savoy, who only survived until 1504. The sudden death of her brother the archduke, Philip the Handsome (Sept. 25, 1506), opened out to her a new career. In 1507 she was appointed by her father regent of the Netherlands and guardian of her nephew Charles, afterwards the emperor Charles V. Charles came of age in 1515, but he entrusted Margaret with the regency, and she held the post until her death in 1530. She was a wise and prudent ruler, of masculine temper and intrepidity, and very capable in affairs.

See E. Münch, *Margaretha von Österreich* (Leipzig, 1883); Th. Juste, *Charles-Quint et Marguérite d'Autriche* (Brussels, 1858); A. Le Glay, *Maximilien I. et Marguérite d'Autriche* (with correspondence, Paris, 1839); De Quinsonas, *Matériaux pour servir à l'histoire de Marguérite d'Autriche* (Paris, 1855), and E. E. Tremayne, *The First Governors of the Netherlands: Margaret of Austria* (1908).

MARGARINE, legally designated oleomargarine in the United States of America, is essentially a mixture of edible fat, water, salt, and minor quantities of solids and flavours derived from ripened skim milk or whole milk. Margarine resembles butter in form, taste, fat content, and utility. Additional ingredients sometimes incorporated are yellow colouring, preservatives, emulsifying agents, and vitamins.

Invention of margarine was the culmination of experiments conducted by the French chemist, Hippolyte Mège-Mouriez prior to 1870. His objective was to make butterfat from beef suet by a process simulating the natural formation of milk fat. Mège-Mouriez observed that cows on restricted rations lost weight but continued to produce milk containing fat. Fat of milk according to his erroneous conception was derived from body fat, which was absorbed, deprived of its stearin, and transformed into butterfat by the action of pepsin in the mammary glands. Guided by this faulty hypothesis Mège-Mouriez designed a successful process for making margarine by (1) crushing fresh beef suet and washing it with water; (2) warming and digesting the washed suet with artificial gastric juice; (3) separating the softer fats from the harder stearin by filtration; (4) digesting and emulsifying the soft fats with water, milk, sodium bicarbonate, mammary tissue, and yellow colouring; (5) solidifying, washing, and salting the resulting emulsion of fat and water. To the finished product he gave the name margarine, which he claimed to be "a fatty body identical in composition with butter." The basis of this claim was the assumption that the fat of butter-like consistency obtained by digesting and filtering partially melted beef fats was an artificial butterfat composed of olein and margarin. He called this product oleomargarine. The term margarine applied by Mège-Mouriez to his finished product was derived from the Greek word, *margarites,* meaning pearl. A fatty substance previously prepared and named margarin by Chevreul because of its pearly lustre, was later shown to be a eutectic mixture of the two common fats stearin and palmitin. The terms oleomargarine and margarine, though misnomers in the chemical sense, were widely adopted and assigned definite meanings through legal definitions of the products to which they are applied.

The first published description of the Mège-Mouriez process was an English patent issued to the inventor in 1869. The following year Mège-Mouriez was awarded the prize offered by Napoleon III for a successful process for preparing commercially a fat as appetizing, nutritious, and stable as butter. This recognition of Mège-Mouriez's achievements was followed by the establishment and rapid growth of the margarine industry in Europe and America. In 1873 the Paris Council of Hygiene approved the sale of margarine but prohibited the use of the term butter in connection with products of this type. A similar policy has been invoked in other countries to prevent representation of margarine as butter.

Progress in the technology of margarine manufacture began with early abandonment of digestion reactions with gastric and mammary tissue extracts. Contrary to the inventor's theory, these digestion procedures did not change beef fat to butterfat or contribute favourable flavours to the final product. Utilization of fats other than oleo oil from beef fat began with additions of neutral lard and then butter. American margarines containing substantial proportions of neutral lard and butter were for a time called "butterine" and during the 1880's were favoured for their superior texture and flavour. However, the general trend throughout the history of the industry has been the replacement of animal fats by vegetable oils. This shift in raw materials, which greatly increased the available quantity and variety of suitable fats, resulted from advances in the technology of refining, deodorizing, and hardening of vegetable oils by hydrogenation. Improvements in the flavour of margarines made from purified bland oils and fats have been brought about through adaptations of the technology of butter making. Sour milk was found to impart more flavour to the fats than sweet milk. Subsequently the margarine industry adopted the butter makers' technique for securing desirable flavours by inoculating pasteurized milk with selected cultures of lactic acid organisms and controlling the degree of ripening. A later development was the substitution of pasteurized cultured skim milk for whole milk. Incorporation of emulsifying agents began about 1885 in Germany with addition of egg yolk to margarine. Other emulsifying agents that have been more widely used include lecithins and other derivatives of glycerol and fatty acids. Advantages sought by the addition of emulsifiers are improvements in texture, appearance, plasticity, and foaming and browning instead of spattering when the margarine is used for frying. The most recent innovation, other than mechanical improvements in manufacture, has been the addition of substantial quantities of vitamins A and D.

The margarine industry originated in France when there was urgent need to supplement deficient supplies of butter and other fatty foods. Manufacture of margarine spread rapidly to other countries where similar needs existed and also proved to be a profitable enterprise in countries producing butter and other edible fats on an export basis. Both manufacture and sale of margarine have generally encountered opposition owing to the fact that a product resembling butter in appearance, flavour, and nutritive value could be made from a wide variety of animal and vegetable fats available at prices far below the cost of production of butterfat. Moreover, similarity between butter and margarine everywhere created regulatory problems in preventing adulteration of butter with margarine, or fraudulent representation of margarine as butter. In most countries legislative action has been promoted to regulate, restrict, or prohibit manufacture and sale of margarine.

The nutritive qualities of margarine have long been debated, particularly with respect to consequences of its use in place of butter. Margarine contains 80 to 85% fat, the proportion being generally the same as prescribed by law for butter. Edible fats and oils, whether from animal or vegetable sources, are mixtures of glycerides of fatty acids, and are equivalent in caloric value. Fats used in margarine differ among themselves and differ from butterfat in the proportion of constituent fatty acids and in vitamin content. In human nutrition no significant differences in dietary value have been demonstrated among the varied mixtures of glycerides (fats) found in margarine or butter. With respect to vitamin content, much emphasis has been placed on the fact that fats used in margarine are generally deficient in vitamins A and D. This deficiency may be compensated by the addition of vitamins, a practice required in some countries and in others prompted by competition.

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MARGARITA, an island in the Caribbean sea belonging to Venezuela, about 12m. north of the peninsula of Araya, and constituting—with Tortuga, Cubagua and Coche—a political division called the Eastern Federal district now known as the state of Nueva Esparta (from 1904 to 1909). The island is about 40m. long from east to west, has an area of 400sq.m., and consists of two mountainous extremities, nearly separated by the Laguna Grande on the south, but connected by a low, narrow isthmus. The highest elevation on the island is the peak of Macanao, 4,484ft., in the western part, the highest point in the eastern part being the peak of Copei, 4,170 feet. The higher valleys of the interior are highly fertile and are well adapted to grazing and stock-raising. The principal industries are fishing and the making of salt. The pearl fisheries, which were so productive in the 16th and 17th centuries, have been continued ever since with more or less success. The Venezuelan pearls are not considered to be as good as the oriental pearls. A domestic industry of the women is that of making coarse straw hats, which are sold on the mainland. The islands have abundant marine life and the fishing is a constant source of livelihood for the people. The products of Margarita, however, are insufficient to support its population, and large numbers periodically emigrate to the mainland. The population was estimated in 1904 at 40,000, composed in great part of half-caste Guayqueri Indians. The population in 1941 was 69,195. The capital is La Asunción (pop. in 1941, 4,061), on the east side of the island and its principal port is Pompatar on the south coast. The two small ports of Puebla de la Mar (Porlamar) and Puebla del Norte are merely open roadsteads. The silicate deposits on the Island of Margarita cover 1,700ac. of property totalling 7,400ac. in extent. The magnesia occurs in massive veins. The Margarita deposit lies in a soft decomposed serpentine formation, where it can be easily handled by steam shovels or other mechanical excavating equipment. The deposit on Margarita island has always been characterized as the highest grade of magnesia yet discovered.

The island of Margarita was discovered by Columbus in 1498, and was bestowed in 1524 upon Marceto Villalobos by Charles V. In 1561 the freebooter Lope de Aguirre ravaged the island, and in 1662 the town of Pompatar was destroyed by the Dutch. For a long time Margarita was attached to Cumana, but in the 18th century it was made administratively independent. Its traders rendered invaluable assistance to the revolutionists in the War of Independence, and the Spanish general, Morillo, was driven from its shores in 1817; in recognition of this it was made a separate State and with the surrounding smaller islands was renamed Nueva Esparta (New Sparta). The first Spanish settlement in South America was Nueva Cadiz, founded in 1515 on the barren island of Cubagua; but the place was abandoned when pearl-fishing and slave-trading ceased to be profitable. The settlement was totally destroyed by earthquake and tidal wave in 1543.

MARGATE, a municipal borough and seaside resort in the Isle of Thanet parliamentary division of Kent, England, 74 mi. S.E. of London by rail. Pop. (1938) 39,470. Area, 10.9 sq.mi. Margate, on the north coast of Thanet, was an ancient and senior non-corporate member of Dover. In 1347 it contributed 15 ships of small tonnage at the time of the siege of Calais. A pier existed before 1500, but by the reign of Henry VIII it was in a decayed condition. The amount of corn shipped was small, the *droits* being insufficient to keep the pier in repair. Under Elizabeth Margate was still an obscure fishing village employing about 20 small vessels ("hoys") in the coasting and river trades, on which in 1791 it chiefly subsisted. In 1777 the pier was rebuilt and about this time Margate first began to be known as a bathing-place. In 1835 it was still a liberty of Dover and no right of citizenship could be acquired. In 1857 it was incorporated.

In 1935 the borough was extended to include the neighbouring resorts of Westgate-on-Sea and Birchington. It is practically contiguous with Broadstairs on the southeast, and during the season is served by pleasure steamers from London. The municipality owns over 8 mi. of sea-front, with promenades along almost the whole distance. Many works to improve the three resorts were undertaken, and Northdown park ($38\frac{1}{2}$ ac.) was purchased as a public park. Margate suffered considerably, however, from air raids in World War II, 8,000 houses having been damaged in 1940–41. A pier constructed in 1815 is now chiefly used by fishermen and colliers. The church of St. John the Baptist, founded in 1050, contains some portions of Norman architecture, the remainder being Decorated and Perpendicular. The manor house of Daundelyon, or Dent de Lion, with its early 15th century gateway remains between Margate and Westgate. During the widening of the Minster road in 1922 an Anglo-Saxon cemetery was discovered.

MARGGRAF, ANDREAS SIGISMUND (1709–1782), German chemist, was born at Berlin on March 3, 1709. He studied chemistry at Berlin and Strasbourg, medicine at Halle, and mineralogy and metallurgy at Freiberg, and returned to his native city in 1735 as assistant to his father, who was chief apothecary at the court. In 1738 he was elected to the Berlin Academy of Sciences, which in 1754 put him in charge of its chemical laboratory and in 1760 appointed him director of its physics class. He died in Berlin on Aug. 7, 1782. His name is especially associated with the discovery of sugar in beetroot in 1747. Marggraf introduced the microscope as an aid to chemical enquiry, and used this instrument to detect the presence of minute sugar crystals. In another research dealing with the nature of alum he showed that one of the constituents of that substance, alumina, is contained in common clay, and that it is quite distinct from lime. He explained and simplified the process of obtaining phosphorus from urine, and made some observations on phosphoric acid; but though he noted the increase in weight that attends the oxidation of phosphorus he remained an adherent of the phlogistic doctrine. For his time he was a skilful chemical analyst.

His papers were presented to the Berlin Academy, and with the exception of a few of the latest were collected in two volumes of *Chymische Schriften* in 1761–67.

MARGHELAN: *see* FERGHANA.

MARGHILOMAN, ALEXANDRE (1854–1925), Rumanian statesman, was born at Buzeu on July 4, 1854. He studied law and political science in Paris. In 1884 he was elected a deputy as a member of the Conservative party, of which he became leader in 1914. Marghiloman was convinced that economic reasons demanded close relations between Rumania and Germany and Austria-Hungary. At the beginning of the World War, he advocated Rumania's neutrality and when in 1916 Bratianu offered him a portfolio in his cabinet, Marghiloman refused on the ground that he could not assume the responsibility of an insufficient military preparation. He remained in Bucharest under the German occupation, where he organized the relief work for the population, but rejected the proposals of the German commander to form in Bucharest a Government for the purpose of concluding a separate peace. In March, 1918, Marghiloman went to Jassy at the request of the king and formed a Government which eventually signed the separate peace with the Central Powers. This treaty, however, was never ratified. When the war ended Marghiloman, whose party had lost all influence in Rumania owing to its Germanophile record, ceased to play any part in Rumanian politics and after his death in Buzeu on May 10, 1925, the Conservative party ceased to exist, its members joining General Averescu's (People's) party.

MARGIN, the amount by which the value of collateral given as security for a loan exceeds the amount of the loan itself. In making collateral loans, banks demand such an excess in order to safeguard themselves in case of shrinkage in the value of the collateral. The margin usually required is about 40%, and when, through decrease in the value of collateral, it falls appreciably below this percentage, the borrower may be required to deposit additional collateral. In the security market *margin* signifies the amount of cash which a person places with his broker when he wishes to buy or sell stock or bonds "on margin." In buying on margin the purchaser supplies only a certain percentage, or margin, of the amount of money required, and the remainder of the funds for the deal are advanced by the broker, either from his own capital or by borrowing.

The minimum margin which a customer must deposit with his broker depends on regulations of the Federal Reserve Board under a law passed by Congress in 1934.

If the market price declines after the purchase, the customer may be called upon for additional margin in order to comply with the margin requirements of his broker. Likewise if a customer sells *short* and the price of the security advances he may be called upon for additional margin. In either case if the additional margin is not supplied and the customer's equity decreases to the point where the broker is in danger of sustaining a loss, the broker may close out the account by the sale or purchase of the security as the case may be. (J. H. B.; X.)

MARGOLIOUTH, DAVID SAMUEL (1858–1940), British Arabic scholar, was born in London on Oct. 17, 1858, the son of a missionary. Educated at Winchester and New College, Oxford, he devoted himself to Arabic studies, in which he obtained a European reputation. In 1889 he became Laudian professor of Arabic at Oxford. He was a member of the council of the Royal Asiatic Society from 1905 onwards, its director in 1927, was awarded its triennial gold medal in 1928, and was its president 1934–37. He held many other honours. His work was done mainly in two branches, the study of the Arabic commentaries on Aristotle and the history of Mohammedanism. With H. F. Amedroz he wrote a standard work on the *Eclipse of the Abbasid Caliphate* (7 vols., 1922).

MARGRAVE (Ger. *Markgraf*), a German title meaning "count of the March." The margraves had their origin in the counts established by Charlemagne and his successors to guard the frontier districts of the empire, and for centuries the title was always associated with this function. In the 12th century the margraves of Brandenburg and Austria (the north and east marks) asserted their position as tenants-in-chief of the empire; with the break-up of the great duchies the others did the same; and the margraves henceforward took rank with the great German princes. The title of margrave very early lost its original significance, and was borne by princes whose territories were in no sense frontier districts; *e.g.*, by Hermann, a son of Hermann, margrave of Verona, who assumed in 1112 the title of margrave of Baden.

MARGUERITE, the popular name for the plant known botanically as *Chrysanthemum frutescens* (family Compositae), a shrubby perennial with smooth leaves cut pinnately into narrow segments and flower-heads two or three inches across produced singly in summer and autumn on slender erect stalks. The white ray-florets surround a yellow disk. It is a native of the Canary isles, and a favourite for decoration and for greenhouse cultivation, window-boxes and open ground in the summer. The yellow marguerite (*étoile d'or*) has somewhat larger pale yellow flowers and glaucous leaves. The plant is propagated from cuttings taken in autumn from old plants and placed in sandy loamy soil in cold frames. By pruning the shoots in autumn the plants may be grown into very large specimens in the course of a few seasons.

The African subshrub, *Felicia amelloides* (family Compositae) known in cultivation as blue daisy, is also called blue marguerite.

MARGUERITE D'ANGOULÊME (1492–1549), queen of Navarre, was the daughter of Charles d'Orléans, count d'Angoulême and was born in Angoulême on April 11, 1492. She was two years older than her brother Francis I. She was betrothed early to Charles, duke d'Alençon, and married him in 1509. She was not very fortunate in this first marriage, but her brother's accession to the throne made her, next to their mother, Louise of Savoy, the most powerful woman of the kingdom. She became a widow in 1525, and married in 1527 Henri d'Albret, titular king of Navarre. Navarre was not reconquered for the couple as Francis had promised, but ample apanages were assigned to Marguerite, and at Nérac and Pau miniature courts were kept up, which yielded to none in Europe in the intellectual brilliancy of their frequenters. Marguerite was at once one of the chief patronesses of letters that France possessed, and the chief refuge and defender of advocates of the Reformed doctrines. Round her gathered C. Marot, Bonaventure Des Périers, N. Denisot, J. Peletier, V. Brodeau, Boaistuau, Le Maçon and many other men of letters, while she protected Rabelais, E. Dolet and others. For a time her influence with her brother prevailed, but latterly political rather than religious considerations led him to wage a fierce persecution against both Protestants and freethinkers, a persecution which drove Des Périers to suicide and brought Dolet to the stake. Marguerite's own inclinations seem to have been rather towards a mystical pietism than towards dogmatic Protestant sentiments. Marguerite died in Odot-en-Bigorre on Sept. 21, 1549. By her first husband she had no children, by her second a son who died in infancy, and a daughter, Jeanne d'Albret, who became the mother of Henry IV. She does not, from the portraits which exist, appear to have been regularly beautiful, but as to her sweetness of disposition and strength of mind there is universal consent.

Her literary work consists of the *Heptaméron,* of poems entitled *Les Marguerites de la marguerite des princesses,* and of *Letters.* The *Heptaméron,* constructed, as its name indicates, on the lines of the *Decameron* of Boccaccio, consists of 72 short stories told to each other by a company of ladies and gentlemen who are stopped in the journey homewards from Cauterets by the swelling of a river. It was not printed till 1558, ten years after the author's death, and then under the title of *Les Amants fortunés.* Internal evidence is strongly in favour of its having been a joint work, in which more than one of the men of letters who composed Marguerite's household took part. It is a delightful book, and strongly characteristic of the French Renaissance. The *Letters* are interesting and good. The *Marguerites* consist of a very miscellaneous collection of poems, mysteries, farces, devotional poems of considerable length, spiritual and miscellaneous songs, etc. The *Dernières poésies,* not printed till 1896 (by M. A. Lefranc), are interesting and characteristic, consisting of verse-epistles, *comédies* (pieces in dramatic form on the death of Francis I., etc.), *Les Prisons,* a long allegorical poem of amorous-religious-historical tenor; some miscellaneous verse chiefly in dizains, and a later and remarkable piece, *Le Navire,* expressing her despair at her brother's death.

Bibliography.—Of the other works, never yet completely edited, the best editions are, for the *Heptaméron,* Leroux de Lincy (1855); for the *Lettres,* F. Genin (1841); and for the *Marguerites,* F. Frank (1873). English translation of the *Heptaméron;* A. Machen (1887), with introduction by A. M. F. Robinson (Mme. Darmesteter), and an anonymous translation (1894) with introduction by G. Saintsbury. The religious poem, *Le Miroir de L'Âme Pécheresse,* was translated by Queen Elizabeth. *See* also V. Durand, *Marguerite de Valois et la Cour de François Ier* (1848); F. Lotheissen, *Königin Margarethe von Navarra* (1885); H. de la Ferrière, *Marguerite d'Angoulême* (1891); Edith Sichel, *Women and Men of the French Renaissance* (1901); P. Courtault, *Marguerite de Navarre* (1904); A. Lefranc, *Grands écrivains de la renaissance* (1914).

MARGUERITE DE VALOIS, (1523–1574), duchess of Savoy, daughter of Francis I., was born on June 5, 1523, in St. Germain-en-Laye, and married Emmanuel Philibert, duke of Savoy, in 1559. She was a good scholar, and at the court of her brother, Henry II, encouraged the early efforts of the Pléiade. (*See* Ronsard, Pierre de.) At the Savoy court at Turin she continued her patronage of literature.

MARGUERITE (MARGOT) DE VALOIS (1553–1615), queen of Navarre, was born on May 14, 1553, daughter of Henry II. by Catherine de' Medici. Famous for her beauty, her learning, and the looseness of her conduct, she was married, after a liaison with the duke of Guise, to Henry of Navarre, afterwards Henry IV., on the eve of St. Bartholomew's day. There were no children of the marriage. Marguerite was established in the castle of Usson in Auvergne, and after the accession of Henry the marriage was dissolved by the pope. But Henry and Marguerite still continued friends; she still bore the title of queen; she visited Marie de' Medici on equal terms; and the king frequently consulted her on important affairs, though his somewhat parsimonious spirit was grieved by her extravagance. Marguerite died in Paris on March 27, 1615. She left letters and memoirs the latter of which are admirably written, and rank among the best of the 16th century. She was the idol of Brantôme, and is the "Reine Margot" of anecdotic history and romance.

Bibliography.—The *Mémoires, Poésies et Lettres* were edited by F. Guessard (1842), L. Lalanne (1858), C. Caboche (1860). The chief of many lampoons against her was the famous *Divorce satirique,* variously attributed to Agrippa d'Aubigné, Palma Cayet and others. *See* L. de Saint Poncy, *Histoire dé Marguerite de Valois* (1887); C. Merki, *La Reine Margot et la fin des Valois* (1905); A. Savine, *La Vraie Reine Margot* (1908); H. N. Williams, *Queen Margot* (1907, 2nd ed. 1911); J. H. Mariéjol, *La Vie de M. de Valois* (1928).

MARGUERITTE, PAUL (1860–1918) **AND VICTOR** (1866–1942), French novelists, both born in Algeria, were the sons of General Jean Auguste Margueritte (1823–70). Paul Margueritte, born Feb. 1, 1860, who has given a picture of his home in Algiers in *Le Jardin du passé* (1895), was sent to the military school of La Flèche for the sons of officers, and became in 1880 clerk to the minister of public instruction. His earlier novels include: *Amants* (1890), *La Force des choses* (1891), *Sur le retour* (1892), *La Tourmente* (1893), *Ma grande* (1892), *Âme d'enfant* (1894) and *L'Eau qui dort* (1896). From the time of his collaboration with his younger brother Victor Paul Margueritte's work gained in colour and force.

Among the books written in common by the brothers, the most famous is the series known under the collective title, *Une Époque,* dealing with the events of 1870–71, and including the novels *Le Désastre* (1898), *Les Tronçons du glaive* (1900), *Les Braves gens* (1901), *La Commune* (1904). They also collaborated in an *Histoire de la guerre de 1870–1871* (1903). These books were founded on documentary and verbal information, amassed with great care and arranged with admirable art; the authors were, in this case, historians rather than novelists. *La Commune* is a bold indictment of the methods adopted by the victorious party. The novelists also attacked the laws governing marriage and divorce and the abuses entailed by the dowry demanded from the bride, in pamphlets and in the novels, *Femmes nouvelles* (1899), *Les Deux vies* (1902), and *Le Prisme* (1905). One of the best is the child story *Poum* (1898). Their literary partnership was dissolved in 1907. Paul Margueritte was one of the original members of the Académie de Goncourt. He died on Dec. 30, 1918.

After World War I Victor Margueritte wrote other novels, the most famous of which is *La Garçonne* (1922), and entered political controversy with two books on the question of responsibility for the war; *Les Coupables* and *Appel Aux Consciences,* both written in 1925. He died March 23, 1942.

MARHEINEKE, PHILIP KONRAD (1780–1846), German Protestant divine, was born at Hildesheim, Hanover, on May 1, 1780. He studied at Göttingen, and lectured at Erlangen and Heidelberg. In 1811 he became professor ordinarius at Berlin, where from 1820 he was also preacher at Trinity Church and worked with Schleiermacher. When he died, on May 31, 1846, he was a member of the supreme consistorial council. At first influenced by Schelling, Marheineke found a new master in Hegel, and came to be regarded as the leader of the Hegelian Right. He sought to explain all the orthodox doctrines of the

Church in an orthodox way in terms of Hegel's philosophy. Marheineke's developed views on dogmatics are given in the third edition (1847) of his *Die Grundlehren der christlichen Dogmatik als Wissenschaft*. When he published the first edition (1819) he was still under the influence of Schelling; the second edition (1827) marked his change of view. His works on symbolics show profound scholarship, keen critical insight, and rare impartiality. The *Christliche Symbolik* (1810–14) has been pronounced his masterpiece.

See A. Weber, *Le Système dogmatique de Marheineke* (1857).

MARI, a Baluch tribe on the Dera Ghazi Khan border of Baluchistan. Land is periodically divided, by lots, according to males—occasionally by families. What has been called hypergamous endogamy prevails among the chiefly families. Artificial defloration seems to be practised on women just before marriage. Female infanticide, attributable to the strict endogamy of females in chiefly families, is no longer practised.

See Census of India, 1911, 1921 and 1931.

MARIANA, JUAN DE (1536–1624), Spanish historian and Jesuit, was born at Talavera. In 1561 he went to teach theology in Rome, reckoning among his pupils Robert Bellarmine, afterwards cardinal; then passed into Sicily, and in 1569 was sent to Paris, where his expositions of the writings of Thomas Aquinas attracted large audiences. He returned to Spain in 1574.

Mariana's great work, *Historiae de rebus Hispaniae,* first appeared in 25 books at Toledo in 1592; ten books were subsequently added (1605), bringing the work down to the accession of Charles V. in 1519, and in a still later abstract of events the author completed it to the accession of Philip IV. in 1621. It was so well received that Mariana was induced to translate it into Spanish 1601–23. Though in many parts uncritical, the work is justly esteemed for its research, accuracy, sagacity and style. Of his other writings the most interesting is the treatise *De rege et regis institutione* (1599). In its sixth chapter the question whether it is lawful to overthrow a tyrant is freely discussed and answered in the affirmative, a circumstance which brought much odium upon the Jesuits, especially after the assassination of Henry IV. of France, in 1610.

See L. von Ranke, *Zur Kritik neuerer Geschichtsschreiber* (Leipzig, 1874); and Cirot, *Études sur les historiographes espagnols; Mariana, historien* (Bordeaux, 1905).

MARIANAO, a suburb of Havana, Cuba, 6 m. from the capital, and about 1,500 ft. above the sea. It, therefore, possesses a pleasant climate which has brought a population (1943) of 120,163 people. On the coast below is Marianao beach, a popular watering-place.

MARIANAS, MARIANNES or **LADRONES ISLANDS:** *see* PACIFIC ISLANDS.

MARIANAS or **MARANHAS,** a tribe of South American Indians on the river Jutahy, north-western Brazil. They wear small pieces of wood in their ears and lips, but are not tattooed. Marianas were found on the upper reaches of the Putumayo across to the Yapurá.

MARIANNA, city of E. Arkansas, U.S.A., on L'Anguille river and Missouri Pacific railway; county seat of Lee Co. Pop. (1940) 4,449. It is the home of the Cotton Branch experiment station, College of Agriculture of University of Arkansas; and a shipping point for agricultural products and livestock.

MARIANUS SCOTUS (1028–1082 or 1083), chronicler (who must be distinguished from his namesake Marianus Scotus [d. 1088], abbot of St. Peter's, Regensburg), was an Irishman by birth, and called Moelbrigte, or servant of Bridget. He was educated by a certain Tigernach, and having become a monk he crossed over to the continent of Europe in 1056, and his subsequent life was passed in the abbeys of St. Martin at Cologne and of Fulda, and at Mainz. He died Dec. 22, 1082 or 1083.

Marianus wrote a *Chronicon,* which purports to be a universal history from the creation of the world to 1082. The *Chronicon* was very popular during the middle ages, and in England was extensively used by Florence of Worcester and other writers. It was first printed at Basle in 1559, and has been edited with an introduction by G. Waitz for the *Monumenta Germaniae historica. Scriptores* (Bd. v.).

MARIA STELLA, the self-styled legitimate daughter of Philip, duke of Orleans. According to her, Louis Philippe was not the son of Philip duke of Orleans, but a supposititious child, his father being one Lorenzo Chiappini, constable at the village of Modigliana in Tuscany. The story is that the duke and duchess of Orleans, travelling under the incognito of Comte and Comtesse de Joinville, were at this village in April 1773, when the duchess gave birth to a daughter; and that the duke, desiring a son in order to prevent the rich Penthièvre inheritance from reverting to his wife's relations in the event of her death, bribed the Chiappinis to substitute their newly-born male child for his own.

Maria Stella, the supposed daughter of Chiappini, went on the stage at Florence and married, at thirteen, the first Lord Newborough, after whose death she married the Russian Count Ungern-Sternberg. In 1830 she published *Maria Stella ou un échange d'une demoiselle du plus haut rang contre un garçon de plus vile condition* (reprinted 1839 and 1849). This coincided with the advent of Louis Philippe to the throne, and her claim became a weapon for those who wished to throw discredit and ridicule on the "bourgeois monarch." She died in poverty in Paris on Dec. 23, 1843.

See R. P. Gallwey, *Mystery of Maria Stella, Lady Newborough* (1907); M. Vitrac, *Philippe-Égalité et M. Chiappini* (1907), which is based on unpublished material in the *Archives nationales,* and destroys Maria Stella's case.

MARIA THERESA (1717–1780), archduchess of Austria, queen of Hungary and Bohemia, and wife of the Holy Roman emperor Francis I., was born at Vienna on May 13, 1717, eldest daughter of the Emperor Charles VI. (*q.v.*) and Elizabeth of Brunswick-Wolfenbüttel. On Feb. 12, 1736 she married her cousin Francis of Lorraine (*q.v.*), then grand duke of Tuscany, and afterwards emperor. Five sons and eleven daughters were born of this marriage. From the date of her father's death on Oct. 20, 1740, till her own death in 1780, Maria Theresa was one of the central figures in the wars and politics of Europe. But unlike some sovereigns, whose reigns have been agitated, but whose personal character has left little trace, Maria Theresa had a strong and in the main a noble individuality. There was no affectation in her assumption of a becoming bearing or in her picturesque words. The common story, that she appeared before the Hungarian magnates in the diet at Pressburg in 1741 with her infant son, afterwards Joseph II., in her arms, and so worked on their feelings that they shouted *Moriamur pro rege nostro Maria Theresia,* is only mythically true. But during the delicate negotiations to secure the support of the Hungarian nobles she undoubtedly did appeal to them with passionate eloquence, and with a pardonable sense of the advantage she obtained from her youth, her beauty and her sex. Maria Theresa was especially preoccupied with her position as heiress of the rights of the house of Austria. Therefore, when her inheritance was assailed by Frederick of Prussia, she fought for it with the utmost determination, and for years cherished the hope of recovering the lost province of Silesia. Her practical sense showed her the necessity of submitting to spoliation when she was overpowered. She accepted the peace of Berlin in 1742 in order to have a free hand against her Bavarian enemy, the emperor Charles VII. (*q.v.*). When Frederick renewed the war she accepted the struggle cheerfully, because she hoped to recover her own. Down to the peace of Aix-la-Chapelle in 1748 she went on fighting for Silesia or its equivalent. In the years following the peace she applied herself to finding allies in France and Russia who would help her to recover Silesia. Here, as later in the case of Poland, she subordinated her feelings to her duty to the state. Though she denied that she had ever written directly to Madame de Pompadour, it is certain that she allowed her ministers to make use of the favourite's influence over the French king. When fate decided against her in the Seven Years' War she bowed to the inevitable, and was thenceforward a resolute advocate of peace.

In internal government she worked to promote the prosperity of her people, and to give more unity to an administration made up by the juxtaposition of many states and races with different characters and constitutions. Her instincts, like those of her enemy Frederick and her son Joseph II., were emphatically absolutist. She suspended the meetings of the estates in most parts of her dominions. She was able to do so because the mass of her subjects found her hand much lighter than that of the privileged classes who composed these bodies. Education, trade, religious toleration, the emancipation of the agricultural population from feudal burdens—all had her approval up to a certain point. She would favour them, but on the distinct condition that nothing was to be done to weaken the bonds of authority. She took part in the suppression of the Jesuits, and she resisted the pope in the interest of the state. Her methods were those of her cautious younger son, Leopold II., and not of her eldest son and immediate successor, Joseph II. She did not give her consent even to the suppression of torture in legal procedure without hesitation, lest the authority of the law should be weakened. Her caution had its reward, for whatever she did was permanently gained, whereas her successor in his boundless zeal for reform brought his empire to the verge of a general rebellion.

In her private life Maria Theresa was equally the servant of the state and the sovereign of all about her. She was an affectionate wife to her husband Francis I.; but she was always the queen of Hungary and Bohemia and archduchess of Austria, like her ancestress, Isabella the Catholic, who never forgot, nor allowed her husband to forget, that she was "proprietary queen" of Castile and Leon. She married her daughters in the interest of Austria, and taught them *not* to forget their people and their father's house. In the case of Marie Antoinette (*q.v.*), who married the dauphin, afterwards Louis XVI., she gave an extraordinary proof of her readiness to subordinate everything to the reason of state. She instructed her daughter to show a proper respect to her husband's grandfather, Louis XV., by behaving with politeness to his mistresses, in order that the alliance between the two courts might run no risk. The signing of the peace of Teschen, which averted a great war with Prussia, on May 13, 1779, was the last great act of her reign, and so Maria Theresa judged it to be in a letter to Prince Kaunitz; she said that she had now finished her life's journey and could sing a *Te Deum,* for she had secured the repose of her people at whatever cost to herself. The rest, she said, would not last long. Her fatal illness developed in the autumn of the following year, and she died on Nov. 28, 1780. When she lay painfully on her deathbed her son Joseph said to her, "You are not at ease," and her last words were the answer, "I am sufficiently at my ease to die."

See A. von Arneth, *Geschichte Maria Theresas* (Vienna, 1863–79) and J. F. Bright, *Maria Theresa* (1897); M. Gael, *Maria Theresa* (1900); also AUSTRIA-HUNGARY.

MARIAZELL, a town in Styria, Austria, situated in the valley of the Salza, near Lake Erlauf and surrounded by peaks of the north Styrian Alps, grows in importance as a summer resort and as a centre for winter sports. It possesses a 12th century miracle-working image of the Virgin enshrined in a special chapel of the 14th century church, which is visited by over 150,000 pilgrims each year. Population 1,900; annexed to Germany in 1938.

See O. Eigner, *Geschichte des aufgehobenen Benedictinerstiftes Mariazell* (Vienna, 1900).

MARIBOR, a town of Slovenia, Yugoslavia, the German *Marburg*. Pop. (1931) 33,331, mainly Slovenes. It is a popular summer resort and tourist centre, picturesquely situated on the Drave, here spanned by a magnificent iron bridge. There was a settlement at Maribor in Roman times, but the present town arose in the 10th century; in the 12th and 13th centuries the town ruled a vast district. The principal buildings are the Cathedral, dating from the 12th century, but with many later additions, among them a 17th century tower 136 ft. high; and the 15th century castle, famous for its sculptures. Maribor, served both by rail and first class roads, and in the midst of a fertile fruit and wine-growing district, has a large trade in wine and grain, and especially in timber from the surrounding forests. Its industrial products are leather, boots and shoes, iron and tinware, liqueurs and sparkling wine, oil refining and milling and it has a weekly market for pork, poultry and eggs. Near by is the village of Mariast, the church of which is a popular place of pilgrimage. Maribor became part of Yugoslavia in 1918, but was occupied by Hungary in 1941, after Yugoslavia's dismemberment. Its population was ruthlessly Germanized.

MARICOPA, a Yuman tribe living near the Pima on Gila river, Arizona; originally no doubt driven out from the lower Colorado by intertribal warfare, like the Halchidhoma and Kohuana whom they absorbed in the 19th century. The date of the Maricopa removal is not known.

MARIE, queen of Rumania (1875–1938), was born at Eastwell Park, Kent, on Oct. 29, 1875, the eldest daughter of Alfred, duke of Edinburgh, second son of Queen Victoria. On Jan. 10, 1893 she married Prince Ferdinand, afterwards king of Rumania. From this marriage six children were born: Prince Charles, who married Princess Helen of Greece, Princess Elizabeth, married to the ex-king George of Greece, Princess Marie, later queen of Yugoslavia, the princes Nicolas and Mircea (d. 1916) and Princess Ileana. The queen was a Protestant, but the children, in accordance with the Rumanian constitution, were brought up in the Orthodox faith. Queen Marie took a great interest in the development of her adopted country. Red Cross and charity organizations were formed at her initiative, and during World War I she saw active service as a Red Cross nurse. She devoted much of her time to writing, and her published works include *The Lily of Life* (1913), *My Country* (1916), and *Ilderim* (1925). With King Ferdinand, Marie was crowned at Alba Julia on Oct. 15, 1922. She visited America in 1926. The following year King Ferdinand died, and she retired from active politics. Queen Marie died at the royal summer residence in Sinaia, July 18, 1938, and was buried at Kurtea de Argesch.

MARIE AMÉLIE THERESE (1782–1866), queen of Louis Philippe, king of the French, was the daughter of Ferdinand IV., king of Naples, and the archduchess Maria Carolina. She was born at Caserta, on April 26, 1782, and received a pious education. Her girlhood was spent in exile. She married Louis Philippe in November 1809. Returning to France in 1814, the duke and duchess of Orleans had barely established themselves in the Palais Royal in Paris when the Hundred Days drove them into exile. Marie Amélie took refuge with her four children in England, where she spent two years at Orleans House, Twickenham. Again in France in 1817, her life at Neuilly until 1828 was the happiest period of her existence. Her attention was absorbed by the care and education of her numerous family, even after the revolution of 1830 had made her queen of the French, a position accepted with forebodings of disaster justified by her early experience of revolutions. During her second exile, from 1848 to her death on March 24, 1866, she lived at Claremont.

See A. L. Baron Imbert de St. Amand, *La Jeunesse de Marie Amélie* (1891), *Marie Amélie au Palais Royal* (1892), *Marie Amélie et la cour de Palerme* (1891), *Marie Amélie et la cour des Tuileries* (1892), *Marie Amélie et l'apogée de règne de Louis Philippe* (1893), *Marie Amélie et la société française en 1847* (1894), and *Marie Amélie et la duchesse d'Orleans* (1893).

MARIE ANTOINETTE (1755–1793), queen of France, ninth child of Maria Theresa and the emperor Francis I., was born at Vienna, on Nov. 2, 1755. She was brought up under an austere régime and educated with a view to the French marriage arranged by Maria Theresa, the abbé Vermond being appointed as her tutor in 1769. Her marriage with the dauphin, which took place at Versailles on May 16, 1770, was intended to crown the policy of Choiseul and confirm the alliance between Austria and France. This fact, combined with her youth and the extreme corruption of the French court, made her position very difficult. Madame du Barry, whose influence over Louis XV. was supreme, formed the centre of a powerful anti-Choiseul cabal, which succeeded in less than a year after the dauphin's marriage in bringing about the fall of Choiseul and seriously threatening the Austrian alliance. Thus the young princess was surrounded by enemies both at court and in the dauphin's household, and came to rely almost entirely upon the Austrian ambassador, the comte de Mercy-Argenteau, whom Maria Theresa had instructed to act as her mentor, at the same time arranging that she herself should be kept informed of all that concerned her daughter, so that she might at once advise her and safeguard the alliance. Hence arose the secret correspondence of Mercy-Argenteau, an invaluable record of all the details of Marie Antoinette's life from her marriage in 1770 till the death of Maria Theresa in 1780.

Marie Antoinette soon won the affection and confidence of the dauphin and endeared herself to the king, but her position was precarious, and both Mercy and Maria Theresa had continually to urge her to conquer her violent dislike for Madame du Barry.

The accession of the young king and queen on the death of Louis XV (May 10, 1774), was hailed with great popular enthusiasm. But her first steps brought Marie Antoinette into open hostility with the anti-Austrian party. She was urgent in obtaining the dismissal of d'Aiguillon, and did all in her power to secure the recall of Choiseul, though without success. Her impatience of the cumbrous court etiquette shocked many people, and her taste for pleasure led her to seek the society of the comte d'Artois and his young and dissolute circle. But the greatest weakness in her position lay in her unsatisfactory relations with her husband. The king, though affectionate, was cold and apathetic, and it was not until seven years after her marriage that there was any possibility of her bearing him an heir.

The end of the period of mourning for the late king was the signal for a succession of gaieties, during which the queen displayed a passion for amusement and excitement which led to unfortunate results. Being childless, and with a husband whom she could not respect, her longing for affection led her to form various intimate friendships, above all with the princesse de Lamballe and the comtesse Jules de Polignac, who soon obtained such an empire over her affections that no favour was too great for them to ask, and often to obtain. In frequenting the salons of her friends the queen not only came in contact with a number of the younger and more dissipated courtiers, but also fell under the influence of various ambitious intriguers whose interested manoeuvres she was induced to further by her affection for her favourites. Thus she was often led to interfere for frivolous reasons in public affairs, sometimes with serious results, as in the case of the trial of the comte de Guines (1776), when her interference led to the fall of Turgot. At the same time her extravagance in dress, jewellery and amusements (including the gardens and theatricals at Trianon which was opened in May 1780 and of the cost of which exaggerated reports were spread), and her presence at horse races and masked balls in Paris without the king gave rise to scandal. At this critical period her brother, the emperor Joseph II, decided to visit France. As the result of his visit he left with the queen a memorandum in which he pointed out to her in plain terms the dangers of her conduct. For a time the emperor's remonstrances had some effect, and after the birth of her daughter, Marie Thérèse Charlotte (afterwards duchesse d'Angoulême), in Dec. 1778, the queen lived a quieter life. The death of Maria Theresa (Nov. 29, 1780) deprived her of a wise friend, and by removing all restraint on the rashness of Joseph II was bound to increase the dislike of the Austrian alliance and cause embarrassment to Marie Antoinette. Her position was much strengthened by the birth (Oct. 22, 1781) of a dauphin, Louis Joseph Xavier François; and on the death of Maurepas, which left the king without a chief minister, she might have exerted great influence in public affairs. But personal motives alone would lead her to interfere in public affairs, especially when it was a question of obtaining places or favours for her favourites and their friends. The influence of the Polignacs was now at its height, and they obtained large sums of money, a dukedom, and many nominations to places. But, in response to Mercy's and Joseph II's urgent representations, Marie Antoinette exerted herself on behalf of Austria in the affairs of the opening of the Scheldt (1783–1784) and the exchange of Bavaria (1785), in which, though she failed to provoke active interference on the part of France, she succeeded in obtaining the payment of considerable indemnities to Austria.

Two more children were born to her: Louis Charles, duke of Normandy, afterward dauphin, on March 27, 1785, and Sophie Hélène Beatrix (d. June 19, 1787), on July 9, 1786. In 1785–1786 the affair of the Diamond Necklace (*q.v.*) revealed the depth of the hatred which her own follies and the calumnies of her enemies had aroused against her. The public held her responsible for the bankrupt state of the country which was the immediate cause of the revolution.

The year 1789 was one of disaster for Marie Antoinette; on March 10 her brother Joseph II died and on June 4 her eldest son. The same year saw the assembling of the states-general, the taking of the Bastille, and the events leading to the terrible days of Oct. 5 and 6 at Versailles and the removal of the royal family to Paris. Then began the negotiations with Mirabeau, whose high estimate of the queen is well-known. But the queen was violently prejudiced against him and he never gained her full confidence. She was naturally incapable of seeing the full import of the revolution. She dreaded the thought of civil war; and even when she had realized the necessity for decisive action the king's apathy and indecision made it impossible for her to persuade him to carry into effect Mirabeau's plan of leaving Paris and appealing to the provinces. Her difficulties were increased by the departure of Mercy for The Hague in Sept. 1790, for Montmorin, who now took his place in the negotiations with Mirabeau, had not her confidence to the same extent. Feeling herself helpless and almost isolated in Paris, she now relied chiefly on her friends outside France—Mercy, Count Axel Fersen and the baron de Breteuil; and it was by their help and that of Bouillé that after the death of Mirabeau, on April 8, 1791, the plan was arranged of escaping to Montmédy, which ended in the flight to Varennes (June 21, 1791).

After the return from Varennes the royal family were closely guarded, but they still found channels of communication with the outside world. The king being sunk in apathy, the task of negotiation devolved upon the queen; but in her inexperience of affairs and the uncertainty of information from abroad, it was hard for her to follow any clear policy. Her courageous bearing during the return from Varennes had greatly impressed Barnave, and he now approached her on behalf of the constitutional party. For about a year she continued to negotiate with them, forwarding to Mercy and the emperor Leopold II letters and memoranda dictated by them, while at the same time secretly warning them not to accept these letters as her own opinions, but to realize that she was dependent on the Constitutionals. She agreed with their plan of an armed congress, and Fersen left Brussels on a mission to the emperor to try to gain his support and checkmate the *émigrés,* whose rashness threatened the queen's plans.

As for the constitution (Sept. 1791), "tissue of absurdities" though the queen thought it, she considered that in the circumstances the king was bound to accept it in order to inspire confidence. Mercy was also in correspondence with the Constitutionals, and in letter after letter to him and the emperor, the queen, strongly supported by Fersen, insisted that the congress should meet as soon as possible, her appeals increasing in urgency as she saw that Barnave's party would soon be powerless against the extremists. But the congress was continually postponed. On March 7, 1792, Leopold II died and was succeeded by the young Francis II. Marie Antoinette's actions were now directed entirely by Fersen, for she suspected Mercy and the emperor of sacrificing her to the interests of Austria. The declaration of war which the king was forced to make (April 20) threw her definitely into opposition to the revolution and she betrayed to Mercy and Fersen the plans of the French generals. She was now certain that the life of the king was threatened, and the events of June 20 added to her terrors. She considered their only hope to lie in the armed intervention of the powers, and endorsed the suggestion of a threatening manifesto which should hold the national assembly and Paris responsible for the safety of the king and royal family. Immediately after Brunswick's manifesto followed the storming of the Tuileries and the removal of the royal family to the temple (Aug. 10). During all these events and the captivity in the temple Marie Antoinette showed an unvarying courage and dignity, in spite of her failing health and the illness of her son. After the execution of the king (Jan. 21, 1793) several unsuccessful attempts were made to rescue her and her children, and negotiations for her release or exchange were even opened with Danton; but as the allied armies approached, her trial and condemnation became a certainty. She had already been separated from her son, the sight of whose ill-treatment added to her sufferings;

she was now parted from her daughter and Madame Elizabeth, and removed on Aug. 1, 1793 to the Conciergerie, where she was under the closest guard and subjected to the most offensive espionage.

On Oct. 14 began her trial. Her noble attitude, even in the face of the atrocious accusations of Fouquier-Tinville, commanded the admiration even of her enemies, and her answers during her long examination were clear and skilful. The following were the questions finally put to the jury:—

(1) Is it established that manoeuvres and communications have existed with foreign powers and other external enemies of the republic, the said manoeuvres, etc., tending to furnish them with assistance in money, give them an entry into French territory, and facilitate the progress of their armies?

(2) Is Marie Antoinette of Austria, the widow Capet, convicted of having co-operated in these manoeuvres and maintained these communications?

(3) Is it established that a plot and conspiracy has existed tending to kindle civil war within the republic, by arming the citizens against one another?

(4) Is Marie Antoinette, the widow Capet, convicted of having participated in this plot and conspiracy?

The jury decided unanimously in the affirmative, and on Oct. 16, 1793 Marie Antoinette was led to the guillotine, leaving behind her a touching letter to Madame Elizabeth, known as her "Testament."

As to the justice of these charges, we have seen how the queen was actually guilty of betraying her country, though it was only natural for her to identify the cause of the monarchy with that of France. To civil war she was consistently opposed, and never ceased to dissociate herself from the plans of the *émigrés*, but here again her very position made her an enemy of the republic. All her actions had as their aim—firstly, the safeguarding of the monarchy and later, when she saw this to be impossible, that of securing the safety of her husband and her son.

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GENERAL WORKS:—A. Sorel, *L'Europe et la Rév. fr.* vol. ii (1885–1904), contains a good estimate of Marie Antoinette. *See* also P. de Nolhac, *Marie Antoinette* (Paris, 1936); which gives good descriptions of Versailles, Trianon, etc.; M. de la Rocheterie, *Histoire de Marie Antoinette* (2 vols., Paris, 1890); G. Desjardins, *Le Petit-Trianon* (Versailles, 1885). For her trial and death, *see* E. Campardon, *Marie Antoinette à la Conciergerie* (1863). *See* also A. Vuaflart and H. Bourin, *Les Portraits de Marie Antoinette* (1909); A. Cabanès, *La Princesse de Lamballe intime* (1922); P. M. de Ségur, *Marie Antoinette* (1921; Eng. trans., 1927); John G. Palache, *Marie Antoinette* (1929); Emile Baumann, *Marie Antoinette et Axel Fersen* (Paris, 1931); Katharine Anthony, *Marie Antoinette* (1933); Marjorie Coryn, *Marie Antoinette and Axel de Fersen* (London, 1938); J. Daniel Chaucier, *The Dubious Tale of the Diamond Necklace* (London, 1939); Charles Kunstler, *The Personal Life of Marie Antoinette*, trans. by Margot Robert Adamson (London, 1940). (C. B. PH.; X.)

MARIE DE FRANCE (*fl. c.* 1175–1190), French poet and fabulist. In spite of her own statement in the epilogue to her fables: "Marie ai num, si suis de France," generally interpreted to mean that Marie was a native of the Île de France, she seems to have been of Norman origin, and certainly spent most of her life in England. Her language, however, shows little trace of Anglo-Norman provincialism. Like Wace, she used a literary dialect which probably differed very widely from common Norman speech. The manuscripts in which Marie's poems are preserved date from the late 13th or even from the 14th century, but the language fixes the date of the poems in the second half of the 12th century.

The *lais* are dedicated to an unknown king, who is identified as Henry II. of England; and the fables, her *Ysopet*, were written according to the *Epilogus* for a Count William, generally recognized to be William Longsword, earl of Salisbury. Marie lived and wrote at the court of Henry II., which was very literary and purely French. Queen Eleanor was a Provençal, and belonged to a family in which the patronage of poetry was a tradition. There is no evidence to show whether Marie was of noble origin or simply pursued the profession of a *trouvère* for her living.

The origin of the *lais* has been the subject of much discussion. Marie herself says that she had heard them sung by Breton minstrels. Gaston Paris (*Romania*, vol. xv.) maintained that Marie had heard the stories from English minstrels, who had assimilated the Celtic legends. In any case the Breton lays offer abundant evidence of borrowing from Scandinavian and oriental sources.

The *lais* which may be definitely attributed to Marie are *Guigemar, Equitan, Le Frêne, Le Bisclavret* (the werewolf), *Les Deux amants, Laustic, Chaitivel, Lanval, Le Chèvrefeuille, Milon, Yonec* and *Eliduc*. The other similar lays are anonymous except the *Lai d'Ignaure* by Renant and the *Lai du cor* of Robert Biket, two authors otherwise unknown. They vary in length from some 12,000 lines to about 100.

Marie's *Ysopet* is a collection of fables translated from an English original which she erroneously attributed to Alfred the Great, who had, she said, translated it from the Latin. Another poem attributed to her is *L'Espurgatoire Seint Patriz*, a translation from the *Tractatus de purgatorio S. Patricii* (*c.* 1185) of Henri de Salterey, which brings her activity down almost to the close of the century.

See *Die Fabeln der Marie de France* (1898), ed. by Karl Warnke with the help of materials left by Eduard Mall; and *Die Lais der Marie de France* (2nd ed., 1900), ed. by Karl Warnke, with comparative notes by Reinhold Köhler; the two works being vols. vi. and iii. of the *Bibliotheca Normannica* of Hermann Suchier; also J. Bédier in *Revue des deux mondes* (Oct. 1891); Alice Kemp-Welch in *Nineteenth Century* (Dec. 1907); and Winkler, "Marie de France" in *Sitzengber. d. Wiener Akad*, vol. 183, 1918. For an analysis of the *Lais* see *Revue de philologie française*, viii. 161 *seq.*; Karl Warnke, *Die Quellen der Esope der Marie de France* (1900). The *Lais* were first published in 1819 by B. de Roquefort. *L'Espurgatoire Seint Patriz* was edited by T. A. Jenkins (Philadelphia, 1894). Some of the *Lays* were paraphrased by Arthur O'Shaughnessy in his *Lays of France* (1872).

MARIE DE' MEDICI (1573–1642), queen consort and queen regent of France, daughter of Francis de' Medici, grand duke of Tuscany, and Joanna, an Austrian archduchess, was born in Florence on April 26, 1573. She married Henry IV. of France in October 1600. Her eldest son, the future Louis XIII., was born at Fontainebleau in September of the next year; the other children who survived were Gaston duke of Orleans; Elizabeth queen of Spain; Christine duchess of Savoy; and Henrietta Maria queen of England. During her husband's lifetime Marie de' Medici showed little sign of political taste or ability; but after his murder in 1610 when she became regent, she devoted herself to affairs with unfailing regularity and developed an inherited passion for power. She gave her confidence chiefly to Concini, afterwards maréchal d'Ancre, the husband of Leonora Galigaï, a friend of her childhood. Under the regent's lax and capricious rule the princes of the blood and the great nobles of the kingdom revolted; and the queen, too weak to assert her authority, consented at Sainte Menehould (May 15, 1614) to buy off the discontented princes. In 1616 Richelieu entered her councils. Louis XIII., who was now 16 years old, threw off the tutelage of his mother and Concini. By his orders Concini was murdered, Leonora Galigaï was tried for sorcery and beheaded, Richelieu was banished to his bishopric, and the queen was exiled to Blois.

After two years of virtual imprisonment she escaped in 1619 and became the centre of a new revolt. Louis XIII. easily dispersed the rebels, but through the mediation of Richelieu was reconciled with his mother, who was allowed to hold a small court at Angers, and resumed her place in the royal council in 1621. For a single day, the *journée des dupes,* Nov. 12, 1630, she seemed to have succeeded against the minister; but the triumph of Richelieu was followed by her exile to Compiègne, whence she escaped in 1631 to Brussels. From that time till her death at Cologne on July 3, 1642 she intrigued in vain against the cardinal.

See A. P. Lord, *The Regency of Marie de Médicis* (1904); L. Batiffol, *La Vie intime d'une reine de France au XVII^e siècle: Marie de Médicis* (1931; Eng. trans., 1908).

MARIE FEODOROVNA (MARIE SOPHIA FREDERIKA DAGMAR) (1847–1928), empress of Russia, second daughter and fourth child of King Christian IX. of Denmark, was born Nov. 26, 1847. Originally betrothed to Nicholas, eldest son of Alexander II., tsar of Russia, on his death she married, on Nov. 9, 1866, the Grand Duke Alexander Alexandrovitch, his younger brother, heir-apparent to the Russian throne, and was known thenceforward as Marie Feodorovna. The grand duke succeeded to the Russian throne as Alexander III., in 1881, on the assassination of his father by revolutionaries. The empress's home life was a happy one, and she took no part in politics. Her husband was for many years in danger of his life and every precaution was taken for his safety. There was on his accession a tendency to reaction, and on the advice of Pobiedonoszeff, Alexander III. refused to accept the Constitution prepared by his father. As his accession to the throne had never been expected, he had been trained as a soldier, and had little political knowledge or ability. The empress interested herself particularly in philanthropy and education, and as head of the "department of the institution of the empress Marie" greatly extended the work of the institution, establishing new schools, hospitals and relief centres of various kinds. She endeared herself to the people of Russia by her personal interest as well as by her wide philanthropic activities. She was trained as a nurse during the Russo-Turkish war, and greatly developed the Russian Red Cross organization, of which she was the head. From the death of Alexander III., in 1894, she lived in retirement in the Anitchkov palace in St. Petersburg (Leningrad), visiting Denmark and England where she was staying on the outbreak of the World War. She returned to Russia, in spite of an attempt in Berlin to send her back to England, and worked actively for the Russian Red Cross. Her attempts to warn her son, Nicholas II., against the influence of Rasputin were unsuccessful. Three months after Rasputin's murder the revolution broke out and the emperor abdicated. The empress Marie, who was at Kiev, met him for the last time at Mohilev. She was permitted, with other members of the royal family, to live in the Crimea, under close guard. When the Crimea came under German occupation she was given the opportunity of returning to Denmark through Germany, but refused, and only left for England after the armistice in April 1919. During her later years she lived at Hvidöre, in Denmark; she died at Copenhagen on Oct. 13, 1928.

The empress had five children, Nicholas, who became emperor as Nicholas II.; George, who died at the age of 23; Xenia, who married the Grand Duke Alexander Mikhailovitch; Michael, who was tsarevich from 1881 until the birth of a direct heir to the throne in 1904; and Olga, whose marriage with Prince Peter Oldenburgsky was dissolved during the war.

MARIE GALANTE, an island in the French West Indies. Pop. (1921) 22,608. It lies in 15° 55′ N. and 61° 17′ W., 16 m. S.E. of Guadeloupe, of which it is a dependency. It is nearly circular in shape and 58 sq.mi. in area. A rocky limestone plateau 675 ft. high occupies the centre of the island, and from it the land descends in a series of well-wooded terraces to the sea. The shores are rocky, there are no harbours, and the roadstead off Grand Bourg is difficult of access, owing to the surrounding reefs. The climate is healthy and the soil rich; sugar, coffee and cotton being the chief products. The largest town is Grand Bourg (pop. 7,000) on the south-west coast. The island was discovered by Columbus in 1493, and received its name from the vessel on which he was sailing. The French who settled here in 1648 suffered numerous attacks both from the Dutch and the British, but since 1766, except for a short period of British rule in the early part of the 19th century, they have held undisturbed possession.

MARIE LESZCZYNSKA (1703–1768), queen consort of France, was born at Breslau on June 23, 1703, being the daughter of Stanislas Leszczynski (who in 1704 became king of Poland) and of Catherine Opalinska. During a temporary flight from Warsaw the child was lost, and eventually discovered in a stable; on another occasion she was for safety's sake hidden in an oven. In his exile Stanislas found his chief consolation in superintending the education of his daughter. Her marriage with Louis XV. took place at Fontainebleau on Sept. 5, 1725. Marie's one attempt to interfere in politics, an effort to prevent the disgrace of the duke of Bourbon, was the beginning of her husband's alienation from her; and after the birth of her seventh child, Louise, Marie was practically deserted by Louis, who openly avowed a series of liaisons. She died at Versailles on June 24, 1768.

See H. Gauthier Villars, *Le Mariage de Louis XV. d'après des documents nouveaux* (1900); P. de Nolhac, *La Reine Marie Leczinska* (1900) and *Louis XV. et Marie Leczynska* (1900); P. Boyé, *Lettres du roi Stanislas à Marie Leszczynska* 1754–66 (Paris and Nancy, 1901); and C. Stryienski's book on Marie Joséphs de Saxe (*La Mère des trois derniers Bourbons,* 1902).

MARIE LOUISE (1791–1847), second wife of Napoleon I., was the daughter of Francis I., emperor of Austria, and of the princess Theresa of Naples, and was born on Dec. 12, 1791. It is probable, though not quite certain, that the first suggestions of a marriage between Napoleon and Marie Louise emanated secretly from the Austrian chancellor, Metternich. The prince de Ligne claimed to have been instrumental in arranging it. In any case the proposal was well received at Paris both by Napoleon and by his ministers; and the difficulties respecting the divorce of Josephine, were surmounted. The marriage took place by proxy in the church of St. Augustine, Vienna, on March 11, 1810. The new empress was escorted into France by Queen Caroline Murat, for whom she soon conceived a feeling of distrust. The civil and religious contracts took place at Paris early in April, and during the honeymoon, spent at the palace of Compiègne, the emperor showed the greatest regard for his wife. "He is so evidently in love with her," wrote Metternich, "that he cannot conceal his feelings, and all his customary ways of life are subordinate to her wishes." His joy was complete when on March 20, 1811, she bore him a son who was destined to bear the empty titles of "king of Rome" and "Napoleon II." Before the campaign of 1812 she accompanied the emperor to Dresden; but after that scene of splendour misfortunes crowded upon Napoleon. In January 1814 he appointed her to act as regent of France (with Joseph Bonaparte as lieutenant-general) during his absence in the field.

At the time of Napoleon's first abdication (April 11, 1814), she succeeded in spite of the efforts of Joseph and Jerome Bonaparte in reaching her father, the emperor Francis, while Napoleon was on his way to Elba. She, along with her son, was escorted into Austria by Count von Neipperg, and refused to comply with the entreaties of Napoleon to proceed to Elba; and her alienation from him was completed when he ventured to threaten her with a forcible abduction. During the Hundred Days she remained in Austria, and manifested no desire for the success of Napoleon in France. At the Congress of Vienna the Powers awarded to her and her son the duchies of Parma, Piacenzá and Guastalla, in conformity with the terms of the treaty of Fontainebleau (March, 1814); in spite of the determined opposition of Louis XVIII. she gained this right for herself owing largely to the support of the emperor Alexander, but she failed to make good the claims of her son to the inheritance. (*See* REICHSTADT, NAPOLEON FRANCIS JOSEPH CHARLES.) She proceeded alone to Parma, and had to acquiesce in the title "duke of Reichstadt" accorded to her son.

Long before the news of Napoleon's death reached her she was living in intimate relations with Neipperg at Parma, and bore a son to him not long after that event. Napoleon on the other hand spoke of her in his will with marked tenderness, and both excused and forgave her infidelity. Neipperg became her morganatic husband; and they had other children. In 1832 she visited the duke of Reichstadt at Vienna when he was dying. Her rule in Parma, conjointly with Neipperg, was characterized by a clemency and moderation which were lacking in the other Italian states in that time of reaction. She preserved some of the Napoleonic laws and institutions; in 1817 she established the equality of women in heritage, and ordered the compilation of a civil code which was promulgated in January 1820. On the death of Neipperg in 1829 his place was taken by Baron Werklein, whose influence was hostile to popular liberty. In 1831 Marie Louise had to take refuge with the Austrian garrison at Piacenza; on the restoration of her rule by the Austrians its character deteriorated, Parma becoming an outwork of the Austrian empire. She died at Vienna on Dec. 18, 1847.

See *Correspondence de Marie Louise 1799–1847* (Vienna, 1887); J. A. Baron von Helfert, *Marie Louise* (Vienna, 1873); E. Wertheimer, *Die Heirath der Erzherzogin Marie Louise mit Napoléon I.* (Vienna, 1882); and *The Duke of Reichstadt* (Eng. ed., 1905). *See* also the *Memoirs* of Bausset, Mme. Durand Méneval and Metternich; and Max Billard, *The Marriage Ventures of Marie Louise,* English version by Evelyn, duchess of Wellington (1910); D. Masson, *L'impératrice Marie Louise* (1902); Cuthell, *An Imperial Victim* (1912); Gachot, *Marie Louise intime* (1912); C. de Clary-et-Aldringen, *Souvenirs* (1914).

MARIENBAD (Czech *Marianské Lázně*), a watering-place in northwest Bohemia on the southeastern outskirts of the Císařský Les at an altitude of 2,093 ft., enclosed on all sides except the south by gently sloping hills clad with pine forests intersected by lovely walks. Pop. (1930) 7,177. Although its mineral springs have been known for centuries and are mentioned in a document dated 1341 as belonging to the abbey of Tepl, they attracted few people until Josef Nehr, the doctor of the abbey, demonstrated their curative properties during the period 1779–1820, and the town did not receive a charter until 1868.

After this date it grew in popularity and became one of the most frequented spas in Europe. The waters are cold and varied in composition, some, like those of Carlsbad, being alkaline-saline but of greater strength, others being rich in iron, and are used in the treatment of liver troubles, gout, diabetes and obesity. Most are used for bottling and drinking but the cure also involves a carefully regulated diet; the water is also bottled and exported in large quantities. In addition to the springs there are peat baths very rich in iron. The town is small and well-built, most of its hospitals, bathing establishments and other public buildings being quite modern.

In the vicinity lie many places of interest, *e.g.,* the rock of Podhorn (2,776 ft.), about 3 mi. E., with extensive views of the Böhmer Wald and Erz Gebirge, and, about 7 mi. E., the old abbey of Tepl, founded in 1193, though the present building dates from the 17th–18th centuries and has a fine library and collection of rare manuscripts; and, to the northeast, the small spa of Königswart. In 1938 Marienbad, as part of the Sudetenland, came under German rule.

MARIENBURG (Polish, *Malborg*), a town in the Prussian province of East Prussia, Germany, 30 mi. by rail to Danzig, on the right bank of the Nogat, a channel of the Vistula, here spanned by bridges. Pop. (1939) 27,013. The castle of the Teutonic order here was originally founded in 1274 as the seat of a simple commandery against the pagan Prussians, but in 1309 the headquarters of the grand master were transferred hither from Venice, and the "Marienburger Schloss" soon became one of the largest and most strongly fortified buildings in Germany. In the middle of the 15th century, the castle passed into the hands of the Poles, by whom it was allowed to fall into neglect and decay. It came into the possession of Prussia in 1772, and was carefully restored at the beginning of the 19th century. It consists of three parts, the Alt- or Hochschloss, the Mittelschloss, and the Vorburg, and is built of brick, in a style of architecture peculiar to the Baltic provinces. Marienburg manufactures agricultural machinery, sugar, and has saw mills. It carries on a considerable trade in grain, wood, flax and is the seat of important cattle and horse markets. In the old market-place, many of the houses of which are built with arcades, stands a Gothic town-hall dating from the end of the 14th century.

MARIENWERDER, a town in the Prussian province of East Prussia, Germany, 3 mi. E. of the Vistula, 23 mi. S. of Marienburg. Pop. (1939) 19,945. The town was founded in the year 1233 by the Teutonic order. It has a cathedral of the 14th century, a triple Gothic edifice, restored in 1874. In the cathedral were buried two grand masters of the Teutonic order. Under Article 96 of the Treaty of Versailles a plebiscite was held to decide whether the territory should belong to Poland or to East Prussia, which resulted in favour of the latter. The industries include saw mills, sugar-refineries, breweries and printing-works.

MARIE THÉRÈSE OF AUSTRIA (1638–1683), queen consort of France, was born on Sept. 10, 1638, at the Escorial, the daughter of Philip IV of Spain and Elizabeth of France. The treaty of the Pyrenees in 1659 stipulated for her marriage with Louis XIV, Marie renouncing any claim to the Spanish succession. Marie Thérèse was married in June 1660, when Philip IV with his whole court accompanied the bride to the Isle of Pheasants in the Bidassoa, where she was met by Louis. She died on July 30, 1683, at Versailles, not without suspicion of foul play on the part of her doctors. Of her six children only one survived her, the dauphin Louis, who died in 1711.

See the funeral oration of Bossuet (Paris, 1684), E. Ducéré, *Le Mariage de Louis XIV. d'après les contemporains et des documents inédits* (Bayonne, 1905); Dr. Cabanès, *Les Morts mystérieuses de l'histoire* (1923); M. Duclos, *Madame de La Vallière et Marie Thérèse d'Austriche* (1904), and the literature dealing with her rivals Louise de la Vallière, Madame de Montespan and Madame de Maintenon.

MARIETTA, a city of Georgia, U.S.A., 20 mi. N.W. of Atlanta, on federal highway 41, at an altitude of 1,118 ft.; the county seat of Cobb county. It is served by the Louisville and Nashville and the Nashville, Chattanooga and St. Louis railways. The population was 7,638 in 1930; 8,667 in 1940. It is both a winter and a summer resort, and has a variety of manufacturing industries. The city was founded *c.* 1840 and chartered 1852.

At Marietta there is a national cemetery, in which more than 10,000 Federal soldiers are buried. The Kennesaw mountain (1,809 ft.), about 2½ mi. west of the city, was the scene of a stubborn action of the Civil War, in which the Federals lost 2,500 men. After the Confederate retreat from Dalton in May 1864, Gen. W. T. Sherman, the Federal commander, made Marietta his next intermediate point in his Atlanta campaign, and the Confederate commander, Gen. J. E. Johnston, established a line of defense west of the town. After several preliminary engagements Sherman, on June 27, made an unsuccessful attempt to drive the Confederates from their defenses at Kennesaw mountain—the only instance in his campaign of a frontal attack on a strongly entrenched position. He then resorted to a flanking movement which forced the Confederate general to retire (July 2) toward Atlanta.

MARIETTA, a city of southeastern Ohio, U.S.A., the county seat of Washington county; on the Ohio river at the mouth of the Muskingum. It is on federal highways 21 and 50, and is served by the Baltimore and Ohio and the Pennsylvania railways. Pop. 15,140 in 1920 (95% native white); and 14,543 in 1940 by federal census. The city's streets are lined with magnificent old shade trees, including the largest elm on record in the United

States. It is surrounded by a hilly country of much natural beauty, devoted largely to market gardens and apple orchards; is the centre of one of the oldest gas and oil fields in the country, still producing about 1,000,000 bbl. annually; and has substantial and diversified manufacturing industries, with an output in 1940 valued at $10,500,000. The assessed valuation of property for 1940 was $16,295,300. The city operates under the mayor-and-council form of government, and has in addition a "service director" with the functions of a city manager. It is the seat of Marietta college (chartered 1835, continuing an academy founded in 1797) which has a valuable historical museum and rare collections of Americana, including the original records of the Ohio Company, the Rodney M. Stimson collection (relating chiefly to the history of the Ohio and the Mississippi valleys), and the Charles Goddard Slack collection of historical documents and prints. In the centre of Mound cemetery (where many of the pioneers are buried) is one of the most perfect specimens of the mound-builders' work, and there are other prehistoric earthworks in and near the city, including a double embankment leading down to the Muskingum river. Marietta is the oldest settlement in Ohio. It was founded on April 7, 1788 (near Ft. Harmer, built in 1785) by a company of revolutionary officers from New England under the leadership of Gen. Rufus Putnam. The name was chosen to honour Marie Antoinette. Here the North-west territory was formally organized, Marietta was made the capital, and on July 15 Arthur St. Clair took his oath of office as the first governor. The blockhouse ("Campus Martius") in which Gen. Putnam lived at first, his later home, and the original land office of the Ohio Company, still stand, and are carefully preserved as historic monuments. Black Hole cave, in the outskirts of the city, was an important "station" on the Underground railway.

MARIETTE, AUGUSTE FERDINAND FRANÇOIS (1821–1881), French Egyptologist, was born on Feb. 11, 1821 at Boulogne, where his father was town clerk. Entrusted with a government mission for the purpose of seeking and purchasing Coptic, Syriac, Arabic and Ethiopic mss. for the national collection, he started for Egypt in 1850; and soon after his arrival he discovered the ruins of the Serapeum and the subterranean catacombs of the Apis bulls. His original mission being abandoned, funds were now advanced for the prosecution of his researches, and he remained in Egypt for four years, excavating, discovering and despatching archaeological treasures to the Louvre, of which he was on his return appointed an assistant conservator. In 1858 he accepted the position of conservator of Egyptian monuments to the ex-khedive, Ismail Pasha, and removed with his family to Cairo. The museum at Bula was founded immediately. The pyramid-fields of Memphis and Sakkara, and the necropolis of Meydum, and those of Abydos and Thebes were examined; the great temples of Dendera and Edfu were disinterred; important excavations were carried out at Karnak, Medinet-Habu and Deir el-Bahri; Tanis (the Zoan of the Bible) was partially explored in the Delta; and even Gebel Barkal in the Sudan. The Sphinx was bared to the rock-level, and the famous granite and alabaster monument miscalled the "Temple of the Sphinx" was discovered. Mariette was raised successively to the rank of bey and pasha. He died at Cairo on Jan. 19, 1881.

His chief published works are: *Le Sérapéum de Memphis* (1857 and following years); *Dendérah,* five folios and one 4to (1873–75); *Abydos,* two folios and one 4to (1870–80); *Karnak,* folio and 4to (1875); *Deir el-Bahari,* folio and 4to (1877); *Listes géographiques des pylônes de Karnak,* folio (1875); *Catalogue du Musée de Boulaq* (six editions, 1864–76); *Aperçu de l'histoire d'Égypte* (four editions, 1864–74, etc.); *Les Mastabas de l'ancien empire* (edited by Maspero) (1883). *See* "Notice biographique," by Maspero in *Auguste Mariette. Oeuvres diverses* (tome 1, Paris, 1904), and art. EGYPT: *Exploration and Research.*

MARIGNANO, BATTLE OF, fought on Sept. 13 and 14, 1515, between the French army under Francis I. and the Swiss. The scene of the battle—which was also that of a hard fought engagement in 1859 (*see* ITALIAN WARS)—was the northern outskirts of the village of Melegnano, on the river Lambro, 10m. S.E. of Milan. The circumstances out of which the battle of Marignano arose, almost inconceivable to the modern mind, were not abnormal in the conditions of Italian warfare and politics then prevailing. The young king of France had gathered an army about Lyons, wherewith to overrun the Milanese; his allies were the republics of Venice and Genoa. The duke of Milan, Maximilian Sforza, had secured the support of the emperor, the king of Spain, and the pope, and also that of the Swiss cantons, which then supplied the best mercenary soldiers in Europe. (*See* SWISS WARS.) The practicable passes of the Alps and the Apennines were held by Swiss and papal troops. Francis, however, boldly crossed the Col de l'Argentière (Aug. 1515) by paths that no army had hitherto used, and Marshal de La Palisse surprised and captured a papal corps at Villafranca near Pinerolo, whereupon the whole of the enemy's troops fell back on Milan. The king then marching by Vercelli, Novara and Pavia, joined hands with Alviano, the Venetian commander, and secured a foothold in the Milanese. But in order to avoid the necessity of besieging Milan itself, he offered the Swiss a large sum to retire into their own country. They were about to accept his offer, not having received their subsidies from the pope and the king of Spain, when a fresh corps of mercenaries descended into Italy, desirous both of gaining booty and of showing their prowess against their new rivals the French and Lower Rhine "lansquenets" (landsknechts) and against the French gendarmerie, whom (alluding to the "Battle of the Spurs" at Guinegatte in 1513) they called "hares in armour." The French took position at Melegnano to face the Swiss, the Venetians at Lodi to hold in check the Spanish army at Piacenza. Alviano, who was visiting the king when the Swiss appeared before Melegnano, hurried off to bring thither his own army. Meantime the French and the Swiss engaged in an exceedingly fierce struggle.

The king's army was grouped in front of the village, facing in the direction of Milan, with a small stream separating it from the oncoming Swiss. On either side of the Milan road was a large body of landsknechts, a third being in reserve. The French and Gascon infantry (largely armed with arquebuses) was on the extreme right, the various bodies of gendarmerie in the centre. In front of all was the French artillery. The battle opened in the afternoon of Sept. 13. As the Swiss advanced in three huge columns, the French guns fired into them with terrible effect, but the assailants reached the intersected ground bordering the stream, and thus protected from the rush of the French gendarmerie, they debouched on the other side, and fell upon the landsknechts. The crowd of combatants, the gathering darkness, and the dust, prevented any general direction being given to the battle by the leaders of either side. Francis himself at the head of 200 gendarmes charged and drove back two large bodies of Swiss which were pressing the landsknechts hard. The battle went on by moonlight till close on midnight, when the Swiss retired a short distance. Both sides spent the rest of the night on the battlefield, reorganizing their broken corps. Francis and his gendarmes were the outpost line of the French army, and remained all night mounted, lance in hand and helmet on head. Next morning at sunrise, the battle was renewed. The Swiss now left their centre inactive opposite the king and with two strong corps attempted to work round his flanks. That on the left made for the French baggage, but found it strongly guarded by landsknechts, who drove them back. The nearest French gendarmerie joined in the pursuit, but a detachment from the Swiss centre fell upon these and destroyed them. This detachment in turn followed up its advantage until as Francis himself expressed it, "the whole camp turned out" to aid the landsknechts and "hunted out" the Swiss. Meantime the Swiss left attack had closed with the French infantry bands and the "aventuriers" (afterwards the famous corps of Picardie and Piedmont), who were commanded on this day by the famous engineer Pedro Navarro. It was in the main a struggle of arquebus against pike, but it was not the arquebus alone, or even principally, that gave the victory to the French. When the Swiss ranks had been disordered, the short pike and the sword came into play, and aided by the constable de Bourbon with a handful of the gendarmerie, the French right more than held its own until Alviano with the cavalry from Lodi rode on to the field and completed the rout of the Swiss. In the centre meanwhile the two infantries stood fast for eight hours, separated by the brook, while the artillery on both sides fired into it at short range. But the landsknechts, animated by the king, endured it as well as the Swiss; and at the last, Francis leading a final advance of his exhausted troops, the Swiss gave way and fled. Only 3,000 Swiss escaped out of some 25,000 who fought. On the French side probably 8,000 were killed or died of wounds. The battle lasted 28 hours. Its tactical lesson was the efficacy of combining two arms against one. The French gendarmerie, burning to avenge the insult of "hares in armour," made more than thirty charges by squadrons, and they were admirably supported by their light artillery which played havoc with the Swiss pikemen whom the mounted charges had brought to a halt. Marignano was thus a landmark in the power of the new arm, and at the same time the last and greatest triumph of the armoured lancer; and as a fitting close to the battle the young king was knighted by Bayard on the field. But, above all, in signalizing the military decline of the Swiss it afforded yet more proof in history of the truth that good soldiership is not enough, without generalship, and that conservatism towards military progress will undermine the firmest foundations of military power.

MARIGNOLLI, GIOVANNI DE', a notable traveller to the Far East in the 14th century, born probably before 1290, and sprung from a noble family in Florence. In 1338 there arrived at Avignon, where Benedict XII. held his court, an embassy from the great khan of Cathay (the Mongol-Chinese emperor), bearing letters to the pontiff from the khan himself, and from certain Christian nobles of the Alan race in his service, who asked for a priest. The pope replied to the letters, and appointed four ecclesiastics as his legates to the khan's court. The name of John of Florence, *i.e.,* Marignolli, appears third on the letters of commission. A large party was associated with the four chief envoys; when in Peking the embassy still numbered thirty-two, out of an original fifty.

The mission left Avignon in December 1338; picked up the Tatar envoys at Naples; and travelled via Constantinople and the Black Sea to the court of Mohammed Uzbeg, khan of the Golden Horde, at Sarai on the Volga. The khan entertained them hospitably during the winter of 1339–1340 and then sent them across the steppes to Armalec, Almalig or Almaligh (Kulja), the northern seat of the house of Chaghatai, in what is now the province of Ili. "There," says Marignolli, "we built a church, bought a piece of ground . . . sung masses, and baptized several persons, notwithstanding that only the year before the bishop and six other minor friars had there undergone glorious martyrdom for Christ's salvation." Quitting Almaligh in 1341, they seem to have reached Peking (by way of Kamul or Hami) in May or June 1342. They were well received by the reigning khan, the last of the Mongol dynasty in China. An entry in the Chinese annals fixes the year of Marignolli's presentation by its mention of the arrival of the great horses from the kingdom of Fulang (*Farang* or Europe), one of which was 11 ft. 6 in. in length and 6 ft. 8 in. high, and black all over.

Marignolli stayed at Peking or Cambalec three or four years, after which he travelled through eastern China to Zayton or Amoy Harbour, quitting China apparently in December 1347, and reaching Columbum (Kaulam or Quilon in Malabar) in Easter week of 1348. He returned home by way of a circuitous route, reaching Avignon in 1353, where he delivered a letter from the great khan to Pope Innocent VI. In the following year the emperor Charles IV., on a visit to Italy, made Marignolli one of his chaplains. Soon after, the pope made him bishop of Bisignano; but he appears to have accompanied the emperor to Prague in 1354–1355; in 1356 he is found acting as envoy to the pope from Florence; and in 1357 he is at Bologna. The date of his death is unknown.

Nobody seems to have noticed the fragmentary notes left by Marignolli of his journeys interpolated in his *Annals of Bohemia,* compiled by order of the emperor, till 1768, when the chronicle was published in vol. ii. of the *Monumenta hist. Bohemiae nusquam antehac edita* by Father Gelasius Dobner.

See *Fontes rerum bohemicarum,* iii. 492–604 (1882, best text); G. Dobner's *Monumenta hist. boh.,* vol. ii. (Prague, 1768); J. G. Meinert, in *Abhandl. der k. böhm Gesellsch. der Wissenschaften,* vol. vii.; F. Kunstmann, in *Historisch-politische Blätter von Phillips und Görres,* xxxviii., 701–719, 793–813 (Munich, 1859); Luke Wadding, *Annales minorum, A.D. 1338,* vii. 210–219 (ed. of 1733, etc.); Sbaralea, *Supplementum et castigatio ad scriptores trium ordinum S. Francisci a Waddingo,* p. 436 (Rome, 1806); John of Winterthur, in Eccard, *Corpus historicum medii aevi,* vol. i. 1852; Mosheim, *Historia Tartarorum ecclesiastica,* part i., p. 115; Henry Yule, *Cathay and the Way Thither,* ii. 309–394 (Hak. Soc., 1866); C. Raymond Beazley, *Dawn of Modern Geography,* iii. 142, 180–181, 184–185, 215, 231, 236, 288–309 (1906).

MARIGNY, ENGUERRAND DE (1260–1315), French statesman, was born at Lyons-la-Forêt in Normandy. After the death of Pierre Flotte and Hugues de Bonville at the battle of Mons-en-Pevèle in 1304, he became Philip IV.'s grand chamberlain and chief minister. In 1306 he was sent to preside over the exchequer of Normandy. He received numerous gifts of land and money from Philip as well as a pension from Edward II. of England. He was an able instrument of Philip's policy, and shared the popular odium which Philip incurred by debasing the coinage. He obtained rich appointments for many of his relatives, and secured increased revenue for the king. His peace with the Flemings in 1314 disappointed the princes of the blood. He was accused of receiving bribes, and Charles of Valois denounced him to the king himself; but Philip stood by him. After the death of Philip IV. on Nov. 29, 1314 the feudal party, whose power the king had tried to limit, turned on his ministers and chiefly on his chamberlain. Enguerrand was arrested, and twenty-eight articles of accusation including charges of receiving bribes were brought against him. He was refused a hearing; but his accounts were correct, and Louis was inclined to spare him anything more than banishment to the island of Cyprus. Charles of Valois then brought forward a charge of sorcery. Enguerrand was condemned at once and hanged on the public gallows at Montfaucon, protesting that in all his acts he had only been carrying out Philip's commands (April 30, 1315).

See contemporary chroniclers in vols. xx. to xxiii. of D. Bouquet, *Historiens de la France;* P. Clément, *Trois drames historiques* (1857); Ch. Dufayard, *La Réaction féodale sous les fils de Philippe le Bel,* in the *Revue historique* (1894, liv. 241–272) and lv. 241–290.

MARIGNY, JEAN DE (d. 1350), French bishop, was a younger brother of the preceding. In 1313 he was made bishop of Beauvais; he completed the choir of Beauvais Cathedral, the enormous windows of which were filled with the richest glass. But the work was interrupted by the Hundred Years' War. Jean de Marigny was one of the king's lieutenants in southern France in 1341 against the English invasion. In 1346 he held Beauvais against the English, who had overrun the country up to the walls of the city. Created archbishop of Rouen in 1347, he enjoyed his new honours only three years; he died on Dec. 26, 1350.

MARIGOLD. This name has been given to several plants, of which the following are the best known: *Calendula officinalis,* the pot-marigold; *Tagetes erecta,* the African marigold, long thought to be native there, but actually Mexican; *T. patula,* the French marigold; and *Chrysanthemum segetum,* the corn marigold. All these belong to the family Compositae; but *Caltha palustris,* the marsh-marigold (*q.v.*), belongs to the Ranunculaceae. *See* also ICE-PLANT.

The first-mentioned is a familiar garden plant with large orange-coloured blossoms, and is probably not known in a wild state. There are now many fine garden varieties of it. The florets are unisexual, the ray florets being female, the disk florets male. This and the double variety have been in cultivation for at least three hundred years, as well as a proliferous form, the "fruitful marigolde" of Gerard (*Herball,* p. 602), in which small flower heads proceed from beneath the circumference of the flower. The figure of "the greatest double marigold," *C. multiflora maxima,* given by Gerard (*loc. cit.,* p. 600) is larger than most specimens now seen, being 3 in. in diameter. He remarks of "the marigolde" that it is called *Calendula* "as it is to be seene to flower in the calends of almost euerie moneth."

Tagetes patula, and *T. erecta,* the French and African marigolds, are natives of Mexico, and are equally familiar garden plants, having been long in cultivation. Gerard figures five varieties of *Flos africanus,* of the single and double kind (*loc.*

cit., p. 609). Besides the above species the following have been introduced later: *T. lucida* and *T. tenuifolia*, both from Mexico.

The Eurasian *Chrysanthemum segetum*, the corn marigold, is frequent in cornfields in most parts of England. When dried it has been employed as hay. It was also used in Germany for dyeing yellow.

MARII, autonomous republic in the Russian S.F.S.R., created Dec. 5, 1936, with Ioshkar-Ola (Joshkarol) (formerly Krasnokokshaisk and Tsarevokokshisk), as its main town. Area 8,996 sq.mi. Pop. (1939) 579,466, urban 75,873, rural 503,593. It is surrounded by the Tatar A.S.S.R., the Chuvash A.S.S.R., and the provinces of Gorky and Kirov, and lies between 55° 50′ N. and 57° 20′ N. and 45° 39′ and 50° 18′ E. The surface consists of a plain sloping south to the Volga river, with higher ground in the east forming the watershed between the tributaries of the Volga and the Vyatka. The chief rivers are the Volga, which flows through part of the southwest, and after passing through the north of the Chuvash A.S.S.R., forms the southeastern boundary of the Marii region, the Great and Little Kokshag and the Vetluga, tributaries of the Volga. The area lies in the taiga forest zone and 64% of it is covered with coniferous forest, pine and fir predominating. Timber and wooden wares made by the peasants provide the largest source of income, the nearness of the Volga being a great asset for export. A railway was constructed in 1923 from Kazan to Ioshkar-Ola, the administrative centre, a small town of 9,400 inhabitants (1934). Kozmodemiansk, on the Volga, has 9,100 (1934) inhabitants and is a great timber centre with an annual timber fair. Apart from these two, there are no other town centres. The soils are not very favourable for agriculture, consisting mainly of sands, clays and forest earths. The climate is severe and continental, ranging between 7° F. and 68° F. and the rainfall averages 17.3 in., falling mostly in summer. In some years the spring rains fail, as in 1921, and the crops are ruined. In other years, however, in spite of poor methods and implements, sufficient rye and oats are grown in the north to allow of export. Potato and flax cultivation is increasing and there are a few indications that the traditional three-field system is being replaced by more intensive methods. Horses, cows, sheep and pigs are reared, but there is little dairying. The continuation of the railway northwards was expected to encourage dairying.

The Marii area was not a war zone in World War I, but it suffered terribly from the 1921 famine and from a disastrous forest fire, and conditions are by no means stable yet. Chalk is worked in the north and there are extensive peat beds which will prove a valuable asset when better transport is provided. There are small glass and flour-milling enterprises, and besides making wooden goods, the peasants make leather, felt, rope, string, pottery and other articles needed for daily use. There is a factory for the production of resin and turpentine. Plans for the improvement of conditions are hampered by the illiteracy of the people, the literacy rate being only 26.2%. Better provision for the present generation is made here than in some other areas, but a large proportion of children is receiving no education and medical help is altogether inadequate; trachoma, itch and other infectious diseases are widespread.

The population consisted in 1934 of Marii 51.4%, Russians 43.6%, with some Tatars and Chuvashes. The Marii were called by the Russians Cheremis. They speak a Finnish dialect akin to Mordvinian and Permian, but are much more dolichocephalic and it has been suggested that they are connected with the neolithic dolichocephalic population of the shores of Lake Ladoga. They inhabited a region farther to the west than their present habitat up to the 11th century, but moved eastward into the marsh and forest region when Slav colonization began, and were settled in their present home in the 14th century. Moscow annexed the region in the 16th century but the Marii remained separate from the Russian colonists and have retained their language and customs. (*See* also FINNO-UGRIAN.)

MARIINSK (1) a town in the Siberian area of the Russian S.F.S.R. in 56° 16′ N., 87° 50′ E., on the Kiya river, which is navigable for rafts only, and on the Trans-Siberian railway. Pop. (1926) 11,419. It has grown since 1856 as an entrepôt for the gold mines situated in the Mariinsk *taiga*, 45 m. from the railway and 65 m. from the town itself. Aluminium is found with the gold.

(2) A village of Asiatic Russia in 51° 53′ N., 140° 10′ E., occupied by the Russians in 1852, and situated on the right bank of the Amur river. It is the centre for the 27 fishing stations extending for 263 m. along the lower Amur river.

(3) A canal in the Leningrad area of the Russian S.F.S.R. linking the Kovzha river with the Vytegra river. It was built in 1808, and forms part of the Mariinsk series of waterways which connect the Volga river with the Ladoga-Neva system.

MARIMBA, a musical instrument which consists of a series of sticks of wood, cut and shaped so that each stick when struck produces a musical tone of definite pitch. As used in modern orchestras, it is placed on a wooden base, is played by striking with sticks, and has usually a range of five octaves. A liquid tone is secured by the use of metal tubes as resonators, or even by gourds. The marimba is of ancient origin, known in South Africa and Central America. It is most commonly used in popular, especially Spanish-American, dance music, but has occasionally been used by classical composers.

MARIN, LOUIS (1871–), French politician, entered the chamber of deputies in 1905, and worked on the financial commission. He was minister of pensions in the Poincaré cabinet from July 1926 until 1928, minister of health in 1934, and was a member of the Flandin and Laval cabinets, 1935 and 1936.

MARINE BIOLOGY is concerned with all kinds of living things that exist in the sea, or that are by nature dependent upon the sea at its surface or at its coastal boundaries. It deals not only with the kinds of marine organisms but also with their life histories and interrelationships. It endeavors to learn and explain the ways in which the various physical and chemical factors (temperature, light, pressure, currents, salinity, plant nutrients, etc.) of the environment operate, together with the organic factors enabling the organisms to survive and to populate every niche of the ocean from the Arctic to the Antarctic and from the surface to abyssal depths. Insofar as investigations have been made, no part of this great environment is without some type of animal life.

Kinds of Organisms Found in the Sea.—The plant life of the sea consists only of the Thallophyta (the most primitive group of plants) and a few angiosperms or flowering plants. No mosses or ferns occur in the sea. The larger of the marine plants are the green, brown and red algae and the eelgrasses. The algae are anchored to the substratum, mainly in depths less than 50 m., by means of "holdfasts." There are no true roots or vascular systems, hence the plants absorb their food from the water bathing their general surfaces. Typically they reproduce by means of microscopic spores which develop into inconspicuous male or female plants called the gametophyte generation. This generation in turn gives rise to the spore-forming sporophyte generation. The eelgrasses have an underground stem and true roots, which obtain nourishment from the mud and sand in which they grow. They are found in depths ranging up to 15 m. The submerged flowers are pollinated by floating pollen, after which true seeds are formed.

The attached plants form an important source of food for animals in the shallow water. However, the chief producers of primary food in the sea as a whole are the microscopic planktonic diatoms and holophytic dinoflagellates. These tiny plants are exceedingly numerous. Under favourable conditions they reproduce at a prodigious rate by means of simple cell division; and, being independent of the bottom, they are capable of growing anywhere in the sea where light and nutrient supply are favourable. More will be said about their importance later.

Bacteria are abundant and widely distributed in the sea. They are significant mainly in the decay of organic material. There are also marine moulds, but they are of little importance in the economy of the sea.

The animal kingdom has its greatest development in the sea. All of the major divisions (phyla) are to be found there and some (Ctenophora, Echinodermata, Phoronidea, Brachiopoda, Chaetognatha) are strictly confined to this habitat. About 44%

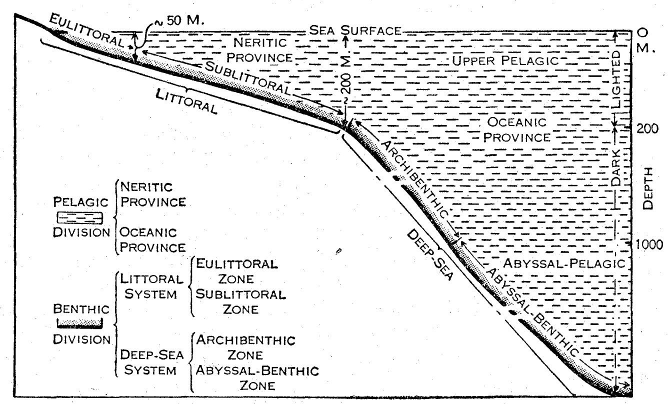
of the recognized classes, the second highest division, are exclusively marine while only about 6% are exclusively nonmarine. The Amphibia are the only type of vertebrates not represented in the sea. The fishes are primarily marine. The reptiles are represented by true snakes and turtles. Many birds are marine in their dependence upon the sea for food. Some, for example the albatrosses, spend much of their life far from land, which they frequent only for nesting. The principal marine mammals are the whales, porpoises, sea cows, seals, sea lions and sea otters.

Of the invertebrates, the crustaceans, molluscs and worms are remarkably diverse and abundant. In the sea, the Crustacea occupy a position comparable numerically to that held by the insects on land. Strangely enough, the insects are almost completely absent from the sea. Only one is known to live its whole life there. A few others skip on the surface or live in the debris on the foreshore.

The life histories of marine animals are extremely diverse. However, it can be stated that most of the invertebrates undergo some type of indirect development in which there is a free-swimming stage (*see* Invertebrate Embryology). Usually the eggs of these animals are spawned free in the water where they are fertilized. Commonly they possess only a small amount of yolk to feed the developing organisms. Correlated with this, they develop first into self-sustaining larvae totally unlike the parents. These larvae drift about in the water for a period of several days or even weeks. Finally, a complete metamorphosis takes place in which the structure and habits of the parent animals are assumed. Animals with this type of life history produce an exceedingly large number of eggs. This serves to compensate for the heavy losses attending a free larval existence. Alternation of generations is another striking feature of many marine animals, especially of the coelenterates. For example, the common jellyfish (hydromedusa) represents the solitary sexual generation, which alternates with the colonial asexual generation. The latter is a sessile hydroid that superficially resembles a tiny plant. Direct development (in which the organism assumes the adult form by gradual growth) is characteristic of the fishes, cephalopods and certain Crustacea.

The Categories of Life in the Sea.—It is possible to classify the marine organisms into three large groups, *i.e.,* the benthos, nekton and plankton, on the basis of their general habitat and locomotory effectiveness. The benthic animals and plants are those that live upon the sea floor either attached, burrowing or creeping. It includes such animals as barnacles, snails, crabs, worms, etc. All of the larger algae and some diatoms, etc., are benthic. In the nekton are placed all of the animals such as fishes, whales, seals, squids, etc., that are capable of swimming effectively against water currents and in making migratory journeys. In the plankton (*q.v.*) are grouped all of the animals and plants, usually microscopic in size, that float in the water with little or no effective swimming and therefore drift about with the water currents. The plankton is divided into (1) phytoplankton, which includes the diatoms, holophytic dinoflagellates and a few other types, and (2) zooplankton, which includes representatives, either adults or young, of nearly all animal groups from the protozoans to the fishes. The floating eggs and larvae of the benthos and nekton are known as the temporary or meroplankton in contrast to the permanent or holoplankton which comprises the organisms that are planktonic during their entire lives.

Zones of Life in the Sea.—As an aid to study of marine biology the environment is commonly classified into a number of divisions and zones based mainly upon a combination of physical and biological criteria (*see* fig.). The two main divisions are the benthic and the pelagic. The former comprises all of the bottom and the latter all of the water overlying the bottom. They are sharply defined, and typically the subdivisions of each are also clearly recognizable, but there is often a good deal of overlapping at the borders (*see* Distribution of Animals). The upper part of the benthic division is known as the littoral system. It is subdivided into an upper or *eulittoral zone,* extending from shore to a depth of about 50 m., and a *sublittoral zone,* from 50 m. to a depth of about 200 m. (considered the edge of the continental shelf). The deep-sea benthic system consists of an archibenthic zone, from 200 m. to about 1,000 m., and an abyssal-benthic zone, from there downward to the greatest depths. Within the littoral zone there is an "intertidal zone" comprising that part of the foreshore that is alternately covered and exposed by the tides. This zone may be broad or narrow, depending upon geographical and topographical position. In the intertidal zone the attached



FROM SVERDRUP, JOHNSON AND FLEMING, "THE OCEANS" (PRENTICE-HALL, INC.)

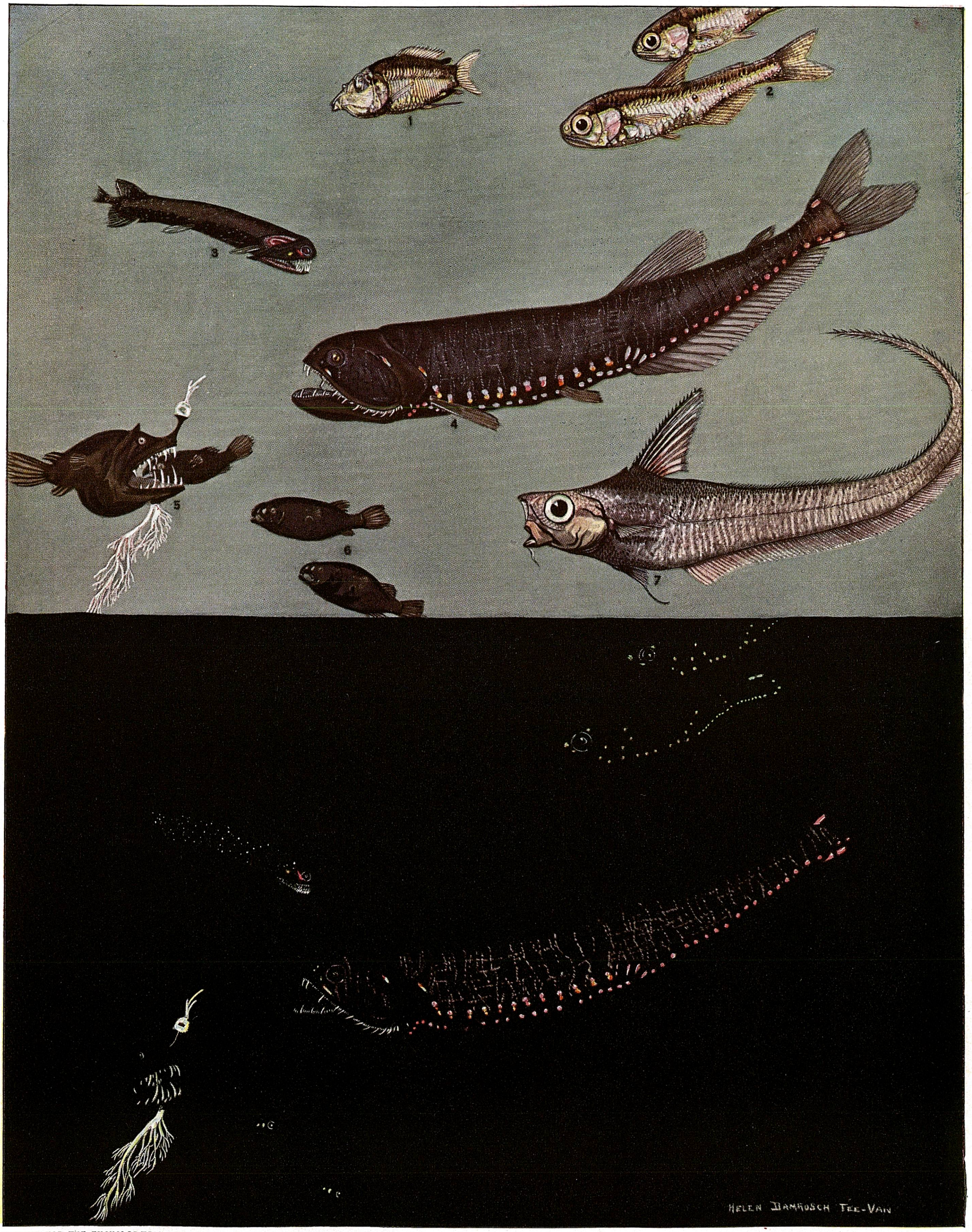
THE MAIN DIVISIONS OF THE MARINE ENVIRONMENT

plants are usually low growing and flexible to withstand the wash of waves. The kinds of animals occurring in this area depend mainly upon the type of bottom, whether rocky or sandy, etc., and upon the degree of exposure to action of the sea. The abundance of life developed in any given section of the zone is determined largely by the degree to which the bottom material can be shifted about by the waves or by other factors such as dilution by rain or runoff, exposure to heat or freezing, or abrasion by ice. During periods of low tide, many animals, such as clams and worms living in mud or sand, find protection from desiccation or heat in their moist burrows. In general, the intertidal animals of rocky exposed coasts are relatively hardy. Often they are provided with heavy streamlined shells and suckerlike structures to hold the close-fitting shell firmly against the rock. Thus they gain protection from impact of waves, and are enabled to retain some water during low-tide periods. Many molluscs, tube worms, and barnacles are firmly and permanently cemented to the rock. The shore crabs and other crustaceans are conveniently flattened to enable concealment in narrow crevices and under rocks. Weak, fragile forms such as the erect lacy bryozoans, sea fans, sea pens, spider crabs, etc., are rare in this zone since they require either the constant mechanical support of water or are unable to tolerate violent water movements. Competition for living space is a serious factor to many littoral animals. It is often critical to the survival of post-larval stages seeking space for attachment.

In the deeper part of the littoral zone the attached plants are more abundant and characteristically larger than in the intertidal area. In the kelp beds of the Pacific the long-stalked *Nereocystis* and *Macrocystis* may grow to a length of more than 100 ft., though most algae are much shorter than this. It is in the subdued light of this zone that we find the beautiful red algae, some of which are used in the manufacture of agar (*q.v.*).

In the sublittoral zone some solar light is available but it is much reduced, hence few plants of importance are found there. Coralline algae grow in the shallower portion where the bottom is rocky or covered with coral or shells. Benthic animals may be abundant in this zone, for much food is washed out in the form of detritus from the upper littoral zone and the production of planktonic plants in the overlying water is favoured by the physical and chemical conditions. (*See* Ocean and Oceanography.)

In the deep-sea benthic system (which includes more than 90% of the bottom of all oceans combined) solar light is still detectable in the shallower (archibenthic) zone while in the abyssal zone perpetual darkness prevails except for the faint and weird light produced by some of the animals living there. The waters are uniformly cold, being but a little above the freezing point for



PAINTED FOR THE ENCYCLOPÆDIA BRITANNICA BY HELEN DAMROSCH TEE-VAN

SOME TYPES OF DEEP SEA FISH

These fishes live in the depths of the sea, half a mile or more beneath the surface, where daylight never penetrates. The water is extremely cold, even at the equator having a temperature near the freezing point. Many have phosphorescent organs that serve to attract prey as well as to shed a faint light around them. In the upper half of the picture the fish are shown in detail and, below, are represented as they would appear in their natural habitat in the ocean depths. 1. *Opisthoproctus grimaldii.* 2. *Myctophum punctatum.* 3. *Malacosteus niger.* 4. *Gonostoma polyphos.* 5. *Linophryne arborifer.* 6. *Rhynchoceratias rostratus.* 7. *Macrourus violaceus*

vast areas of the ocean floor. No primary food is produced within these zones. It must be precipitated from the lighted waters above or be carried in with water currents from the littoral zones. The scarcity of primary food results in a scarcity of animals in the abyssal depths. In general, chemical conditions are not favourable for production of planktonic plants in the lighted waters of the oceanic province which lies above the deep-sea zones. Much of the plant material that is produced is eaten or disintegrated in the course of sinking to the great depths where the abyssal animals live. The deep-sea animals, in general, are modified representatives of familiar shallower-water types. As in the littoral fauna, many species are similar to or related to ancient fossil types, indicating that they too have existed for a very long time.

The Pelagic Division is the home of the plankton and nekton. It comprises all of the water overlying the floor of the sea. The coastal waters to depths of about 200 m. are the Neritic Province and the waters with greater depths are the Oceanic Province. Though no sharp line can be drawn between these two, yet each has its characteristic planktonic plants and animals. For example, the temporary plankton, *i.e.,* the eggs and young of bottom animals and the jellyfish with sessile stages, is a conspicuous part of the neritic plankton. Neritic diatoms frequently form resting spores that sink to the bottom when temperature or other living conditions become unfavourable. In the oceanic province there is greater stability of living conditions, and the formation of spores of the neritic type is not the rule. Resting spores that sink to the bottom in great depths could have no value unless they be returned to the lighted surface, and this is unlikely. The surface oceanic animals are often blue in colour. Many are hyaline. In the deep waters of the oceanic province where solar light is much reduced or absent the colours are mostly red, brown, violet-black or black. Light-producing organs are notably conspicuous, especially among the fishes living at about 300–500 m. These organs may be arranged in specific patterns, and the colour of the light produced may also be specific. This is perhaps an aid to the animals in recognizing their kind, for eyes are functional in these depths and are often unusually large or protruding, the better to intercept the faint rays of light. Below mid-depths blind fishes and squids are found, and the light-producing organs are reduced or absent. But the bottom-feeding fishes of great depths possess eyes, made useful presumably because of the luminescence of benthic animals.

FUNDAMENTAL ECOLOGICAL FACTORS IN THE SEA
I. PHYSICO-CHEMICAL

The biologically important physico-chemical factors are usually interactive and affect the organisms in various and complicated ways. It is useful, however, to discuss a few of these factors and their general applications under separate headings.

The Sea-Water Medium.—Sea water is chemically a most suitable biological medium, for it contains in solution all of the elements necessary to the structure and maintenance of organisms. The ratios of the major salts entering into the salinity of sea water are similar to those of body fluids, and the total concentration of the salts is also similar to that found in the bodies of most marine organisms, particularly in the invertebrates. Thus, there is maintained a favourable osmotic relationship between the external environment and the internal body medium. This isotonic relationship lessens the labour required by excretory organs in maintaining the proper concentration of fluids within the body and precludes the need of impervious membranes. This is in contrast with the hypertonic condition of fresh-water forms where the body fluids are more concentrated than the water and therefore tend to become diluted through osmosis.

Sea water is normally alkaline and tends to remain so because of its buffer capacity, which resists any change in pH (hydrogen ion concentration). This is a boon to the many calcium-precipitating forms.

The density of the water offers the mechanical support necessary to unarmoured or flaccid forms such as jellyfishes and sea anemones, and provides the buoyancy required by all pelagic forms.

Hydrostatic pressure increases about one atmosphere for each ten metres of depth. This restricts the vertical range of many animals that are intolerant to pressure change, but it does not act to eliminate life from the abyssal depths, where the pressure is upward of 1,000 atmospheres, *i.e.,* about 15,000 lb. per sq.in. The pressure can be tolerated because it is equal inside and outside the body tissues, and water is but little compressed. Some eurybathic (tolerating a wide range of depths) pelagic forms migrate through depths corresponding to a pressure variation of 40 or more atmospheres.

Temperature.—Compared with aerial temperatures the marine environment has only a narrow range of about $-2°$ to $30°$ C. Rarely is the seasonal range over $26°$ C, and in the deep sea there is no season with respect to this factor. Along the coast in boreal waters of Europe the difference between summer and winter temperatures is about $10°$ to $15°$ C. Though this is a relatively small range, it is sufficient to permit favourable spawning seasons for a mixed fauna of arctic-boreal (spawning from January to April between $-1°$ and $11°$ C), boreal (spawning from March to July between $4°$ and $6°$ C), and Mediterranean-boreal (spawning from May to October between $7°$ and $22°$ C) forms.

An outstanding example of temperature control of biological activity is that associated with calcium precipitation. The fact that calcium is more readily precipitated in warm than in cold water is believed responsible for the preponderance of heavy-shelled animals in the tropical waters as compared to the cold waters of higher latitudes. A temperature of about $20°$ C or more is required for a vigorous growth of the reef-producing corals. They are therefore confined to shallow water of low latitudes, especially to the western portion of tropical seas where upwelling of deep cold water is not so conspicuous a feature as it is along the west coasts of Africa and the American continents. The skeletal structures of deep-sea animals are only weakly developed, owing apparently to the difficulty of calcium precipitation in low temperature combined with great hydrostatic pressure. For instance, the sea urchins of the deep sea are leathery, and the many calcareous sponges occurring in shallow water are entirely replaced by siliceous species below a depth of 300 m.

The number of species of animals occurring in tropical seas is far greater than that of the colder seas, but the density of the population is usually less. This probably results from acceleration of biological processes in general by the higher temperatures.

The animals of cold waters frequently grow to a larger size than the same or related species living in warm water. In the case of planktonic forms it is thought that the greater viscosity of cold water is partly responsible, since it enables larger forms to survive with less expenditure of energy in keeping afloat. A lowering of temperature from $25°$ C to $0°$ C doubles the viscosity and this is very important to floating forms with a density near that of water. In the cold-water forms there is also a longer growing period before sexual maturity is reached, and this may contribute to the larger size and greater age attained.

A study of the temperature and salinity tolerance of organisms is important, not only to an understanding of present-day fauna, but it provides a key to the interpretation of ecological conditions in the ancient seas that have left their histories written in the fossil remains of their inhabitants.

Oxygen.—In the sea the maximum oxygen content is only about 9 ml./litre compared with 200 ml./l. for air. In the "oxygen minimum layer" of mid-depths of the great oceans and at or near the bottom in many bays or basins, there may be little or no free oxygen. Hence many animals have a precarious existence with respect to this factor. In experimental tests *Calanus finmarchicus,* a cosmopolitan planktonic copepod, succumbed when the oxygen content was lowered to between 1 and 2 ml./l. at temperatures of $5°$ to $15°$ C. In nature there appears to be, however, a somewhat greater degree of tolerance to low concentrations, for *Calanus* has been taken from $7°$ C water with an oxygen content of less than 1 ml./l. Sluggish benthic animals sometimes occur on mud bottoms with extremely little oxygen. But only anaerobic bacteria can survive when there is a complete absence of oxygen with its accompanying increase of hydrogen sulphide. There are many such stagnant environments. Classical examples of these are the deep waters of the Black sea and certain deep Norwegian fjords that have at the mouth a shallow sill that prevents free circulation of bottom water with the outside. The water strata overlying these toxic basins may teem with plant and animal life. Occasionally owing to storms, dense water may be forced in over the sill, and creeping along the bottom it displaces the toxic water upward with catastrophic results for the animal life. For the ocean in general, however, there is ample oxygen for animal respiration even in abyssal depths, as discussed below. Respiration in sea water is believed to be facilitated by the presence of carbonates that make the elimination of carbon dioxide easier than in fresh water.

Light.—This factor has its greatest significance as a source of energy for photosynthesis by plants, but it is also closely associated with the behaviour and structure of the animals, as a few selected examples will reveal. It is believed to be the stimulus controlling the diurnal migrations of countless numbers of pelagic animals, especially of the plankton that live at depths of about 50 to 300 m. where the light is much diminished and diffused. The copepods and chaetognaths are the animals that have received most study with respect to this behaviour. During the daylight hours they seek depths well below the surface, but as sunset approaches they slowly swim toward the surface, having their maximum distribution there usually between sunset and midnight.

The reduction of solar light in depths of 300 to 1,000 m., and its total absence in the abyssal depths, has left an unmistakable stamp on the animal life. The uniform colours, light-producing organs, and modifications of the eyes characteristic of these animals have already been mentioned. Various types of tentacular organs, some with luminescent lures, are also characteristic. In some of the fishes the males are dwarfed and parasitic externally upon the females. One or more may occur permanently attached and with the circulatory system united with that of the female. This habit is presumably an adaptation to prevent separation and loss of the sexes from each other in a sparse population.

Plant Nutrients.—In addition to the "conservative" salts that make up the salinity so important to the osmotic balance of the organisms, there are a number of "nutrient" salts, mainly nitrates, phosphates, iron and other trace elements. Unlike the salinity, the concentration of nutrient salts fluctuates widely because of irregular utilization by the phytoplankton. The degree of change in concentration therefore becomes an index of biological activity (photosynthesis) in the lighted water layers.

Upon death of the plants, or of the animals that have been nourished directly or indirectly by the plants, the nutrients are again in time returned to mineralized state. This occurs mostly by bacterial action in the deeper water where the dead organisms have accumulated. There is considerable lag, however, between utilization and regeneration of the nutrients and their return to the lighted waters. This results in seasons of high plant production alternating more or less regularly with others of low production. The function of marine bacteria in this cycle is concerned with transformations of the complex protein molecules of dead organisms and wastes to the simpler mineralized state. This is accomplished by a series of steps. In the nitrogen cycle, for example, the NH_2 group is split off from the amino acids by various bacteria, and the process is carried forward by nitrifying bacteria through oxidation of ammonia to nitrites and nitrates ($NH_3 \rightarrow NO_2 \rightarrow NO_3$). The plants may utilize the ammonia and nitrites but the nitrates appear to be their chief source of nitrogen. Its regeneration is somewhat retarded in nature. It should be mentioned here that bacteria transform not only the particulate organic matter but also the dissolved organic matter. Thus, they reclaim vast quantities of nutrient material not directly utilizable by plants or by animals.

Water Circulation.—To plants water circulation is a vital factor because only through ascending water currents, or through the slow process of diffusion, can the plant nutrients be transported from the deep water to the surface layers where they periodically become depleted owing to organic production. In shallow water the circulation is sufficiently deep to tap the nutrient supply accumulated there. Therefore, coastal areas are rich in marine life. In contrast, the waters of the open sea are commonly relatively barren because of depletion of nutrients at the surface and the absence of effective water circulation to bring about renewal from subsurface layers. There are notable exceptions; for example, along the Pacific equatorial current, where special hydrographic conditions draw subsurface waters to the surface.

To animals the water circulation has many ecological relationships, directly or indirectly. Through this agency the waters are aerated and the wastes of metabolism dispersed. As a result of the great current systems and mixing processes described under OCEAN AND OCEANOGRAPHY, even the waters of abyssal depths have sufficient dissolved oxygen to support some animal life. The distribution of temperature is so closely associated with water currents that the endemic distribution of stenothermic (thermically sensitive) animals coincides with the main current systems which are directly responsible for the dispersal of the pelagic organisms and also of the bottom organisms through their floating larvae. It is the conveyance of particulate food (plankton and organic detritus) by water currents that makes possible the many sessile animals such as barnacles, hydroids, bryozoa, oysters, etc., so characteristic of the sea.

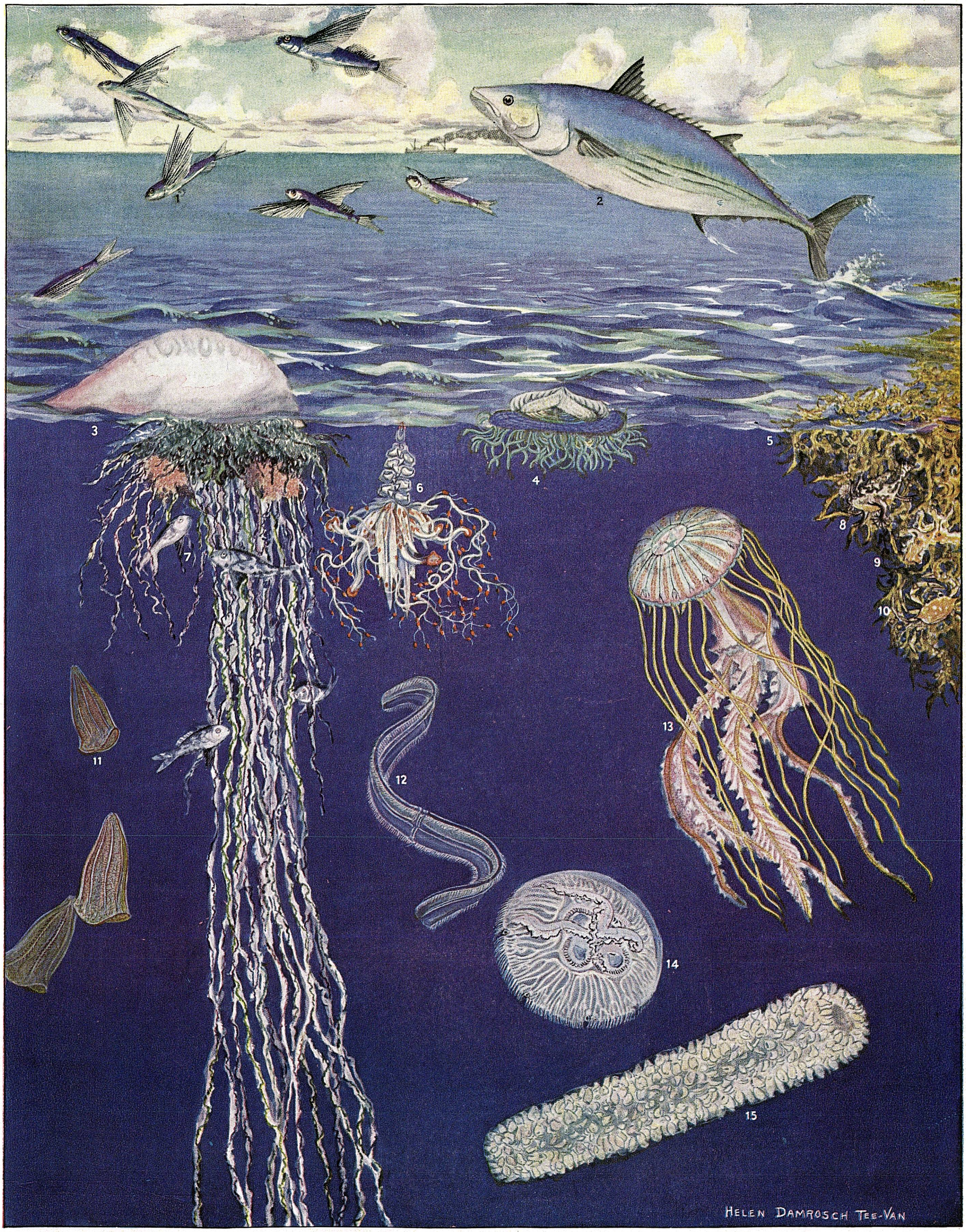
II. ORGANIC

In the foregoing, some of the relations of the external physical and chemical factors to the lives of marine plants and animals have been considered. We have now to consider some of the interrelations of the organisms themselves. These are mainly nutritional, and, to gain an understanding of the fundamental aspects of these relationships, we must look first to the microorganisms making up the phytoplankton and the zooplankton, and the way in which these are utilized.

Pelagic Organisms.—It has been pointed out that sea water is a dilute nutrient medium suitable for plants, but only about 2% (*i.e.,* the upper littoral zone) of the sea bottom has sufficient light for attached plants to flourish, and much of this is unsuitable because of unfavourable bottom for attachment. In order to utilize the vast resources of plant nutrients from the surface to depths of about 50 m. over the entire sea, diatoms, dinoflagellates and a few other microscopic plants have become adapted to a passive floating existence. The principal feature adapting these plants to a floating life is their small size. The rate of sinking of an organism heavier than water is governed by the ratio of surface to volume. The simplest way to increase this ratio is by reduction of absolute size. The development of spines and the formation of chains of cells are additional adaptations of these plants. Attesting to the success of these means of populating the vast surface areas of the oceans is the fact that no other type of plants has come into being that can so completely meet the requirements of the pelagic habitat. An apparent exception is the sargassum weed, which is present in large quantities in the Sargasso Sea. This, however, is a littoral algal plant drifted to sea where it is able to grow vegetatively and to accumulate under special conditions.

In order to utilize the abundant supply of dispersed and microscopic plants mentioned above, special types of plant eaters are required. This demand has led to a planktonic population of very small herbivorous "filter-feeders." Chief among these are the small (0.05 to 8 mm.) but exceedingly numerous Copepoda (*q.v.*). These animals are provided with a screening device formed by bristles of the mouth appendages (first and second maxillae). There are of course many other small grazers including the euphausiids, some protozoans, the larval stages of many benthic invertebrates and some fishes.

These tiny herbivores accomplish two important ends in the economy of the sea; namely, (1) utilization of the microscopic primary food, and (2) conversion into animal substance sufficiently large to be caught by the larger but less numerous carnivorous filter feeders or plankton feeders of the sea. Among these are the plankton-feeding fishes such as the herring, sardine, anchovy, menhaden, mackerel, etc. These fishes screen the copepods and other small plankton food from the water with the aid



PAINTED FOR THE ENCYCLOPÆDIA BRITANNICA BY HELEN DAMROSCH TEE-VAN FROM DATA OBTAINED FROM THE AMERICAN MUSEUM OF NATURAL HISTORY

SURFACE LIFE OF THE OCEAN

1. Caribbean flying fish *(Halocypselus evolans)* pursued by (2) an oceanic bonito (*Gymnosarda pelamis*). 3. Portuguese man-of-war (*Physalia arethusa*) whose long tentacles are fatal to all invaders except (7) the diminutive Portuguese man-of-war fish (*Nomeus gronovii*), which spends its life undisturbed among the streamer-like arms. 4. *Velella cyanea*. 5. Sargasso weed and small fish that inhabit it: (8) mouse fish (*Pterophryne histrio*), (9) naked mollusc (*Scyllaea pelagica*), (10) swimming crab (*Portunus sayi*). 6. *Nectalia loligo*. 11. *Beroe ovata*. 12. Venus' girdle (*Cestus veneris*). 13. *Dactylometra quinquecirrha*. 14. Common jellyfish (*Aurelia flavidula*). 15. *Pyrosoma atlanticum*

of the "gill rakers" through which the water must pass in its course through the mouth and out over the gills. It is significant that fishes of this type constitute the bulk of the fish population of the sea.

Other notable plankton feeders are the whalebone whales (*see* CETACEA). These giants—among which is the largest of all animals, the blue whale—gather large quantities of plankton by means of the frayed ends of the whalebone plates suspended in the mouth. The copepods, euphausiids, pteropods, etc., are screened from the water as the animals swim with open mouth. Herring are also caught in this manner. It is well known among whalers that these animals make long migrations, seeking out feeding grounds such as the Antarctic, where there is a notable production of phytoplankton and zooplankton. The basking shark, the largest of all fishes, also feeds upon the zooplankton.

The plankton-feeding fishes also feed more or less upon each other and are in turn the prey of other larger predaceous fishes; for example, the tunas, dolphins, salmon, etc., that are not provided with efficient means for filtering the water.

Noteworthy among the predaceous pelagic animals are the toothed whales. The sperm whale dives to great depths in search of the giant squid upon which it feeds. The killer whales are known as wolves of the sea because of their voracity and habit of hunting in packs. They feed not only upon fish, seals and birds, but attack also other larger whales.

Benthic Organisms.—The significance of microscopic particulate food in suspension is also evident in a study of the structure and feeding habits of the bottom-dwelling animals. Many of these animals, such as the barnacles, clams, mussels, sponges, tube worms, hydroids, etc., feed upon plankton or floating detritus as it sinks or is swept within reach by water currents. These animals are often called suspension feeders. Many kinds of screening and concentrating devices are used for this purpose. Usually they consist of bristles, gratings, ciliated tentacles or grooves, or even mucous sheets or films that are eaten after becoming filled with microscopic food. Water is pumped through these structures, or the food-gathering bristles are swept rhythmically through the water. Among the detritus feeders there are also many that, like the sea cucumbers and certain worms, ingest mud and bottom ooze for the digestible material it usually contains. Much of this material is dead plankton precipitated from above. Finally, there are a great number of rapacious benthic animals like crabs, lobsters, bottom-living fishes, cephalopods, sea stars and worms that are relatively active and that feed upon the scavengers and plankton feeders and upon each other.

Many benthic animals are found habitually associated together in more or less distinct communities of greater or lesser extent. The principal components of these associations have similar requirements or tolerances with respect to substratum salinity, exposure, etc. They may, in turn, condition the environment so that yet other forms with similar salinity tolerances become associated with them because of the food they supply or the shelter they offer. As an example we may consider an intertidal association in which mussels and barnacles, both requiring hard surfaces for attachment, cover the rocks and thus provide special shelter and concealment for many small crabs, worms, isopods, etc., while the whole assemblage supplies food for the more highly active and predaceous forms such as fishes, large crabs and sea stars. Thus, through selective survival of pelagic larvae, or through trial and error in seeking out suitable conditions, there are built up markedly different associations on rock, mud and other habitats. Associations of benthic animals (and also the pelagic forms on a larger scale) are striking phenomena of the sea. Frequently the attached plants furnish a great deal of primary food for the coastal communities, but most of this food is used, as explained above, only after it has become detritus. The growing plants are of great ecological significance, however, as animal sanctuaries. They provide protection against predators, afford surfaces for attachment, lessen the shock of waves, and in the intertidal zone they shield against heat and desiccation. Usually the primary food and also the plankton and detrital food of the non-predaceous members of an association are brought into the area through the agency of water currents or precipitated from the water above. Where environmental conditions are rigorous with respect to physical and chemical factors, many potential members are eliminated but those suitable to survive may become very abundant, owing to absence of serious competition for space and food. Among individuals within the community there are always other more restricted and intimate relationships such as commensalism, symbiosis and parasitism.

MARINE BIOLOGICAL METHODS

The preliminary procedure in investigating the organisms in any area of the sea is descriptive and consists of identifying, describing and cataloguing the many species of animals and plants that occur within the area. This is a very large task, especially in hitherto unstudied areas. It requires the labour of several investigators, each of whom is a specialist in one or more of the biological groups involved. The reports and monographs published by these specialists give formal diagnosis of each species and record its distribution. These reports are tools in the hands of subsequent investigators dealing with analytical studies such as the ecology of the individual species or groups of species. (*See* ECOLOGY, ANIMAL.)

The methods of collecting and of analyzing and studying the material after it has been collected depend upon the objectives of the investigations, whether taxonomy, embryology, ecology, etc. These objectives also determine the number and kinds of physical or chemical observations that are made in the field in conjunction with the collecting. The equipment and procedures available for the study of the inorganic factors of the environment have been vastly improved since the famous "Challenger" Expedition of 1873–1876, which has been the model for subsequent work. Accurate reversing thermometers now enable determination of temperatures at any desired depth and the bathythermograph provides a continuous temperature record downward from the surface. Light intensity can now be accurately measured with photoelectric apparatus lowered into the sea. Chemical procedures assure proper evaluation of oxygen, salinity and the major plant nutrient salts. Coring devices are available for use in collecting undisturbed bottom sediments for study of microorganisms in the muds. Sonic depth finders provide numerous or continuous soundings. These are important devices, some of which have grown out of the needs of marine biologists for accurate and quickly obtained data to use in ecological interpretations. Others are borrowed directly from other branches of marine sciences—physics, chemistry and geology—and applied to biological research.

In ecological work the numbers of individuals of any species occurring in a unit space in a given area are determined and correlations made with the external environment. The numerical and nutritional relationships to other animals and plants in the community are also determined in order to ascertain the relative importance and interdependence of the various members. For embryological studies of the animals, living specimens are brought to the laboratory where the processes of fertilization, cleavage and larval development are observed under the microscope. Similarly, the algal spores shed from living plants are cultured under experimental conditions to learn their life histories. The planktonic diatoms are likewise grown to ascertain their nutritional requirements and rate of photosynthesis under various conditions of light. Numerous other studies; for example, the osmotic balance, oxygen consumption, reaction to light, etc., require living material for experimental procedures under controlled conditions. But the common objective of experimental and field observations is to understand the organisms in nature and under natural conditions. For these reasons marine biological laboratories are established at seasides where live material is available and natural conditions observable (*see* below).

Benthic collecting in the intertidal zone requires but simple equipment for digging out the burrowing forms or prying loose those that are attached to rocks or piles. When statistical studies are involved, the area covered and its relative position with respect to mean low tide is carefully recorded, for nowhere else in nature are specific organisms confined to such a narrow vertical range as are some of the species living within the intertidal zone.

In deep water a dredge operated from a power or sail boat is used. Where the bottom is smooth, various types of trawls are commonly used instead of the dredge. For quantitative surveys in shallow water, some type of "grab"—such as the Petersen grab—that scoops up the material from a known area of bottom (*e.g.*, $\frac{1}{4}$ sq.m.) is employed.

In collecting the microscopic plants that make up the phytoplankton, fine silk nets are used for qualitative work; but, for quantitative studies, "water bottles" (cylindrical metal containers of a litre or more capacity) that can be closed at any desired depth are used to obtain a definite volume of water together with its passive organisms.

In the analysis of phytoplankton collections, an aliquot sample of the water collected by means of the water bottle is centrifuged to concentrate the diatoms and dinoflagellates in the sample. The organisms thrown down in this manner are then counted on a ruled slide or in a counting chamber under the microscope. From these counts calculations are made giving the number of plants per litre of water. Sometimes the whole sample is filtered through a fine net and examined, and computations made as above.

Chemical methods are also used for determining the amount of phytoplankton. With this method extractions with acetone are made of the yellow-green pigments in the chlorophyll. The pigment obtained in this manner in a known volume of acetone is determined colorimetrically with an arbitrary standard of 25 mg. of potassium chromate and 430 mg. of nickel sulfate dissolved in one litre of water. The results are reported as "pigment units" which amount to 3.3×10^{-3} mg. of organic carbon. The ratios, by weight, of the major constituents of plankton are carbon, 41; nitrogen, 7.2; phosphorus, 1.

The zooplankton is more sparse and irregular in its distribution than is the phytoplankton, hence larger nets of coarser bolting cloth are used, or other filtering devices—such as the Hardy Plankton Recorder or the Clarke-Bumpus Plankton Sampler—that likewise strain a relatively large quantity of water are employed.

The volume of the material collected with the nets is determined by allowing it to settle in graduated cylinders or by draining off the fluid. The organisms of interest are counted and the stages of development noted. If the volume of water filtered in collecting the sample can be determined, the number of organisms or the volume in cubic centimetres is given for one cubic metre of water or for one square metre of ocean surface.

The methods for collecting nektonic animals for study of marine biology are essentially those of commercial fisheries; various trawls, nets, setlines, traps, etc., being the standard equipment. Much of the biological material studied or the statistics accumulated are obtained directly from the commercial catches of fish or whales. This is particularly true where the biological research is conducted by some government agency for the conservation of marine fisheries resources. Statistics are kept relative to the size of catch, size of fish or whales, area fished, gear and effort involved. In the study of migration of certain fishes like the salmon or the halibut, living specimens are tagged from commercial catches, liberated and later recovered largely from similar catches. Our information on the biology of whales has resulted largely from co-operation between scientists and whalers. (*See* ZOOLOGICAL COLLECTING: *Marine Collecting,* for other details.)

MARINE BIOLOGICAL STATIONS

Marine biological stations are laboratories (usually operated by universities or government agencies) where the various types of research and studies related to marine life can be most efficiently carried on. For this reason they are established at seasides where living plants and animals can be readily collected for laboratory study or observed under natural environmental conditions. They are usually situated well away from harbours that are likely to be contaminated with sewage or oil. Aquaria with circulating sea water are maintained for the purpose of display or study of live material. Vessels equipped for dredging or trawling are often owned or chartered by the laboratories, and row boats are available for work along shore. Some laboratories are also equipped with diving gear for observations in shallow water. Many of the biological stations are officially open only during the summer months, when they are attended by investigators and students from universities or other schools. Some of the stations now maintain resident staffs engaged mainly in research.

The most famous marine biological station is at Naples. It was founded in 1872 by Dr. Anton Dohrn. Another well-known Mediterranean station was founded by Prince Albert I at Monaco. The largest U.S. station is at Woods Hole, Mass., where there are also an oceanographic institute and a fisheries laboratory, combining to make this a famous centre for marine biological studies. Other important U.S. stations are at Mt. Desert Island, Maine; Cold Spring Harbor, Long Island, N.Y.; Solomons Island, Md.; and on the Pacific coast at La Jolla, Calif.; Pacific Grove, Calif.; and Friday Harbor and Seattle, Wash. The Fisheries Research Board of Canada operates stations at Nanaimo, B.C., and at St. Andrews, N.B. Prior to World War II there was one German station, a large excellently equipped laboratory at Helgoland. The Scandinavian countries operate several good stations along their coasts. The principal British station is that founded by the Marine Biological Association of the United Kingdom and is situated at Citadel Hill, Plymouth. Other English and Scottish biological and fishery stations are at Cullercoats in Northumberland; Port Erin in the Isle of Man; Millport and Aberdeen in Scotland and at Lowestoft. There are 15 or more French stations, the better known being at Roscoff and Arago de Banyuls. Russia has about 11 stations most of which are for fisheries research. In the Orient Japan has maintained about 14 stations, and before 1936 China maintained four stations. There are fewer tropical and semitropical stations. Among the better known of these is the Bermuda station.

Throughout the world in 1937 there were about 105 marine biological stations and 25 purely fisheries research stations. About one-half of the former included fisheries investigations and biological instruction as part of their activities, otherwise the work was mainly general biological research. A growing need for a wider scope in marine research has led to establishment of oceanographic laboratories where biological work is carried on as actively as before but with greater facilities to study all phases of the environment as a whole, particularly at sea. *See* T. W. Vaughan (1937) for detailed accounts of the various institutions.

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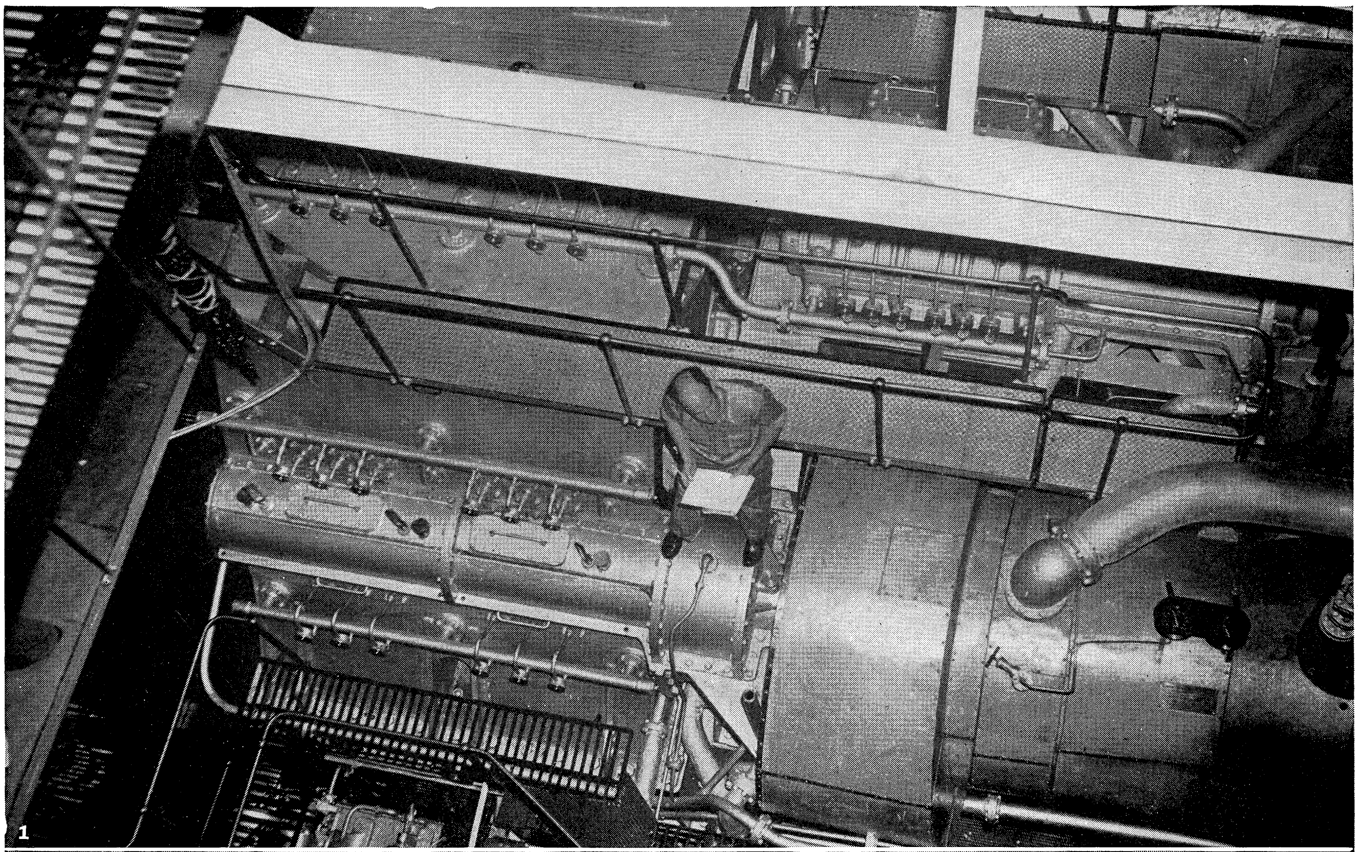
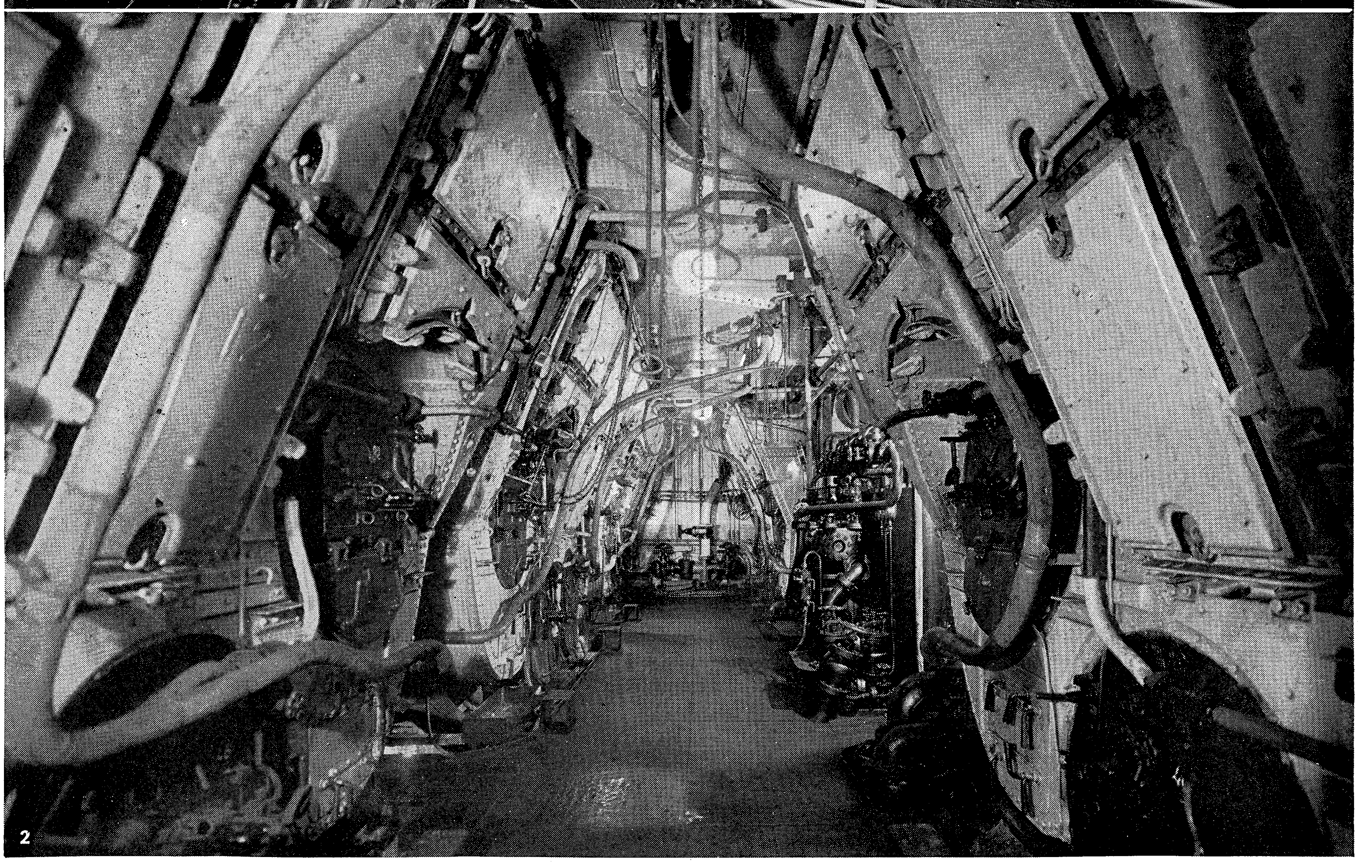
MARINE ENGINEERING. There are three distinct types of marine engines, and these may be grouped as follows: (1) steam engines with coal or oil-fired boilers; (2) internal combustion engines, such as the diesel or semi-diesel engines; and (3) the above two types with electrical transmission of power between the prime mover and the propeller shaft; viz., engines with turbo-electric or diesel-electric drives. Of course, group (1) includes reciprocating steam engines, turbines (geared or otherwise) or combined turbine and reciprocating engines. These types are described on subsequent pages.

Reciprocating Marine Steam Engines.—All marine reciprocating engines now installed are stage-expansion engines, that is, steam expands in stages from the highest pressure cylinder, through the intermediate stages, and finally exhausts into the condenser, where it is condensed and returned to the boiler in the form of feed water.

Stage-expansion engines may be grouped as follows. Compound:—In this type there are two cylinders, the high-pressure and the low-pressure. Steam actuates the piston in the high-pressure cylinder, and from there it passes into the low-pressure cylinder, completes its work in this cylinder, and finally exhausts to the condenser. *Triple expansion.*—In this engine, as its name implies, steam exerts its power in three stages before exhausting to

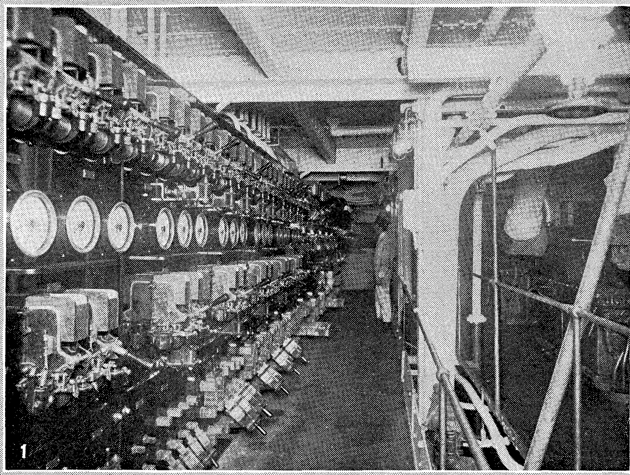


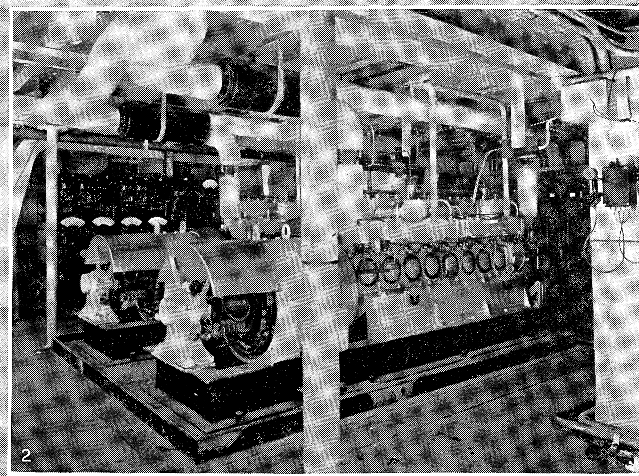


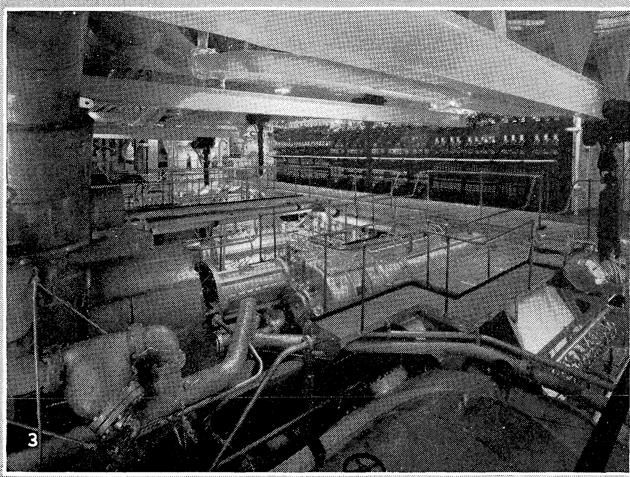
BY COURTESY OF (1) UNITED STATES LINES, (2) THE FRENCH LINE

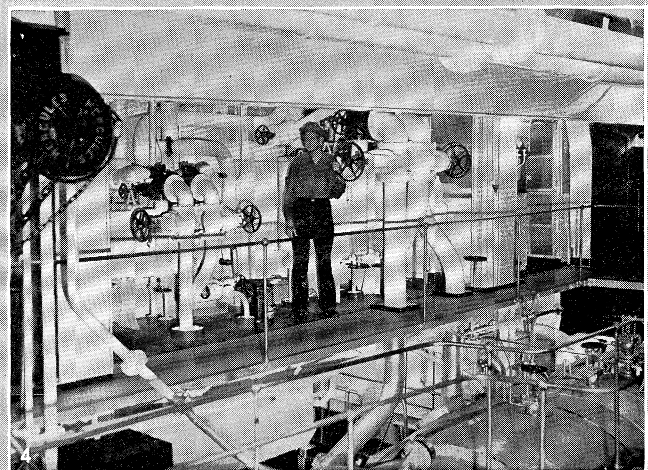
POWER MACHINERY OF LARGE OCEAN LINERS

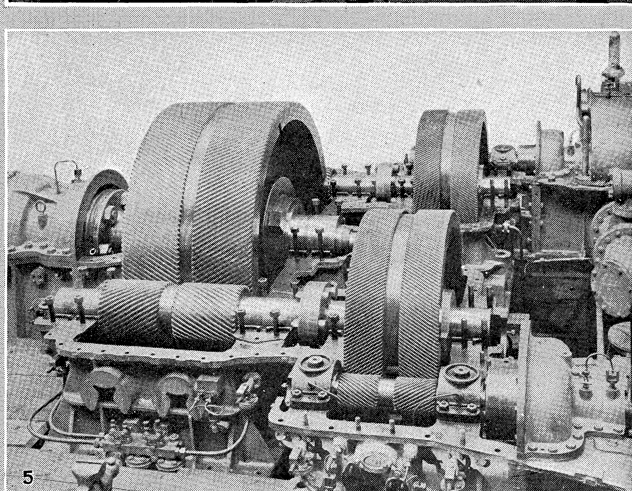
1. Looking down on the main turbine and reduction gears of the 26,454-ton S.S. "America" of the United States Lines. Propulsion is provided by triple-expansion turbines which drive twin propellers connected to the reduction gearing. Steam for the turbines is provided by six oil-burning water-tube boilers. Shaft power is 34,000 h.p., and the approximate speed is 22 knots. 2. One of the many sections of the boiler room, S.S. "Ile de France." Each boiler is rated at 2400 h.p.; 32 boilers on ship, 4 furnaces to each boiler, four sets of tubes to each furnace, total of 514 smoke tubes (63.5mm. diam.), 190 water tubes (40mm. diam.). Oil is used for fuel, the burners being visible along passageway

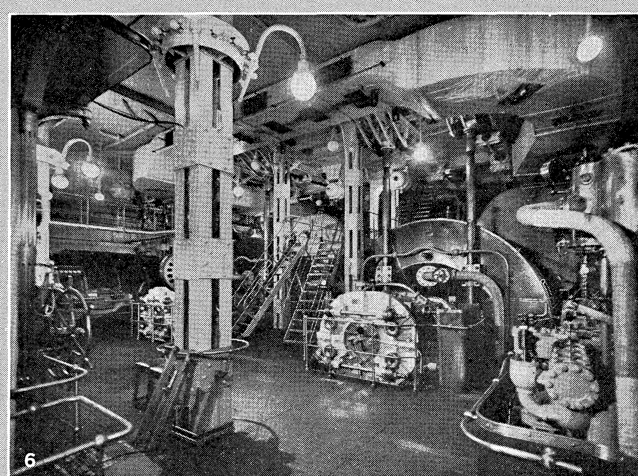












BY COURTESY OF (1) THE ROYAL MAIL STEAM PACKET COMPANY, (2) CUNARD WHITE STAR LTD., (3) UNITED STATES LINES, PHOTO BY BYRON CO., N.Y., (4) UNITED STATES LINES, (6) THE FRENCH LINE

MODERN CONTROL SYSTEMS AND POWER MACHINERY IN OCEAN VESSELS

1. Main switchboard in electrically-driven motorship "Alcantara," 22,500-tons, built by Harland & Wolff, Belfast. Board controls distribution of electric power to motor-driven auxiliary machinery and lighting circuits of the ship

2. Auxiliary electric generating plant, remote from the main power stations of the S.S. "Queen Mary." The two gasoline engines can provide emergency power in less than five minutes

3. View of engine room of the S.S. "America," built at Newport News, Virginia. Two sets of turbines deliver 34,000 shaft h.p.; the propeller speed is 128 revolutions per minute

4. Auxiliary air ejector (left) and main air ejector (right) of the S.S. "America"

5. Parsons' double reduction gearing as fitted in the fabricated 1st class ships. At right are two turbines whose shafts have pinions operating the two reduction gears (centre) which in turn operate the large reduction gear (left) direct connected to shaft of ship

6. View of engine room, S.S. "Ile de France." At right, water pump; background, steam turbines; left, controls; above, ventilator

the condenser. *Quadruple expansion.*—In this type the steam is used four times before exhausting into the condenser, the usual design being to fit two intermediate cylinders.

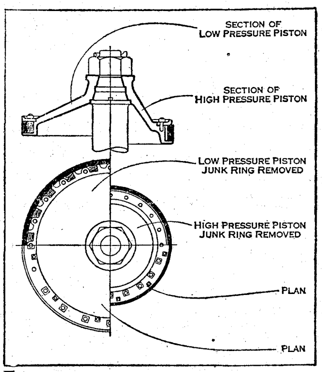


FIG. 1.—HIGH-PRESSURE AND LOW-PRESSURE PISTONS

General Construction.—The engine cylinders are supported by columns, which also act as a guide for the crossheads. This crosshead forms a hinged joint between the piston rod and the connecting rod, which is provided with turned pins on either side, connected to the forked end of the connecting rod, and provided with suitable bearings. The connecting rod is in turn connected to the crank with suitable bearings. The eccentrics governing the valve motion are keyed on to the shaft, the eccentric straps usually being made of a brass composition, lined with white metal. Link motion affords a means of quick reversal, and also allows an earlier or a later cut-off of the steam by regulating the valve admitting the steam to the cylinders. The link operates in conjunction with two eccentrics, and is actuated by means of a small steam reversing engine, or by a hand wheel connected with a reversing shaft. The reversing mechanism is placed along the front of the engine. Fig. 1 shows details of the high-pressure and low-pressure pistons of a high-powered marine reciprocating steam engine.

The advent of the marine steam turbine, the Lentz Double Compound, and the marine internal-combustion engines, and the electric transmission of power for propelling machinery certainly has led many shipbuilders to install one or the other of these

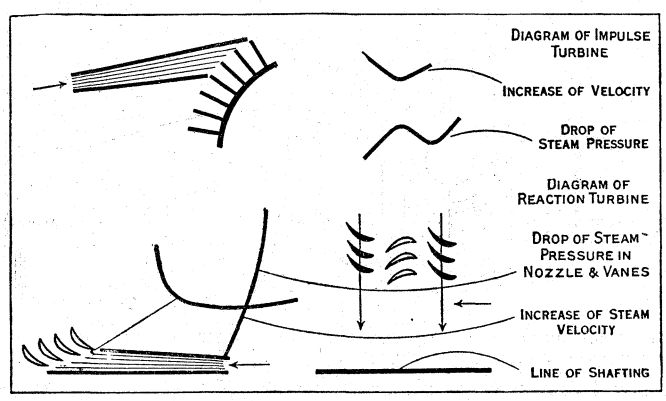


FIG. 2.—DIAGRAM SHOWING ACTION OF STEAM IN IMPULSE AND REACTION TURBINES

types, but it is interesting to note that in some recent large liners the carefully balanced triple-expansion engine has been installed. Experiments are being carried out to utilize steam at a much higher pressure than formerly, and excellent results are expected.

Combined Reciprocating Engines and Steam Turbines.—This method ensures that the whole of the expansive energy of the steam is utilized to its fullest extent. An excellent example of this arrangement is the White Star "Olympic." The arrangement has proved an economical one, and is as follows: each wing propeller shaft is driven by a reciprocating engine, the low pressure cylinder of which exhausts into a Parsons low-pressure turbine driving the central shaft.

MARINE STEAM TURBINES

The advantages of the marine steam turbine which have led to its more general adoption during the past few years are as follows: (*a*) There are fewer working parts, as no slide valves, pistons or connecting rods are required. This means also that fewer spare parts have to be carried; (*b*) the steam is supplied direct from the boilers with no intervening loss, such as occurs through glands, etc., when a reciprocating steam engine is the prime mover; (*c*) there is considerably less danger of breakdown, a big asset in the case of warships and passenger steamers; (*d*) engines are placed well down in vessel, an all-important point in warships; (*e*) there is less expenditure of lubricating oil; (*f*) there is no cylinder lubrication, thus clean feed water is returned to the boilers; (*g*) there is absence of vibration, a big factor in warships and passenger steamers; (*h*) smaller attendance is required than in the case of reciprocating steam engines; (*i*) there is superior governing (balance), good parallel running and even-turning moment; (*j*) priming (the passage of water mixed with the steam from the boilers), which would fracture the cylinder covers of a steam reciprocating engine, has no material effect on a marine steam turbine; (*k*) overloading (forcing the turbines) can be indulged in within reasonable limits; (*l*) it is more economical than the reciprocating marine steam engine except at the lowest speeds.

The large-sized turbines are more economical in steam per horse-power developed than the best triple or quadruple expansion engine, as the turbine is able to take full advantage of the whole of the expansive energy of the steam. Two well-known types of marine turbines in general use are the combined impulse and reaction turbine and the impulse turbine. There are naturally many modifications of these types.

Combined Impulse and Reaction Turbines.—This arrangement consists of the usual reaction turbine with a single impulse stage, in the nozzles of which there is a considerable pressure and consequently loss of heat, giving a large proportion of effective work in this stage. The effect of this is the shortening of the turbine with economy, and permitting for moderate powers of the complete expansion of the steam on a single shaft. There is a saving in weight and space, the machinery arrangement is simplified, and the propulsive efficiency is improved with slower propeller speed. The nozzles are grouped in a box on the forward side of the cylinder, the impulse rotor blading is fitted on a rim, and for astern working, astern nozzles are fitted. This arrangement is particularly suitable for light warships. The action of the impulse turbine and the reaction turbine is shown diagrammatically (fig. 2).

Geared Turbines.—Fig. 3 shows the general arrangement. These turbines are rapidly gaining favour for marine propulsive purposes. The chief trouble with the marine turbine arose with the propeller. It is necessary that a turbine for maximum efficiency should run at a high rate of revolution, while for propeller efficiency, much lower rates of revolution are necessary. The solution for this was by the introduction of some form of gearing between the turbine and the propeller. Experiments have been made with several forms of reduction gearing, such as

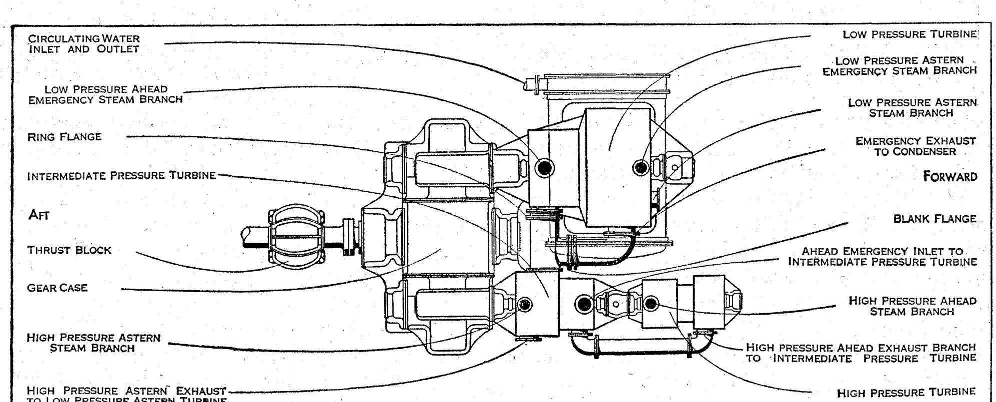


FIG. 3.—GENERAL ARRANGEMENT OF MARINE GEARED TURBINES

the electrical, hydraulic and mechanical. Mechanical gearing appears to show advantages over the other forms, an efficiency of over 98% being obtained in the case of the single reduction and over 97% with the double reduction. There is practically no limit to the ratio of such reduction. A complete unit of geared turbines is to be found in certain twin screw torpedo-boat destroyers. Double-reduction gearing finds favour for the following reasons: (*a*) the type permits larger ratio between revolutions of turbines and propellers without excessive size of gear wheels; higher revolution of turbine permits, for the same power, smaller turbines, and increase in the number of turbines for the same power further reduces the size of each unit; (*b*) high revolutions or greater blade speed are possible, resulting in the nearest approach to the point where the blade speed in relation to the steam speed gives maximum economy; (*c*) a small turbine permits of a pivot-thrust block being used, as the dummy can be omitted, and all unbalanced load taken by the block; (*d*) small turbines have small rotors and can thus be made of a much more robust construction; (*e*) variations in temperature for any single turbine are kept moderate, and these turbines are therefore suitable for use with superheated steam; (*f*) the parts being smaller, the turbines can more easily be overhauled, repaired or renewed. Plate II. (fig. 5) shows an example of double-reduction gearing.

The Turbo-electric Drive.—The first application of electricity for the transmission of power between the prime mover and the propeller shafts in ships was first adopted in America in the year 1908. This proved most successful, and many of the world's warships are now so equipped. The electrical equipment is an alternating current generator suitable for direct coupling to a high-speed turbine, a motor of suitable speed for direct coupling to the propeller shaft, a direct current exciter or an auxiliary generator, from which direct current can be obtained, and suitable control gear. The whole can be regarded as a reduction gear, the ratio of reduction being proportional to the number of poles on the generator and motor. The main driving power is transmitted magnetically across large air gaps giving an elastic medium for absorbing shocks, and thus making it a simple and reliable form of speed reduction. The electric drive lends itself particularly to any speed reduction between the turbine and the propeller. The general advantages are perfect balance with no sliding surfaces and no reciprocating parts, thus making this method free from vibration and smooth in operation; the electric drive is noiseless, an important factor in passenger ships; there is perfect control in heavy seas without danger of the propellers racing; the rapid manoeuvring of the machinery is a very big asset in warships; and the upkeep costs are less than with any other form of marine propelling machinery.

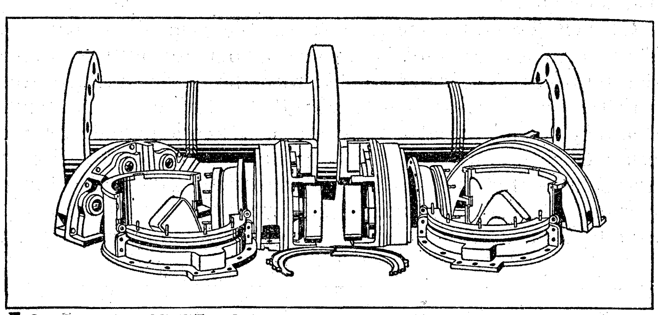


FIG. 4.—COMPONENT PARTS OF MICHELL THRUST BLOCK, SHOWING THE SINGLE COLLAR ON THE SHAFT

The Michell Thrust Block.—With all marine installation of gearing a Michell thrust block is essential to the satisfactory working of the gears. The whole of the gearing is an independent unit as far as attachment to the turbine is concerned, being driven from the turbine by a flexible coupling. It is necessary, therefore, to hold the gearing in a position from which it will not vary more than a predetermined amount. There being no collars for this purpose on the gear shaft, and as a slight lateral movement is necessary when the thrust collar moves over from driving ahead to astern, the whole of the gearing is located from the thrust block. The Michell block possesses marked advantages over the older form of multiblock. The device (fig. 4) consists of one collar on the shaft, the thrust being taken by a series of pads capable of a slight rocking movement. These pads maintain a continuous flow of oil between the metal surfaces, which are thus kept apart by as many oil wedges as there are pads to produce them.

MARINE INTERNAL COMBUSTION ENGINES

One of the principal reasons which has led to the adoption of the internal-combustion engine for marine propulsion is the thermal efficiency of this prime mover. The thermal efficiency of a diesel engine is 40% to 45%, according to size; whereas that of a reciprocating steam engine with coal-fired boilers is 20% to 25%. As regards running, the fuel bill is about half that for an oil-fired boiler ship fitted with geared turbines; there is a very great saving of space occupied by the machinery, and a reduction in personnel. Against these advantages we have the greater initial cost, complication of parts, a greater number of spare parts have to be carried, and it is probable that the repair and upkeep bill will exceed that for steam units. For a given power the diesel compares unfavourably as regards weight with the steam turbine and oil-fired boiler combination, and the head-room is greatly limited (this, especially from a naval point of view, is a marked disadvantage); but the possibilities of this prime mover are endless. The diesel has been and is being installed in large liners, and doubtless when a speed of, say, 25 knots can be reached, combined with a simple and reliable design of engine, this type of engine will be installed in the mammoth Atlantic record-breakers. The present types of marine internal-combustion engines work either on the two-stroke or on the four-stroke principle; but many competent authorities affirm that the marine oil engine of the future will be a double-acting two-stroke with port-scavenging, this design giving an engine of low initial cost and simple construction. The solid (or mechanical) injection of

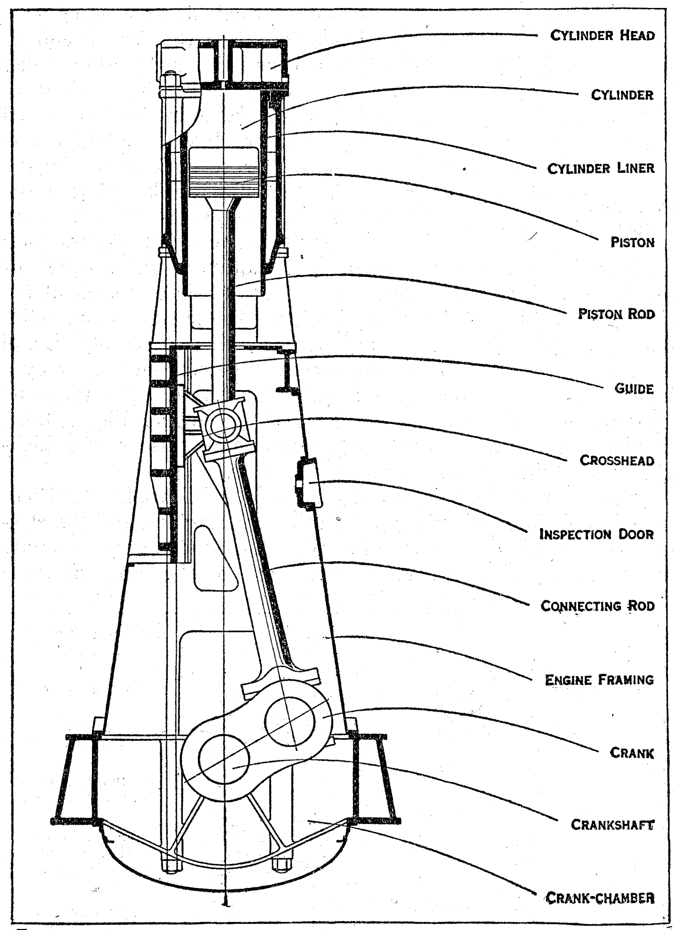


FIG. 5.—BURMEISTER AND WAIN MARINE DIESEL ENGINE, SHOWING SECTION THROUGH ONE CYLINDER

the fuel is likely to be adopted generally in preference to the air injection system, owing to the reduction in first cost that is obtained by its use.

Operation of the Four-stroke Marine Diesel Engine.—The working principle of this engine is as follows: during the first downward stroke the piston draws air in through the suction valve; during the return stroke the suction valve and all other communications with the atmosphere are closed and the air in the cylinder is compressed. Towards the end of the stroke, the fuel pump injects into the cylinder the necessary quantity of oil for the combustion stroke, so that when the piston arrives at dead centre the fuel burns rapidly, raising the pressure and temperature in the cylinder. During the next downward stroke of the piston the burnt gas is expanded, doing work; during the fourth stroke, the piston sweeps out the burnt gasses into the atmosphere through the open exhaust-valve, completing the four cycles. Fig. 5 shows a section through one cylinder of a four-stroke marine engine by Burmeister and Wain. For single-screw ships, long-stroke engines running at low revolutions are employed in order to obtain a good propeller efficiency. For twin-screw ships, short-stroke engines are used, as higher speeds are permissible without reducing the propeller efficiency.

The Two-stroke Marine Diesel Engine.—A good example of this marine internal-combustion engine is the Sulzer two-stroke,

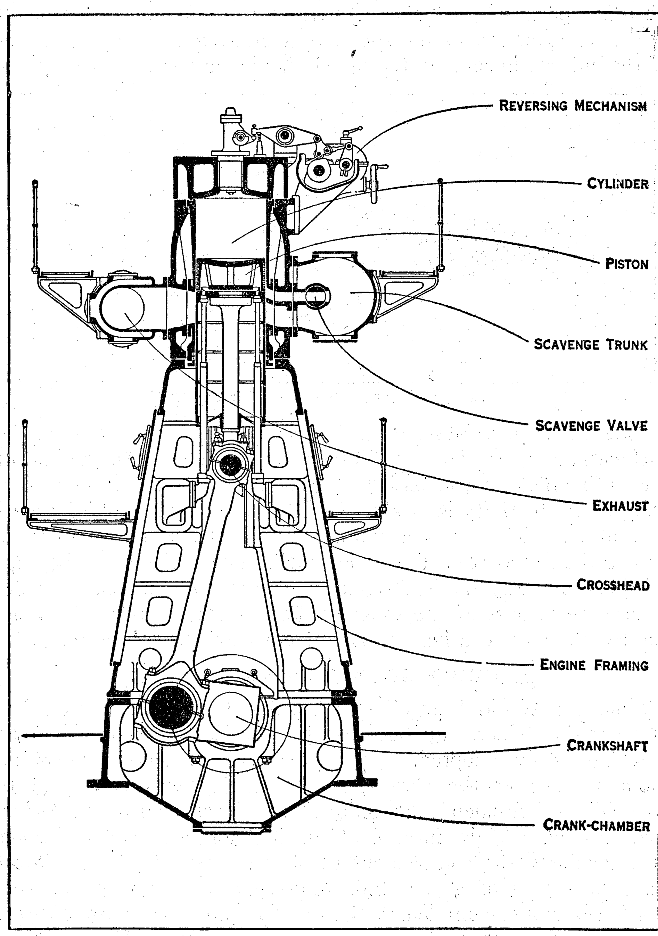


FIG. 6.—SECTION THROUGH SULZER TWO-CYCLE MARINE ENGINE

a section through this engine being shown (fig. 6). The distinctive feature of this design is the method of scavenging and recharging the cylinder; *i.e.*, removing the burnt products of the firing stroke and replacing these with a charge of fresh air. This is accomplished as follows: The scavenge air supplied by a pump is led to the scavenge trunk, which communicates with the cylinder through two ports at the bottom of the liner, the upper port being controlled by a valve. When the piston is at the top of its stroke, and combustion takes place in the usual manner, both ports are closed by the piston skirt. The piston then moves down and first uncovers the upper scavenging port, but the valve being closed no action occurs until the piston moves farther down and uncovers the exhaust ports situated opposite the scavenge ports. Exhaust commences immediately and relieves the pressure in the cylinder, so that when the lower range of scavenging ports is uncovered the air enters the cylinder and commences to sweep out the remainder of the exhaust products. The scavenging valve opens before the completion of the down stroke, so that the scavenging takes place through both upper and lower ports, and continues through the upper port until after the piston on its upward stroke has covered the exhaust port. This arrangement ensures a most effective means of clearing out the exhaust products, and also provides for an excess quantity of air by enabling the compression stroke to commence slightly above atmospheric pressure. In other words, supercharging is possible. In marine engines of over 1,000 h.p. electrically driven scavenging pumps are provided.

The Diesel-electric Drive.—The application of this drive has been made to smaller ships. The employment of electric transmission allows comparatively small diesel engines, each coupled to a generator, to be used, the power being transmitted to motors on the propeller shafts. The arrangement and speed of the engines are independent of the propeller shaft, and the engines are short and not of excessive height. As there is no mechanical connection between the engines and the propeller shaft, the subdivision of the ship with watertight bulkheads, to comply with the regulations, is simplified. In vessels fitted with this type of machinery it will be possible to use the same prime mover for both propelling and auxiliary purposes.

MARINE STEAM GENERATORS

Water-tank Boilers.—In this type of marine steam generator the *fire passes through the tubes* and the water circulates outside the tubes. The principal boiler of the mercantile marine, and, till late years, of the various navies of the world, is the cylindrical Scotch marine boiler (fig. 7), the various parts being clearly indicated. The experience gained after many years with this boiler proved it to be undoubtedly a good, safe and easily understood generator, and also comparatively easy to clean. These boilers are made single-ended and double-ended, and are cylindrical in shape with flat ends. The illustration shows a single-ended type. The furnaces or flues are corrugated in order to allow for expansion and compression. One to four furnaces are fitted, either terminating in a common combustion chamber, or, a better plan, being fitted with an independent combustion chamber to each furnace. In the boiler shown the furnaces are fitted each with separate combustion chambers, and are stayed as shown. The tubes are of commercial size, being obtainable in practically every port in the world, and are fitted with cap ferrules at the combustion chamber end to prevent burning away of the tube ends. The boiler is, however, excessively heavy, unequal strains are set up (unless a feed water circulator is used), and the space per horse-power is much greater than with the water-tube types. Another point against this boiler is the length of time taken to raise steam, ten to 14 hours usually being allowed. Against these disadvantages we have the greater quantity of water carried, with consequent ease of keeping steam and water levels, and the same skill is not required in firing up, cleaning fires, etc., as is necessary with the water-tube types. The boiler is fairly economical as compared with the water-tube types. Of course, in the case of explosion, much greater damage would be done owing to the greater steam and water space.

Water-tube Boilers.—As its name implies, in this type of generator the *water passes through the tubes,* and the heat from the furnaces outside the tubes. It is only within the last few years that the water-tube boiler has been seriously considered as a rival to the cylinder water-tank generator. For naval purposes, of course, there is no question as to which type is suitable; and for both naval and mercantile marine purposes the two outstanding features of the water-tube boiler are common. Briefly, these two points are as follows: (*a*) the water-tube boiler is very much lighter; (*b*) the boiler requires much smaller space for the same horse-power, or gives much greater horse-power for the same space. Both these fac-

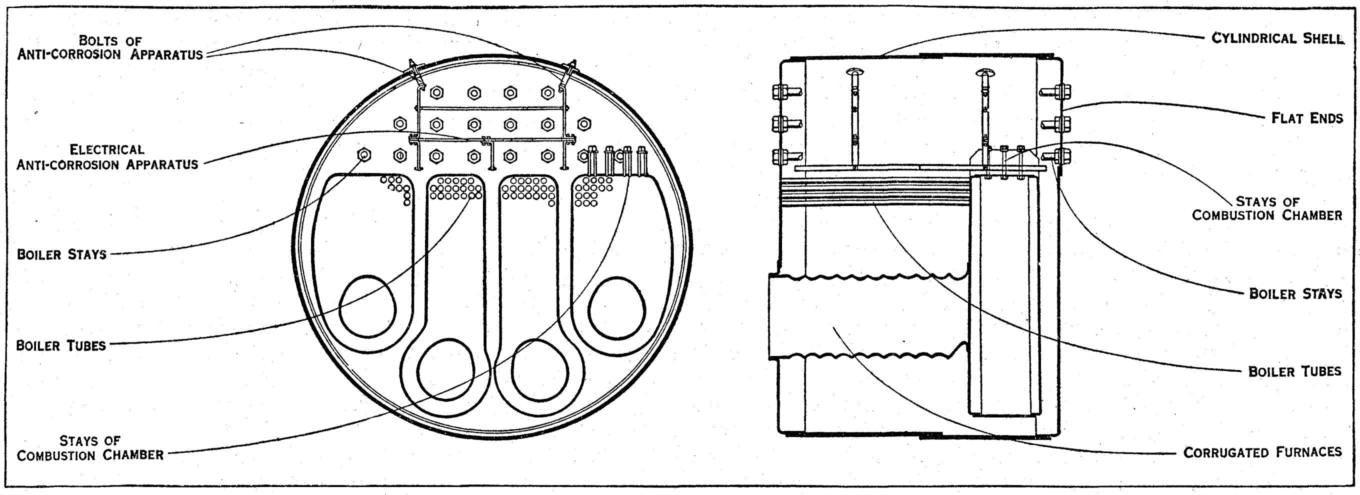


FIG. 7.—SINGLE-ENDED CYLINDRICAL SCOTCH MARINE BOILER

tors are of paramount importance in the merchant service. By the reduction of boiler weight and space the cargo-carrying capacity, or passenger accommodation, is greatly increased, with consequent greater earning power for the vessel.

It must be borne in mind that much higher pressures can be carried, which is essential for warships, mail steamers, and cross-Channel packets, especially when turbine-engined; and this pressure can be carried with perfect safety. Forcing, that is, using a higher pressure than that for which the boiler was designed, can be carried out, and steam can be raised very quickly without undue strain on the working parts.

One of the best known marine water-tube boilers is the *Yarrow* (fig. 8). The construction is simple and thus the process of cleaning, an all-important matter with water-tube boilers, is an easy matter. The Yarrow boiler consists of a large water drum and two lower water drums, connected by a series of inclined generating tubes (fig. 8). The boiler feed water is pumped into the steam drum, descends through the tubes most remote from the fire and rises through the tubes nearest the fire, where it is converted into steam. After leaving the steam drum the steam enters a super-

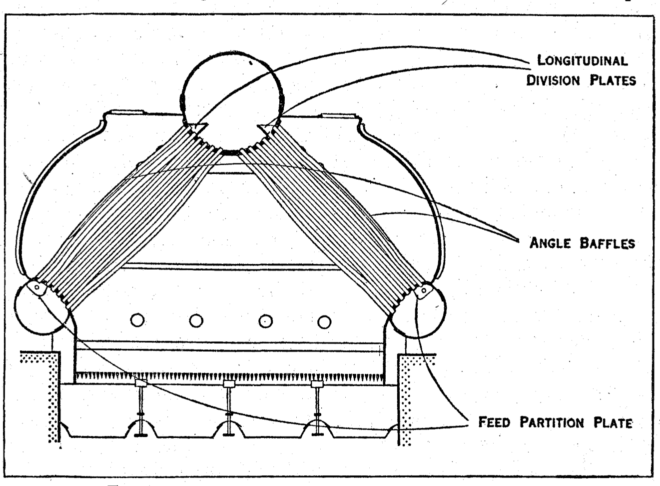


FIG. 8.—YARROW MARINE WATER-TUBE BOILER

heater, where it is superheated, and thence through the steam valve to the engine.

General.—The modern trend is towards much higher boiler pressures, higher temperatures, and the more efficient burning of the fuel and generation of steam in the boilers. There is no reason why pressures of 700 lb. or 800 lb., should not be carried, as the trials of the high-pressure turbine steamer "King George V." were most successful, and showed a marked improvement in the consumption of fuel, in this case coal, compared with such a vessel using steam at the normal working pressure. Superheating the steam, air preheating, increase in boiler feed water temperature and analysis of the funnel gases are all receiving due attention, as are also the best means to adopt to ensure protection and cleanliness of the boiler surfaces against corrosion.

Prevention of Boiler Corrosion.—Zinc slabs or bars are fitted to the interior of marine boilers so as to be electro-negative to all other parts of the boiler to attract the galvanic attention of acids. The zinc slabs are suspended in the steam and water spaces of the boilers; in some water-tube boilers zinc angle bars are used.

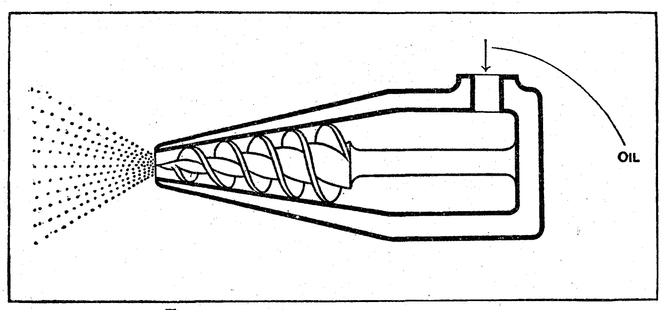


FIG. 9.—SIMPLE OIL FUEL SPRAYER

It is essential that slabs are fitted so as to protect the whole of the surfaces, and worn slabs should be renewed. The latest method of preventing boiler corrosion is the *electrolytic.* By this system electrolytic conductivity is produced in the water by supplying a current of electricity from a source outside the boiler to metallic anodes, insulated from the boiler shell. The current can be supplied continuously and its strength controlled; *i.e.,* increased or decreased regardless of the wear or deterioration produced on the anodes, thereby ensuring permanent efficiency of protection.

OIL BURNING IN MARINE BOILERS

Since the World War oil fuel burning for marine boilers has made rapid strides, and but for the question of cost would be more generally adopted. As an example of saving in boiler room staff, after the Cunarder "Aquitania" was converted to burn oil, her firemen were reduced to 42, as against 320 when coal-burning. Again in a coal-burning torpedo-boat destroyer of 10,000i.h.p. the complement of stokers was 30. In the latest class destroyers of 28,000s.h.p. and 1,400 tons, burning oil fuel alone, the stoker complement is 12. *The advantages of oil fuel are as follows:* (*a*) superior evaporative power per weight of fuel carried, giving increased radius of action—1 lb. of oil with a heat value of 19,000 B.T.U. will evaporate 15 lb. of water up to and at 212°F., and 1 lb. of coal with a heat value of 14,500 B.T.U. will evaporate 10 lb. of water up to and at 212°F.; (*b*) ease of shipping into bunkers and putting into fires—only hoses and attachments are required; (*c*) less stokehold staff and bunker space required; (*d*) absence of coal dust and ashes—a big asset; (*e*) no necessity to open furnace doors with consequent loss; (*f*) proper regulation of combustion, and capability of forcing the boiler; that is, obtaining more than the designed output.

Disadvantages of Liquid Fuel.—(*a*) Uncertainty of obtaining supplies; (*b*) complication of piping and machinery; (*c*) possible leakage and danger from fire; (*d*) special appliances required for burning; (*e*) liquid and solid impurities found in the oil; (*f*) widespread contamination of water-ways.

Method of Burning.—Before entering the boiler furnace the oil has to be atomized, that is, split up into a fine spray, and for this purpose three methods are adopted; *i.e.*, atomizing by means

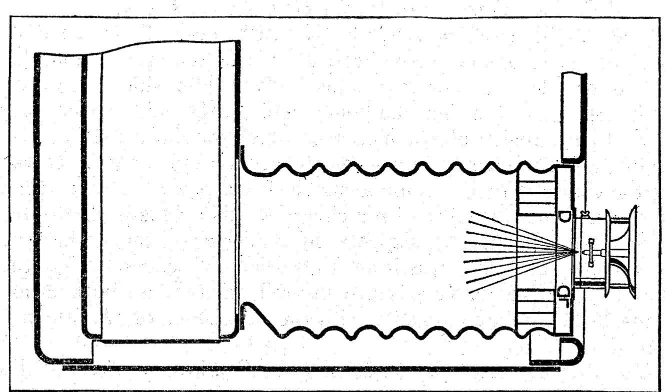


FIG. 10.—MARINE BOILER FURNACE, SHOWING OIL SPRAYER IN POSITION

of steam, compressed air, and pressure. Owing to freedom from breakdown and reliability the last method is generally adopted in naval and marine practice. Many different forms of burners or sprayers are adopted. Fig. 9 shows a simple sprayer, in which the oil is forced round a series of helical threads upon the surface of a cone. By this means a whirling motion is imparted to the oil, the narrowed passage at the exit producing an increase in velocity. These factors greatly assist the spraying. The sprayers are fitted to distribution boxes on the furnace front. Fig. 10 shows a patent form of sprayer fitted to the furnace front of a cylindrical marine boiler. The pressure system of oil burning is very simple and is as follows: oil is drawn from the ship's tanks and strained; this removes all solid impurities which would choke the sprayers. The oil is delivered from the oil pumps under pressure, an air vessel in the pipe-line assisting in maintaining a steady supply. The oil next passes to filters called cold filters and from there to heaters. This heating process may form particles of carbon in the oil, which particles are removed by passing it through filters fitted on the delivery side of the heater. From these filters, called hot filters, the oil passes under pressure to the distribution boxes on the boiler front, and from these through the sprayers, where it is atomized, to the furnace. For warships and fast passenger steamships oil is the ideal boiler fuel, but it is not considered that oil will become general in the mercantile marine owing to the question of cost. Many ships are now fitted to burn oil alone, coal alone or coal and oil combined.

Marine Auxiliaries. The great increase in the number of auxiliary engines now fitted in naval and mercantile vessels calls for as much attention as do the main propelling engines. As regards design, the majority of marine auxiliaries follow accepted practice, but the following units call for special consideration.

Marine Condensers.—The modern method is to ensure high vacuum combined with reliability and that the weight of the apparatus be as low as possible consistent with the work the condenser is called upon to perform. Separate air pumps are installed, one pumping out the feed water, and the other maintaining a high vacuum by pumping air from a cooler part of the condenser. Tube failure, through corrosion, is a frequent source of trouble, and the many experiments carried out with tube metal mixtures have not eliminated this.

Electrolytic Protection, similar to that used to prevent boiler corrosion, has been adopted with good results. Metallic packing for the tubes, in place of the ordinary tape packing, has been tried with excellent results.

In connection with marine condensers a system has been devised known as the *closed feed system.* By this method the condensate is removed from the condenser and discharged to the boiler without exposure to the atmosphere, thus preventing air mixing with the water and causing boiler corrosion. Another method coming into favour is the removal of the air in the feed water by mechanical de-aeration, and this method seems to possess advantages over the removal of the air by chemical means.

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MARINE INSURANCE. Marine insurance is the insurance of interests—property and earnings—that may be imperilled in a maritime adventure. These two groups of interest include such as (1) ship and goods, (2) freight and passage money. Marine insurance is also a protection against certain liabilities such as shipowner's liability for collision damages, and carriers' responsibility for goods, and against losses occasioned by sacrifices for the general safety of an adventure. (*See* AVERAGE.) It is transacted in all nations having trade which necessitates transport, even those which have no sea ports, and is the safeguard of the shipowner, merchant, banker, mortgagee, and of any who risk their property, money, or credit in commercial or financial enterprise and of those who have occasion to send valuable objects from one place to another. Primarily marine insurance is concerned with sea transport, but it is adapted to the insurance of transport of any kind, and frequently policies concerning goods for overseas transport include a certain amount of risk on shore. *See* also LLOYDS.

Practice.—In practice marine insurance is a complicated business transacted for the most part through the medium of brokers who, by their expert knowledge, can select the best market in which to place their clients' risks, and obtain the terms most suitable for the adventure to be insured. So far as the hulls of ships are concerned, sailing vessels are generally insured for each voyage, while steamers are insured for periods of time, generally twelve months. The risks against which the hulls of ships are insured by the full (with average) policy, are the perils of the seas, and similar perils covered by the traditional marine policy in common use, including sacrifices made in "General Average" (*see* AVERAGE). It is also customary to add, by the use of clauses, insurance against liability for damage done by collision and certain other liabilities and perils. It is also customary in Great Britain to exclude war risks from the marine policy, these being insured separately, or covered on a mutual basis by associations formed for that purpose amongst shipowners. During World War I the amount to be covered on both ships and cargo against war risks was so great that the British Government instituted a war risk bureau which functioned simultaneously with the open market, and this system of a national war risk insurance office was also adopted by other countries, including some of those which remained neutral. So far as marine perils are concerned, the hulls of ships are also insured under policies which do not include the risk of particular average, and also under policies which cover total loss, general average (other than damage to ships), salvage charges and collision liabilities, these being known as "free of damage absolutely" insurances. Another form of insurance is the "free of particular average" policy which does not pay particular average unless the vessel has been stranded, sunk, on fire, or in collision. "Particular average" is partial loss caused by a peril insured against, and which is not general average. In connection with hull insurances, shipowners also insure their freight, their insurance premiums, and an indefinite interest known as "disbursements," the amount of which represents the financial loss over and above the actual value of the vessel which a shipowner incurs when his vessel is totally lost.

Goods and merchandise, valuables, securities and other concrete transportable interests are insured under the traditional marine form of policy, risks being added by means of clauses, of which the principal are the "with average" and "free of particular average" clauses of the Institute of London Underwriters. The "with average" clauses cover practically every fortuitous accident which may occur during transit, while the "free of particular average" clauses cover total loss, general average and certain other liabilities, but do not cover particular average unless the vessel has been stranded, sunk, on fire or in collision. These clauses also extend the risk of sea transit to cover the goods from the time they leave the warehouse at the port of shipment, until delivery at the consignee's or other warehouse at the destination named in the policy, or until the expiry of fifteen days from midnight of the day on which the discharge of goods from the overseas vessel is completed, whichever may first occur. Extension of the risk to 30 days from the completion of discharge is made when the destination to which the goods are insured is without the limits of the port of discharge.

Legislation.—In Great Britain, marine insurance was the subject of sporadic legislation up to the end of the 19th century. In the reign of Elizabeth an Act was passed (*43 Eliz. c. 12*) setting up a Court of Policies of Insurance to arbitrate in cases of dispute. The Act of 1720 incorporating the Royal Exchange Assurance and London Assurance, has already been mentioned. In 1745 an Act (*19 Geo. 2. c. 37*) prohibited the issue of wagering policies, and also policies of re-insurance, and although this Act was not finally repealed until the passing of the Act of 1906, its provisions with regard to re-insurance became obsolete. From the passing of this Act, until the Act of 1906 there appears to have been no legislation of importance dealing with marine insurance, other than certain finance acts dealing with policy duties, but during that period case law, mainly owing to the efforts of Lord Mansfield, had created precedents on practically every point likely to be raised on marine policy, and the Act of 1906 (*6 Edw. 7 c. 41*) was largely a codification of this case law, although certain provisions with regard to the prohibition of gambling policies were embodied in it. These provisions were amplified by the Marine Insurance (Gambling Policies) Act of 1909.

The Act of 1906, while codifying the existing law, did not, however, do away with litigation over points not previously decided. It is by no means as comprehensive as some of the continental codes, and while its provisions have proved singularly free from ambiguity since they have seldom been the subject of litigation, there still arise questions outside its scope which have to be decided in courts of law. It is, nevertheless, to the Marine Insurance Act of 1906 that reference may best be made on points arising out of marine insurance questions, especially where matters of principle and not of detail are concerned.

The Policy.—Reference has already been made to the marine policy, which, in Great Britain, is invariably based upon the traditional form which has been evolved from the early policies mentioned in the historical review. The Marine Insurance Act gives a form of policy which may be used, but which is not compulsory. This form is based on the traditional policy, and is, in fact, almost identical with the form adopted by Lloyd's underwriters in 1779 (*see* LLOYD'S). The custom is, however, to supplement the policy by a clause excluding war risks, while since 1919, as a result of the case of *British and Foreign Marine Insurance Co.* v. *Sanday* (*Times L.R. 266 and 374*) it has become customary to add the *frustration clause* which prevents underwriters from being held liable for loss due to loss of market caused by the frustration of a voyage owing to arrests, restraints or detainments of kings, princes or peoples.

This policy, archaic in form, and described by Justice Buller as an "absurd and incoherent document," has been so explored in the course of time, by means of legal action, that there remains very little, if any doubt as to the legal interpretation of any of its clauses.

It has already been shown, however, that the policy, by itself, is rarely used, and in modern practice the contract of marine insurance is usually expressed in a policy based upon the traditional form, but supplemented or modified by clauses in which the real terms of the contract are to be sought, rather than in the policy itself.

All policies of marine insurance must be stamped in accordance with the Stamp Act 1891 (*54 and 55 Vict. c. 39*) if they are to have validity in Great Britain.

The scale of stamp duties payable on policies of marine insurance is that of the Finance Act, the current scale in 1928 being that of the Act of 1920 (*10 and 11 Geo. 5 c. 18 s. 41*).

The provisions of the Act, together with those of the schedule, prevent any insurance being effected for more than twelve months, but to meet the cases of vessels insured for time which are at sea or in distress at the time the policy expires, the Act of 1901 provides that a policy of sea insurance may contain a continuation clause, and shall not be invalid on the ground only that by reason of the clause it may become available for a period of more than twelve months. A policy with a clause of this nature is chargeable with a stamp duty of sixpence in addition to that otherwise chargeable, and the "Institute time clauses" under which the majority of British vessels are insured, contain a continuation clause which is in conformity with the provisions of the Finance Act of 1901.

The Revenue Act 1903 (*3 Edw. 7 c. 16*) allows marine policies on building risks to run for periods longer than twelve months, and to be stamped as voyage policies.

The Contract.—From the Marine Insurance Act it is learnt that a contract of marine insurance is one whereby the insurer undertakes to indemnify the assured in a manner and to the extent thereby agreed, against marine losses. It may, by express terms, or by usage of trade, be extended so as to protect the assured against losses on inland waters or on any land risk which may be incidental to any sea voyage. It is to be noted, however, that subsequent litigation, *Muller* v. *l'Union Maritime* (*Ll.L. Rep. KB.17. 90.CA.18. 339. HL. 20.90*) throws doubt on whether the contract is identical, with regard to the risk on land, to that with regard to the risk on sea.

The Act defines "maritime perils" as "perils consequent on or incidental to, the navigation of the sea, that is to say, perils of the seas, fire, war perils, pirates, rovers, thieves, captures, seizures, restraints and detainments of princes and peoples, jettison, barratry and any other perils either of the like kind or which may be designated by the policy." Before the Act was passed, case law had decided that "all other perils" meant only perils *ejusdem generis* with those of the sea, but even now it cannot be said that the end of dispute as to what is, or what is not covered by the policy has been reached, although precedents exist on all the main points. In practice, however, the marine cargo policy is frequently extended by clauses (the express terms of the Act) to cover perils not strictly those of the seas, such as, for instance, theft, the risk of "thieves" in the policy meaning "robbery with violence, or breaking in." Insurances on the hulls of vessels are also extended by clauses, the principal addenda being the indemnification of the assured against liability for collision done to any other ship or vessel; loss or damage due to accident in loading or discharging, or through the negligence of the master, mariners, engineers or pilots, and loss or damage due to the bursting of boilers, or through latent defects in the machinery or hull.

These clauses are, so far as Great Britain is concerned, mostly those issued by the "Institute of London Underwriters," a body composed of representatives of the marine insurance companies.

Insurable Interest.—The Act, after stating that every contract of marine insurance by way of gaming or wagering, is void, proceeds to define what an insurable interest is. A person has an insurable interest when he stands in any legal or equitable relation to the adventure, or to any insurable property at risk therein in consequence of which he may benefit by the safety or due arrival of the insurable property, or may be prejudiced by its loss, or by damage thereto, or by the detention thereof, or may incur liability in respect thereof. He must, however, be interested in the subject matter insured at the time of loss, though he need not be when the insurance is effected. An example of the application of this is when goods are sold in transit, and the insurance is transferred to the purchaser. An assured cannot, however, acquire interest subsequent to a loss by any act or election after he is aware of the loss.

Insurable Value.—Subject to the express provisions or valuation of the policy, the insurable value of ship, freight goods, and other subject matter is laid down by the Act. Broadly speaking, this is the value of the interest at the inception of the risk plus incidental charges, including insurance. It is now the almost invariable practice to insert the value in the policy, in which case that value becomes the basis of all claims and adjustments.

Disclosure and Representation.—The Marine Insurance Act states that "a contract of marine insurance is a contract based upon the utmost good faith, and, if the utmost good faith be not observed by either party, the contract may be avoided by the other party." This is the basis of the whole of the business of marine insurance, which, in Great Britain, is largely transacted by means of verbal representations by the assured or his broker to the underwriter, and this being so, the importance of the observance of the principle of good faith is apparent. According to the Act, the assured must disclose to the insurer, before the contract is concluded, every material circumstance which is known to the assured, who is deemed to know every circumstance which, in the ordinary course of business, ought to be known by him. Failure to make such disclosure voids the contract. The Act also states that every circumstance which would influence the judgment of a prudent insurer in fixing the premium, or determining whether he will take the risk, is material, but no circumstance need be disclosed which is known or presumed to be known to the insurer. Every material representation made by the assured or his agent to the insurer during the negotiations for the contract, and before the contract is concluded, must be true, or the insurer may void the contract. Representations as to matters of expectation or belief must be made in good faith, but representations may be corrected or withdrawn before the contract is concluded. The contract of marine insurance is deemed to be concluded when the proposal of the assured is accepted by the insurer, whether the policy be then issued or not: and for the purpose of showing when the proposal was accepted, reference may be made to the slip, or covering note, or other customary memorandum of the contract, although it be unstamped. To appreciate the meaning of this provision it is necessary to explain that in Great Britain marine insurance is generally transacted by making a brief memorandum of the essential details of a risk on a slip, upon which the insurer writes the amount he will accept on that risk, appending his initials. The contract thus expressed cannot be legally enforced, but when a stamped policy is prepared embodying its terms, the slip may be produced as evidence of the intentions of the parties to the contract. A covering note is a memorandum issued by the insurer, or by a broker, to the assured, stating that the risk is covered, the terms on which the insurance has been effected, and the premium to be paid.

Measure of Indemnity.—According to the Act, the sum which the assured can recover in respect of a loss is, in the case of an unvalued policy, the full extent of the insurable value, or in the case of a valued policy, the full extent of the value fixed by the policy; this, however, is subject to any express provisions of the policy. In the event of total loss the measure of indemnity is the sum fixed by the policy, in the case of a valued policy, or in an unvalued policy, the insurable value of the subject matter insured. In the case of partial loss of a ship, the measure of indemnity is the reasonable cost of repairs, less the customary deductions, but not exceeding the sum insured in respect of any one casualty. The customary deductions are for depreciation, *i.e.,* since new material is substituted for old when repairs are effected, but in the case of steamships it is generally expressly agreed that no deductions shall be made. In the case of freight, the measure of indemnity is such proportion of the sum fixed by the policy, in the case of a valued policy, or the insurable value in the case of an unvalued policy, as the proportion of the freight lost by the assured bears to the whole freight at the risk of the assured under the policy.

In the case of partial loss of goods, the measure of indemnity, in the case of a valued policy, is such proportion of the sum fixed by the policy as the insurable value of the part lost bears to the insurable value of the whole, ascertained as in the case of an unvalued policy. In the case of an unvalued policy, the measure of indemnity for partial loss is ascertained as in the case of total loss, *i.e.,* the insurable value of the subject matter insured. In the case of goods arriving damaged by a peril insured against, the measure of indemnity is such proportion of the sum fixed by the policy in the case of a valued policy, or of the insurable value in the case of an unvalued policy, as the difference between the gross sound and damaged values at the place of arrival, bears to the gross sound value. In the case of general average and salvage charges, the measure of indemnity (subject to the provisions of the policy) is the full amount of the contribution, if the subject matter liable for contribution is insured for its full contributory value, but if it is not so insured, or if only part be insured, the indemnity payable by the insurer must be reduced in proportion to the under-insurance, and where there has been a particular average loss which constitutes a deduction from the contributory value and for which the insurer is liable, the amount must be deducted from the insured value in order to ascertain what the insurer is liable to contribute. Where the assured has effected an insurance in express terms against any liability to a third party the measure of indemnity, subject to any express provision in the policy, is the amount paid or payable by him to such third party in respect of such liability. An instance of this is insurance against collision liability, where it is customary for the insurer to cover only three-fourths of the risk, leaving one-fourth to be borne by the assured. The practice has arisen, however, of covering the assured's one-fourth mutually in associations of shipowners formed for that purpose.

In cases not specifically provided for in the Act, the principle enunciated in the provisions of the Act is to be applied.

Warranties.—In marine insurance a "warranty" is some particular thing that the assured undertakes shall, or shall not be done—an undertaking that some condition shall be fulfilled; or the affirmation or negation of the existence of a particular state of fact. Warranties must be complied with exactly, whether they be material to the risk or not; or the insurer is discharged from liability as from the date of the breach of warranty.

Examples of warranties are where the assured warrants that a vessel is in good safety on a certain date; where he warrants that a vessel shall not proceed on certain voyages; or where he warrants that he is uninsured for a specified proportion of the amount at risk.

These are "express warranties," and must be included in, or written upon, the policy, or must be contained in some document incorporated by reference into the policy.

There are also "implied warranties" as, for instance, that the vessel shall be seaworthy at the commencement of the voyage, but there is no implied warranty of seaworthiness in a policy for a period of time; nor, in the case of goods, that the goods are seaworthy. Breach of warranty is excused, under the Marine Insurance Act, when, by change of circumstance, the warranty ceases to be applicable to the circumstances of the contract, or where compliance with the warranty is rendered unlawful by any subsequent law. A breach of warranty may be waived by the insurer; and in practice it is customary, in the case of some warranties, to make provision in the policy to the effect that in the event of breach, the risk is "held covered" either at a specific premium, or at a premium "to be arranged." According to the Act, when an additional premium is to be arranged in a given event, but no arrangement is made, then a reasonable additional premium is payable.

Where a warranty is broken, the assured cannot avail himself of the defence that the breach has been remedied, and the warranty complied with, before loss.

Double Insurance.—Where two or more policies are effected by or on behalf of the assured on the same adventure and interest, or any part thereof, and the sums insured exceed the indemnity allowed by the Marine Insurance Act, the assured is said to be over-insured by double insurance. In such circumstances he may according to the Act, claim payment from the insurers in such order as he may think fit, unless the policy otherwise provides, but he is not entitled to receive any sum in excess of the indemnity allowed by the Act. Where, however, the policy is a valued policy, the assured must give credit as against the valuation for any sum received by him under any other policy without regard to the actual value of the subject matter insured. Where the policy is unvalued, he must give credit, as against the full insurable value, for any sum received by him under any other policy, and where the assured receives a sum in excess of the indemnity allowed by the Act, he is deemed to hold such sum in trust for the insurers, according to their right of contribution amongst themselves.

The insurers, on their part, are bound, by the Act, to contribute rateably to the loss in proportion to the amount for which they are liable under their contracts, and if any insurer pays more than his proportion of a loss, he is entitled to maintain an action for contribution against the other insurers. Where the assured has over-insured under an unvalued policy, a proportionate part of the premium is returnable, but if the policies have been effected at different times, and the earlier policy has, at any time, borne the entire risk, or if a claim has been paid on the policy in respect of the full sum insured, no premium is returnable in respect of that policy; nor is any premium returnable when a double insurance is effected knowingly by the assured.

Subrogation.—Where there is a loss either partial or total, the insurer becomes entitled to the advantage of every right of the assured in respect of the subject matter of the loss. A good example of this is where there has been a total wreck, and the underwriter has paid a total loss, since he then becomes entitled to the proceeds of the sale of the wreck. On broad lines, the assured must account to the insurer for any diminution of the loss. A very general application of this right of subrogation is where the insurer pays a loss and then proceeds against a third party to recover; for his own benefit, but in the name of the assured; in respect of a liability that third party may have incurred.

Re-Insurance.—Re-insurance is the indemnification of one insurer by another in respect of liabilities that the former has incurred in the course of business, and the Marine Insurance Act of 1906 gives the re-insured an insurable interest in his risks, but stipulates that unless the policy provides, the original assured has no right or interest in respect of such re-insurance. Re-insurance may be either facultative, which is the re-insurance of specified individual risks, or by treaty. A treaty of re-insurance is an agreement by one insurer to accept a stated proportion of the whole, or any specified part of, the business accepted by another, it being customary to place limits as to the maximum amount that may be given off under the treaty. In connection with these treaties an anomalous situation has arisen concerning their validity under British law, for while they are undoubtedly contracts of marine insurance, the fact that they cover no specified amount makes it impossible to pay duty on them in accordance with the provisions of the Stamp Act so that it would seem that they are unenforceable in law. The leading legal decision on this point is that of the House of Lords *In re National Benefit Assurance Co., Ltd.* (31 *Ll. L. Rep.* 321). In practice, however, legal difficulties are not likely often to arise, since most treaties provide that stamped policies shall be issued in respect of the risks accepted under the contract, and in the event of dispute arising, legal action can be taken on these policies.

Institutions.—In marine insurance, the institutions which exist for the purpose of furthering and protecting the interests of underwriters play a very prominent part. In Great Britain the oldest of these institutions is the Liverpool Underwriters Association, founded in 1802, but the leading body is the Institute of London Underwriters, founded in 1884, and composed of the majority of the companies transacting marine business in London, including the London branches of companies in Liverpool and other provincial cities. This body formulates and issues the clauses to which reference has already been made, and a special feature of its work in this connection is the drafting of special sets of clauses for the insurance of trades. These clauses are drafted after consultation with the Trade Associations interested in the commodities to be insured, and are therefore acceptable to both parties to the contract of insurance. Examples of these clauses are the "London Jute Associations Clauses" and the "London Corn Trade Associations Clauses." The institute has established various sub-committees, of which the most important is the "Technical and Clauses Committee," the title of which explains its functions, and which keeps in close touch with various trade associations with a view to maintaining clauses in accordance with the requirements of the trades those associations represent. An important committee which sits under the auspices of the institute, is the "Joint Hull Committee," on which Lloyd's Underwriters and the Liverpool market are represented, and which deals with such matters as the framing of agreements with regard to hull rates and values, the drafting of "warranties," governing voyages and seasons, and similar matters.

Lloyd's Underwriters Association is another important market institution, to which practically all the active underwriting members of Lloyd's belong, and which works in close collaboration with the Institute of London Underwriters on matters of principle, and sometimes on matters of practice. Lloyd's Brokers Association is a body representative of the brokerage side of the business at Lloyd's while the Corporation of Insurance Brokers represents brokers in all parts of Great Britain. The Chartered Insurance Institute, largely educational in function, holds examinations in marine insurance, and there are local institutes in connection with the Chartered Institute.

Market Institutions in Other Countries.—Elsewhere there are, in most markets, local or national institutions concerned with the regulation and government of business, such as the Central Underwriters Association of Norway, the Association for the Improvement of Marine Insurance in Holland, the "Verband" or Union of Underwriters in Germany, and the "Union des Syndicats" in Paris. These are similar, in many respects to the Institute of London Underwriters, and are in constant communication with that body and each other. There is also the "International Marine Insurance Union" with headquarters in Berlin, in which the majority of national markets are represented by the leading companies. This institution holds an annual conference at which matters of common interest are discussed, and has been the means of promoting a number of international agreements, the principal of which is the "dangerous drugs" agreement, by which underwriters are pledged to incorporate in all policies on drugs a clause making it imperative that all claims shall be accompanied by a certificate from the government of the country of origin authorizing the shipment in respect of which the claim is made. This agreement made in the first place at the instance of the British Foreign Office, has proved effective in checking the trade in opium, cocaine, and other drugs scheduled in the International Opium Convention.

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UNITED STATES

Marine insurance business in America as in Great Britain, is transacted for the most part through the medium of brokers. Sailing vessels are generally insured for each voyage, and steamers are insured for periods of time, generally 12 months. The risks against which the hulls of ships are insured are about the same in the United States as in Great Britain. Goods and merchandise are insured against various risks and on various terms and conditions dependent on the nature of goods, voyage, trade customs, etc.

The various States all have their insurance laws for the licensing and regulation of the companies and the activities of agents and brokers, and all the States also have a so-called insurance department as a branch of the State Administration. Until recently, there has been no uniformity in the laws of the various States dealing with marine insurance. There has been some effort to bring about uniformity and the District of Columbia, New York, Pennsylvania and New Jersey passed laws bringing about uniformity as to regulation and taxation. There is no Federal act similar to the Marine Insurance Act of 1906 which codified the laws of England, and most of the States have no such code.

The law and practice governing the contract, and regarding insurable interest, insurable value, disclosure and representation, measure of indemnity, warranties, double insurance and reinsurance are substantially the same as in Great Britain. There are some variations and amongst them is the rule of law as to what constitutes a constructive total loss and the extent of the insurers' liability in the case of general average and salvage charges where the contributory value of the interest is in excess of the insured value. As regards an implied warranty of seaworthiness in a policy for a period of time the law of the United States is not as broad and as favourable to the assured as the English act. In the United States many, if not most, double insurance policies provide how losses and premiums shall be dealt with in such cases. The most common clause provides that resort shall first be had to the policy of earlier date for collection of a loss or a claim, and that only the excess of the whole loss or claim over the amount recoverable under the policy of earlier date shall be recovered under the policy of later date, and that the premium attaching to the excess of the amount insured over the insurable interest in the policy of later date shall be refunded.

Regarding subrogation, in the United States, on payment of a loss the insurers acquire the rights of the owners in respect of and to the extent of the amount paid.

The American Institute of Marine Underwriters suggests policy forms and acts on behalf of underwriters in matters affecting the general welfare of the business but does not deal with rates. Practically all the American and various foreign companies admitted to do business in the United States are members of this organization. The United States Salvage Association participated in by most American companies supplies services for the survey and inspection of hulls. The American Marine Insurance Syndicate composed of most American and a large percentage of the foreign admitted companies, issues joint policies on the hull, disbursements, and earnings of steamers. It has become the chief market for the insurance of these risks on American steamers.

The Board of Underwriters of New York, formed in 1820, is composed of the principal American and foreign admitted companies. Its principal functions are the reporting of casualties, handling of losses, surveying of cargo, handling of proceeds, stowage of cargo, inspection of the loading and discharging of vessels, arbitrations, salvage awards, examination of adjustments, reports on maritime inventions and the appointment of commissioners of pilots. (W. N. D.)

See S. B. Ackerman, *Insurance* (1939).

MARINES may be defined as sea-soldiers, that is, soldiers trained for fighting at sea as well as on land. They have been employed from the earliest times. The Greeks and Romans used soldiers specially armed and trained for service in their fleets, called Epibatai and Classiarii respectively. In mediaeval times soldiers were embarked in the ships of war, and in the Tudor navy each ship had its complement of soldiers as well as sailors.

Great Britain.—The marine was not included in the complements of ships until the Admiralty obtained an order in Council, dated Oct. 26, 1664, instituting the "Duke of York and Albany's Regiment of Foot," a regiment of 1,200 "Land souldgers prepared for sea service." It was principally recruited in the City of London, probably from the trained bands, and hence the privilege shared by the marines of marching through the City with colours flying, drums beating and bayonets fixed. This regiment, after service in the Dutch war, was disbanded in 1689. Two other regiments were raised in 1690 and disbanded in 1699.

In June 1702, six marine regiments were raised and six line regiments were detailed for sea service; these regiments captured Gibraltar in 1704, and held it during the subsequent siege from Oct. 1704 to April 1705, for which service the corps still bears the name *Gibraltar* on its appointments. Most of these regiments were transferred to the army in 1713. In 1739 marines were again required in the fleet, and ten regiments in all were formed; also three regiments in New York by the provincial authorities for service at Carthagena; all were disbanded at the peace in 1749.

On April 5, 1755, the Admiralty established the corps on its present basis; organization in regiments having proved unsatisfactory, 60 companies were raised and divided into three divisional headquarters, one each at Chatham, Portsmouth and Plymouth, from which officers and men were, and still are, drafted as required for service afloat or elsewhere. These headquarters are their homes to which they remain attached throughout their service, active or reserve. The Royal Marines are a trained body of soldiers maintained by the Admiralty for service at sea or with the fleet; their charges are borne on the naval estimates. Parliament in the Army Annual Act gives the authority for a force of marines, the numbers being fixed by Order in Council; when ashore, since 1879, they have been subject for discipline to the Army Act; prior to this they had their own Annual Mutiny Act and Articles of War. When afloat they are subject to the disciplinary provisions of the Naval Discipline Act, but in both cases their conditions of service, enlistment and discharge are still governed by the unrepealed portions of their own Acts 11 and 12 Vict. c 63.

The marines were an infantry corps until 1804 when, owing to difficulties with the Royal Artillery manning the bomb vessels, Lord Nelson suggested that the marines should perform the duty; accordingly a company of artillery was formed at each headquarters from picked officers and men, who were then trained and paid as artillery. In 1919 the pay of both branches was assimilated to that of the Royal navy. In 1805 a 4th Division with another artillery company was formed at Woolwich. Before the institution of the naval gunnery school, known as H.M.S. "Excellent," the artillery companies were the only body of seamen or marines who were systematically trained in gunnery. In 1832, however, the artillery companies were ordered to be disbanded, but two were retained. In 1855 the infantry branch became a corps of light infantry and adopted the badge of the Bugle, the R.M.A. Companies wearing the Grenade. In 1862 the artillery companies, which had increased to 17, under a colonel, quartered in Ft. Cumberland but attached to the Portsmouth Division (then stationed at Gosport), were formed into a separate corps as the Royal Marine Artillery, and the officers, who had hitherto been interchangeable, were placed on a separate list. In 1867 the barracks at Eastney were built for them. In 1869 the Woolwich division was abolished, and a depot was established at Deal to train all recruits. In 1904 the naval Band Service was transferred to the Royal Marines, and bandsmen for the navy are now recruited as marines and trained at the R.N. School of Music at Eastney.

In the World War of 1914–18 the corps was largely expanded, and though many auxiliary units had to be raised, the organization worked efficiently and met all demands as they arose. Besides the artillery and infantry units afloat and ashore, the corps provided 2,000 men to man the guns of the defensively armed merchantmen and raised the following units for Admiralty work:—submarine miners, labour corps for discharge of the supply ships in France, engineers and the auxiliary units for the R.N. Division. The R.M. units on shore included the howitzer and anti-aircraft brigades, and the siege guns R.M.A. on the Western Front; the R.M.L.I. brigades in Antwerp, Gallipoli and France; heavy batteries in East Africa; the landing force (4th Bn) at Zeebrugge; garrisons of coast defences and naval bases; and numerous ship landing parties. At the armistice the strengths, including reserves, were:—R.M.A. 9,412, R.M.L.I. 30,140, R.M. Band 1,633. The numbers were gradually reduced until, in 1923, the strength was only 9,000, consequent on which, coupled with the Treasury demands for economy, one division was ordered to be reduced, with the result that the R.M.A. & R.M.L.I. were once more amalgamated into one corps with the title of the Royal Marines; the distinctive badges of the grenade and bugle being replaced by the older badge of the Lion and Crown. Enlistment into the corps is for 12 years with the colours with permission to re-engage for another nine years to earn a pension. There are also two classes of reserve, (i) men who have completed 12 years with the colours, (ii) pensioners.

Training.—The Royal Marine is now a fully trained infantry soldier; he is likewise a naval gunner, similar to the Bluejacket. Selected men qualify as naval gunlayers and gunnery instructors, land artillery specialists, machine gunners, signallers, etc. Recruits are trained in infantry drill and musketry at Deal and are then transferred to one of the headquarters to complete their training; headquarters also carry out the training of all the specialists. Officers are entered by direct competition; they are trained with the corps and at the various naval schools of instruction; they also attend the army instructional schools and pass the army examinations for promotion.

Badges.—The badge of the corps is the "Globe" (granted by King George IV in 1827 in place of inscribing the battle honours—which were too numerous—on the colours) surrounded by the laurel wreath (awarded for services at Belleisle, 1761) with the name *Gibraltar* and the motto *Per Mare Per Terram.* The original badge of the "Foul Anchor" is also worn with the Royal Crest of the Lion and Crown. The corps was granted the title of "Royal" in 1802 for services in the French wars.

(H. E. Bl.)

Bibliography.—Gillespie, *History of the Marine Corps (to 1803)*; Nicolas, *History of the Royal Marine Forces (to 1845)*; Edye, *History of the R.M. Forces 1664–1701;* Col. C. Field, *Britain's Sea Soldiers to 1912,* 2 vols.; Gen. Sir H. E. Blumberg, *Britain's Sea Soldiers, 1914–1919. Note*—For an account of the Marine forces of France and Germany *see* under the respective countries.

United States Marine Corps.—Founded in 1775, and observing its official birthday on Nov. 10, the Marine Corps, instead of following the model of the British marines, was developed to provide the navy with a trained land-fighting force, capable of combat missions ashore that frequently are vital to the execution of sea power. As an offensive weapon, the Marine Corps was used successfully in every war beginning with the Revolution, when it consisted of two battalions, and reached a high state of perfection in World War II as a large army with its own artillery, tanks and air force. Marines have other functions, the duties in which the service was conceived originally by the British. They man the secondary batteries aboard battleships, aircraft carriers, heavy cruisers, and some light cruisers; they protect American bases outside the continental United States, and American embassies throughout the world; they guard naval property within the country, and they have been called upon for police duty in peacetime. From its inception the Marine Corps operated as an entity with its own commanding officer and a complete administrative organization. Originally it was headed by a major; in 1944, by a lieutenant general—the difference in rank affording some idea of the growth of the corps. It is under the direction of the secretary of the navy, and its duty under the nation's naval policy is to support the fleet or any part of it in the accomplishment of its mission.

Amphibious operations were the forte of the Marine Corps beginning as early as 1776, when marines spear-headed the seizure of New Providence, in the Bahamas, by Commodore Hopkins's Continental fleet. From then on its history was studded with exploits which provided a heritage of valour in which the corps take inordinate pride. The Marine Corps hymn, with its famous opening lines, "From the halls of Montezuma to the shores of Tripoli," epitomizes the far-flung services the marines have given the United States. Loyalty to tradition and pride of accomplishment are inculcated into the men of the corps until they are rounded into perhaps the deadliest fighting men in the world. Their motto is *Semper Fidelis.* Their emblem, worn as an insignia and emblazoned on their standards, is the western hemisphere superimposed upon a foul anchor and surmounted by an eagle with wings spread.

The corps expanded and contracted as national or international conditions warranted. After the Revolution it was disbanded for 15 years, but after 1798 it had a continuous existence, although in peaceful periods it had been skeletonized. Beginning with the Spanish American War it had almost a continuous growth. In 1898 it numbered 75 officers and 2,000 enlisted men. In 1917 it had 511 officers and 13,124 men. During the nation's participation in World War I the corps grew steadily, and a total of 31,824 marines was sent to France as part of the American Expeditionary Force. Two regiments, comprising the 4th Brigade of marines, formed a part of the 2nd Division, and served with conspicuous gallantry and success in Belleau Wood and the Argonne. In the period following World War I, the corps again contracted, but not to a serious degree, for it had many peacetime pursuits in the ensuing quarter century. When the United States began to re-arm seriously in 1940, the corps totalled about 30,000 officers and men.

When Japan launched her attack on Pearl Harbor, Dec. 7, 1941, marines were trapped on a number of island outposts, in the Philippines and in China. The heroic marine defenders of Wake Island wrote another page in the corps' tradition. Immediately after the declaration of war against Japan and the axis powers, expansion of the corps began. When the offensive phase of the Pacific warfare began in earnest in Aug. 1942, marines launched the attack which took Guadalcanal and Tulagi, in the Solomons. During 1942 and 1943 four full divisions of marines, the First to Fourth inclusive, were identified as in action from the Solomons, on the south, to the Marshalls, on the north. In 1944, the Marine Corps totalled 403,000 officers and men. (W. B. Ck.)

Bibliography.—E. N. McClellan, *History of the Marine Corps,* manuscript (USMC, Washington); J. H. Craige, *The Marines Have Landed,* in "Sea Power," November 1943; Division of Public Relations, USMC, historical material.

MARINETTE, a city in northeastern Wisconsin, U.S.A., on the Green Bay waters of Lake Michigan, a port of entry, and the county seat of Marinette county. It is on the "Gulf to Lakes route," federal highway 41, and is served by the Chicago and North Western and the Chicago, Milwaukee, St. Paul and Pacific railways and by the Ann Arbor Railway car ferry across Lake Michigan. The 1940 census recorded the population at 14,183. Marinette with its sister city, Menominee, Mich., handled huge quantities of white pine during the 1890s and early 1900s. The Menominee river, interstate boundary between Wisconsin and Michigan, once famous for huge logging drives, is known for its abundance of silver smelt. An annual carnival celebrates the smelt season. Since the decline of lumbering industries in this section, diversified industry has been developed, and Marinette has become a trading centre for some 80,000 people. Marinette was settled by the French about 1830 and was named for Queen Marinette of the Menominee Indians, a white woman who became a noted fur-trader and was regarded by the Indians as a superior being. The city was incorporated in 1887.

MARINETTI, FILIPPO TOMMASO (1876–1944), Italian writer, born at Alexandria on Dec. 22, 1876, studied in Paris, graduating at the Sorbonne; in 1899 he also graduated in law at the University of Genoa. He was the founder of the futurist movement, publishing the original futurist manifesto in the Paris *Figaro* on Feb. 20, 1909. For a time he edited the international review *Poesia,* but his most characteristic work was *Mafarka le futuriste,* published in French in 1910. He also wrote for the stage *Le roi Bombance* (1905), a satirical tragedy, and other plays, and published a volume on the futurist theatre, *Teatro sintetico futuristo* (1916). In 1914 he wrote an extraordinary volume entitled *Zang-tumb-tumb* on the Balkan war, and particularly on the siege of Adrianople. On the outbreak of World War I he advocated Italian intervention in his *Guerra sola igiene del mondo* (1915). *Otto anime in una bomba* (1919) deals with war experiences, while in *Futurismo e fascismo* (1924) he expresses his support of the fascist movement. He was admitted to the Italian Academy in 1929, and was a member of the National Council of Corporations. Marinetti died Dec. 2, 1944.

MARINI or **MARINO, GIOVANNI BATTISTA** (1569–1625), Italian poet, born at Naples Oct. 18, 1569. After a riotous youth, during which he became known for his *Canzone de' baci,* he secured the powerful patronage of Cardinal Aldobrandini, whom he accompanied from Rome to Ravenna and Turin. An edition of his poems, *La Lira,* was published at Venice in 1602–14. His ungoverned pen and disordered life compelled him to leave Turin and take refuge from 1615 to 1622 in Paris, where he was favourably recognized by Marie de' Medici. There his long poem *Adone* was published in 1623. *Adone* contains over 40,000 lines; the story of Venus and Adonis is overlaid with all kinds of digressions, mythological, descriptive, etc. Its smooth and polished verse and its fanciful style found many imitators. He died at Naples on March 25, 1625. The licence, extravagances and conceits of Marini, the chief of the school of "Seicentisti" (*see* ITALIAN LITERATURE), marked the close of a great era, and the beginning of a period of decadence. "Marinism" was in Italy what "Gongorism" was in Spain. It was part of a general movement in favour of an artificial and ornamented style which was evident throughout western Europe.

Marini also wrote a religious epic, *La strage degli innocenti* (1633) and other works, of which a selection was edited by Zirardini (1862). A new edition of his letters, *Epistolario,* appeared in 1924. *See* A. Gustarelli, *La vita et l'opera di G. Marino* (Leghorn, 1918).

MARINKOVIĆ, DR. VOIESLAV (1876–1935), Yugoslav statesman, was born in Belgrade on May 1, 1876. He was educated in Belgrade and Paris, and in 1901 entered the ministry of finance in Belgrade. In 1906 he entered the Skupština; in 1913 represented Serbia on the Finance conference in Paris charged with liquidating the financial side of the Balkan Wars; in 1916 he was Serb Delegate to the Inter-Allied conference in Paris. He was a Progressive member of the coalition cabinet 1914–7, when he resigned office, and took part in drafting the Corfu Declaration. In Nov. 1918 he rejoined the cabinet. In 1919, with Davidović (*q.v.*) and others, he formed the Democratic Union (afterwards Party). From Dec. 1921–June 1922 he was minister of the interior, and carried through the reorganization of the Electoral Law. In the Davidović Cabinet (1925) he became minister of foreign affairs, and resumed that office after Dr. Ninčić had resigned in Dec. 1926. In his policy Marinković leant definitely more towards France than his predecessor. From April to July 1932 he was prime minister and foreign minister.

MARINO, town, Italy, province of Rome, 15 mi. southeast of Rome by rail, and also accessible by electric tramway. Pop (1936) 8,062 (town); 13,248 (commune). It is on a spur of the Alban Hills, 1,165 ft. above sea level, and occupies the site of the ancient Castrimoenium, a *municipium* of no great importance, though the surrounding district, which now produces much wine, is full of remains of ancient villas. In the early 13th century it belonged to the Frangipani, but passed to the Orsini in 1266. In 1379 a battle took place here between the partisans of Urban VI. and those of the anti-pope Clement VII. of Geneva (the Orsini having taken the side of the latter), who were, however, defeated; and in 1399 Marino was apparently under the Papacy. In 1419 it passed to the Colonna family, to whom it still belongs.

See T. Ashby, in *Papers of the British School at Rome,* vols. iv., v.; F. Tomassetti, *Campagna Romana* iv. (1926) 173 *seq.*

MARINUS, the name of two popes. MARINUS I., sometimes called Martin II., pope from 882 to 884, was the son of a Tuscan priest, and entered the church at an early age, becoming a deacon about 862. Three successive popes sent him as legate to Constantinople, and he also negotiated on behalf of pope John VIII. with the emperor Charles the Fat. About the end of December 882 he succeeded John VIII. as pope. Having secured his position, Marinus restored Formosus, cardinal-bishop of Porto, and anathematized Photius. This pope was on friendly terms with the English king, Alfred the Great. He died in May 884, and was succeeded by Adrian III.

MARINUS II., sometimes called Martin III., pope from 942 to 946, was merely the puppet of Alberic (d. 954), prince and senator of the Romans. He died in May 946, and was succeeded by Agapetus II.

MARINUS, neo-Platonist philosopher, was born in Palestine and was early converted to the old Greek religion. He succeeded to the headship of the neo-Platonic school at Athens on the death of Proclus. But he was compelled to seek refuge at Epidaurus from persecution by the Christians. His chief work was a biography of Proclus, first published with the works of Marcus Antoninus in 1559; separately by Fabricius at Hamburg in 1700, and re-edited in 1814 by Boissonade with emendations and notes.

MARINUS OF TYRE, geographer and mathematician, the founder of mathematical geography, flourished in the 2nd century A.D. He lived before Ptolemy, who acknowledges his great obligations to him. His chief merits were that he assigned to each place its proper latitude and longitude, and introduced improvements in the construction of his maps.

See E. H. Berger, *Geschichte der wissenschaftlichen Erdkunde der Griechen* (1903).

MARIO, GIUSEPPE, COUNT OF CANDIA (1810–1883), Italian singer, the most famous tenor of the 19th century, son of General di Candia, was born at Cagliari in 1810. While serving as an officer in the Sardinian army he was imprisoned at Cagliari for some trifling offence. On his release he fled to Paris. There his success as an amateur vocalist produced an offer of an engagement at the Opera. He studied singing for two years under M. Ponchard and Signor Bordogni, and made his début in 1838 in Meyerbeer's *Robert le Diable.* In 1839 he joined the company of the Théâtre Italien, which then included Malibran, Sontag, Persiani and Grisi, Rubini, Tamburini and Lablache. In a short time he won a European reputation in Italian opera. Mario had a handsome face and a graceful figure, and his voice, though less powerful than that of Rubini or that of Tamberlik, had a softness and richness which have never been equalled. He was an ideal stage lover, and he retained the grace and charm of youth long after his voice had begun to show signs of decay. He created very few new parts, that of Ernesto in *Don Pasquale* (1843) being perhaps the only one deserving of mention. Among his best parts were Otello in Rossini's opera of that name, Gennaro in *Lucrezia Borgia,* Almaviva in *Il Barbiere di Siviglia,* Fernando in *La Favorita,* and Manrico in *Il Trovatore.* In 1856 he married Giulia Grisi, the famous soprano, by whom he had five daughters. Mario bade farewell to the stage in 1871. He died at Rome in reduced circumstances on Dec. 11, 1883.

MARION, FRANCIS (1732–1795), American soldier, was born in 1732, at Winyah, near Georgetown, S.C., of Huguenot ancestry. In 1761 he served in a campaign against the Cherokees. In 1775 he was a member of the South Carolina Provincial Congress. Commissioned a captain, he took an active part in the defence of Ft. Moultrie in Charleston harbour (1776), and in the unsuccessful siege of Savannah (1779). In 1780 the British captured Charleston and overran the State. Made a brigadier-general by Governor Rutledge, Marion showed his genius in organizing a band of guerrilla volunteers; he gained recruits and trained them to be fearless riders and good marksmen, and "Marion's Brigade" became known far and wide for its successful exploits against the British. His sudden attacks often resulted in the capture of superior numbers and intimidated the Tories. Col. Tarleton was sent to capture him, but soon despaired of finding "the old swamp fox," who eluded him by following swamp paths. His men united with Gen. Greene's forces for important engagements at Georgetown, Ft. Watson, Ft. Motte and Eutaw Springs. For a skilful rescue of Col. Harden's men, hemmed in by a superior British force which he defeated at Parker's Ferry, he received the thanks of Congress. In 1782, his brigade deteriorated during his absence; and there was a conspiracy to hand him over to the British. From 1782 to 1790, Marion served in the State senate where he opposed harsh treatment of the Tories. He was made commander of Ft. Johnson with a salary of £500 per annum, in recognition of his services. He died on his estate in Berkeley county on Feb. 27, 1795. As a soldier he was quick, resourceful and calm, a great partisan leader.

See W. D. James, *Life of Francis Marion* (1821); M. L. Wiems, *Life of Francis Marion* (1833); W. G. Simms, *Life of Francis Marion* (1844); E. McCrady, *History of South Carolina in the Revolution* (1901–02).

MARION, a city of southern Illinois, U.S.A., 100 mi. S.E. of Saint Louis; the county seat of Williamson county. It is served by the Chicago and Eastern Illinois, the Illinois Central and the Missouri Pacific railways. Pop. (1920) 9,582 (93% native white); and 9,251 in 1940 by the federal census. It is the commercial centre of a rich agricultural and coal-mining region, and has various manufacturing industries. The city was founded about 1842 and incorporated in 1896.

MARION, a city of Indiana, U.S.A., 60 mi. N.E. of Indianapolis, on the Mississinewa river; the county seat of Grant county. It is served by the Big Four, the Chesapeake and Ohio, the Nickel Plate, the Pennsylvania and electric railways, and by motorbus and truck lines. The population was 23,747 in 1920; 26,767 in 1940. It is the trade centre for a fertile farming region, and has important manufactures (including glass, radios, electric stoves and lanterns, wire and cables, shoes, food and dairy products, malleable iron, paper and flour) with an estimated output in 1940 valued at $32,616,438. Marion college (established 1889) is an institution of the Wesleyan Methodist church. At Upland (12 mi S.E.) is Taylor university (1846). Marion is the seat of a United States Veterans bureau hospital (accommodating 1,750 psychiatric cases). The city was chartered in 1889 and is named after Gen. Francis Marion. It was a "station" on the underground railroad (the name given to the secret chain of passages by which slaves were passed along into Canada or other free territory).

MARION, a city of Ohio, U.S.A., 44 mi. N. by W. of Columbus; the county seat of Marion county. It is on federal highways 23 and 30, and is served by the New York Central, the Erie, the Chesapeake and Ohio and Pennsylvania railways. Population in 1940 was 30,817. It is the trade centre of a rich farming district. There are many limestone quarries in the county. The principal products manufactured include power shovels, dredges, road rollers, tractors, castings, refrigerator units, soybean products, flour and conveying equipment. Large railroad shops and yards are located there. Marion was the home of former President Warren Gamaliel Harding from 1884 until his death in 1923. It was the scene of his "front-porch campaign" in 1920, and there he is buried. The city was laid out in 1821 and chartered in 1890.

MARIONETTES and **PUPPETS,** jointed figures which, by various devices, are made to move in mimicry of persons or animals—usually for dramatic performances. The closely related shadows are flat cutout figures which are exhibited in silhouette against a lighted screen.

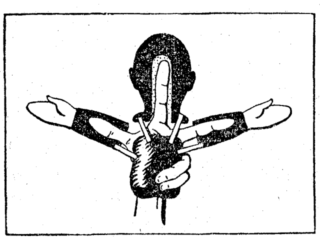


FIG. 1


FIG. 2

The following are commonly accepted methods of producing simple types of hand puppets, rod puppets, string puppets (marionettes), and shadow figures.

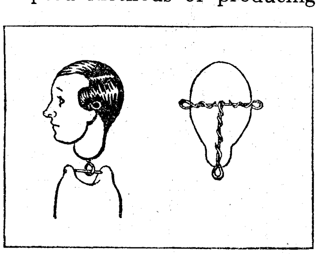


FIG. 3

Hand Puppets can be of wood, plaster, plastic wood, papier-mâché or stuffed cloth. Head and neck are in one piece with a hole running up the neck for the first finger of the operator (fig. 1). The arms consist of cylindrical cuffs (cardboard strengthened with cloth) which are glued or tacked to wooden hands. The operator's second finger and thumb fit, each, into a cuff. A small stuffed bag is suspended by tapes from a ledge at the base of the neck. Grasping this bag in the palm with the two last fingers gives a firmer control. The cuffs also are attached to the bag with tapes. This framework of the hand puppet is then concealed—the head by a mask and wig (unless the face and hair are already carved and painted on), the rest by clothing firmly attached to the ledge at the base of the neck (fig. 2). If desired, legs and feet can be attached.

To operate, put the doll on the hand like a glove, always keeping the forearm upright so that the puppet will stand straight. Arm and head movements are made with the fingers. The stage has no floor; a curtain or a three-sided screen with an opening for the proscenium arch is required. The little roll or draw curtain is suspended from a frame-work or from wooden strips across the top of the screen. Painted or dyed scenery behind the dolls is similarly suspended. Puppets must be held high so that the operator's head is invisible. A ledge along the base of the proscenium arch offers a place on which to rest "properties." The stage lighting (floods or strips) should shine upon the puppets' faces, as well as upon the scenery. Humorous, lively plays are best for this grotesque, intimate type of puppet-show.

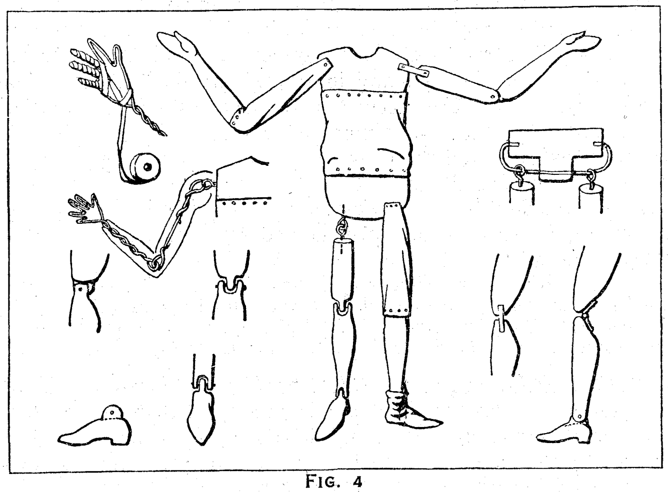


FIG. 4

String Puppets (Marionettes) are made of the same materials as hand puppets. If the head is of plaster or stuffed cloth put a wire from ear to ear with a loop at either end, and another wire, twisted on to this, running down through the neck with a loop at the end (fig. 3). If the head is of wood, screw eyes at sides and at bottom of neck are used. The torso can be one piece; but separate shoulders (fig. 4), and hip pieces of wood with a centre section of loosely stuffed cloth give flexibility to the body. Limbs can be wood, loosely jointed, or a wire skeleton padded, or firmly stuffed cloth. The joints must be flexible: brass hinges, double screw eyes, leather or cloth straps or carved wooden joints. Hands can be of wood, plaster or of wire wound about with narrow tape. If the doll is of stuffed cloth the feet, lower arms and hips should be weighted with lead (fig. 5). Faces and hands should be painted, like theatrical "make-up," to carry at a distance—with either oil or water paints. When dressing the doll freedom must be allowed for movement of neck, elbow, shoulder, etc.

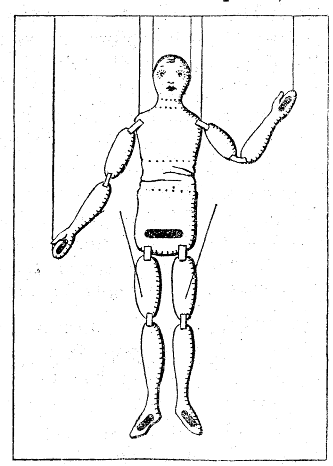
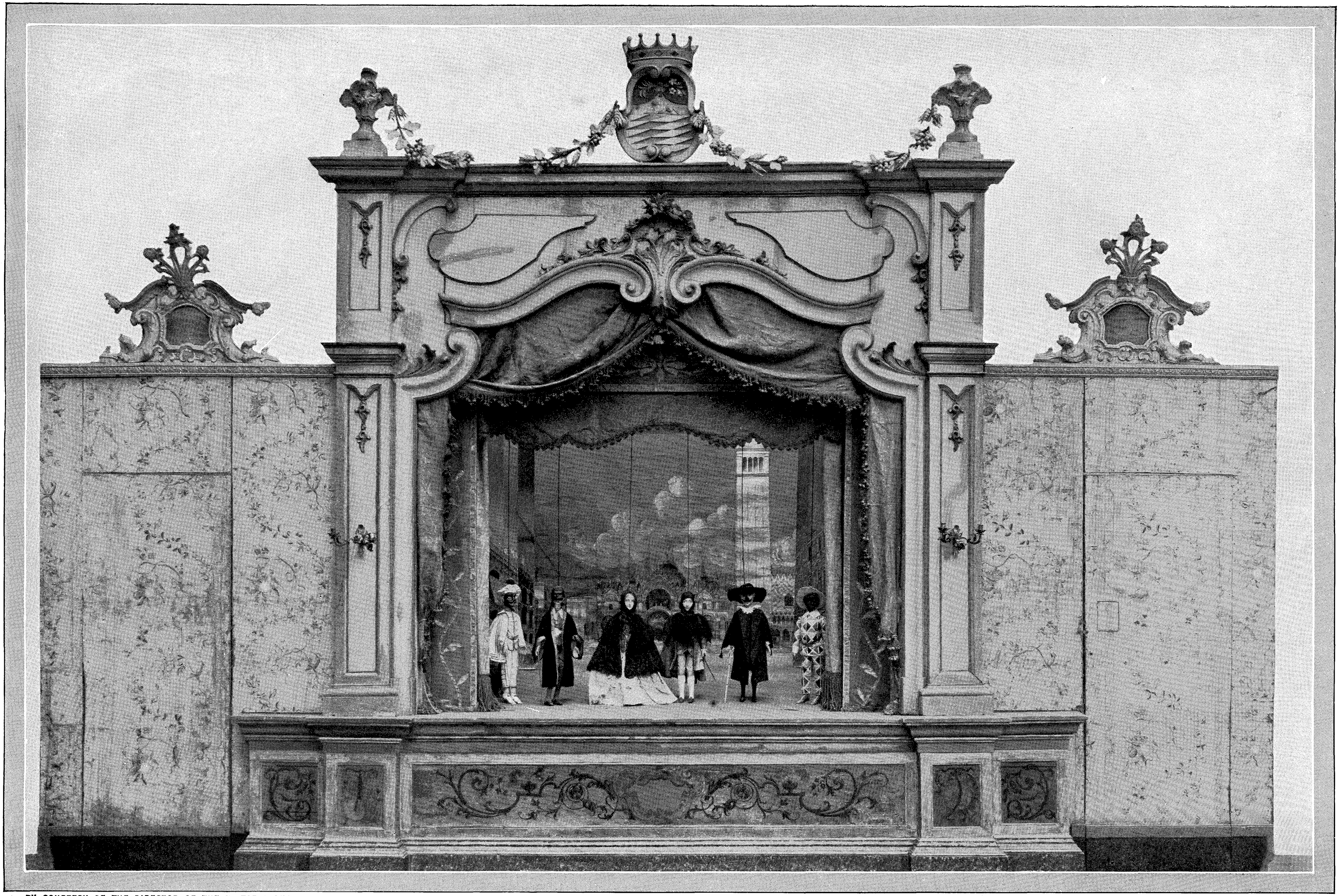


FIG. 5

The marionette is suspended by strings from a controller held in the hand of an operator above. This controller (fig. 6) can be a flat strip of wood about 10 in. long with a shorter cross-bar. A leather strip tacked to the cross-bar slips over the back of the operator's hand. The head strings are tied (from the loops at ears) to ends of cross-bar and hold the weight of the doll. The hand strings are attached to the front end of the controller. The back string from the back waist-line of doll, is attached to the rear



BY COURTESY OF THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM

AN ITALIAN MARIONETTE THEATRE

A marionette theatre of the first half of the 18th century, with a scene of Saint Mark's Square, Venice. The figures, reading from the left are: Scapir, Pantaloon, Columbine, the Captain, the Doctor of Law and Harlequin. Probably one of the stock plays of the Comédie Italienne. Artist unknown

BY COURTESY OF (1) MAURICE STERNE, (2, 3, 7) THE AMERICAN MUSEUM OF NATURAL HISTORY, (4, 5) HELEN H. JOSEPH, "BOOK OF MARIONETTES" (THE VIKING PRESS), (6) THE SMITHSONIAN INSTITUTION, (8) HENRY EICHHEIM, (9) DEPARTMENT OF FINE ARTS, BROOKLYN MUSEUM

ASIATIC PUPPETS AND SHADOW FIGURES

1. Wayang from the Island of Bali. From the collection of Maurice Sterne
2. Burmese puppets made of painted wood
3. Javanese Wayang Golek
4. Turkish shadow figure, Karagheuz
5. Sinhalese puppets
6. Siamese shadows of the King of Siam, 1876
7. Chinese shadow dolls
8. Bungaro, famous Japanese puppet manipulator
9. Japanese marionette

BY COURTESY OF (1) WILLIAM SIMMONDS, (2, 6, 8) "PUPPETRY," (3) "PUPPETRY," PHOTOGRAPH BY A. KRUEGER, (4) "THEATRE ARTS," (5) B. M. BERNAND, (7) "PUPPETRY," PHOTOGRAPH BY CHARLES HANCE, (9) REMO BUFANO, (10) WILLIAM DUNCAN AND HARRY PATTON, (11) TONY SARG

MODERN MARIONETTES

1. Dryad and two fauns in puppet pantomime of a woodland scene, by William Simmonds, London
2. Spejbl and Hurvinek, marionette characters created by Josef Skupa, Pilsen
3. Witch and Dido, marionette characters from Purcell's "Dido and Aeneas," by Harro Siegel, Berlin
4. "Death and the Maiden," by Richard Teschner, Vienna
5. Don Quixote, marionette from the Luxembourg Puppet theatre, directed by Robert Desarthis, Paris
6. Accordionist, a hand puppet from the troupe of Max Jacob, Hohnstein
7. Ice skater, a marionette of Rufus Rose, American
8. Farmer's Boy, by Waldo Lanchester, Malvern
9. Alchemist and Chinese Medicine Man, giant 12-ft. marionettes created by Remo Bufano at New York World's Fair, 1939
10. Tatterman Marionettes "She Stoops to Conquer"
11. One of Tony Sarg's marionettes

end of controller. A separate bar is generally used for the foot controller, and a hole in the centre of this bar allows it to be hung up, when not in use, upon a peg at front of main controller. The strings are attached at the knee, not foot, of the doll. Shoulder strings or extra strings for special gestures can always be added.

Practice is required for operating string puppets smoothly. To turn or bend the head, tip the controller sidewise (or pull on the shoulder strings). To seat or bow the doll, tip the controller forward or pull on the back string. To walk puppet take the foot control in free hand and tilt it from side to side, moving the figure on with main controller at desired speed.

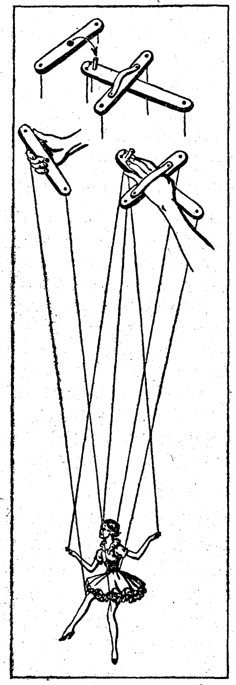


FIG. 6

A marionette stage is a miniature replica of any stage except that the wings are left open to allow passage of dolls, strings and controllers. Operators stand on a platform directly behind and higher than the puppet stage. A strong rail, waist high, in front of this "bridge" supports the weight of the operators, leaning against it. A rail at the back of the bridge is used to hang dolls upon. The bridge and the wings and the space below the puppet stage are concealed from the audience, usually by draperies. Behind these a framework forms the proscenium arch and supports the little curtain, also the front lights of the stage. Lighting and scenery must be planned not to catch the marionette's strings.

Rod Puppets are worked from below by rods (fig. 7). The head (of material similar to other puppets') can be made with a hole bored up the neck. A thin dowel fastened in this hole extends down below the feet and serves to hold and walk the puppet. The body usually consists of wooden shoulder and hip pieces attached horizontally at proper points to the upright dowel. Wire, or cloth stiffly stuffed with cotton, can be made to give a shape to the torso. Arms and legs are constructed as are the limbs for string puppets but the legs are generally allowed to hang without control. The arms are moved from below by thin rods of wood or wire attached to the palms. To articulate the neck of a rod puppet a more complicated construction is required. The head must be hollow and pivoted over the neck which is modelled (hollow) in one piece with the shoulders. A slender hollow metal tube is used instead of the upright dowel to allow strings attached at very precise points inside the head to drop down below the feet. By pulling these strings the operator can nod the figure's head. A convenient method of standing the puppet when not being held is to have two round disks about an inch apart fastened to the dowel just below the feet. Wooden strips must be built in just below the stage floor level at required places. These strips have slots cut into them at intervals into which the rod can be firmly set. Otherwise the stage, lighting, decor, etc., for rod puppets are similar to those for hand puppets. Rod puppets move slowly and gesture gracefully, hence are well suited for religious plays or dramas of fantasy.

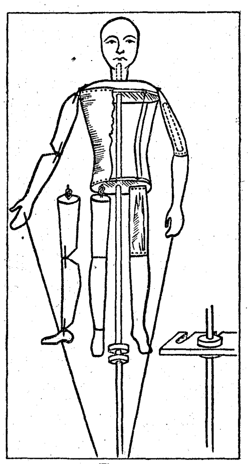


FIG. 7

Shadow Plays.—Somewhat like rod puppets, shadow plays are usually worked from below, at an opening in a screen or curtain; but this opening is covered with white cloth, drawn tight. The figures are cut in silhouette out of cardboard or tin and attached to slender staves by which they are held and moved, directly behind or in front of the cloth (fig. 8). Movable arms or jaws can be cut out separately, joined with brass clips and moved from below by wires or threads concealed behind the figure. Faces must be in profile. A light from behind throws the shadows plainly into view. Some suggestion of scenery can be painted upon the cloth or hung close against it. (*See* DOLLS; PANTOMIME; MASKS; THEATRE.)

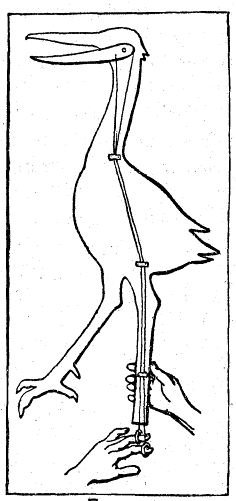


FIG. 8

BIBLIOGRAPHY.—C. Magnin, *Histoire des Marionettes en Europe;* E. Gordon Craig, all numbers of *The Marionette* (1918); Helen Haiman Joseph, *A Book of Marionettes* (1929); Paul McPharlin, ed., all volumes of *Puppetry,* international yearbook (1929); Cyril William Beaumont, *Puppets and the Puppet Stage* (1938); Remo Bufano, *Be a Puppet Showman* (1933); R. B. Inverarity, *Manual of Puppetry* (1938); Mills and Dunn, *Marionettes, Masks and Shadows* (1927). (H. H. Jo.)

MARIOTTE, EDMÉ (*c.* 1620–1684), French physicist, spent most of his life at Dijon, where he was prior of St. Martin-sous-Beaune. He was one of the first members of the Academy of Sciences founded at Paris in 1666. He died at Paris on May 12, 1684. The first volume of the *Histoire et mémoires de l'Académie* (1733) contains many original papers by him upon a great variety of physical subjects, such as the motion of fluids, the nature of colour, the notes of the trumpet, the barometer, the fall of bodies, the recoil of guns, the freezing of water, etc.

His *Essais de physique,* four in number, of which the first three were published at Paris between 1676 and 1679, are his most important works, and form, together with a *Traité de la percussion des corps,* the first volume of the *Oeuvres de Mariotte* (2 vols., Leyden, 1717). The second of these essays (*De la nature de l'air*) contains a statement of Boyle's Law, which Mariotte discovered independently; in France it is called Mariotte's Law.

MARIPOSA LILY (*Calochortus*), the name given to a genus of beautiful plants of the lily family (Liliaceae), comprising about 40 species native to western North America, some 25 of which are found in California. They are tulip-like perennials, with simple or somewhat branched stems, ½ft. to 4ft. tall, rising from coated corms and bearing a few narrow leaves and showy white, yellow, lilac or bluish flowers, often spotted or marked in the centre. The three large broad petals, 1 to 2in. long, usually bear a conspicuous basal gland. Several species are in cultivation. (*See* SEGO LILY.)

MARIPOSAN or YOKUTS, a linguistic stock of North American Indians, including some 40 small tribes. Its former territory was in southern California, around Tulare lake. The Mariposans were fishers and hunters. Their villages were a single row of wedge-shaped huts, with an awning of brush along the front.

MARIS, JACOB (1837–1899), Dutch painter, the eldest of three brothers, all of whom became artists, was born at The Hague on Aug. 25, 1837. He first studied at the Antwerp academy, and subsequently in Hébert's studio in Paris from 1865 till 1871. He worked mainly in Holland. Though he painted, especially in early life, domestic scenes and interiors, it is as a landscape painter that Maris will be famous. He was the painter of bridges and windmills, of old quays, massive towers and level banks; even more was he the painter of water, and misty skies, and chasing clouds. In all his works, whether in water or oil colour, and in his etchings, the subject is always subordinate to the effect. Maris has shown all that is gravest or brightest in the landscape of Holland, all that is heaviest or clearest in its atmosphere—for instance, in the "Grey Tower, Old Amsterdam," in the "Landscape near Dordrecht," in the "Sea-weed Carts, Scheveningen," in "A Village Scene," and in the numerous other pictures which have been exhibited in the Royal Academy, London, in Edinburgh (1885), Paris, Brussels and Holland, and in various private collections. Jacob Maris died at Karlsbad on Aug. 7, 1899.

MATTHEW MARIS (1839–1917), younger brother of Jacob, was born at The Hague on Aug. 17, 1839. He was given an allowance by the Queen of Holland and for some time lived and worked with his brother Jacob, on whom his more spiritual and mystical nature had a refining influence. There is a touch of mediaevalism in many of his figures. "Souvenir of Amsterdam," "Bride of the Church," "The Four Mills," and "Girl Feeding Chickens" are among his most successful works. In 1885 he went to London to design windows. He died there Aug. 17, 1917.

WILLIAM (WILLEM) MARIS (1844–1910), youngest of the brothers, was born at The Hague, Feb. 18, 1844. He developed under the influence of Jacob and Matthew and lived for the greater part of his life in London. His paintings of cattle grazing, the most famous of which is "Cows beside a Ditch" (Ryks Museum, Amsterdam), are modern in treatment and have great charm of colour and feeling. He died in London in 1910.

MARITIME PROVINCE, a former province of Russia, in East Siberia; *see* FAR EASTERN AREA.

MARITIME TERRITORY, a term used in international law to denote coastal waters which are not Territorial Waters although in immediate contact with the sea. Thus any strait through which the right of passage of foreign vessels can be forbidden (as the Solent or the Inland sea of Japan), or bays so landlocked that they cannot be held to form part of any ocean-highway, are maritime territory.

MARIUPOL, a seaport of the Ukrainian S.S.R., at the mouth of the Kalmius, in 47° 6′ N., 37° 35′ E. Pop. (1939) 222,427. The harbour is situated four miles southwest of the town and has a depth of about 24 ft. Pilotage is necessary up the 5-mi. long channel from the harbour to the roadstead. Grain is loaded partly by hand and partly by elevators and iron partly by hand and partly by winches. The town has smelting, graphite and ultramarine works and manufactures knitted goods. Its exports are mainly grains, iron, coal and oilcake, and its imports merchandise for local use. The town is linked by rail with the north, but not directly with Taganrog. A coasting route goes to Berdiansk. The place is said to have been inhabited in remote times under the name of Adamakha; the present town was built only in 1779, by Greek emigrants from the Crimea, and there is a fishing industry.

MARIUS, GAIUS (155–86 B.C.), Roman general, of plebeian descent, the son of a small farmer of Cereatae (mod. *Casamare,* "home of Marius") near Arpinum. He served first in Spain under Scipio Africanus, and rose from the ranks to be an officer. In 119 as tribune he proposed a law intended to limit the influence of the nobles at elections. This brought him into conflict with the aristocratic party, who prevented him from obtaining the aedileship. When about forty years of age he married a lady of patrician rank, Julia, the aunt of Julius Caesar. Praetor in 115, he subdued Further Spain. In the war with Jugurtha (109–106) he came to the front as lieutenant of the consul Quintus Caecilius Metellus Numidicus. He came home in 108 to stand for the consulship, was elected, and proceeded to upset all precedent by over-ruling the Senate on the question of his command, and getting the war with Jugurtha assigned to him by the Assembly. He then raised a large army by another unconstitutional departure, enrolling the classes without property (*capiti censi*), probably the most momentous step he ever took. He superseded his old commander Metellus, and took with him as quaestor L. Sulla, who commanded the cavalry. Between them they brought the war to a triumphant issue, and Marius passed two years in his province of Numidia, which he thoroughly subdued and annexed. The surrender of the person of Jugurtha to Sulla gave rise to the view that he, not Marius, had really ended the war, and so laid the foundation of the subsequent enmity between the two leaders.

Marius was next appointed to the command against the Cimbri and Teutones, who had destroyed two Roman armies near the lake of Geneva. Marius, out of unpromising materials and a demoralized soldiery, organized a well-disciplined army, with which he inflicted on the invaders two decisive defeats, the first in 102 at Aquae Sextiae (Aix), 18 m. north of Marseilles, and the second in the following year near Vercellae (*Vercelli*), about midway between Turin and Milan. In 101 Marius was elected consul a fifth time (previously in 107, 104, 103, 102), hailed as the "saviour of his country," and honoured with a triumph.

The glorious part of his career was now over. A very able soldier, as a politician he on the whole failed, though he retained the confidence of the popular party almost to the last. But he unfortunately associated himself with the demagogues Saturninus (*q.v.*) and Glaucia, in order to secure the consulship for the sixth time (100). Later their excesses forced him to turn against them, and this cost him his popularity. So he left Rome for Asia, where he endeavoured to provoke Mithridates to hostilities. On his return he served as legate in the Social War (90), and defeated the Marsi on two occasions. In 88 war broke out with Mithridates, and Sulla was appointed by the senate to the chief command. While Sulla was at Nola with the army, the tribune Sulpicius Rufus started a programme of revolutionary legislation which included the transfer of the command to Marius. Sulla marched on Rome, crushed the revolution, and outlawed Marius, who fled with a price on his head. After a picturesque series of incidents which included a frustrated attempt to land at Carthage, he settled for the time in Cercina. No sooner had Sulla left for the East, than Cinna's revolution started. Marius joined Cinna, forced his way into Rome and entered on a reign of terror in which senators and nobles were slaughtered wholesale. He had himself elected consul for the seventh time, in fulfilment of a prophecy given to him in early manhood. Less than three weeks afterwards he died of fever, on Jan. 13, 86.

He carried out to their logical conclusion the processes begun by Rufus, and under the new organization the soldier was a man who had no trade but war. He did not himself use the army as a political weapon, but under the new order the great general was bound to become the ruler of the State.

For Marius the original sources are numerous passages in Cicero's works, Sallust's *Jugurtha,* the epitomes of the lost books of Livy, Plutarch's *Lives* of Sulla and Marius, Velleius Paterculus, Florus and Appian's *Bellum civile. See* F. D. Gerlach, *Marius und Sulla* (Basel, 1856); I. Gilles, *Campagne de Marius dans la Gaule* (1870); W. Votsch, *Marius als Reformator des römischen Heerwesens* (with notes and references to ancient authorities) 1886; A. H. J. Greenidge, *History of Rome,* vol. i. (1904); also ROME: *Ancient History: The Republic.*

MARIVAUX, PIERRE CARLET DE CHAMBLAIN DE (1688–1763), French novelist and dramatist, was born at Paris on Feb. 4, 1688. His father became director of the mint at Riom in Auvergne, and Pierre was brought up there and at Limoges. Marivaux began his literary career by writing plays, admirable and graceful comedies, of which the most famous are *Le jeu de l'amour et de l'hasard* (1730), *Les Fausses Confidences* (1736), *Le Legs* (1736) and *L'Epreuve* (1740). If they lacked something in depth and characterization, they were full of witty dialogue, much of it about trifles, but exquisite in its way. This dialogue gave a new word to the French language, *marivaudage;* the style perfectly reflects the gallantry and the *sensibilité* which is the subject matter. Simultaneously Marivaux conducted two or three short-lived periodicals, in the *Spectator* style: *Le Spectateur français* (1722–23), *L'indigent Philosophe* (1727), and *Le Cabinet du philosophe* (1732).

In 1731 Marivaux published the first two parts of his best and greatest work, *Marianne,* a novel of a new and remarkable kind. The eleven parts appeared in batches at intervals during a period of exactly the same number of years, and, after all, it was left unfinished. In 1735, another novel, *Le Paysan parvenu,* was begun, but this also was left unfinished. *Marianne* is an extremely important step in the legitimate development of the French novel—legitimate, that is, in opposition to the brilliant but episodic productions of Le Sage. Its connection, and that of *Le Paysan parvenu,* with the work not only of Richardson but of Fielding is also an interesting though a difficult subject. The subject matter of Marivaux's peculiar style has been generally, and with tolerable exactness, described as the metaphysics of love-making. His characters, in a happy phrase of Crébillon's, not only tell each other and the reader everything they have thought, but everything that they would like to persuade themselves that they have thought. He was elected a member of the Academy in 1742. He survived for more than 20 years, contributing occasionally to the *Mercure* and writing plays. He died on Feb. 12, 1763, aged 75 years.

Marivaux was, though a great cultivator of *sensibilité,* on the whole decent and moral in his writings, and was unsparing in his criticism of the rising *Philosophes.* This last circumstance, and perhaps jealousy as well, made him a dangerous enemy in Voltaire. He had good friends, not merely in the rich, generous and amiable Helvétius, but in Mme. de Tencin, in Fontenelle, and even in Mme. de Pompadour, who gave him, it is said, a considerable pension, of the source of which he was ignorant.

The best and most complete edition of Marivaux is that of 1781 in 12 vols. reprinted with additions 1825–30. The plays had been published during the author's lifetime in 1740 and 1748. There are modern editions by Paul de Saint Heylli Victor (1863), by G. d'Heylli (1876) and by E. Fournier (1878), while issues of selections and separate plays and novels are numerous. Of works concerning him J. Fleury's *Marivaux et le Marivaudage* (Paris, 1881), G. Larroumet's *Marivaux, sa vie et ses oeuvres* (1882; new ed., 1894), the standard work on the subject, and G. Deschamps's *Marivaux* (1897), in the *Grands écrivains français,* are the most important.

MARJORAM, aromatic herbs or undershrubs, belonging to the genera *Origanum* and *Majorana* (family Labiatae). Wild marjoram (*O. vulgare*), a perennial native to Europe and Asia, is common in dry copses and on hedgebanks in England and is naturalized in the eastern United States. It has many stout stems 1 to 3 ft. high, bearing short-stalked somewhat ovate leaves and clusters of purple flowers. Sweet marjoram, *M. hortensis,* and pot marjoram, *M. Onites,* are cultivated for the use of their aromatic leaves, either green or dry, for culinary purposes; the tops are cut as the plants begin to flower and are dried slowly in the shade. (*See* FLAVOURINGS.)

MARK, ST., author of the second Gospel. In Acts (xii. 12) we read of "John, whose surname was Mark," and gather that Peter was a familiar visitor at the house of his mother Mary—a centre of Christian life in Jerusalem. That he was, as his Roman surname suggests, a Hellenist, follows from the fact that he was cousin (Col. iv. 10) of Barnabas, who belonged to Cyprus. When Barnabas and Paul returned from their relief visit to Judaea (*c.* A.D. 46), Mark accompanied them (xii. 25). Practical capacity seems to have been his distinctive excellence (*cf.* 2 Tim. iv. 11); and when, not long after, they started on a joint mission beyond Syria, Mark went as their assistant (xiii. 5). After leaving Cyprus and on arrival at Perga in Pamphylia (*see* PAUL), he withdrew, probably on some matter of principle, and returned to Jerusalem (xiii. 13). When, then, Paul proposed, after the Jerusalem council of Acts xv., to revisit with Barnabas the scenes of their joint labours, he demurred to taking Mark with them again, feeling that he could not be relied on should fresh openings demand a new policy. But Barnabas stood by his younger kinsman, and "took Mark and sailed away to Cyprus" (xv. 38 *seq.*).

When Mark reappears it is in Paul's company at Rome, as a fellow-worker joining in salutations to Christians at Colossae (Col. iv. 10; Philem. 24). This, along with its context, points to a reconciliation during Paul's last sojourn in Jerusalem or Caesarea. Not long after Col. iv. 10 Mark seems to have been sent by Paul to some place in the province of Asia, lying on the route between Ephesus and Rome. For in 2 Tim. iv. 11 Paul bids Timothy, "Pick up Mark and bring him with thee, for he is useful to me for ministering."

Once more Mark's name occurs in the New Testament; this time with another leader, Peter, the friend of his earliest Christian years in Jerusalem, to whom he attached himself after the deaths of Barnabas and Paul. Peter's words, "Mark, my son," show how close was the spiritual tie between the older and the younger man (1 Pet. v. 13); and as he is writing from Rome ("Babylon," since Paul's death and the policy it implied), this forms a link with the early tradition which speaks of Mark as writing his Gospel under the influence of Peter's preaching (in Rome). Such is the gist of the tradition preserved from "the elders of former days" by Clement of Alexandria (in Eus. ii. 15, vi. 14), a tradition probably based on Papias's record (Eus. iii. 39) of the explanation given by "the Elder" (John) as to the contrast in form between Mark's memoirs of Peter's discourses and some other Gospel (*see* MARK, GOSPEL OF), but further defining the place where these memoirs were written as Rome. He had acted to some degree as Peter's interpreter or dragoman (ἑρμηνεύς), owing to the apostle's imperfect mastery of Greek; and the fact that he assisted alike Barnabas, Paul and Peter, helps to show the essential harmony of their message.

The identification of the author of the second Gospel with Mark enables us to fill in our picture a little further. Thus Mark was perhaps himself the youth (νεανίσκος) to whom his Gospel refers as present at Jesus's arrest (xiv. 51 *seq.; cf.* his detailed knowledge as to the place of the last supper, 13 *seq.*). It was probably as writer and not in his own person, that he became known as "he of the stunted extremities" (κολοβοδάκτυλος, "curt-fingered"), a title first found in Hippolytus (*Haer.* vii. 30), in a context which makes such metaphorical reference to his gospel pretty evident. It was too as evangelist that he became a subject of later interest, and of speculative legends due to this; *e.g.,* as one of the Seventy (first found in Adamantius, in the 4th century), the founder of the Alexandrine Church (a tradition in Eusebius, ii. 16) and its first bishop (id. ii. 24), and even author of the local type of liturgy (*cf.* the *Acts of Mark,* ch. vii., not earlier than the end of the 4th century).

As to his last days and death nothing is really known. It is just possible that Alexandria was his final sphere of work, as the earliest tradition on the point implies (the Latin *Prologue,* and Eusebius as above, probably after Julius Africanus in the early 3rd century). That he died and was buried there is first stated by Jerome (*De vir. ill.* 8), to which his *Acts* adds the glory of martyrdom (*cf.* Ps.-Hippolytus, *De LXX Apostolis*).

LITERATURE.—H. B. Swete, *The Gospel acc. to St. Mark* (1898), Introduction, § I., where the authorities are fully cited; also the art. in Hastings's *Dict. of the Bible.* The Patristic and other legends are discussed at length by R. A. Lipsius, *Die apokr. Apostelgesch. u.s.w.* (1884), ii. 2, and T. Schermann, *Propheten- und Apostellegenden* (1907), 285 *seq.;* M.-J. Lagrange, *Evangile selon S. Marc,* 4th ed. (Paris, 1929), pp. xvi–xxxii. (J. V. B.)

MARK, a word of which the principal meanings are in their probable order of development—boundary, an object set up to indicate a boundary or position; hence a sign or token, impression or trace. *See* MARK SYSTEM.

Mark, in the monetary sense, was until recently the name of a German silver coin, and as such is probably a distinct word and not of Teutonic origin; it is found in all Teutonic and Romanic languages, Latinized as *marca* or *marcus.* The mark was originally a measure of weight (varying during the middle ages, but *c.* 8 oz.) for gold and silver only and was common throughout western Europe (*see* Du Cange, *Gloss. med. et infim. Lat. s.v. Marca* for a full list). In England the "mark" was money of account only, and apparently came into use in the 10th century through the Danes. It was first taken as equal to 100d., but after the Norman Conquest was equal to 160d., (20d. to the oz.) = two-thirds of the pound sterling, or 13s.4d., and therefore in Scotland 13½d. English; the mark (merk) Scots was a silver coin of this value, issued first in 1570 and afterwards in 1663. (*See* MONEY, MEDIAEVAL.)

The pre-war German *mark* was adopted in 1873, and first issued in 1875, as the standard of value and the money of account. It was of the value of 6·146 grains of gold, 900 fine, and was equal to English standard gold of the value of 11·747d. (in New York 23·821 cents). After the collapse of the mark (*see* GERMANY; CURRENCY; REICHSBANK) the mark was replaced in 1923 by the *rentenmark,* issued by the newly founded Rentenbank, and in 1924 by the *reichsmark,* issued by the Reichsbank, both of the same nominal value as the mark; the *reichsmark* is a nickel coin; the *rentenmark* is paper only, 5 being the lowest denomination.

MARK, GOSPEL OF, the earliest in date, though the second in canonical order, of the Four Gospels. For the evidence that Mk. was used as a source by the compilers of Mt. and Lk., and that it is therefore older than they, *see* the article GOSPEL. It was clearly of high authority in the period just after it was written. There are reasons for thinking that it was known not only to Mt. and Lk. but to Jn., and it was certainly used by the author of the apocryphal *Gospel of Peter.* It is perhaps quoted or echoed by the Roman writer Hermas about A.D. 140; it was used by Tatian (who had been in Rome, and who about A.D. 170 made a Harmony of the Gospels in Syriac); and it was ranked as one of the Four Gospels by Irenaeus (about A.D. 180). Irenaeus, like Tatian, had been in Rome, and the evidence of early quotations may be thus said to be in favour of Rome as a place of origin for Mk. It must certainly have been backed by some powerful Church in order to secure a place in the Canon, since, despite its vogue in the first century, it fell at a later date into relative disrepute. It is seldom quoted in antiquity—the longer and fuller Gospels of Mt. and Lk. were preferred to it. The earliest known commentary on Mk. dates from the fifth century. There are mss. of the Gospels in which it stands not second, but last, of the four.

Early Traditions Regarding the Gospel.—The earliest tradition with regard to the writing of the Gospel is contained in a fragment of Papias (quoted by Eusebius, *H.E.,* III. xxxix. 15), which may be translated as follows:

"This also the presbyter used to say: Mark indeed, who became the interpreter of Peter, wrote accurately, as far as he remembered them, the things said or done by the Lord, but not, however, in order. For he had neither heard the Lord nor been his personal follower, but at a later stage, as I said, he had followed Peter, who used to adapt the teachings to the needs [of the moment], but not as though he were drawing up a connected account of the oracles of the Lord: so that Mark committed no error in writing certain matters just as he remembered them. For he had one object only in view, viz.:—to leave out nothing of the things which he had heard, and to include no false statement among them."

It is not clear how much of this statement goes back to the unnamed "presbyter," how much represents Papias' own amplification of what the "presbyter" had said. Papias himself appears to have been Bishop of Hierapolis in Phrygia about A.D. 140, and a great champion of oral tradition. It is clear that criticisms had been made on Mk.'s Gospel on the ground of its defective "order"; and it is probable that the Gospel which is being tacitly preferred to it is that of Mt., in which it was thought that the materials were arranged in a more orderly way, and which, moreover, was (wrongly) supposed to be actual work of the Apostle St. Matthew. The fragment in any case embodies the perfectly sound critical judgment that no particular importance is to be attached to the "order" of Mk., who has produced a work which is essentially a "miscellany," a narrative built up out of anecdotes which were originally disconnected, and which had been used "in accordance with the needs of the moment" for the purpose of preaching.

The statement that "Mark became the interpreter of Peter" is less valuable. It is not likely that the unnamed "presbyter" would have possessed precise information upon this point, any more than that the Apostle Peter would have required, in the strict sense, an "interpreter." (Galilee was very largely a bilingual country, and it is probable that the original disciples of Jesus would have been able to speak a little colloquial Greek.) If the Gospel reached Asia Minor from Rome, this fact would suffice by itself to explain the tradition—it would be taken for granted that the authority of Peter, who (with S. Paul) had been a Roman Apostle, was behind it. The Gospel, no doubt, does contain, *inter alia,* authentic "Petrine" traditions, but it is a mistake to regard it as being *exclusively* "Petrine"; and it is of interest to observe that the earliest tradition stresses the fact that the author of the Gospel had not been himself an eye-witness. The claim which is made (and it is probably a just one) is that he represents the traditions of eye-witnesses at second-hand.

Irenaeus, in the account which he gives of the Gospel (Iren. *Adv. Haeres,* III. i. 2; *cf.* III. x. 6), echoes Papias' words, and is clearly dependent on Papias: but he adds one new fact (the knowledge of which he may have owed to his residence at Rome), viz.:—that the Gospel was written *after the deaths of the Apostles Peter and Paul.* The information is, no doubt, to be trusted.

Later traditions are perhaps hardly worth quoting. There are allusions to Mk. in the Muratorian Fragment (end of the second century) and in Hippolytus (who described Mark as "docked" or "curt-fingered"). Clement of Alexandria (conflicting with Irenaeus) suggests that the Gospel was written while S. Peter was still alive, and S. Chrysostom inferred wrongly from some words of Eusebius, who represents Mark as "proclaiming in Egypt the Gospel that he had written" (Euseb., *H.E.,* II. xvi. 1), that the Gospel was written, not at Rome, but in Egypt.

Place of Origin, Authorship, Date.—In the light of the evidence given above, it may be assumed that Rome—not Antioch or Jerusalem—was the place of origin of the Gospel.

The tradition that Mark was the author may be also accepted. A tradition sufficiently in touch with facts to claim for the oldest of our Gospels (itself an anonymous work) the authorship not of an Apostle, but of a personage of the second rank—a companion of the Apostles, but a man not otherwise particularly prominent—is in all probability correct. On the Evangelist *see* the article MARK, ST.

The date of writing is no doubt correctly indicated by Irenaeus —Mark wrote "after the deaths" of Peter and Paul; and the tradition is probably to be trusted which connects their martyrdoms with the persecution of Roman Christians by Nero in A.D. 64–65 (Tacitus, *Annals,* XV. 44). The Gospel is addressed to a Martyr Church (*see* below). It was perhaps written about A.D. 65–67. B. W. Bacon, on the ground mainly of an argument based on a minute study of what he believes to be the historical perspective implied in chapter xiii. of the Gospel, would fix the date ten years later. On the other hand, a comparison of Mk. xiii. 14 with Lk. xxi. 20 may be held to suggest that Mk. (unlike Lk.) was writing *before* A.D. 70—the year in which Jerusalem fell.

Literary Characteristics.—The Gospel is written in rough, colloquial, sometimes ungrammatical Greek, highly Semitic in colouring—the kind of Greek which might be the work of a bilingual teacher whose native speech was Semitic, and who lacked literary culture. There are Aramaic idioms (parataxis, asyndeton); there is a characteristic Semitic monotony of style: there are actual Aramaic phrases and words, with accompanying Greek renderings (Mk. v. 41, vii. 11, 34, xiv. 36, xv. 22, 34). There are vulgarisms (ii., 4, 9, 11—*krabbaton,* "pallet-bed"; iii. 10, v. 29, 34—*mastix,* "scourge," in the sense of "disease"; xv. 43—*euschemon,* "of good social position," here probably in the sense of "rich"), and Latinisms both of vocabulary (v. 9, 15—*legio;* vi. 27—*speculator;* vi. 37, xii. 15, xiv. 5—*denarius;* xii. 14—*census;* xii. 42—*quadrans;* xv. 15—*flagellare;* xv. 16—*praetorium;* xv. 39, 44, 45—*centurio*), and perhaps also of style (ii. 23, xiv. 65, xv. 1, 15). The theory of actual translation from an Aramaic original, advocated by some scholars, is improbable. The phenomena are best explained by the assumption that the author—a Jew writing at Rome for a Greek-speaking Church—was an imperfect Greek scholar, who habitually *thought* in Aramaic, and who wrote such rough, colloquial Greek as he was able to achieve.

Criticism.—On the "Synoptic Problem" *see* the article GOSPEL. That Mk. was known in substance to Mt. and Lk. is quite certain. The question has been raised whether they knew Mk. in its canonical form, or a supposed earlier edition ("Proto-Mark," *Urmarcus*). Neither Mt. nor Lk. contains anything to correspond with Mk. iv. 26–29, Mk. viii. 22–26, or Mk. xiv. 51, 52, and there are a few other "common omissions" of less importance; Lk., moreover, omits bodily the whole of Mk. vi. 45–viii. 27. The theory of an *Urmarcus* is nevertheless to be rejected. The sections omitted by Lk. are Marcan in style, and plausible reasons can be assigned for their omission; and the fact that the conclusion of the Gospel is missing (*see* below), and that a comparison of Mk. xvi. 7 *sqq.* with Lk. xxiv. 6 *sqq.* suggests that it was already missing in the copy of Mk. used by Lk., seems decisive—a later editor who was prepared to add considerable sections in the middle of the book would surely have supplemented also the conclusion. Apart from a few possible interpolations and glosses (i. 2; ii. 19b; ii. 26—the words *when Abiathar was high priest;* viii. 35—the words *and the gospel's;* ix. 41—the words *because ye are Christ's*, and perhaps vii. 3–4—the note on Jewish ceremonial ablutions) it may be presumed that we possess the Gospel (unfinished) in the form given to it by its author.

That the Gospel, as it stands, *is* unfinished seems certain. The authentic text breaks off at Mk. xvi. 8. The verses which follow (Mk. xvi. 9–20) are missing from certain of the mss. of Mk., and are clearly a summary compiled later, and based on the writings of Lk. An alternative and shorter conclusion, contained in some mss. either alone or in combination with Mk. xvi. 9–20, serves as additional evidence that the true conclusion was missing. It would clearly have contained an account of the appearance of the risen Christ to St. Peter (Mk. xvi. 7; *cf.* 1. Cor. xv. 5, Lk. xxiv. 34). The conclusion may have been accidentally lost, but it is more probable that it was never written—the Evangelist broke off, and was prevented from completing his task.

With regard to the question of the possible *sources* of Mk., various conflicting views have been held. The theory of B. Weiss, who believed in a fundamental "Apostolic Source" or "Original Gospel," supposed to underlie both Mk. and the Synoptic tradition in general, is now generally abandoned. The more fashionable theory that the sources of Mk. are to be reduced exclusively to the oral teaching of Peter is probably in process of abandonment. J. Weiss, who maintained that Mk.'s

Gospel was "not a source, but a confluence of sources," attempted to distinguish (1) Petrine traditions, (2) stories of conflicts and discussions between our Lord and His adversaries, (3) isolated *logia* or sayings, with or without an historical framework, and (4) further popular traditions, of which the origin cannot be precisely determined. All these elements are no doubt actually represented in the Gospel; the delimitation and reconstitution of the supposed written or oral sources is a different matter. Attempts at hypothetical "source-criticism" in a case of this kind are rarely profitable, and neither the theory of E. Wendling (who believed in an original *Urmarcus,* the work of an "historian," revised and redacted successively by two subsequent writers, respectively designated by Wendling as "poet" and "theologian"), nor the more recent hypothesis of E. Meyer (a "disciples" source side by side with a source which speaks rather of "the Twelve"), is of any great value. Of greater importance is the question of Mark's possible relation to the Synoptic source known as "Q" (*see* the article GOSPEL). "Q," in some form, is probably earlier than Mk.; and it has been thought that Mk. (which in the main is a narrative Gospel) may have presupposed "Q," and been written to supplement it. There are points at which it has been thought that Mk. actually depended on "Q" —*e.g.,* the Beelzebub controversy (Mk. iii. 22–30), the catena of sayings in Mk. iv. 21–25, the discourse on the sending out of the Twelve (Mk. vi. 7–11), the sayings on discipleship in Mk. ix. 35–37, 41–50, and the brief anti-Pharisaic discourse in Mk. xii. 38–40. A comparison with the parallels in Mt. and Lk. suggests that in all these cases the sayings in question were represented in "Q," and as a rule in a much fuller form. In these cases—and perhaps also in the exceedingly brief and allusive accounts in Mk. of the Baptist's preaching, and of the Temptation of Jesus—it appears in fact not improbable that Mk. presupposed fuller knowledge on the part of his readers, or in other words that behind Mk. (not as a source which he incorporates, but as an already known document, with the contents of which he occasionally makes contact) the "Q" tradition is implied as being *in some form* familiar to the Christians of Rome.

It has been argued, lastly, that St. Mark's Gospel is "Pauline." It is certainly Gentile-Christian, and in its attitude to the Law anti-Jewish (*cf.* esp. Mk. vii. 1–23): but in Galatians St. Paul claims St. Peter's concurrence with his policy as regards "the gospel of the uncircumcision" (Gal. ii. 6 *sqq.*). There is little in Mk. that is *distinctively* Pauline—even the argument about the rejection and "hardening" of Israel (*cf.* Mk. iii. 5, iv. 11–12, vii. 6 *sqq.*), which exhibits affinities with the argument of Romans ix.–xi., may be set down to the account of the general missionary apologetic of the Church. St. Paul would have endorsed St. Mark's Gospel; but so, probably, would St. Peter—the Roman Church in the next generation looked back to the two "good Apostles" as having harmoniously taught and worked side by side (Clem. Rom. *ad Corinth.* v. 3).

Arrangement and Message.—The Gospel falls into three divisions, of which the first (Mk. i. 1–viii. 26) is in the main a collection of stories illustrative of Jesus' activity in Galilee. The starting-point is the preaching and Baptism of John, by whom Jesus Himself is baptised—the ideal type of Christian Baptism with water and with the Spirit: and a Voice hails Him as Son of God. He proclaims the Good News of God's Coming Kingdom, calls four men to follow Him, and in their company heals the sick, casts out demons, and performs mighty works. A collection of "conflict stories" which follows (Mk. ii. 1–iii. 6) serves from one point of view to render intelligible His subsequent Crucifixion, from another point of view to set forth the authority of the Son of Man to forgive sins (Mk. ii. 5–12) and to justify the independence of Christians in respect of the Jewish Sabbath (ii. 23–iii. 6) and of fasting (ii. 18–22). The "mystery of the Kingdom of God" is set forth in parables (iv. 1–34); and Jesus is manifested in mighty works as the Stiller of the Storm (iv. 35–41), Conqueror of Demons (v. 1–20), and Deliverer from Sickness (v. 25–34) and Death (v. 21–24, 35–43). The twice-told story of the Feeding of the Multitudes (vi. 31–44, viii. 1–9) is perhaps meant to suggest Jesus the Giver of the Bread of Life both to Jews and to Gentiles. In the stories of the Deaf-mute (vii. 31–37) and the Blind Man of Bethsaida (viii. 22–26) the Messiah opens blind eyes, and has unstopped the ears of the deaf (*cf.* Is. xxxv. 5).

The second, or central, division of the Gospel extends from Mk. viii. 27 to Mk. x. 45, and is concerned with the theme of the coming Passion. The confession of Peter at Caesarea Philippi is not specially welcomed in Mk. (contrast Mt. xvi. 13–19), and the disciples are enjoined to say nothing about it (Mk. viii. 30): the doctrine of the Passion, on the other hand, is proclaimed openly (Mk. viii. 32). It is by the road of suffering and death that the Son of Man must pass to His coming glory—the glory which the episode of the Transfiguration (a symbolic vision in which the representatives of Law and of Prophecy, seen for a moment in conversation with the Messiah, disappear to leave Jesus alone) heralds by way of anticipation (Mk. ix. 2 *sqq.*). The predictions of the Passion, thrice repeated (Mk. viii. 31, ix. 30–32, x. 32–34), sound like strokes of a bell—the Lord initiates His disciples beforehand into the mystery of His sufferings and death. At the same time there is set forth also the doctrine of discipleship as a *via crucis* for those who would follow. The true greatness consists in humility (Mk. ix. 33–37), it is needful to become as a little child (Mk. x. 13–16), the call is for utter self-sacrifice (x. 17–22)—wealth and worldly possessions are a hindrance (x. 23–31). The Son of Man came to give Himself a ransom (x. 45), it is a question of taking up the Cross after Jesus (viii. 34), of being prepared to drink of His Cup and to be baptised with His Baptism of blood (x. 38). The Gospel here becomes "virtually an impressive sermon addressed to the reader"—a sermon valid for all time, but peculiarly apt for the martyr-Church of first-century Rome.

The third division of the Gospel (x. 46–xvi. 8) is concerned with the actual story of the Passion at Jerusalem. The Messiah enters the Holy City in a guise meant to recall the prophecy of Zech. ix. 9 *sqq.,* and in the capacity of Zion's King (Mk. xi. 1–11). The Temple is cleansed (xi. 15–19), there are conflicts with chief priests and elders and scribes, Pharisees and Herodians and Sadducees (xi. 27–xii. 27). A brief christological section (xii. 35–37) suggests that the Messiah is a Greater than David, and that "Son of David" is an inadequate title. An apocalyptic discourse (Mk. 13) gives expression to the conviction that the grievous calamities and troubles which were to befall both the Church and the world (and which in part had already befallen the former) had been foreseen by the Lord—it is believed by many scholars that a brief Jewish-Christian apocalypse descriptive of the *dénouement* of world-history in three stages, viz.:—(1) Signs of the End (xiii. 7–8), (2) Manifestation of Antichrist, Great Tribulation, Flight of Believers (xiii. 14–20) and (3) Dissolution of the existing World-order, Coming of the Son of Man, Gathering of the Elect (xiii. 24–27), has been here incorporated along with authentic sayings of Jesus.

The remainder of the Gospel (Mk. xiv. 1–xvi. 8) comprises the story of the plot against Jesus' life, the Last Supper and Institution of the Eucharist, the disloyalty of Peter, the Agony and Arrest in the Garden, the examination before the Sanhedrin, the trial before Pilate, the Lord's Sufferings, Crucifixion and Death. The Burial of Jesus is seen by the women (Mk. xv. 40 *sqq.*) and the authentic text of the Gospel breaks off with the account of the Empty Tomb and the message of the Angel (xvi. 1–8).

Theology of the Gospel.—Mark is a frank super-naturalist —there is no non-supernatural Christianity in the New Testament—and his supernaturalism is of a naïve, popular kind. He believes both in demons and in miracles, and his Jesus is predominantly a Wonder-worker. For him Jesus is the Son of God (in the sense of a divine, supernatural Being), to whom witness is borne at His Baptism and Transfiguration by supernatural Voices from heaven, who is recognized by the demons (who are supposed to possess supernatural knowledge) as their destined destroyer and foe, and who is manifested in works of supernatural power. St. Mark's Jesus is clothed with authority from heaven (i. 27), knows the secrets of men's hearts (ii. 8, iii. 4, 5), is ranked higher than the angels (xiii. 32), and as the "Son of Man" is the Judge who shall come "with the clouds" (xiii. 26–27, xiv. 62), who already upon earth has the authority to forgive sins (ii. 10), and who is Lord of the Sabbath (ii. 28). At the same time He is genuinely man. He can be tired (iv. 36), angry (iii. 5) and grieved (iii. 5); He can sigh (vii. 34, viii. 12) and be moved with indignation (x. 14); He can be "greatly amazed" and "sore troubled" (xiv. 33); He dislikes being called "good" (x. 18), and is not omniscient (xiii. 32). He is addressed by His disciples as "Teacher" or "Rabbi" (iv. 38, ix. 38, x. 35, xiii. 1; ix. 5, xi. 21, xiv. 45). He is the Servant of God, who gives His life as "a ransom for many" (x. 45). If the doctrine of the Incarnation is implicit rather than explicit in this Gospel, its fundamental message is the setting forth of two themes: (1) the conviction of primitive Christianity as to the supernatural *power* of the Lord Jesus, and (2) the great doctrine and fact of the Cross.

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MARKET. The word "market" or some similar one derived from the Latin *mercatus* appears in most European languages, and always refers to the place or method of contact between buyer and seller. The contact may be relatively simple, direct and personal, as in a market place, meat market, or farmer's roadside market. It may be a highly organized institution such as those for securities, cotton, or grain; or it may be almost an abstraction, such as the "labour market."

Historically the word usually meant a place at which a number of buyers and of sellers met at fairly frequent recurrent fixed times to do business, under certain rules and regulations, in one or at most a few kinds of goods. Meetings at such long intervals as three, six, or twelve months were called fairs; while business conducted by peddlers or in private retail stores or warehouses or by personal orders was not regarded as taking place in the market proper.

In ages when the volume of trade was small and transportation difficult it was good for sellers to know that if they took their wares to a certain spot on an appointed day they would find buyers gathered there. This knowledge centralized supply and demand, saved time and stimulated production for sale. Produce which became available only at certain seasons—wool, grain, cotton, furs, young livestock, etc.—could be disposed of at the end of the productive period in an annual fair. Commodities which were being produced the year round—butter, cheese, eggs, fish, handicraft wares, cloth, etc.—would need to be sold weekly at a market. Further, while a producer of seasonal commodities would not mind a long trip to a remote fair once a year, the seller of goods which were produced continuously needed some nearby market since he could not afford to spend more than one day a week taking his goods to market, selling them, buying what he required, and then returning home.

While fairs were, therefore, located relatively wide apart, markets had to be thickly sprinkled over settled areas. If, however, they became too numerous, the supply of goods or of buyers in each might be inadequate or uncertain, and the owner of the market would suffer a severe decline in the income he received from tolls, stall dues and other charges. During the rapid expansion of the western European economy in the 13th century the supply of markets seems to have outrun the demand to such an extent that strong efforts were made to prevent new ones from being set up wherever they might injure existing ones. Lawyers urged that markets should be at least two leagues (six miles) apart. This figure was probably quite reasonable and acceptable; it was near to the seven-mile radius which even in the early 19th century protected the markets in London from excessive competition; and it emphasized the essentially local character of the business transacted in the market.

Some markets remained general in character, and were chiefly devoted to the exchange of farm produce for urban manufactures. John Ramsay M'Culloch, in his *Dictionary of Commerce and Commercial Navigation* (1835 edition), defined a market as "a public place in a city or town where provisions are sold." Producer and consumer met there face to face. But if an area specialized in some staple product, middlemen would flock there to obtain their supplies for a wider national or foreign market. One classic illustration of this condition was the cloth markets of Yorkshire and other textile areas. To them small producers residing over a radius of not more than five or six miles brought their weekly output of one or two pieces of cloth, and sold it to merchants, commission agents or factors. Held at first in a main street or market place for a fixed period of time on the regular market day, they were eventually transferred indoors when large "cloth halls" were built, often sponsored and financed by the merchants who bought the fabrics. Larger producers did not rely on such local outlets, but sent their wares in bulk to the central market at Blackwell hall in London.

Similar developments took place in many continental markets. In Bruges, Belgium, the large open market place had by 1240 become flanked on one side by a *halle* in which cloth was sold on three days each week. By 1300 a second hall (the *Waterhalle*) was built astride a small river so that goods could easily be unloaded, and was open every day. A third hall, the *Cruudhalle* (Spice Hall) appeared, to serve as market centre for Spanish wool, drugs, spices and other goods from the Mediterranean.

Legally a market was the property and source of income of the person on whose land it was held or to whom it had been granted. In feudal society subordinate lay or religious landowners sought from their superiors the right to hold a fair or market; and in modern states the same rule may prevail that the right has to be obtained from the state. The charter which granted the mediaeval franchise gave the owner power to collect tolls on goods sold—or even on all goods displayed, and fees for the use of stalls; it protected his clients from competition by restricting sales in stores on market day; occasionally it conferred the right to operate a mint. In return it explicitly or by implication imposed the obligation to see that the king's peace or the peace of God prevailed, and to preserve law and order in the market's operations. This involved the provision of a market court to deal promptly with disputes concerning sales, disorder, or violations of the regulations touching weights and measures, price, quality, forestalling, etc. A clerk of the market had to be provided to approve all weights and measures, and a steward to preside over the court.

Some markets passed eventually into the hands of the towns in which they were located; but private or corporate persons continued to seek permission to establish markets well into modern times, as for example the grant of Covent Garden market to the Duke of Bedford in 1670.

With the rise of large towns, factory production, and intensified commercial activity in the 19th century the need for public markets increased in some respects and declined in others. Where production of manufactured articles passed into the hands of fewer larger units, private buying and production to fill orders caused the cloth halls and similar markets to shrink in importance and finally disappear. At the same time the maintenance of direct contact between large bodies of urban consumers and the rural food producers became well-nigh impossible because of the vast number of the former, the need for obtaining supplies from a wider national or international area, and the call for large storage facilities.

The development of large-scale rapid transportation, bulk handling, refrigeration and local or terminal produce warehouses bridged the physical gap so far as the commodities were concerned; but the commercial transactions involved the expansion of the class of intermediaries, whether purchasers or commission agents, wholesalers or retailers. In addition they led to an increase in the importance of private sales, wholesale markets, or auction sales, in which the consuming public played little or no part as buyer, but relied for its supplies on the storekeeper who bought his goods in the wholesale market, often at an hour when most of his customers were fast asleep.

The history of most expanding European cities reveals the efforts made by civic or private enterprise to expand the accommodation for both wholesale and retail purchases. For instance, Leeds, a Yorkshire cloth centre, more than trebled its population between 1801 and 1851. In 1801 it had a weekly market for grain, cattle and hogs, and a twice-weekly one for cloth and provisions. By 1851 it had added a fortnightly fair for cattle and sheep, and eight periodical leather fairs each year; it had removed the markets for provisions and livestock from the narrow main street, created a large open "free market" area for use by farmers, and set up a meat market with an underground slaughterhouse. Meanwhile groups of investors had erected buildings for a bazaar, a meat and fish market, a central provision market, a corn exchange, leather fairs and a stock exchange.

On the continent private and municipal markets were expanded as populations became more dense. The municipal *Halles Centrales* in Paris eventually covered ten acres in the middle of the city, and the customers were retailers and consumers alike. Yet they could not handle all the needs of the metropolis, and other markets, therefore, had to be created or expanded.

In North America the European type of market developed naturally, rather than as the result of charter grants, to meet similar requirements, and in its most simple form can still be seen in operation in the market squares or halls of some of the older United States and Canadian towns. The expectation of getting fresher or cheaper produce from a farmer still takes customers there in spite of the lavish array of retail stores. Of larger markets to supply retailers as well as consumers, the Fulton fish market in New York city or the Faneuil Hall market in Boston are examples. Rapid urbanization and the rising cost of living after 1900 stimulated interest in efficient and economical marketing and led to considerable activity in providing city markets. Private enterprise, especially by the railroads, began to establish terminal markets at which country produce is unloaded and displayed for sale. But in most of the public markets the customer is rarely the consumer. The spread of suburban stores, the extension of chain stores, the congestion of traffic around public markets, and possibly the American consumer's lack of interest in the possibility of saving a few cents by taking a trip to the big market, have all made that institution, even in its most streamlined form, a minor part in the system of distribution. (*See* also FAIR; EXHIBITION AND TRADE FAIR.)

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ECONOMIC THEORY

In economic theory the term "market" means the general conditions under which buying and selling are conducted.

In the theory of the market several types are distinguished. At one end of the scale is the perfectly competitive market, at the other end is perfect monopoly, and there are many intermediate forms. It may be said that perfect competition and perfect monopoly are limiting cases rarely to be found in practice, and that most actual markets fall into the intermediate forms known as "imperfect competition." A perfectly competitive market is characterized by the following conditions: (1) the number of buyers and sellers in effective contact must be large enough so that the action of any one of them has no appreciable effect on the price. That is to say, the operations of each individual buyer or seller are so small a proportion of the total, that each can buy or sell as much as he wishes at the prevailing price. (2) The commodity involved must be homogeneous in the sense that each buyer does not care from whom he buys, and each seller does not care to whom he sells, as long as the standard commodity is involved in the transaction. In a perfectly competitive market any price differences between different parts of the market will be equal to the costs of transport of the commodity from one part to the other. This conformity of prices is effected through the operation known as arbitrage, *i.e.,* by operators buying in the "cheap" place (which will raise the price there) and selling in the "dear" place (which will lower the price there). The equilibrium price in a competitive market is that which "clears the market," *i.e.,* the price at which the quantity of the commodity offered for sale is equal to the quantity which people are willing to buy. If the price is above this level, more will be offered for sale than buyers can be found to accept, and the fear of being left without a buyer will induce sellers to lower their prices. If the price is below that level, less will be offered for sale than people are willing to buy, and buyers will raise their prices for fear of not finding a seller.

The closest approach to the perfectly competitive market is to be found in the organized commodity and security exchanges, such as the grain and cotton markets, the metals markets and the stock markets. Such markets tend to arise wherever men deal in exchangeables that are homogeneous and simple enough to be bought and sold by description. Such markets are characterized by great flexibility of prices, and also by short-run speculative price movements which may be due to the temporary emotional states of the marketers rather than to any basic underlying factor. The organized markets in different centres are closely connected by telegraphic communication and by specialized "arbitrageurs" who operate in many centres, so that in peacetime there is a world market for many of the standard raw material commodities and for many securities.

When the commodity is not homogeneous enough to be graded and sold by description, a common form of market is the auction. Wool, livestock, eggs, meat and vegetables are frequently sold in this manner. When the commodities sold by auction are fairly homogeneous, the results of this form of market will not be very different from those of perfect competition. The price will lie somewhere between the highest price which the most eager buyer is willing to pay and the highest price which the second most eager buyer will pay.

At the other extreme to perfect competition stands monopoly. A monopolist may be defined as a seller whose product is different from that of any other seller. A seller is in a situation of perfect monopoly if, in addition, the demand for his product does not depend upon the price or sales policy of any other individual seller or small group of sellers. Whereas the seller in a perfectly competitive market can sell as much as he wishes at the prevailing price, a monopolist must either lower his price or increase his selling cost in order to expand sales. The relationship between price, selling costs, and sales is sometimes known as the "market" of an individual seller. In perfect competition the seller has a "perfect market," and there are no selling costs, for if the seller can sell as much as he wants at the prevailing price, obviously there is no need for him to advertize. The existence of a sales problem is a sign of monopoly.

Probably most firms operate under some form of "imperfect competition" exhibiting both monopolistic and competitive elements. Three main types may be distinguished. Monopolistic competition is a situation where there is a large cluster of sellers (firms) selling similar but not identical products, and where firms are free to enter the cluster or to withdraw from it. The fact that the products are not identical (*i.e.,* there is "differentiation of the product") means that each firm is to some extent in a position of monopoly in that it has an imperfect market; it can have a price and sales policy, for if it lowers its price it will attract only a finite amount of business from its competitors, and if it raises its price it will not lose all its business to its competitors, the products of different firms not being perfect substitutes. On the other hand the ability of new firms to enter the cluster makes it impossible in the long run for the firms in it to make abnormal (monopoly) profits, for if the firms in the cluster are making abnormally high profits, other firms will be attracted into it, and the competition of the products of the new firms will lower the demand for the product of each of the other firms, and so will lower profits. This process will go on until profits are normal—*i.e.,* are at a level at which on balance no firms are attracted or repelled. It can be shown that the end result of monopolistic competition is that firms operate at a level of output which is below the optimum efficiency.

Virtually the whole retailing industry, and the great part of the manufacture of consumers goods, are carried on under monopolistic competition. Thus if a single retail store raises its prices without neighbouring stores raising their prices, it will not lose all its business, since it has a certain clientele that will stay by it for reasons of convenience or of personal preference even if its prices are relatively higher. Similarly the manufacturer of a single breakfast food could raise his price without losing all his sales to other breakfast foods, since the different breakfast foods are not perfect substitutes. Nevertheless, these elements of monopoly probably do not enable retailers, or most manufacturers, as a group to enjoy abnormal profits, because if profits are high new firms will be attracted to that locality or to the production of a similar commodity. It is probable also that most retailers, and many manufacturers, could produce more efficiently if their sales were higher; they are prevented from expanding sales, however, by the limited (*i.e.,* monopolistic) nature of their market.

Another form of imperfect competition is called oligopoly, this being a situation where there are few sellers. If the product of each seller is perfectly substitutable for that of any other the situation is known as perfect oligopoly. In such a case any price change by one firm will be immediately followed by a similar price change by the other firms. It can be shown that this condition is likely to result in price leadership by one firm. This is a common phenomenon in industries producing fairly standardized products—*e.g.,* steel, cement, sugar. If there are few sellers in a cluster producing products which are highly but not perfectly substitutable, a situation known as imperfect oligopoly may develop. In this condition a cut in price by one firm will not be imitated immediately by others. Hence price-cutting, or "cut-throat competition" may arise, and a highly unstable situation ensue. There is, therefore, a strong tendency for firms in oligopoly to come to some agreement on division of markets or on price policy: the "basing point system" found in the steel and cement industries is a case in point, also the market-sharing arrangements of cartels. The possible varieties of oligopoly are many, as many different plausible assumptions about the behaviour of firms under these circumstances may be made.

The market forms which have been described above also apply to buying markets: thus we may have monopsony (a single buyer), oligopsony (few buyers), in various forms, and so on. Various forms of selling markets may be combined with various forms of buying markets in almost infinite variety. A very important market situation is bilateral monopoly, in which a single buyer faces a single seller. All cases of collective bargaining, *e.g.,* between labour unions and employers associations, or between milk producers and milk distributors, fall into this category. The price (or wage) then depends, within certain limits, on the relative bargaining power of the two parties. The "strike" (a temporary failure to effect a bargain) is a characteristic feature of bilateral monopoly. It should be noted that the above classifications are rough divisions only, and that in practice one market form shades imperceptibly into another.

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(K. E. B.)

MARKET BOSWORTH, a township of Leicestershire, England, 105 mi. N.N.W. from London by rail and near the Ashby-de-la-Zouch canal. Pop. (1931) 864. The church of St. Peter is Perpendicular. At the grammar school, founded in 1528, Dr. Samuel Johnson was a master about 1732, but found the work unbearable. The trade of Market Bosworth is principally agricultural, but there are brickworks. Two miles south is the scene of the battle of Bosworth (1485), where Richard III fell before Henry earl of Richmond, who thereupon assumed the crown as Henry VII. Pop. of rural district (est. 1938) 24,220.

MARKET DRAYTON, a market town and urban district, Shropshire, England, situated on a high bank overlooking the upper waters of the Tern near the N.E. border of the county. Pop. (est. 1938) 4,896. Area 2.2 sq.mi. It is in the parish of Drayton in Hales. The market for cattle and cheese, granted by Henry III, is well-known, and there are breweries and manufactures of agricultural implements. On Blore Heath, 3 mi. east in Staffordshire, Audley Cross marks a great battle in the Wars of the Roses (1459), in which the Yorkists were successful.

MARKET GARDENING: *see* HORTICULTURE.

MARKET HARBOROUGH, a manufacturing market town in Leicestershire, England; on the river Welland and the Grand Union canal. Pop. of urban district (est. 1938) 9,417. Area, 7.5 sq.mi. It is 82 mi. N.N.W. from London by the L.M.S. railway. The church of St. Dionysius (*c.* 1250) with a tower and spire, is mainly Decorated and Perpendicular. The grammar school, founded in 1614, occupies modern buildings, but the original half-timbered building, raised upon pillars of wood, remains. Industries include rubber and textiles, boots, shoes and corsets. The general market, held for 700 years in the streets, was housed in a new building in 1938. This is an important fox-hunting centre.

MARKET INDEX, a business indicator revealing the activity of one or more industries, or of the actual or potential capacity of a given district to absorb an article or service offered for sale. The "business barometers" which indicate financial, industrial, and commercial conditions may constitute market indexes revealing business activity, but provide no basis for estimating the sale of a particular item. The market index is more than a financial statement for the people of a district. It is rather a system of indicators which reveal the relative conditions of trading areas from which may be computed sales possibilities. The factors necessary for an effective market index are of three classes: (a) Those which indicate the pulse or the tempo of business—its relative activity—such as the barometers; (b) Those which show the ability to buy; the wealth available for buying; (c) Those which reveal the disposition to buy; (d) In addition to these, other influences such as climate, racial characteristics, and habits of living need to be considered.

(a) Business is regarded as "good" or "bad" as it is above or below the average for the past five or ten years. The sale of electric current, car loadings, transactions on the stock market, bank clearings, department store sales, unfilled orders for steel, and the sale of machine tools are the more important factors used in determining the activity of business. The food industry varies little whether other industries are active or slack. Style goods, building materials, home furnishings, clothing, and luxuries are among the goods which move rapidly in good times and slowly when business is poor. Other businesses like those of the cobbler, the hat cleaner, and second-hand stores thrive on "hard times." Increased unemployment, falling wages, and slackening retail sales presage increased business for them. For most manufacturers, however, good business conditions mean more sales, more labour, more raw materials, and often increased operating capital.

(b) The ability to buy means wealth, especially wealth that produces income. It is reflected in such things as the per caput of life and fire insurance in effect; income tax returns; automobile registrations; homes owned; and savings deposits.

(c) Willingness to buy is not always found where wealth is greatest. Of course there must be resources with which to buy as well as a disposition to spend. This is reflected in retail sales, the number of dentists per thousand population, the number of new automobiles sold, and other purchases such as mechanical refrigerators, telephone rentals, attendance at places of amusement, and magazine and newspaper circulation.

(d) No item has been found which year after year sells in direct proportion to the population. Salt might seem to be such an article, but as it is used extensively in packing houses and to feed livestock, per capita sales are much larger in some districts than in others. So a market index for salt would require a factor to represent the number of cattle, sheep, and horses in the district. Tea is consumed in larger quantities by descendants of Northern European stock than by native Americans or those of the Latin countries, so a racial factor must be represented in a market index for tea.

Other things being equal the sale of straw hats would be in proportion to the number of days in the year of "summer heat." But other things are seldom equal. Hence the index becomes complex. The Negroes wear few straw hats, so they should be eliminated from the number of possible customers. The well-to-do buy straw hats more liberally than the poor. So a factor showing the ability to buy should be included. This might be the per capita sales of haberdashery stores. Men of the same town will buy more straw hats when business is good than when it is poor. So a factor indicating the activity of business is indicated. Comparing the possible sales of two districts would then depend upon the sizes of the two populations, excluding Negroes; the number of days of summer heat in each district; the sales of haberdashery stores; and the comparative state of business in the two territories. This index, when properly computed, enables a sales manager to fix sales quotas for the different trading areas, to apportion advertising expenditures in proportion to sales potentials, and to forecast sales more accurately than by reference to past performance.

In the United States it was anticipated that when retail sales became known that fact of itself would provide an unfailing index, sufficiently accurate for practical purposes. But such exceptions as the sales of food stores illustrate the inadequacy of this as a one item index. In urban districts, green vegetables, eggs, and butter and milk are among the items bought, while in rural districts these items are largely provided by the home. So in computing an index for the sale of a package cheese, food store sales would indicate too much for cities and not enough for towns and villages. Most other items have similar exceptions, so the careful marketing man compiles an index, and verifies estimates by all available data. (H. E. A.)

MARKETING. Marketing is essentially the distribution of goods from the producer to the consumer. The central fact is the sale, but to secure sales the goods must be assembled from the places where they were produced, graded when qualities differ, sorted when there are different varieties, stored, moved to market and in many cases thence to the place of consumption. All of these processes constitute a part of the marketing operation.

I. IN THE UNITED STATES

Methods of Marketing.—The simplest form of marketing and the most primitive is the sale by the producer directly to the consumer. In the aggregate, sales made in this way even at present run into immense volume, although but a small part of the total of business. Modern business, the development of large cities and an increasing division of labour in industry, all tend to reduce this form of marketing. There is still a considerable amount of marketing of produce, particularly fruits and vegetables, direct from farmers to consumers, by parcel post and by direct sale. Again, certain specialties, complicated machines and machines requiring much attention and service after the first sale, usually are sold direct by manufacturers to consumers through the medium of specialty salesmen. The salesman is the representative of the producer in the marketing transaction. Again, if a retailing house does so large a business that it can advantageously engage in manufacturing some of the lines of goods it sells, it may combine production with distribution.

MANUFACTURERS' AND PRODUCERS' METHODS

The Wholesaling System.—Most products of common use, such as foods, clothing, footwear, house furnishings, lumber, fuel and so on, are marketed through middlemen. The manufacturer of men's clothing or of shoes usually sells his product to retailers scattered over the country, who in turn sell to consumers. Manufactured food products, dry goods, drugs, hardware and house furnishings are generally sold first to wholesalers, who in turn sell to retailers. Farmers' produce, fruits, vegetables, butter and eggs, are commonly marketed through local buyers, then to wholesalers or wholesale distributors, to jobbers, then to retailers and lastly to consumers.

The Auction System.—In the case of highly perishable goods, such as fruits, where no time may be lost in effecting sales in order that they may reach the consumer before spoiling, the auction system is used. Wholesale buyers and salesmen come together at a designated place at a set time and clear their transactions. The auction is used also for known standards or qualities, which are bought and sold in wholesale quantities at certain dates each year, as carpets, rugs, wool, furs and fruits, and in marketing second-hand goods, works of art, antiques and even real estate.

The Commission Merchant and Broker.—Variation in marketing occurs through variation in ownership of the goods to be marketed. To illustrate: producers or local buyers usually sell outright to wholesalers all goods marketed through the wholesaler-retailer channel of distribution; but in highly perishable goods, such as fruits, dressed poultry, live poultry, etc., and also in cases where the value of the goods runs very high in proportion to the value of the service rendered by the wholesale middleman—as, for example, finished textiles, real estate, commercial paper and stocks and bonds—the wholesaler (or dealer who takes his place) frequently, if not usually, merely sells or buys as the agent of the owner and secures a commission or brokerage instead of a profit for his services. This arrangement in the case of perishable goods relieves the wholesale dealer of the risk from loss, and, in the case of costly goods, of the burden of financing the goods. Such wholesalers are known variously as commission dealers and brokers.

Market Speculation.—While goods are being gathered together in wholesale quantities and made ready for distribution to the retail trade other factors in marketing frequently enter in, factors of a speculative nature. Standardized goods that are not readily perishable, such as grain, cotton, wool, silk, provisions, coffee, sugar and so on, are likely to be bought purely for speculative purposes. Thus a lot of grain or cotton may be bought and sold several times before being moved to consumption. It is but another step for these speculators to make their ventures in hope of gain on what they think future prices will be. Hence "selling futures" is a common occurrence on the great exchanges that deal in the commodities named. Dealing in futures is an essential function of marketing, but it needs careful regulation to prevent unfair practices.

Conditions That Govern Methods.—If producers are many and small, and are located far apart, it is almost certain that their products will have to be assembled by a local buyer of some kind; whereas if the producers are able to turn out large quantities they may be able to deal with wholesalers directly. If consumers use small quantities or small lots of any product at one time it is almost certain that they must purchase from retailers. But a large consumer would be able to buy more advantageously direct from the producer.

Time is a very important element in the marketing of perishable goods. There must be no delay, and little time can be given to the sale of any particular unit. An illustration of a perishable article is the daily paper, the weekly or monthly magazine. Timeliness is the essence of their value. This makes necessary a highly specialized marketing organization to carry papers or magazines over the country and, in the case of magazines, to place them on sale everywhere at the same time. Such specialized handling calls for expense not incurred in goods not perishable.

A low-priced article with a small margin of gross profit to the seller cannot be sold in the same way as an article that offers a wide margin. Where the margin above costs of production is not sufficient to permit the article to be sold direct or to be advertised and sold by itself by the mail-order method, it must take its way to the consumer through the channels of trade followed by thousands of other similar articles.

Competition.—The competition in the sales field of any article may readily determine the channel of distribution that is taken. Certain manufacturers of soaps, perfumes and toilet goods have found it so difficult to place their products advantageously in drug-stores and similar retail outlets because of the number of competing lines that they have found it advisable to sell, especially in country districts or small towns, direct to consumers by means of agents and canvassers working on a commission basis. A motor-car tire maker found it so difficult to break into the market through automobile dealers and garages that he sold his product to a mail-order house. A new product must as a rule be sold through specialized marketing systems which may be abandoned after the public has begun to know and to demand the article.

WHOLESALING

Wholesaling in the United States is in a state of unrest and change. Much of the criticism that has been made against middlemen during the past 25 years as causes of the high costs of living has been specifically levelled at wholesalers. More and more manufacturers on the one hand and more and more retail institutions on the other have adopted direct means of selling or buying their goods with the result that jobbing lines have been greatly limited. National advertising has apparently helped the movement of manufacturers selling direct to retailers. The great increase in interest of the masses of the people in fashion and fashion goods that developed during the World War and at its close has made it necessary for retailers to work more closely with manufacturers on these classes of goods. Practically all lines of wholesaling have declined to some extent, some very greatly. As a result, many old, well-known wholesale houses have gone out of business, others have formed mergers and still others have changed the character of their business. Some wholesalers have through adoption and promotion of their own private brands of goods virtually become manufacturers. Still others have secured their retail outlets for themselves by becoming chain-store organizations.

RETAILING

Types of Retailing.—Goods reach consumers by retail in the following ways: by canvassing, that is, by sale from house to house; from samples; by peddling, that is, by sale from stock carried by wagon or truck or even from a pack carried on the

TABLE I.—*Retailing in the United States*
From Census of Business: 1935

Types of Operation	No. of Stores and Per Cent of Total					
	1935	%	1933	%	1929	%
Total, All Types	1,653,961	100·0	1,526,119	100·0	1,543,158	100·0
Individually Owned	1,474,149	89·1	1,349,356	88·4	1,375,509	89·1
Chains	127,482	7·7	141,676	9·3	148,037	9·6
Leased Dept's	7,181	·4	..	..	4,271	·3
Utility-operated	3,936	·3	4,127	·3	4,053	·3
Mail-order	378	..	311	..	271	..
Direct-selling	6,349	·4	6,934	·5	1,661	·1
Other Types	34,486	2·1	23,715	1·5	9,356	·6

	Volume of Sales (add 000)					
	1935	%	1933	%	1929	%
Total, All Types	$33,161,276	100·0	$25,037,225	100·0	$49,114,653	100·0
Individually Owned	24,246,112	73·1	17,846,332	71·3	38,081,504	77·5
Chains	7,550,186	22·8	6,372,554	25·4	9,834,846	20·0
Leased Dept's	156,111	·4	..	..	154,024	·3
Utility-operated	123,242	·4	76,079	·3	163,371	·3
Mail-order	420,027	1·3	244,381	1·0	515,237	1·0
Direct-selling	125,316	·4	107,813	·4	93,961	·2
Other Types	540,282	1·6	390,066	1·6	271,710	·7

back of the salesman; by sales made through circular or catalogue by mail; by retail stores owned by independent merchants, chain-store operators, department stores, company or commissary stores and consumers' co-operatives. During the early 1930s there was a rapid extension of house to house selling on such lines as groceries, meats, fruits, vegetables, dry goods, apparel, hosiery, home furnishings, soaps, spices, and patent medicines. In many cases specially constructed trucks or vans were used, veritable stores or shops on wheels. House to house selling by the canvassing method grew enormously during the years from 1921 to 1925 in the United States. There were similar periods of high activity in canvassing following 1893 and 1907, suggesting that this method of selling seems to thrive best in a time immediately following a business depression. The mail-order method of selling to consumers suffered severe declines following the business depression of 1920 and 1921, but has since regained its former position in the system of retail distribution. However, this method of retail selling has apparently reached its maturity in relation to other types of retailing. The leading mail-order concerns are now rapidly expanding into chain-store organizations. Department stores are, in general, showing slight gains in the communities in which they are situated. Individual department stores, here and there, however, continue to show remarkable growth. Chains have enjoyed the most rapid development since 1920, but in recent years even they show indications of having reached their maturity of relative growth. The single, independently owned stores, while hardest hit by competition of the newer types of retailing, are now apparently holding their own. There are now more of such retail stores than ever before. Table I gives the statistics of retailing for the U.S.A. as shown by the censuses of 1929, 1933, and 1935.

Concentrated Buying.—A part of the competitive battle for trade among the various types of institutions consists in the utilization of large buying power. Large chain-store systems, mail-order houses, and large department stores frequently purchase their goods direct from producers and secure the prices usually given wholesale purchasers. But concerns that buy direct from producers, and thereby eliminate the wholesalers, as a rule incur most of the usual expenses of wholesaling, such as interest on the investment in the larger stock of goods, storage risks, buying expense in dealing with numerous producers instead of a few wholesalers, extra record-keeping and, with chain-stores, reshipments to their various stores throughout the country. Since 1920 there has been a rapid development in group, co-operative, and central buying by independent retailers of all kinds. Such organizations are variously known as retailers' co-operatives, retailer owned wholesalers, and voluntary chains.

Comparative Costs of Marketing. — Much interest has centred on the possibility of determining relative economic efficiencies of the various types of marketing institutions by comparison of their respective costs of doing business. Table II shows average costs of operation, not only for wholesale but also for retail institutions.

Comparing the various methods of retailing, as exemplified in the ordinary independent stores, the department stores and the mail-order house, from such facts as are available, it does not seem possible to assert positively that any one method presents decided general economic advantages over the rest. Each presents certain advantages. Where there are differences in service these differences seem to be fully compensated in expense—that is, the public pays for what it gets and in proportion to what it gets.

Costs of selling through mail-order houses are not officially known. They are supposed to range from 18 to 30% of sales. But the knowledge of a general figure of this kind for a large mail-order house with many departments would be of little value for purposes of comparison with other kinds of businesses. Costs of selling in mail-order houses vary from department to department just as in department stores. All things considered, the general costs of running a large mail-order house are probably somewhat lower than those for a large department store handling similar classes of goods. The lower costs of selling, so far as consumers are concerned, are offset in part at least by the costs of transportation and other expenses incidental to ordering by mail.

The figures presented in Table II clearly show a wide range in costs from line to line, but they do not point conclusively to any important differences in costs of operation from one type of distribution to another. Differences in services rendered, not shown at all in the table, account for differences in costs. There are also wide differences in costs from concern to concern due to differences in management efficiency.

TABLE II.—*Marketing Costs**
Percentage on sales

	Wholesale			Retail		
	Lowest	Highest	Usual	Lowest	Highest	Usual
	%	%	%	%	%	%
Automotive Equipment	16	26	23·5	15	29	24
Clothing	12	18	16	20	30	24
Drugs	12	20	15	23	33	28
Dry Goods	11	17	14	15	30	23
Electrical Supplies	10	20	14	20	31	26
Groceries	5	15	9	9	22	14
Hardware	13	21	18	11	32	23
Jewellery	15	20	18	24	40	32
Shoes	12	26	15	13	34	24
Furniture				20	35	25
General merchandise				10	30	16
Department stores				18	32	28
Chain-stores (Shoes)				10	57	24
Chain-stores (5 and 10c)				..	..	26
Chain-stores (Groceries)				..	..	16
Chain-stores (Drugs)				..	..	28

*Compiled and adapted from reports of the Harvard bureau of business research, Northwestern university bureau of business research, several national trades associations and personal studies.

POSSIBLE ECONOMIES IN DISTRIBUTION

Avoidable Waste.—The following statements outline briefly a few of the details of distribution which it seems certain must receive attention in order to secure more economical distribution. No doubt many more could be added. Poor roads greatly increase the costs of bringing the farmers' crops and produce to market, costs that must be added to the price that consumers eventually pay. Inadequate truck and railway transportation is another element that makes a considerable addition to the costs.

Handling.—Delay in transportation as a factor of expense in distribution has not been given the attention that it deserves. Poor location of terminals makes a great deal of expensive cartage necessary. Congestion of traffic in city thoroughfares is a growing cause of increased costs in distributing goods. Inadequate, inefficient, poorly located storage facilities cause huge losses. Inadequate, unauthoritative and inaccurate collection and dissemination of market information such as is needed by producers, distributors and consumers is responsible for great waste. Through lack of such information business in many lines now passes constantly from glut to famine and back again. Poor packing of merchandise, inefficient loading, rough handling and uneconomical methods of handling are causes of waste and therefore of higher costs of distribution.

Salesmanship.—To refer more specifically to the activities of marketing through wholesalers and retailers, there is a startling loss of the wholesale salesman's time in finding customers, in making appointments, in fruitless interviews. The time of both salesmen and buyers is lost. Probably less than a sixth of a salesman's time, averaging salesmen of all classes, is actually employed in selling or even in displaying and describing merchandise. Anything that can be done to improve this condition would increase efficiency and decrease costs.

Advertising.—Advertising is or should be an invaluable aid to marketing. In the list of expenses of distribution it occupies a prominent place. There is certainly room for improvement in its administration. Much study has been given in some organizations to such problems as the proper selection of mediums and the right use of the space taken. No doubt much greater progress can and will be made in the future in these directions, but the greatest loss in advertising seems to be in the lack of faith of the public in the advertising. If people gave more credence to advertising, much less of it would be needed to secure the same result. The remedy, of course, lies in the direction of raising the standards and shutting out the dishonest advertiser. (*See* ADVERTISING.)

Duplication.—Duplication in delivery organizations by retail stores is a source of economic waste. There are many who think that there are too many retail stores. Would goods be sold for less if there were fewer? Probably not, because a large part of the competitive losses now occurring are borne by the dealers themselves in unpaid services. It may be argued that if their number were reduced the rentals for the locations that would be eliminated could be saved. This cannot be definitely checked by such experience as has been recorded in any public way. Concentration of retailing seems invariably to result in increasing rents. In fact, rents tend to increase faster than sales, so that the fewer the stores the higher the share of the landlord. More study is needed to determine the exact effects of restriction of the number of stores on costs of distribution. Further there is the fact that the store plant is unused for a large part of the time. Store hours are by custom and legislation steadily growing shorter. This means that the capital invested in stock and plant has fewer hours in which to produce.

Dishonesty.—Finally, there is undoubtedly an enormous loss due to unfairness and dishonesty, a loss that is now carried in large part if not wholly as an expense of distribution, being added to the price paid by the consumer. Failure to return containers lent by distributors seems a small item, but in such a business as milk distribution in large cities the loss to milk distributors due to non-return of empty bottles is enormous. Uncollectable debts and the cost of collecting delayed payments are important items in the expenses of distribution. Disregard of contracts in such matters as refusal of goods after placing orders, failure to deliver goods after orders are placed, abuse of the privilege to return goods, claims for adjustment and many other similar items make up large losses. Unfair competition, efforts made not to increase legitimate business but to impede or even to destroy competitors, commercial bribery, "graft" and the exercise of monopoly, all burden distribution expense far too much. A source of considerable loss is theft by employees, burglars and shoplifters. Some retail establishments count upon a fixed percentage on their sales representing losses due to this cause, a percentage that is added to the gross expenses which form part of the selling prices.

Many of the losses of the distributive business, including theft, breakage, fire and so on, are covered by insurance, the cost of which is carried as an expense against the distributing process. Anything that can be done to reduce these losses will by that much reduce expenses of distribution and prices of goods.

EDUCATION IN MARKETING

The leaks and wastes enumerated above are certainly responsible for at least a quarter of the present costs of marketing. They may be responsible for a third or even more. Here, then, is a great field for reducing costs by improving present methods. The first general step towards such improvement is education. Before 1860 the apprenticeship system was general in England and to some extent in America, in retail, wholesale, and importing houses. The apprenticeship system gradually broke down about the middle of the 19th century, and for years no systematic training was provided for young people other than the haphazard effect of their experience. The first training of modern salesmen in America seems to have been by the subscription book houses that flourished during the '70s and '80s. Their canvassers or book agents were thoroughly drilled or schooled in the art of selling or in securing orders.

During the '90s sales managers in specialty manufacturing concerns, notably the National Cash Register Company, of Dayton, O., began training their men in special schools held at the factory.

Training salespeople for retail stores seems to have begun in the '90s in such subjects as arithmetic, spelling and writing and, in 1905, in sales methods, under the auspices of the Women's Educational and Industrial Union in Boston. Educational service to salespeople and other workers is now commonly found in the better classes of both wholesale and retail stores. A beginning has been made also in education in distribution and marketing in colleges and public schools. Several colleges offer courses in marketing, selling, sales management and advertising. Many high schools give similar but more elementary courses. Trade associations have a marked educational bent in practically all lines pertaining to marketing. Through the trade associations better accounting, better advertising and better personnel work have been the objects of systematic educational programmes.

Training Through the Public Schools.—In 1936 a beginning was made by the nation as a whole in the encouragement of vocational training for retailing and the other distributive trades by the passage of the George-Deen Act of Congress appropriating a modest sum of money for distribution to the various States on the condition that they likewise appropriate similar sums to be used for instruction in these trades. Actual distributions of money were not begun until the latter part of 1937. The States have been prompt in their utilization of these funds and progress is being made in the inauguration of real training for marketing.

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II. IN GREAT BRITAIN

The work and methods of the large wholesale markets in London and Liverpool for wheat, raw cotton, wool and tea have now for long been familiar to students of marketing in Great Britain and Ireland. The lack of organization, however, and the inefficiency characteristic of the distributive process throughout the greater part of the United Kingdom have hitherto placed serious obstacles in the way of those who seek to investigate price margins and the profits of middlemen and retailers. Some of these barriers were temporarily removed during the World War. The increase in size of the business unit and a growing willingness on the part of these larger firms to furnish information when requested are gradually removing others. Economy imposed by rising costs and increasing competition from abroad will soon remove the remainder.

In the home trade, regarded from the producers' point of view, there can be distinguished at least five important marketing channels depending mainly, but not entirely, on the nature of the product handled. The simplest is that often adopted by the farmer, the market-gardener and fisherman. Here, arrangements are made with middlemen dealers for outright purchase of the crop or catch. What then happens is the concern of consumers alone. The other four methods apply primarily, but not exclusively, to manufactured goods. Of these the oldest, and still that most frequently employed, is distribution through wholesale merchants who sell to retailers who in turn sell to the consumers. In this case the producer employs no travellers and sets up no selling organization on his own account. If, however, he desires to sell a branded article (which is not infrequent in modern English industry) he may still use the same agents, but he has to advertise and himself employ travellers to canvass the retailer. Selling direct to consumer in retail shops set up and owned by the manufacturer constitutes the third plan. This is of growing importance in the drug and the boot and shoe trade. Again, the plan of canvassing consumers directly through the medium of specially trained salesmen has proved useful, but it appears to be more successful in America than in Great Britain. It is especially applicable to soap, books, corsets and household articles appealing to working class women. The remaining method, postal selling or mail order, is encouraged by the c.o.d. system for parcels worked through the post office. Potential customers are canvassed by letter, catalogue or press advertisement. This plan, however, in England is of more importance to the retailer than to the manufacturer. Generally, a combination of two or more of the five is employed in any comprehensive scheme of distribution.

In the older market organization many manufactured products often passed through four channels from producer to consumer: commission house, factor, wholesaler, retailer; but modern business conditions tend to lessen the number of middlemen and to transfer some of their functions to other agencies such as banks and transport undertakings. Yet, 90% of all groceries, 70% of hardware and dry goods and a smaller per cent of drugs, are sold through the manufacturer-wholesaler-retailer channel.

The wholesaler's services to the manufacturer embrace the provision of warehousing facilities in addition to supplying a complete selling organization, extending credit to retailers and often financing them. He also buys ahead and, therefore, takes risks as to price fluctuations and change of style. Further functions are the packing of goods and the conduct of their transport.

As long as independent manufacturers only are served the system works smoothly; but often wholesalers themselves brand goods and compete with the manufacturers whose goods they distribute. Sometimes they actually own and operate factories themselves. In the case of certain dry goods and silk articles wholesalers' brands are of long standing and cause no restlessness among manufacturers; but in groceries they are new and are the cause of much friction. Other types of middlemen include the sales agent, the factor and the broker; but it is no longer possible to define the precise scope of each of these classes.

The wholesaler works on fairly narrow margins of gross profit. In the drug trade he generally obtains 10% on proprietary articles and 12½% on sundries. In groceries the margin is 5%; but certain food-stuffs in which competition is especially keen leave him as little as 2½. In hardware and dry goods the figure normally exceeds 12½ and reaches 15 on proprietary goods in this group. The smaller the margin the greater is the tendency to instability; but on the other hand the greater also the probable turnover.

The retail shop method of selling is by far the most important in Great Britain. In its modern form it dates from the 1870's when rapidly changing price levels forced the older retailers out of their easygoing ways. The increasing variety of goods produced in consequence of improved manufacturing methods, the decay of industries conducted in the home, the increased urbanization of the population, all demanded from the shop owner a growing efficiency if he was to survive. Further, the rise of the department store constituted a new development which became inevitable when the size of stocks forced the retailer to classify his goods. From classification into sections it was but a step to make each department independent and self-supporting, and thus turn a general store into a group of specialized shops under one roof. Independent of this movement, but simultaneous with it, was the rise of the multiple shop firm. Then, later, came mail order and postal selling, and the concomitant advertising which greatly extended the scope of retail trade.

To-day the general shop is largely confined to villages. In the towns department stores and specialized shops are the rule. Of the two latter it would seem that the specialized shop has secured the greater economies in operation. That this is true of the multiple shop firms dealing each in a single class of commodities is not open to doubt; for figures confidential to the trade which have been worked out and analysed indicate in their favour a margin of 2 to 3% in the cost of conducting business. It is reckoned that this cost for a London department store should be about 10% below the figure for New York and for the provinces about 2% less than for London. This gives 16% for London and 14% for the rest of the country.

Perishable Foodstuffs.—The producers of perishable foodstuffs ordinarily sell their product outright to middlemen who seek to take advantage of the special circumstances which necessarily attend trade in these commodities. Apart, however, from the greater difficulties that growers of such produce must always encounter, the conservatism of all who handle these articles creates and maintains others for the existence of which no adequate justification can be found. It is true that old vested interests, such as market rights on the part of individuals or their assignees and surviving manorial privileges, offer many obstacles to improvement; but scarcely less important hindrances are the reluctance of the smaller British producers to form societies for co-operation in sale of produce and the inability of many existing markets, especially in the larger towns, to cope with a growing volume of business.

Fruit and Vegetable Markets.—In certain centres where local production is insufficient or erratic and foreign imports are needed to ensure supplies or where transport facilities and geographical situation are exceptionally favourable the markets for fruit and vegetables possess more than merely local importance. Many of these are well organized and are sensitive to price movements in other markets. Since, however, they draw a large proportion of their supplies direct from the producer, and these supplies are liable to fluctuation, they require an additional and a more reliable source from which to supplement the local output and from which special lines and imported supplies may be obtained to balance demand.

This source they find in the central markets at important ports, and especially in the Covent Garden market in London, which has become a national distributing centre for fruit and vegetables. Privately owned by the Covent Garden Estates Company, Ltd., this market handles not only produce raised within carting distance of London, which is required for London consumption, but also main crop produce in general demand, part of which is regularly reconsigned to other distributing centres, and certain produce in limited demand or supply, such as glass-house produce which commands a high price and most of which is reconsigned to other markets. Much of this reconsignment business is economically indefensible; but it cannot be replaced entirely by direct consignment to provincial markets until the latter become more developed and price movements in them much less liable to be influenced by small alterations in supply and demand.

Meat and Fish Markets.—Wholesale meat markets are generally owned and managed by local authorities, and exist only in those centres of population (not more than 20 in number) where the magnitude of possible trade justifies their establishment and where retailers are assured of adequate supply with wide range of quality and prices. In smaller towns the place of the municipally owned market is taken by wholesale butchers who purchase live stock, slaughter it and sell the meat to retail dealers; and in the city of Sheffield, where no meat market proper exists, the wholesalers sell at the slaughter-houses which they rent from the local authority. By far the largest and most important of wholesale meat markets proper is the London central market at Smithfield which in a single year handles between 400,000 and 500,000 tons, including 40% of the total imports of meat into the whole country. Unlike Covent Garden, it undertakes practically no reconsignment of produce to other wholesale markets; but its prices for both home and imported meat (although not officially issued under the imprimatur of the City of London Corporation, which is its owner and manager) are largely used as a basis for wholesale dealings in other parts of Great Britain.

In the foreign meat trade a network of depôts has been established by certain large distributing firms in all the principal cities and towns in the country. To them supplies of chilled or frozen meat are despatched from the ports of entry. They, therefore, serve as small markets from which retailers can secure supplies.

Fish is handled at Hull, Grimsby, Fleetwood, Aberdeen and other ports, usually by Dutch auction, and is distributed by the wholesale purchasers to their stalls and to representatives in certain provincial fish markets (Birmingham, Glasgow, Liverpool, Manchester and others) and also to the very important Billingsgate market in London.

Cereals.—Wheat is usually sold by sample in the local corn-market nearest the producer's home. Certain of these small markets, however, attract a considerable quantity of grain from areas outside their immediate neighbourhood, and some of the largest dominate large tracts of country, frequently serving as depôts for the receipt of both home-produced and imported wheat and for its export to other consuming centres. The purchasers at these local markets include millers among their number; but sale outright to merchants and sale by merchants or agents on commission are not uncommon, the latter being, perhaps, the usual plan in Scotland. Producers' co-operative societies may also be employed, which may sell direct to millers, or to merchants whom the larger milling-firms find it more convenient to employ in their purchasing of home-grown wheat in bulk.

Barley when sold for malting and distilling is usually sold in the larger market-towns by merchants acting on a commission basis on behalf of the farmer. Oats are largely consumed on the farms of the growers, but direct sale by the producer to oatmeal millers is common. Merchants, however, frequently buy outright for sale to large consumers such as collieries and railways.

After wheat is milled it is usually sold direct to bakers, confectioners or other users, generally through travellers employed by the milling companies. Occasionally factors or wholesale dealers intervene, who purchase from millers for resale on their own account to small bakers in the more sparsely populated districts. Distribution by this method is uncommon, however, in the case of home-milled flour; although imported flour is nearly always handled by wholesale dealers of this kind.

At the next stage, that of baking, a few firms in several of the more important centres of population confine themselves to a purely wholesale trade. A fair number attempt to combine partial retail distribution with wholesale manufacture and usually possess retail shops where the bread is sold over the counter direct to the consumer or from which door-to-door delivery by van may be undertaken. The majority of baking firms, however, confine themselves strictly to retail trade.

Poultry and Eggs.—Owing to the fact that British producers of poultry and eggs have no export trade to foreign markets, there is no obligation on them to conform to standardized methods in the disposal of their products. There is consequently great variety in the marketing of these commodities and the plan adopted by an individual producer depends partly on the scale upon which he is operating and partly on his situation relative to his market or his customers. Sale may take place (*a*) by private treaty in the producing area; (*b*) by auction in the producing area; (*c*) directly to distant distributors; (*d*) through commission salesmen in distant wholesale markets; (*e*) through co-operative societies. To the first of these classes may be assigned sales at local weekly markets of eggs and dressed poultry to local customers, sales by parcel post or rail direct to the consumer, sales from door to door often in conjunction with milk and vegetables, sales to local distributors in the nearest market town and sales at the farm. This latter plan is common throughout England and Wales, intermediaries known as higglers (also as cadgers and hagglers) going round in districts where the farms are scattered and distant from the larger consuming centres. The higgler calls at the farm with a vehicle once or twice a week, buys all the eggs and poultry available and pays cash without much regard to classification or to quality. He then resells privately or in open market to wholesale and retail distributors; but he may occasionally send consignments to wholesale markets for sale on commission. The system of selling by local auction has been greatly extended in recent years.

Costs of Distribution.—The costs of distribution vary considerably with the nature of the commodity handled, the method adopted and the degree of efficiency in the market organization available to the producer. In the case of cereals the fees paid by the farmers in the local corn-exchange are very small. Sixpence per day, one guinea per year, one penny on each occasion the market is entered, threepence per person entrance fee for sale by sample, are a few examples taken at random of the rentals and fees in actual operation at the present time. Cartage to the market or railway station is also the farmers' expense. This is reckoned at 1s. to 2s. 6d. per quarter of grain up to a distance of eight to ten miles. Merchants selling wheat on commission for growers are paid 9d. to 1s. per quarter or 2d. or 3d. per hundredweight. These figures are slightly higher in the cases of barley and oats. A rent ranging from two guineas to over eight guineas per annum is charged to merchants who operate in the local exchanges and who require stands, desks or space on the market floor. For fruit and vegetables the costs incurred in the complete marketing process are proportionally greater than for cereals. Considerable expense arises in the preparation of produce for the market. Cartage to railway station is estimated in Lincolnshire on the average to amount to 3s. to 4s. per ton. Railway charges are, on the whole, reasonable. In the distributive market itself porterage charges and market tolls are an additional burden and then there are the payments to the commission salesman for his services.

It is calculated that wholesalers make a net profit of about 2% on sales to retailers, and that the latter obtain a net profit of over 6% on the cost of the goods or a little under 4% on turnover.

Meat Costs.—In the meat trade the following estimates taken from the Linlithgow report exhibit well the costs incurred and prices paid and received in the passage of beef from the English farmer to consumers in larger industrial centres.

	£	s.	d.
Farmer receives for one animal from dealer at local market	31	0	0
Farmer's expenses (tolls, etc.)		9	3
Farmer's net receipts	30	10	9
Dealer receives from wholesale butcher	32	10	0
Dealer's expenses (rail, tolls, feeding, etc.)		18	6
Dealer's net profit		11	6
Wholesale butcher receives from retailer	30	3	9
Wholesale butcher receives for hide and offals	3	10	6
Gross receipts of wholesale butcher	33	14	3
Expenses of wholesale butcher (slaughtering)		13	2
Wholesale butcher's gross profit		11	1
Retailer's receipts from consumers	36	9	10
Retailer's payment to wholesale butcher	30	3	9
Retailer's gross profit	6	6	1

The weight of meat sold in this instance was 690 pounds. The net price paid by consumer being £36 9s. 10d. and the receipt from offals being £3 10s. 6d. the difference between the net price received by the farmer and the total made by meat and offals is, therefore, the difference between £40 0s. 4d. and £30 10s. 9d., *i.e.,* £9 9s. 7d. The corresponding differences for Wiltshire bacon and for pork were £3 14s. 7d. and £1 16s. 6d. for weights of 140 and 148 lb. respectively.

The same committee also collected figures showing the receipts from the sale of a forequarter of frozen beef weighing 187 lb. and costing £2 14s. 6½d. or 3½d. per pound. In this case £5 6s. 1½d. was realized, giving a gross profit of 48·6%. When it is remembered that the expenses of the retailer in the case of frozen meat are substantially less than in the case of home-killed meat, owing to the absence of slaughtering and dressing costs, the very remunerative character of trade in foreign meat is readily perceived. Again, competition appears to be less active in the retail meat trade generally than it was before 1914, and this notwithstanding an increase in the number of establishments since that date. It would seem to be the case that butchers, having been encouraged to purchase collectively during the war period, still combine to keep down prices both of stock and meat; and further that retailers to a considerable extent agree on the prices consumers are required to pay and on the whole refrain from underselling one another in open competition.

Poultry, Egg and Milk Costs.—In the selling of poultry and eggs at the local market, apart from the cost of conveying the produce to the place of sale, the vendor usually has to pay market tolls and, in the case of sales by auction, the auctioneer's fee. The average tolls charged (by the local authorities who usually own the markets) are ½d. to 2d. for poultry and from ¼d. per score to 6d. per hundred for eggs. Auction charges generally range from 5 to 7½% of the price realized and, consequently, are higher than those for selling live stock. This, no doubt, is because of the smaller value of the individual lots put up for sale. The higgler's profit in the districts where he flourishes is from 1d. to 2d. per doz. on eggs. This is not excessive; but his service, nevertheless, is not economical.

The dealer's business is more speculative, owing to the rapid fluctuations in prices from day to day and from market to market. His average profit of from 2d. to 4d. per doz. on eggs is, therefore, reasonable, especially as he provides boxes and pays transport charges. Commission salesmen's charge is 5% of the selling price, and wholesale dealers purchasing on their own account aim at a gross profit on eggs of about 2d. per doz. and from 2d. to 3d. per lb. on dead poultry. Probably it is in the retail section that profit margins in this trade are greatest and most open to question, 14% on eggs and 20 to 30% on poultry being the averages for the whole country. Producers complain that the difference between the prices they receive for poultry and those paid by the public has increased disproportionately in recent years.

Milk producers, acting through the National Farmers' Union, succeed in getting 1s. per gal. in summer and 1s.4½d. in winter when consumers pay 2s. and 2s.4d. respectively.

Co-operative Marketing.—The organization of producers on a co-operative basis for the disposal of their produce and for carrying out the processes involved in marketing is not a new development in Great Britain; but the progress made is insignificant compared with what has taken place elsewhere. Figures in the returns furnished to the chief registrar of friendly societies for the year ending March 31, 1925, referring to societies operating only in England and Wales, establish the fact that roughly about 3½% of the total value of agricultural produce marketed in England and Wales was handled by co-operative marketing societies or co-operative societies with marketing branches. The following table which is taken from No. 1, of the economic series published in 1925 by the Ministry of Agriculture and Fisheries (Great Britain), shows the number and turnover of agricultural marketing societies and certain other societies handling agricultural produce as part of their general trading during the period 1923–24. The table excludes turnovers in grain, hay, potatoes, etc., of general trading societies.

Commodity Handled.	Number of Societies.	Turnover.†
		£
Dairy produce	63	1,447,627
Eggs and poultry	43	349,262
Fruit and vegetables	18	301,932
Livestock*	9	375,128
Auction marts (live stock)	18	1,081,953
Slaughterhouses	11	415,270
Bacon factories	6	694,826**
Wool	13	200,000††
Total	181	4,865,998

*This entry covers societies selling live stock on behalf of members otherwise than through an auction mart owned or rented by the society.

†Turnover in respect of produce handled, and not necessarily total turnover of society.

**1924 figures.

††Estimated value.

These 181 societies are widely distributed without any union or centralizing agency which might secure joint action or otherwise look after common interests. Attempts have been made from time to time, but unsuccessfully, to federate them or to institute an advisory body to assist them to sell advantageously.

The present trend is in the direction of the several groups of societies forming their own trading federations on a commodity basis and thus falling into line with the general course of development towards larger scale marketing and trade. The growth under Government encouragement of export associations in the dominions for the marketing of agricultural produce in England and the formation of great co-operative pools by farmers in both the United States and Canada are adding seriously to the difficulties of the smaller home societies. Thus, the union of the latter is hastened under the stimulus of competition from imported produce; and trading federations of groups of such societies are rapidly growing in importance.

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(J. G. Sm.)

MARKET-PLACE, the mediaeval descendant of the Greek agora and the Roman forum (*qq.v.*); an open space, generally approximately rectangular. It was usually placed near the centre of the town, as in the market cross of Chester, at the intersection of the two main streets. The town hall (*see* GOVERNMENTAL ARCHITECTURE) was frequently built on the market-place, and occasionally its ground floor was open and served as additional market space.

A *market cross* was a monument topped by a cross, situated in the market-place; or the market-place itself, so-called from the monument.

MARKETS, PRIMITIVE: *see* TRADE, PRIMITIVE.

MARKHAM, SIR CLEMENTS ROBERT (1830–1916), C.B. (1871), K.C.B. (1896), English geographer and historical writer, son of the Rev. David F. Markham, canon of Windsor, was born on July 20, 1830 at Stillingfleet, near York, and went to Westminster school. He entered the navy in 1844 and passed for a lieutenant in 1851. In 1850–51 he served on the Franklin search expedition in the Arctic regions, under Captain Austin. He retired from the navy in 1852, and then travelled in Peru and the forests of the eastern Andes. In 1853 Markham entered the Civil service, and in 1854 was appointed on the board of control of the East India Company. He visited South America again in 1860, in order to arrange for the introduction of the cinchona plant into India, a service of the highest value. In 1865 he visited Ceylon and India, to report upon the Tinnevelly pearl-fishery and the cinchona plantations. From 1867–77 the geographical section of the India office was under his charge. On the Abyssinian expedition of 1867–68 he served as geographer, and was present at the storming of Magdala. He was elected F.R.S. in 1873. In 1875 he accompanied the Arctic expedition under Sir George Nares as far as Greenland. In later years Sir Clements Markham travelled extensively in western Asia and the United States. He was secretary to the Hakluyt Society from 1858–87, and its president from 1889–1909. From 1863–88 he acted as secretary to the Royal Geographical Society, and was elected president in 1893, retaining office for the unprecedented period of 12 years. He was president of the International Geographical Congress which met in London in 1895. It was almost entirely due to his exertions that funds were obtained for the National Antarctic Expedition under Captain Robert Scott, which left England in the summer of 1901. After his retirement from the India Office, he continued to devote himself to geographical research and travelled widely. He died in London on Jan. 30, 1916.

Sir Clements Markham conducted the *Geographical Magazine* from 1872–78, when it became merged in the *Proceedings of the Royal Geographical Society.* Among his many publications may be mentioned: *Peru* (1880); *The War between Chili and Peru* (1879–81; 3rd ed., 1883); *Life of John Davis the Navigator* (1889); a *Life of Richard III.* (1906); also lives of *Admiral Fairfax, Admiral John Markham, Columbus* and *Major Rennel;* a *History of Peru;* editions with introduction of 20 works for the Hakluyt Society, of which 14 were also translations; about 70 papers in the Royal Geographical Society's *Journal. The Lands of Silence,* an important history of Arctic and Antarctic exploration, was completed posthumously by Dr. H. H. Guillemard and published in 1921.

See Sir A. H. Markham, *The Life of Sir Clements Markham* (1917); Sir J. Scott Keltie, Memoir in *The Geographical Journal* vol. xlvii. (1916).

MARKHAM, EDWIN (1852–1940), an American poet, was born at Oregon City, State of Oregon, on April 23, 1852, but grew to manhood on a lonely but beautiful valley ranch in central California. He attended the State normal school at San José, and later graduated from Christian college at Santa Rosa, after which he became a high school principal and superintendent at various places and finally headmaster at the Tompkins Observation school, Oakland, connected with the University of California. This he gave up in 1899, after his poetry had won favour, and devoted himself to writing and lecturing. He gained national fame in 1899 with the newspaper publication of "The Man with the Hoe," his most widely known poem. It so well expressed the economic and social mood of the time that it was reprinted in nearly every newspaper of the country and was the subject of wide editorial comment. His first book of verse *The Man with the Hoe and Other Poems* (1899) was followed in 1901 by *Lincoln and Other Poems,* the dignified title piece of which found almost as much favour as "The Man with the Hoe." His third and fourth books of verse, *Shoes of Happiness* (1915) and *Gates of Paradise* (1920) show, perhaps, a higher general quality than the first two, though they lack single poems with such wide appeal. In 1937 he published *The Star of Araby.*

MARKHAM, GERVASE (or JERVIS) (1568?–1637), English poet and writer, third son of Sir Robert Markham of Cotham, Nottinghamshire, was born probably in 1568. He was a soldier of fortune in the Low Countries, and later was a captain under the earl of Essex's command in Ireland. He was acquainted with Latin and several modern languages, and had an exhaustive practical acquaintance with the arts of forestry and agriculture. He was a noted horse-breeder, and is said to have imported the first Arab. Very little is known of the events of his life. The story of the murderous quarrel between Gervase Markham and Sir John Holles related in the *Biographia Britannica* (*s.v.* Holles) has been generally connected with him, but in the *Dictionary of National Biography,* Sir Clements R. Markham, a descendant from the same family, refers it to a contemporary of the same name. Gervase Markham was buried at St. Giles's, Cripplegate, London, on Feb. 3, 1637.

Markham's writings include: *The most Honorable Tragedy of Sir Richard Grinvile* (1595), reprinted (1871) by Professor E. Arber; *The Poem of Poems, or Syon's Muse* (1595), dedicated to Elizabeth, daughter of Sir Philip Sidney; *Devoreux, Vertues Teares* (1597); *The Teares of the Beloved* (1600) and *Marie Magdalene's Teares* (1601) long and rather commonplace poems on the Passion and Resurrection of Christ, both reprinted by Dr. A. B. Grosart in the *Miscellanies of the Fuller Worthies Library* (1871); *Herod and Antipater, a Tragedy* (1622) was written with William Sampson, and with Henry Machin he wrote a comedy called *The Dumbe Knight* (1608). *A Discourse of Horsemanshippe* (1593) was followed by other popular treatises on horsemanship and farriery. *Honour in his Perfection* (1624) is in praise of the earls of Oxford, Southampton and Essex, and the *Souldier's Accidence* (1625) turns his military experiences to account. He edited Juliana Berners's *Boke of Saint Albans* under the title of *The Gentleman's Academie* (1595), and produced numerous books on husbandry, many of which are catalogued in Lowndes's *Bibliographer's Manual* (Bohn's ed., 1857–64).

MARKHAM, MRS., the pseudonym of ELIZABETH PENROSE (1780–1837), English writer, daughter of Edmund Cartwright the inventor of the power-loom. She was born at Goadby Marwood, Leicestershire, on Aug. 3, 1780. In 1804 she married the Rev. John Penrose, a voluminous theological writer. Mrs. Penrose took the *nom de plume* of "Mrs. Markham" from a village in Nottinghamshire. Her best known book was *A History of England from the First Invasion by the Romans to the End of the Reign of George III.* (1823), which went through numerous editions. In 1828 she published a *History of France.* The distinctive characteristic of "Mrs. Markham's" histories was the elimination of all the "horrors" of history, and of the complications of modern party politics, as being unsuitable for the youthful mind. "Mrs. Markham" died at Lincoln on Jan. 24, 1837.

See Samuel Smiles, *A Publisher and his Friends* (2 vols., 1891); G. C. Boase and W. P. Courtney, *Bibliotheca Cornubiensis* (3 vols., 1874–82).

ADAPTED FROM ZOOLOGICAL SOCIETY OF LONDON PHOTOGRAPH

MARKHOR (CAPRA FALCONERI)

MARKHOR ["snake-eater"], a large Himalayan wild goat (*Capra falconeri*), characterized by its spirally twisted horns and long shaggy winter coat. From the Pir-Panjal range of Kashmir, the region of the markhor extends westwards into Baltistan, Astor, Hunza, Afghanistan and the trans-Indus ranges of the Punjab. The twist of the horns varies locally.

MARKIRCH: *see* STE-MARIE-AUX-MINES.

MARKO KRALYEVIĆ, Serbian hero, was a son of the Serbian king or prince, Vukašin (d. 1371). Chagrined at not himself becoming king after his father's death, he headed a revolt against the new ruler. Later he took service with the sultan, and was killed in battle about 1394. Stories of strength and wonder have gathered round his name. He is supposed to have lived for 300 years, to have ridden a horse 150 years old, and to have used his enormous physical strength against oppressors, especially against the Turks. He is a great figure in Serbian poetry, and his deeds are also told in the epic poems of the Rumanians and the Bulgarians. One tradition relates how he retired from the world owing to the advent of firearms, which, he held, made strength and valour of no account in battle.

The Serbian poems about him were published in 1878; a German translation by Gröber (*Marko, der Königssohn*) appeared at Vienna in 1883.

MARK SYSTEM. At the middle of the 19th century, the opinion prevailed widely among scholars that throughout the Germanic world society tended to be organized in communities whose members claimed kinship with each other, cultivated their lands in common, and administered justice in their own assemblies. It was held that these communities were known as "Marks," from the march, or boundary, which separated each from its neighbours, and that traces of their existence still survive in the numerous place-names containing the element *-ing,* which are found in all regions of Germanic settlement. Later research proved that early Germanic society was far more complicated than the framers of this theory had realized, and demonstrated a strong element of individualism in primitive Germanic law. On the philological side it has been shown that the element *-ing* bore a far wider sense than that of kindred alone, that, for example, the original *Readingas* of Reading are as likely to have been the free and unfree dependents of *Read* as his actual or reputed kinsmen. The Mark theory, in fact, was much too simple an explanation of the complex phenomena of primitive society, but it still deserves respect as one of the great constructive generalizations which have determined the direction of research into the problems of social history. (F. M. S.)

MARL, a calcareous clay, or mixture of calcium carbonate and argillaceous matter. The term (from O.Fr. *marle,* late Lat. *margila,* dim. of *marga: cf.* Du. and Ger. *Mergel*), is applied to a great variety of rocks and soils with a considerable range of composition. Marls pass, on the one hand, into clays by diminution in the amount of lime, and on the other, into argillaceous limestones; in popular usage, however, many substances are called marls which would be better termed sandy clays. The practice, formerly more extensively in vogue, of top-dressing land with marls to increase fertility, and the use of many different kinds of earth and clay for that purpose, has led to a general misapplication of the term.

Typical marls are soft, earthy and of a white, grey or brownish colour. The lime of some is present in the form of shells, whole or broken (as in the Coralline Crag of East Anglia, the Oligocene marls of the Isle of Wight, etc.); in others it is a fine impalpable powder mixed with the clay. Sand is usually not abundant, but is rarely absent. A large variety of accessory minerals may be proved by microscopic examination to exist in marls. In the Keuper Marls (Trias) of England, small perfect dolomite crystals have been found. Individual crystals or large masses of concretionary gypsum, celestine and strontianite are found in such deposits and are valuable economically. While marls are frequently shallow-water marine deposits, many well-known examples are of fresh-water origin. Such are the Purbeck and Oligocene marls of the south of England. (P. G. H. B.)

MARLBOROUGH, EARLS AND DUKES OF. The earldom of Marlborough was held by the family of Ley from 1626 to 1679. JAMES LEY, the 1st earl (*c.* 1550–1629), was lord chief justice of the King's Bench in Ireland and then in England; he was an English member of parliament and was lord high treasurer from 1624 to 1628. In 1624 he was created Baron Ley and in 1626 earl of Marlborough.

In 1689 John Churchill was created earl and in 1702 duke of Marlborough (*see* below). After the death of his only son Charles in 1703 an act of parliament was passed in 1706 settling the duke's titles upon his daughters and their issue; from them the present family is descended.

The 7th duke of Marlborough, JOHN WINSTON SPENCER-CHURCHILL (1822–83), a prominent Conservative, was lord-lieutenant of Ireland 1876–1880, and when marquess of Blandford (the courtesy title borne by the duke's eldest son in his father's lifetime) was responsible for the act of 1856 called the "Blandford Act," enabling populous parishes to be divided for purposes of Church work.

MARLBOROUGH, JOHN CHURCHILL, 1ST DUKE OF (1650–1722), English soldier, was born in the small manor house of Ash, in Musbury, Devonshire, the son of Winston Churchill of Glanville Wotton, Dorset. He went to St. Paul's school from 1663 to 1665. When fifteen he became page of honour to the duke of York, and about the same time his sister Arabella became maid of honour to the duchess, two events which contributed greatly to the advancement of the Churchills. In 1667 he received through the influence of his master a commission in the Guards, and left England for service at Tangier but returned home in 1670. For a short interval Churchill remained in attendance at the court, and it was during this period that his natural carefulness was shown by his investing in an annuity a present of £5,000 given him by the duchess of Cleveland.

In 1672, when England sent 6,000 troops to aid Louis XIV. in his attempt to subdue the Dutch, Churchill was made a captain in the company of which the duke of York was colonel, and soon attracted the attention of Turenne, especially at the siege of Nimeguen. When Maestricht was besieged in June 1673 he saved the life of the duke of Monmouth, and received the thanks of Louis XIV. In 1678 he married Sarah Jennings (b. June 5, 1660), the favourite attendant on the Princess Anne, younger daughter of the duke of York.

On the accession of James II. the Churchills received a great increase in fortune. Colonel Churchill had been created a Scotch peer as Lord Churchill of Eyemouth in Dec. 1682; and for his services on a special mission from the new monarch to Louis XIV. he was made in May 1685 Baron Churchill of Sandridge in Hertfordshire. When the duke of Monmouth attempted his ill-fated enterprise in the western counties, the second position in command of the king's army was bestowed on Lord Churchill, and in July 1685 he was raised to the rank of major-general. Through his energy at the battle of Sedgemoor (July 6) the king's side was victorious. After the death of Monmouth he withdrew as far as possible from the administration of public business. Whilst on his embassy to the French court he had declared that if the king of England should change the religion of the state he should leave his service, and it was not long before the design of James became apparent. Churchill was one of the first to send overtures of obedience to the prince of Orange, to whom he had gone on a commission in 1678. Although he continued in a high position under James and drew the emoluments of his places, he promised William of Orange to use every exertion to bring over the troops to his side. James had been warned against him, but the warnings were in vain, and on the landing of the Dutch prince at Brixham Churchill was promoted to be lieutenant-general (Nov. 7, 1688) and was sent against him with 5,000 men. When the royal army had advanced to the downs of Wiltshire and a battle seemed imminent, James was dismayed to find that at night his general had gone to the opposite camp.

Churchill was sworn as a privy councillor in Feb. 1688–89 and in April became earl of Marlborough. William felt, however, that he could not place implicit reliance in his friend's integrity; and, with a sense of the manner in which Marlborough's talents might be employed without detriment to the stability of his throne, he sent him in June 1689 with the army into the Netherlands, and in the autumn of 1690 into Ireland, where owing to his generalship Cork and Kinsale fell into his hands after short sieges. For some time there was no open avowal of any distrust in Marlborough's loyalty, but in May 1692 he was thrown into the Tower on an accusation of treason. Though the evidence against him was slight, and he was released, there is no doubt that Marlborough was in close relations with the exiled king at St. Germain, and that he even went so far as to disclose, in May 1694, to his late master the intention of the English to attack Brest. During the Fenwick plot of 1696 he was charged again with treason, but William ignored the accusation.

During the last years of William's reign Marlborough once more was placed in positions of responsibility. Higher honours came on the accession of Anne in March 1702. He was appointed a Knight of the Garter, captain-general of the English troops both at home and abroad, and master-general of the ordnance. A week or two after the death of William it was agreed by England, Holland and Austria that war should be declared against France on the same day, and on May 4, 1702 the War of the Spanish Succession was declared by the three countries. Marlborough was made commander-in-chief of the united armies of England and Holland, but throughout the war his plans were impeded by the jealousy of the commanders who were nominally his inferiors, and by the opposite aims of the allied countries. He himself wished to penetrate into the French lines; the anxiety of the Dutch was for the maintenance of their frontier and for an augmentation of their territory; the desire of the Austrian emperor was to secure that his son the Archduke Charles should rule Spain. In the first year of the campaign it was shown that the armies of the French were not invincible. Several fortresses which Louis XIV. had seized upon surrendered to the allies; Kaiserswerth on the Rhine surrendered in June; Venlo on the Meuse in Sept., and Liége on Oct. 29. For these brilliant exploits Marlborough was raised (Dec. 14, 1702) to be duke of Marlborough, and received £5,000 per annum for the queen's life. His only surviving son, the marquess of Blandford, was seized whilst at King's College, Cambridge, with smallpox, and died on Feb. 20, 1703.

The result of the campaign of 1703 inspired the French king with fresh hopes. The plans of Marlborough were frustrated by his Dutch colleagues. When he wished to invade the French territory they urged him to besiege Bonn, and he was compelled to give way. It surrendered in May, whereupon he returned to his original plan of attacking Antwerp; but because of the incapacity of the Dutch leaders, the French surprised the Dutch division in June and inflicted on it a loss of many thousands of men. Marlborough was forced to abandon his enterprise, and all the compensation which he received was the capture of the insignificant forts of Huy and Limburg. After a year of comparative failure for the allies, Louis XIV. entered upon an offensive movement against Austria; and Marlborough, smarting under the misadventures of 1703, was eager to meet him. The French were sent to join the forces of the elector of Bavaria and to march by the Danube to seize Vienna. Marlborough divined their intention, and while making a feint of marching into Alsace led his troops into Bavaria. The two armies met near the village of Blenheim on the left bank of the Danube. The early part of the fight was in favour of the French. Three times were the troops led by Prince Eugène, which were attacking the Bavarians, the enemy's left wing, driven back in confusion; Marlborough's cavalry failed on their first attack in breaking the line of the enemy's centre. But in the end the victory of the allies was conclusive. Nearly 30,000 of the French and Bavarians were killed and wounded, and 11,000 of the French who had been driven down to the Danube were forced to surrender. Bavaria fell to the allies. Poets and prose writers were employed to do Marlborough honour, and the lines of Addison comparing the English commander to the angel who passed over "pale Britannia" in the storm of 1703 have been famous for over two centuries. The manor of Woodstock, which was transferred by act of parliament from the crown to the duke, was a reward more after his own heart. A palace was built in the park at the royal expense, and £240,000 of public money was spent on the buildings. Marlborough was also created a prince of the empire and the principality of Mindelheim was formed in his honour.

During the following year Marlborough was hampered by tedious formalities at The Hague and by jealousies at the German courts. The armies of the French were again brought up to their full standard, but the generals of Louis were instructed to entrench themselves behind earthworks and to act on the defensive. On a July night these lines were broken through near Tirlemont, and the French were forced to shelter in Louvain. Marlborough in vain urged an attack, and when 1705 had passed away the forces of the French king had suffered no diminution. This tempted Villeroi in the next spring into meeting the allies in an open fight. But through the superior tactics of Marlborough the battle of Ramillies (May 23, 1706) ended in the total rout of the French, and caused the transference of nearly the whole of Brabant and Flanders to the allies. Five days afterwards the victor entered Brussels in state, and the inhabitants acknowledged the rule of the archduke. Antwerp, Ostend, Menin and Dendermonde soon surrendered. Again a year of triumph was succeeded by a period of depression. During 1707 fortune inclined to the other side, with the result that in July 1708 Ghent and Bruges returned to the allegiance of the French, and Marlborough, fearing that their example might be followed by other cities, advanced towards Oudenarde. The battle, which raged on the high ground above Oudenarde, ended in the defeat of the French (July 11, 1708).

Marlborough then wished to advance on Paris, but he was overruled. The allied army invested the town of Lille, and after nearly four months, and a loss to the combatants of 30,000 men, the citadel surrendered in December. By the end of the year Brabant was again subject to the allies. The French king sued for peace, and Torcy his minister endeavoured by promises of large sums to obtain the support of Marlborough to his proposals. These attempts were vain, and when the winter passed a French army of 110,000, under the command of Villars, took the field. In Sept. 1709 Tournay capitulated, and the two leaders, Marlborough and Eugène, led their forces to Mons. For the last time during the protracted war the two armies met in fair fight at Malplaquet, on the south of Mons (Sept. 11, 1709). The fight was long and doubtful, and although the French ultimately retreated, it was in good order, and their losses were less than those of their opponents. The campaign lasted for a year or two after this indecisive contest, but it was not signalized by any such "glorious victory" as Blenheim. The French concentrated on the construction of fresh lines of defence, and the war dragged on until the Peace of Utrecht in June 1712.

These victories had not prevented the position of Marlborough from being undermined by party intrigues at home. In the early part of Anne's reign his political friends were among the Tories, and the ministry under Sidney Godolphin was chiefly composed of members of that party. After a year or two, however, the more ardent Tories withdrew, and two younger adherents of the same cause, Harley and St. John, were introduced in May 1704 into the ministry. The duchess, partly through the influence of her son-in-law, the earl of Sunderland, who came into office against the queen's wish in Dec. 1706, and partly through the opposition of the Tories to the French war, had gone over to the Whig cause, and she pressed her views on the sovereign with more vehemence than discretion. The love of the two friends changed into hate, and no opportunity for humiliating the family of Marlborough was allowed to pass. Sunderland and Godolphin were the first to fall (July–Aug. 1710); a few months later the duchess was dismissed from her offices; and the fall of Marlborough himself came on the last day of 1711. He went to the Continent in Nov. 1712 and remained abroad until the death of Anne (Aug. 1, 1714).

Then he once more returned to England and resumed his old military posts, but he took little part in public affairs. He died on June 16, 1722, at Cranbourn Lodge, near Windsor. His remains were deposited in Westminster Abbey, in the vault at the east end of King Henry VII.'s chapel, but they now rest in a mausoleum in the chapel at Blenheim. His widow, to whom must be assigned a considerable share both in his rise and in his fall, survived till Oct. 18, 1744. To Pitt she left £10,000 and to Chesterfield twice that sum and a reversionary interest in her landed property at Wimbledon.

The rapid rise of Marlborough to the highest position in the State was due to his singular tact and his diplomatic skill in the management of men. Through his consideration for the welfare of his soldiers he held together for years an army drawn from every nation in Christendom. Alike in planning and in executing, he took infinite pains in all points of detail. Nothing escaped his observation, and in the hottest moment of the fight the coolness of his intellect was conspicuous. His enemies affected to attribute his uniform success to fortune, and they magnified his love of money by drawing up balance sheets which included every penny which he had received, but omitted the pounds which he had spent in the cause he had at heart. All that can be alleged in excuse of his attempts to serve two masters, the king whom he had deserted and the king who had received him into favour, is that not one of his associates was without sin in this respect.

Bibliography.—Marlborough's *Letters and Despatches* were edited by Sir George Murray (5 vols., 1845). See *Lives* by W. Coxe (3 vols. 1818–19) and by G. J. Wolseley (1894); G. Saintsbury, *Marlborough* (1885); S. J. Reid, *John and Sarah, Duke and Duchess of Marlborough* (1914); E. Thomas, *The Life of the Duke of Marlborough*, (1915); F. Taylor, *The Wars of Marlborough, 1702–09* (2 vols. 1921); C. T. Atkinson, *Marlborough and the Rise of the British Army* (1921); H. G. Edwards, *A Short Life of Marlborough* (1926); D. B. Chidsey, *Marlborough* (1929). *See* also the article by Sir Leslie Stephen in the *Dict. Nat. Biog.* which gives a full bibliography of the older works.

MARLBOROUGH, a market town and municipal borough in the Eastern parliamentary division of Wiltshire, England, 75¾ mi. W. of London by rail. Pop. (1938) 4,678. Area, 2.3 sq.mi. It is near Savernake forest, and in the valley of the river Kennet.

The antiquity of Marlborough is shown by the Castle mound, an earthwork, which local legend makes the grave of Merlin; and the name of Marlborough has been regarded as a corrupt form of Merlin's berg or rock. Near the site of the modern Marlborough (Merleberge, Marleberge) was originally a Roman *castrum* called Cunetio, and later there was a Norman fortress in which William I. established a mint. In Domesday it was royal demesne. The castle, built under Henry I., by Roger, bishop of Salisbury, was held for Matilda against Stephen, and became a favourite residence of Henry II., Savernake being a royal deer-park. In 1267 Henry III. held his last parliament here, at which the Statute of Marlborough was passed. Marlborough was captured by the royal forces in 1642, and partly burnt. The town was constituted a suffragan see by Henry II. Sacheverell, the politician and divine, was born here in 1674, and educated at the grammar school. In 1653 the town was nearly destroyed by fire, and it again suffered in 1679 and 1690; after which an act was passed forbidding the use of thatch. Marlborough, from its position on the Great Bath road, was a famous coaching centre.

The first charter was granted by John in 1204, and conferred a gild merchant, together with freedom from all pleas except pleas of the Crown and from all secular exactions by sea and land. Later charters were obtained from Henry IV. in 1407 and from Elizabeth in 1576. The former granted some additional exemptions whilst the latter incorporated the town under the title of mayor and burgesses of Marlborough. Marlborough returned two members to parliament until 1867 when the number was reduced to one, and in 1885 the representation was merged in that of the county.

There is one broad street in which most of the houses are Jacobean, those on the north side having projecting upper stories. St. Peter's church, a Perpendicular building, is said to have been the scene of the ordination of Cardinal Wolsey in 1498. The church of Preshute, largely rebuilt, but preserving its Norman pillars, has a curious piscina, and a large black basalt font dating from 1100–50. There is a 16th century grammar school. Marlborough college was opened in 1843, originally for the sons of clergymen. The town's trade is mainly agricultural.

MARLBOROUGH, a city of Middlesex county, Massachusetts, U.S.A., 28 mi. W. of Boston, on federal highway 20, and served by the Boston and Maine and the New York, New Haven and Hartford railways. Pop. (1940) 15,154, federal census. The city occupies 21 sq.mi. in a fertile, hilly region, and has several lakes, including beautiful Williams pond, within its borders. Its manufactures (especially boots, shoes, small metal goods, paper boxes) had a total output in 1940 valued at $15,000,000. The town of Marlborough was incorporated in 1660. It was destroyed by the Indians in March 1676, during King Philip's War, and was abandoned for a year. In 1890 it was incorporated as a city.

MARLIN, a city of Texas, U.S.A., 100 m. S. of Dallas, near the Brazos river; the county seat of Falls county and an important health resort. It is served by the Missouri Pacific and the Southern Pacific railways. Pop. (1930) 5,338 (34% Negroes); 6,542 by the federal census in 1940. It has sanatoria, clinics and hotels developed to utilize the waters (147° F) of its mineral wells, which send out 380,000 gal. a day. The city was founded in 1848 and named after a pioneer settler. It has made steady growth, due to the fertility of the black waxy prairie and river bottomlands surrounding it. In 1890 the city engaged an artesian-well driller to provide a well of soft water. At a depth of 3,350 ft. he struck a flowing well of hot mineral water. The first bath-house was built in 1895, and after that the development of facilities for treatment proceeded rapidly.

MARLOW, a town and urban district in Buckinghamshire, England, on the Thames, 31½ mi. W. of London by G.W.R. Pop. (1938) 5,364. Area 2.5 sq.mi. Great Marlow appears as a manor in Domesday Book, but its "borough and liberties" are not mentioned before 1261. It was then held by the earls of Gloucester, and its importance was probably due to the bridge across the Thames, first built, according to tradition, by the Templars at Bisham. In 1342 the mayor and burgesses presented to a chantry and continued to be patrons till 1394. A market was held by the Despensers who had succeeded the De Clares as lords of the manor in the 14th century. In the 16th century the market was given up, but was revived and held in the 18th century, only to disappear again before 1862. In 1792 there were two fairs, one of which, for horses and cattle, is still held on Oct 29. Lace and satin-stitch work used to be made to a considerable extent. A weir and lock, near the modern church of All Saints, separate two reaches of the river, and the town is a boating and fishing resort. The village of Little Marlow, with foundations of a Benedictine nunnery of the time of Henry III, lies near the river 2 miles below. The town is mainly modern, but a few old houses remain, such as the grammar school, founded as a bluecoat school in 1624, adjoining which is a house occupied by the poet Shelley in 1817. Brewing is the chief industry.

MARLOWE, CHRISTOPHER (1564–1593), English dramatist, the father of English tragedy, and instaurator of dramatic blank verse, the eldest son of a shoemaker, was born in Canterbury on Feb. 6, 1564. He was christened at St. George's Church, Canterbury, on Feb. 26, 1563/4, some two months before Shakespeare's baptism at Stratford-on-Avon. His father, John Marlowe, is said to have been the grandson of John Morley or Marlowe, a substantial tanner of Canterbury. The father, who survived by a dozen years or so his illustrious son, married on May 22, 1561 Catherine, daughter of Christopher Arthur, at one time rector of St. Peter's, Canterbury, who had been ejected by Queen Mary as a married minister. The dramatist had as fellow pupils at the King's School, Canterbury, Richard Boyle, afterwards earl of Cork, and Will Lyly, the brother of the dramatist. He matriculated at Benet (Corpus Christi) College, on March 17, 1571, taking his B.A. degree in 1584, and that of M.A. three or four years later.

Francis Kett, the mystic, burnt in 1589 for heresy, was a fellow and tutor of his college, and may have had some share in developing Marlowe's opinions in religious matters. Marlowe's classical acquirements were of a kind which was then extremely common, being based for the most part upon a minute acquaintance with Roman mythology, as revealed in Ovid's *Metamorphoses.* His spirited translation of Ovid's *Amores* (printed 1596), was at any rate commenced at Cambridge. His translation of "The First Book of Lucan," printed posthumously in 1600, belongs to the last years of his short life. The famous lyric, "Come live with me and be my love" was first printed in its entirety in *England's Helicon* (1600). *Hero and Leander,* based on Musacus, also belongs to the last years. Before 1587 he seems to have quitted Cambridge for London; of his life there, apart from his four great theatrical successes and his connection as a dramatist with the Lord Admiral's and Strange's companies, we know hardly anything; but he evidently knew Thomas Kyd, who shared his unorthodox opinions. Nash criticized his verse, Greene affected to shudder at his atheism; Gabriel Harvey maligned his memory.

On the other hand, Marlowe was intimate with the Walsinghams of Scadbury, Chiselhurst, kinsmen of Sir Francis Walsingham: he was also the personal friend of Sir Walter Raleigh, and perhaps of the poetical earl of Oxford, with both of whom, and with Walter Warner and Robert Hughes the mathematicians, Thomas Harriott the astronomer, and Matthew Royden, the dramatist is said to have met in free converse. He seems at least to have been associated with what was denounced as Sir Walter Raleigh's school of atheism, and to have dallied with opinions which were then regarded as putting a man outside the pale of civilized humanity. In October 1588 Marlowe gave bail for his appearance for an unspecified offence. Serious charges were brought in 1593. As the result of some depositions made by Thomas Kyd under the influence of torture, the Privy Council were upon the eve of investigating some charges against Marlowe when his career was abruptly terminated. Thanks to the researches of Dr. Hotson, it is now established definitely on the evidence of documents in the Public Record Office, that Marlowe was killed by a companion of his, one Ingram Frizer, at an inn at Deptford on May 30th, 1593. Frizer and Marlowe, together with two friends named Robert Poley and Nicholas Skeres, had repaired to the inn to dine and sup. A quarrel arose about paying the bill; Marlowe in a sudden fit of temper attacked Frizer from behind. Frizer in the ensuing struggle stabbed Marlowe, who died instantly. Frizer was subsequently pardoned, as having killed Marlowe in self-defence. A full account of the documentary evidence which supports these facts is given in Dr. Hotson's book, *The Death of Christopher Marlowe* (1925). Dr. Hotson points out that it is important to note that Ingram Frizer was, in the relevant documents, described as "gentleman" and did not forfeit the good graces of his employers, the Walsinghams, who were friends of the man whom he slew.

Thus the various stories of Marlowe's death, as retailed by Thomas Beard (*The Theatre of God's Judgments*) in 1597, Francis Meres in his *Palladis Tamia* (1598), Anthony à Wood in his *Athenae Oxonienses* (1691) and repeated by later writers, may be dismissed as mere legend.

Marlowe was buried on June 1, 1593, at Deptford.

Marlowe's career as a dramatist lies between the years 1587 and 1593, and his four great plays are *Tamburlaine the Great,* an heroic epic in dramatic form divided into two parts of five acts each (*c.* 1587, printed in 1590); *Dr. Faustus* (1588, entered at Stationers' Hall 1601); *The Famous Tragedy of the Rich Jew of Malta* (dating perhaps from 1589, acted in 1592, printed in 1633); and *Edward the Second* (printed 1594). The very first words of *Tamburlaine* sound the trumpet note of attack in the older order of things dramatic:—

> From jigging veins of riming mother wits
> And such conceits as clownage keeps in pay
> We'll lead you to the stately tent of war,
> Where you shall hear the Scythian Tamburlaine
> Threatening the world with high astounding terms
> And scourging kingdoms with his conquering sword.

It leapt with a bound to a place beside Kyd's *Spanish Tragedy,* and few plays have been more imitated by rivals (Greene's *Alphonsus of Aragon,* Peele's *Battle of Alcazar, Selimus, Scanderbeg*) or more keenly satirized by the jealousy and prejudice of out-distanced competitors. Other plays in which Marlowe is said to have had a share are *The Massacre at Paris* (1593), printed in his name; *Dido, Queen of Carthage* (1593), with Nashe; *Lust's Dominion* (*c.* 1600), the original draft of which may have been by Marlowe; and the lost play, *The Maiden's Holiday,* in the list of plays burnt by Warburton's cook. Some critics have traced his hand in other plays, among these being the Shakespearian *Titus Andronicus, Henry VI.,* and *Richard III.* The following notes on the plays and on the poems are taken from the article written by Swinburne for the 9th ed. of the *Encyclopædia Britannica.* (T. S.; X.)

Estimate on the Plays.—With many and heavy faults, there is something of genuine greatness in *Tamburlaine the Great;* and for two grave reasons it must always be remembered with distinction and mentioned with honour. It is the first poem ever written in English blank verse, as distinguished from mere rhymeless decasyllabics; and it contains one of the noblest passages, perhaps indeed the noblest, in the literature of the world, ever written by one of the greatest masters of poetry in loving praise of the glorious delights and sublime submission to the everlasting limits of his art.

The just and generous judgment passed by Goethe on the *Faustus* of his English predecessor in tragic treatment of the same subject is somewhat more than sufficient to counterbalance the slighting or the sneering references to that magnificent poem which might have been expected from the ignorance of Byron or the incompetence of Hallam. What most impressed the author of *Faust* in the work of Marlowe was a quality the want of which in the author of *Manfred* is proof enough to consign his best work to the second or third class at most. "How greatly it is all planned!" the first requisite of all great work, and one of which the highest genius possible to a greatly gifted barbarian could by no possibility understand the nature or conceive the existence.

Tamburlaine is monotonous in the general roll and flow of its stately and sonorous verse through a noisy wilderness of perpetual bluster and slaughter; but the unity of tone and purpose in *Doctor Faustus* is not unrelieved by change of manner and variety of incident. In the vision of Helen, for example, the intense perception of loveliness gives actual sublimity to the sweetness and radiance of mere beauty in the passionate and spontaneous selection of words the most choice and perfect; and in like manner the sublimity of simplicity in Marlowe's conception and expression of the agonies endured by Faustus under the immediate imminence of his doom gives the highest note of beauty, the quality of absolute fitness and propriety, to the sheer straightforwardness of speech in which his agonizing horror finds vent.

It is now a commonplace of criticism to observe and regret the decline of power and interest after the opening acts of *The Jew of Malta.* This decline is undeniable, though even the latter part of the play (the text of which is very corrupt) is not wanting in rough energy; but the first two acts would be sufficient foundation for the durable fame of a dramatic poet. In the blank verse of Milton alone—who perhaps was hardly less indebted than Shakespeare was before him to Marlowe as the first English master of word-music in its grander forms—has the glory or the melody of passages in the opening soliloquy of Barabbas been possibly surpassed.

In *Edward the Second* the interest rises and the execution improves as visibly and as greatly with the course of the advancing story as they decline in *The Jew of Malta.* The scene of the king's deposition at Kenilworth is almost as much finer in tragic effect and poetic quality as it is shorter and less elaborate than the corresponding scene in Shakespeare's *King Richard II.*

Of *The Massacre at Paris* (acted in 1593, printed 1600?) it is impossible to judge fairly from the garbled fragment of its genuine text which is all that has come down to us. To Mr. Collier, among numberless other obligations, we owe the discovery of a noble passage excised in the piratical edition which gives us the only version extant of this unlucky play.

In the tragedy of *Dido, Queen of Carthage* (completed by Thomas Nashe, produced and printed 1594), a servile fidelity to the text of Virgil's narrative has naturally resulted in the failure which might have been expected from an attempt at once to transcribe what is essentially inimitable and to reproduce it under the hopelessly alien conditions of dramatic adaptation.

The Poems—One of the most faultless lyrics and one of the loveliest fragments in the whole range of description and fanciful poetry would have secured a place for Marlowe among the memorable men of his epoch, even if his plays had perished with himself. His *Passionate Shepherd* remains ever since unrivalled in its way—a way of pure fancy and radiant melody without break or lapse. The untitled fragment, on the other hand, has been very closely rivalled, perhaps very happily imitated, but only by the greatest lyric poet of England—by Shelley alone. Marlowe's poem of *Hero and Leander* (entered at Stationers'

Hall in September 1593; completed and brought out by George Chapman, who divided Marlowe's work into two sestiads and added four of his own, 1598), closing with the sunrise which closes the night of the lovers' union, stands alone in its age, and far ahead of the work of any possible competitor between the death of Spenser and the dawn of Milton.

The place and the value of Christopher Marlowe as a leader among English poets it would be almost impossible for historical criticism to over-estimate. To none of them all, perhaps, have so many of the greatest among them been so deeply and so directly indebted. Nor was ever any great writer's influence upon his fellows more utterly and unmixedly an influence for good. He first, and he alone, guided Shakespeare into the right way of work; his music, in which there is no echo of any man's before him, found its own echo in the more prolonged but hardly more exalted harmony of Milton's. He is the greatest discoverer, the most daring and inspired pioneer, in all our poetic literature. Before him there was neither genuine blank verse nor a genuine tragedy in our language. After his arrival the way was prepared, the paths were made straight, for Shakespeare. (A. C. S.)

Marlowe's fame, so finely appreciated by Shakespeare and Drayton, was obscured from the fall of the theatres until the generation of Lamb and Hazlitt. Collected editions are by A. Dyce (1858, 1865, 1876); A. H. Bullen (3 vols., 1884–85); "Best Plays" in the Mermaid series by Havelock Ellis with an Introduction by J. A. Symonds (1887–89). The best modern text is that edited by C. F. Tucker Brooke (Oxf. Univ. Press, 1910). *See* J. G. Lewis, *Marlowe, Outlines of his Life and Works* (1891); J. H. Ingram, *Christopher Marlowe and his Associates* (1904); H. Jung, *Das Verhältnis Marlowes zu Shakespeare* (1904). For further information the reader should consult the histories of the stage by Collier, Ward, Fleay, Schelling and E. K. Chambers, and the studies of Shakespeare's predecessors by Symonds, Mezières, Boas, Manley, Churton Collins, Feuillerat and J. M. Robertson. *See* also Verity's *Essay on Marlowe's Influence* (1886); *Mod. Lang. Rev.* iv. 167 (M. at Cambridge); Swinburne, *Study of Shakespeare* (1880); C. F. T. Brooke, *The Marlowe Canon* (Baltimore 1922), and *Marlowe's Versification and Style* (1922); E. Seaton, *Marlowe's Map* (1924); and the separate editions of *Dr. Faustus, Edward II.*, etc. The main sources of Marlowe were as follows: for *Tamburlaine,* Pedro Mexia's *Life of Timur* in his *Silva* (Madrid, 1543), Anglicized by Fortescue in his *Foreste* (1571) and Petrus Perondinus, *Vita Magni Tamerlanis* (1551); for *Faustus:* a contemporary English version of the Faust-buch or *Historia von D. Johann Fausten* (Frankfort, 1587), and for *Edward II.,* the *Chronicles* of Fabyan (1516), Holinshed (1577) and Stow (1580).

MARLOWE, JULIA [Sarah Frances Frost] (1866–), American actress, was born near Keswick, England, on Aug. 17, 1866, and arrived with her family in America in 1875. Her first formal appearance on the stage was in New York in 1887, although she had before that travelled with a juvenile opera company in *H.M.S. Pinafore,* and afterwards was given such parts as Maria in *Twelfth Night* in Miss Josephine Riley's travelling company. Her first great success was as Parthenia in *Ingomar,* and her subsequent presentations of Rosalind, Viola and Julia in *The Hunchback* confirmed her position as a "star." In 1894 she married Robert Taber, an actor, with whom she played until their divorce in 1900. Subsequently, she had great success as Barbara Frietchie in Clyde Fitch's play of that name, and other dramas. For many years, beginning in 1904, she acted with E. H. Sothern —to whom she was married, Aug. 17, 1911—in a notable series of Shakespeare plays, as well as in modern drama.

MARLY-LE-ROI, a village of northern France in the department of Seine-et-Oise, 5 mi. N. by W. of Versailles by road. Pop. (1936) 2,018.

Marly-le-Roi owes its celebrity to the Château built towards the end of the 17th century by Louis XIV, and now destroyed. The remains now consist of a large basin, the park and a small forest. Near Marly-le-Roi is the hamlet of Marly-la-Machine, where, in 1684, an immense hydraulic engine, driven by the current of the river, was erected; it raised the water to a high tower, where the aqueduct of Marly began (700 yds. in length, 75 in height, with 36 arches) carrying the waters of the Seine to Versailles.

MARMALADE, a preserve originally made of quinces, but now commonly of Seville or other tart oranges, or of other citrus fruit. The term is sometimes (improperly) used for jams. A standard recipe for marmalade is: Two lemons, 12 Seville oranges, slice thin, remove pips, cover and steep for three days in cold water, allowing three pints water to each lb. of fruit. Then boil in a preserving pan till tender, let cool and add 1 lb. of sugar for each lb. of fruit. Boil, skimming well and cook until the mixture stiffens quickly when dropped on a cold plate.

MARMANDE, a town of south-western France, capital of an arrondissement in the department of Lot-et-Garonne, 35 mi. N.W. of Agen, on the Southern railway from Bordeaux to Cette. Pop. (1936) 8,223. Marmande was a *bastide* founded about 1195 and its position on the Garonne made it an important place of toll. It soon passed into the hands of the counts of Toulouse, and was three times besieged and taken during the Albigensian crusade, its capture by Amaury de Montfort in 1219 being followed by a massacre of the inhabitants. It was united to the French crown under Louis IX. A short occupation by the English in 1447, an unsuccessful siege by Henry IV. in 1577 and its resistance of a month to a division of Wellington's army in 1814, are the chief events in its subsequent history. Marmande is situated on the Garonne at its confluence with the Trec. The Garonne is here crossed by a suspension bridge. Public institutions include the sub-prefecture, and tribunals of first instance and commerce. Apart from the administrative offices, the only building of importance is the church of Notre-Dame, which dates from the 13th, 14th and 15th centuries. Among the industries are iron-founding, steam sawing, manufacture of woollens and brandy-distilling.

MARMONT, AUGUSTE FREDERIC LOUIS VIESSE DE, DUKE OF RAGUSA (1774–1852), marshal of France, was born at Châtillon-sur-Seine on July 20, 1774, the son of an ex-officer in the army. He studied mathematics at Dijon with a view to entering the artillery, and there met Bonaparte, with whom he later served in Toulon. Marmont became Bonaparte's aide-de-camp, remained with him during his disgrace, and accompanied him to Italy and Egypt, being promoted to general of brigade. He returned to Europe in 1799, organized the artillery for the expedition to Italy, and was made general of division for his services at Marengo. In 1801 he became inspector-general of artillery, and in 1804 grand officer of the Legion of Honour, but was not made marshal. In 1805 he fought at Ulm, and then became for five years governor of Dalmatia, where his beneficent régime was long remembered. In 1808 he became duke of Ragusa, and in 1809 Napoleon summoned him to take part in the closing operations of the Austrian War, and made him governor-general of the Illyrian provinces of the empire. In July 1810 Marmont succeeded Masséna in command in the north of Spain, and was wounded at Salamanca. He was hardly cured when, in April 1813 Napoleon gave him the command of a corps with which he served throughout the defensive campaign of 1814, until the last battle before Paris, from which he drew back his forces to the commanding position of Essonne, where he had 20,000 men. Marmont then took upon himself a political role which has been stigmatized as treasonable, concluding a secret convention with the enemy. This act was never forgiven by Marmont's countrymen, and although made a peer of France and a major-general of the royal guard at the Restoration, he was never trusted. In July 1830 he was ordered to put down any opposition to the ordinances, and although opposed to the court policy he only gave up the attempt to suppress the revolution when it became clear that his troops were outmatched. The duc d'Angoulême ordered him under arrest, fearing further treachery, but Marmont went into exile with the king, forfeiting his marshalate. He finally settled in Vienna, and became tutor to the duke of Reichstädt. He died at Venice on March 22, 1852. Marmont's *Memoires* are of great value for the military history of his time.

His works include *Voyage en Hongrie, etc.* (4 vols. 1837); *Voyage en Sicile* (1838); *Esprit des institutions militaires* (1845); *Mémoires* (8 volumes, 1856).

MARMONTEL, JEAN FRANÇOIS (1723–1799), French writer, was born at Bort (in Cantal), on July 11, 1723. After studying with the Jesuits at Mauriac, he taught in their colleges at Clermont and Toulouse; and in 1745, acting on the advice of Voltaire, he set out for Paris to try for literary honours. From 1748 to 1753 he wrote a succession of tragedies which, though only moderately successful on the stage, secured the admission of the author to literary and fashionable circles. He wrote a series of articles for the *Encyclopédie;* also the libretti of several comic operas, among others *Sylvain* (1770) and *Zémire et Azore* (1771). In the Gluck-Piccini controversy he was an eager partisan of Piccini with whom he collaborated in *Didon* (1783) and *Pénélope* (1785). In 1758, through Madame de Pompadour, he obtained a place as a civil servant, and the management of the official journal *Le Mercure,* in which he had already begun the famous series of *Contes moraux.* The merit of these tales lies partly in the delicate finish of the style, but mainly in the graphic and charming pictures of French society under Louis XV. The author was elected to the French Academy in 1763. In 1767 he published a romance, *Bélisaire,* which incurred the censure of the Sorbonne and the archbishop of Paris for a chapter on religious toleration. Marmontel retorted in *Les Incas* (1778) by tracing the cruelties in Spanish America to the fanaticism of the invaders.

He was appointed historiographer of France (1771), secretary to the Academy (1783), and professor of history in the Lycée (1786). Marmontel retired in 1792 to Evreux, and soon after to a cottage at Abloville in the department of Eure. To that retreat we owe his *Mémoires d'un père* (4 vols., 1804, new ed. by M. Tourneux, 3 vols., 1891), giving a picturesque review of his whole life, a literary history of two important reigns, a great gallery of portraits extending from the venerable Massillon, whom more than half a century previously he had seen at Clermont, to Mirabeau. He died on Dec. 31, 1799 at Abloville.

The *Contes Moraux* were early translated into English, and many editions of them exist. A summary of the best of them is given by G. G. Saintsbury in *Hist. of the French Novel,* vol. i. (1917).

See also C. A. Sainte-Beuve, *Causeries du lundi,* iv.; S. Lenel, *Un Homme de lettres au XVIII. siècle, Marmontel* (1902).

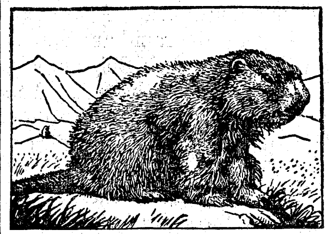
MARMORA (anc. *Proconnesus*), an island in the sea of the same name. (*See* below.) Originally settled by Greeks from Miletus in the 8th century B.C., Proconnesus was annexed by its powerful neighbour Cyzicus in 362. The island has at all times been noted for its quarries of white marble which supplied the material for many of the buildings of Constantinople.

See C. Texier, *Asie mineure* (1839–49); M. I. Gedeon, *Προκόννησος* (Constantinople, 1895); an exhaustive monograph by F. W. Hasluck in *Journ. Hell. Stud.,* xxix. (1909).

MARMORA, SEA OF, the small inland sea which (in part) separates the Turkish dominions in Europe from those in Asia, and is connected through the Bosporus with the Black Sea (*q.v.*) and through the Dardanelles with the Aegean. It is 170 m. long (E. to W.) and nearly 50 m. in extreme width, and has an area of 4,500 sq.m. Its greatest depth is about 700 fathoms, the deepest parts (over 500 fathoms) occurring in three depressions in the northern portion—one close under the European shore to the south of Rodosto, another near the centre of the sea, and a third at the mouth of the Gulf of Ismid. There are several considerable islands, of which the largest, Marmora, lies in the west, off the peninsula of Kapu Dagh, along with Afsia, Aloni and smaller islands. In the east, off the Asiatic shore between the Bosporus and the Gulf of Ismid, are the Princes' Islands. The Sea of Marmora is the ancient *Propontis,* Turk. *Marmara Denizi.*

MARMOSET, the name of any of the small tropical American monkeys classed in the family Callithricidae. Marmosets are not larger than squirrels and present great variation in colour; all have long tails, and many have the ears tufted. They differ from the other American monkeys in having one pair less of molar teeth in each jaw. The common marmoset, or ouistiti, is *Callithrix jacchus. See* PRIMATES.

MARMOT, a large, thickly built, burrowing Alpine rodent allied to the squirrels, and typifying the genus *Marmota,* of which there are numerous species ranging from the Alps through Asia north of the Himalaya, and in North America. All these may be included under the name marmot. In addition to their stout build and thickly haired tails, marmots are characterized by the absence of cheek-pouches. Europe possesses two species, the Alpine or true marmot (*M. marmota*), and the more eastern bobac (*M. bobac*); and there are numerous kinds in Central Asia, one of which, the red marmot (*M. caudata*), is a larger animal, with a longer tail. Marmots inhabit open country, either among mountains, or in the plains; and associate in large colonies, forming burrows, each tenanted by a single family. During the daytime the hillock at the entrance to the burrow is frequently occupied by one or more members of the family. In the winter when the ground is deep in snow, marmots retire to the depths of their burrows, and the winter sleep is probably unbroken. From two to four is the usual number of young in a litter. There are three species in North America, the most widespread of these known as woodchucks (*q.v.*); two other species occur in the western mountains. The red-bellied marmot (*M. flaviventris* ranges from New Mexico and southern California to British Columbia, while the hoary marmot or whistler (*M. caligata*) is found from Alaska to the high mountains of Idaho. (*See* RODENTIA.)



THE ALPINE MARMOT, A RODENT RELATED TO THE GROUND SQUIRRELS

MARNE, a department of north-eastern France, made up from Champagne-Pouilleuse, Rémois, Haute-Champagne, Perthois, Tardenois, Bocage and Brie-Pouilleuse, districts formerly belonging to Champagne, and bounded west by Seine-et-Marne and Aisne, north by Aisne and Ardennes, east by Meuse, and south by Haute-Marne and Aube. Pop. (1936) 410,238. Area 3,168 sq. miles.

The western half of the department is hilly (920 ft. near Reims) with Tertiary rocks of the Paris basin deeply cut by Marne, Vesle and Suippe. From beneath the eastward-facing scarp edge of these rocks the chalk emerges to floor the eastern half of the department (Champagne Pouilleuse), the surface of which rises eastward up the dip slope of the rock to the forested scarp (860 ft.) of the Lower Chalk, again facing east. From beneath this, in turn, emerge the impervious Lower Cretaceous rocks of La Champagne humide, drained by the upper Aisne, which runs northward, parallel to the scarp.

Marne has the temperate climate of the Seine region; the annual mean temperature is 50°, the rainfall about 24 in. Oats, wheat, rye and barley, lucerne, sainfoin and clover, and potatoes, mangold-wurzels and sugar-beet are the principal agricultural crops, and choice vegetables are grown. The raising of mixed merino sheep and of other stock and bees is profitable. The vineyards on the hill slopes of Reims, Épernay and Châlons produce the best Champagne. Pine woods are largely planted in Champagne-Pouilleuse. The department produces peat, fire-clay, millstones and chalk.

Reims has an old-established woollen industry. The manufacture of wine-cases and other goods for the wine trade is carried on. There are also small metalworks. Besides these there are glassworks, whiting and oil works. The chief imports are wool and coal; exports are wine, grain, live-stock, stone, whiting, pit-props and woollen stuffs. Communication is afforded chiefly by the river Marne and by the Eastern railway. There are four arrondissements—namely those of Châlons (the capital), Épernay, Reims, and Vitry-le-François—with 33 cantons and 662 communes. The department belongs partly to the archbishopric of Reims and partly to the see of Châlons. Châlons is the headquarters of the VI. army corps (Metz). Its educational centre and court of appeal are at Paris. The principal towns are Châlons-sur-Marne, Reims, Épernay and Vitry-le-François, Ay and Sézanne.

MARNE, a river of northern France, 328 m. long, rising on the Plateau of Langres, 3 m. S. of Langres, flowing in a wide valley across the Jurassic and Cretaceous rocks of the Paris basin and uniting with the Seine at Charenton, an eastern suburb of Paris. Leaving Langres on the left the river flows northward, passing Chaumont, as far as St. Dizier, where it turns west, receives the Blaise (left), passes Vitry-le-François where it receives the Saulx (right), Châlons and Epernay, where it enters picturesque and undulating country of Tertiary rocks. It passes Chateau-Thierry and Meaux and is joined by the Petit-Morin (left), Ourcq (right) and Grand-Morin (left). It is canalized from Paris to Dizy beyond which it is accompanied by a lateral canal which connects with the Saône. It is also connected by canal with the Rhine and the Aisne.

MARNE, THE FIRST BATTLE OF THE (Sept. 6–9, 1914), the first great turning point in the World War. A strategically decisive victory for the Allies, it brought the rapid and apparently resistless advance of the German hosts through Belgium and France to a halt and forced them to retire northwards. The French reckon in the battle only the Armies west of Verdun, thus excluding Dubail's and de Castelnau's Armies[1] in Alsace-Lorraine; the Germans include the whole front from Belfort round to Paris, and, as they attacked on this with all their seven Armies and the fighting east of Verdun formed an important part of their plan, their definition is followed here.

After the "Battles of the Frontier" in the later part of August and the retreat of the French and British forces, Gen. Joffre attempted to lengthen his line to the westward and prevent envelopment of the Allied left flank by collecting near Amiens on the left of the British Expeditionary Force a new army, under Gen. Maunoury, formed of divisions drawn from other parts of the line. Before this Army could be completely organized, its leading divisions came into contact with the enemy and became involved in the general retirement.

At this period the B.E.F., under Field-Marshal Sir John French, consisted of:—

I. Corps (Lieut.-Gen. Sir D. Haig)
 1st Division (Maj.-Gen. S. H. Lomax),
 2nd Division (Maj.-Gen. C. C. Monro).
II. Corps (General Sir H. L. Smith-Dorrien),
 3rd Division (Maj.-Gen. H. I. W. Hamilton),
 5th Division (Maj.-Gen. Sir C. Fergusson).
III. Corps (Maj.-Gen. W. P. Pulteney),
 4th Division (Maj.-Gen. T. D'O. Snow), with 19th Infantry Brigade attached.

The Cavalry Division (Maj.-Gen. E. H. H. Allenby), of 4 cavalry brigades, and the 5th Cavalry Brigade.

The Royal Flying Corps (Brig.-Gen. Sir D. Henderson) of 5 squadrons.

Lines of Communication troops.

The German Movements and Orders Before the Battle.—As the German pursuit proceeded, Gen. von Kluck, commanding the German I. Army on the extreme west of the line, which had fought at Mons and Le Cateau and occupied Amiens, came to the conclusion that the B.E.F. and Maunoury's troops were routed and practically dispersed, and that Gen. Lanrezac's Army on the right of the British was in consequence the left of the French line. The action of Lanrezac in attacking at the battle of Guise (Aug. 29–31), without assistance on his left, confirmed him in these views. In conjunction, therefore, with Gen. von Bülow (II. Army), instead of continuing the advance in order to cross the Seine below Paris, as ordered, Kluck on Aug. 31 wheeled south-eastwards past the northern front of the French capital, with the object of striking the supposed French flank. After some of his advanced troops and his cavalry corps had been roughly handled by the British on Sept. 1, he turned south, but subsequently resumed his south-eastward course. The German Supreme Command at first accepted Kluck's views, but on Sept. 4 Gen. von Moltke, the Chief of the General Staff and virtual Commander-in-Chief, became alarmed. Information reached him that the French were passing divisions from east to west, and that there were considerable assemblies of troops near Paris. On the evening of the 4th he despatched to the seven German Armies, warning messages, which he consolidated into a formal operation order on the 5th. This order brought to an end the great wheel that was to sweep the French into Switzerland, and substituted for it a plan by which the Paris forces were to be held off by the I. and II. Armies, whilst the other five armies attacked and enveloped what remained of the French forces. The supreme command operation order, the only one issued in regard to the battle, is of such importance that the greater part of it is quoted:—

"The enemy is bringing up new formations and concentrating superior forces in the neighbourhood of Paris to protect the capital and threaten the right flank of the German Armies.

"The I. and II. Armies must therefore remain (*sic*) facing the east front of Paris. Their task is to act against any operations of the enemy from the neighbourhood of Paris and to give each other mutual support to this end.

"The IV. and V. Armies are still operating against superior forces. They must maintain constant pressure to force them south-eastwards . . . Whether by co-operating with the VI. and VII. Armies they will then succeed in forcing any considerable part of the enemy's forces towards Swiss territory cannot yet be foreseen.

"The VI. and VII. Armies will continue to hold the enemy in position in their front, but will take the offensive as soon as possible against the line of the Moselle between Toul and Epinal, securing their flanks against these fortresses.

"The III. Army . . . will be employed as the situation demands either . . . to support the I. and II. Armies or to cooperate . . . in the fighting of our Armies on the left wing."

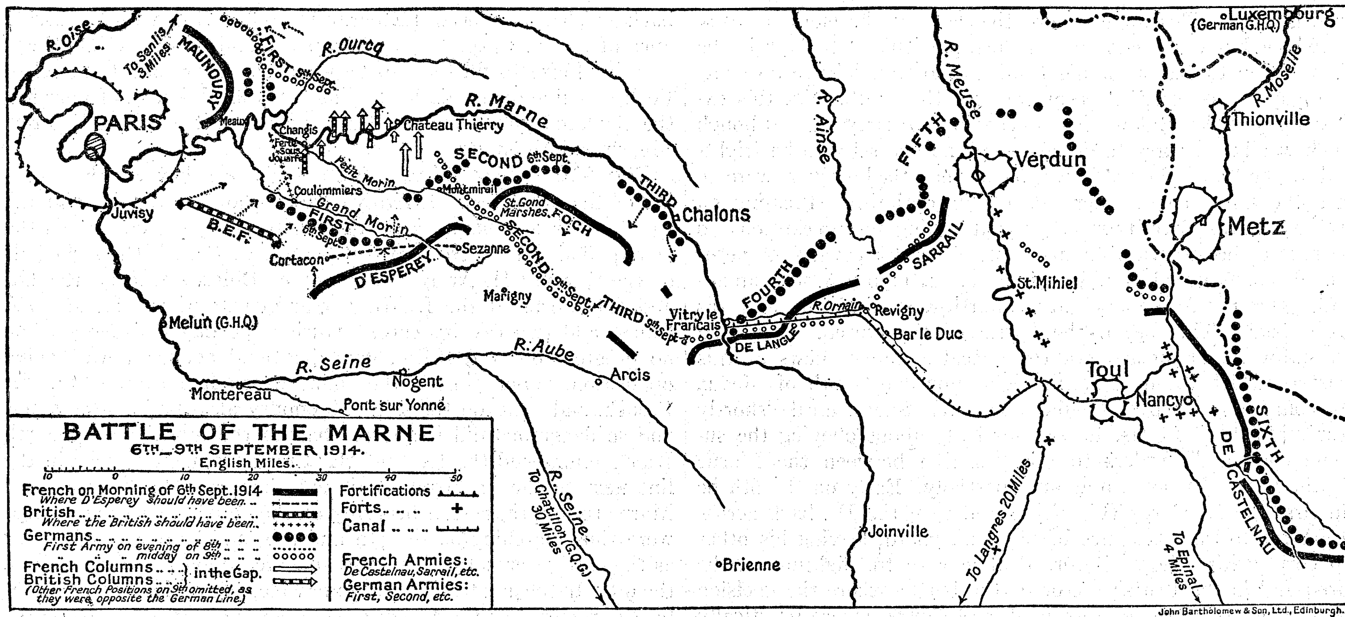
Regardless of the fact that the I. Army was beyond the Marne going south, it was ordered *to remain*, facing west, between the Oise and the Marne, and the II. Army, not yet across the Marne, was ordered to remain between that river and the Seine. The II. Army took immediate steps to obey this order; Bülow ordering his right corps as pivot to halt and the remainder to wheel forward so as to change front from south to west. The first stage of the wheel, to be carried out on the 6th, was to be to the line Montmirail–Marigny, a position not quite reached by the II. Army when the battle came to an end on the 9th. The I. Army continued its advance on Sept. 5 towards the Seine, Kluck reporting that he considered it best to settle with the French armies in the field first and then invest Paris. He, however, began preparatory steps for facing west, and when, in the afternoon, the representative of the supreme command, Lieut.-Col. Hentsch arrived, he approved of the preparations, but added that "the movement to face west might be made at leisure; no special haste was necessary." Thus on the afternoon of September 5 four corps of the I. Army were across the Grand Morin, with two cavalry corps ahead of them; but there was only a weak flank guard, the IV. Reserve Corps (3 infantry brigades) and the remains of the 4th Cavalry Division (smashed up by the British on Sept. 1) in échelon behind its right flank. The II. Army was a day's march behind the I., still facing south; the other German Armies were acting in conformity with their orders.

The French and British Movements and Orders.—The change of direction, to the south-east, of the German I. Army had been observed and reported by British aviators on the morning of Sept. 3, and they added at 5 P.M. that it was crossing the Marne. At 7 P.M. Maunoury reported that there were no German troops west of a line Paris–Senlis; at 8:45 P.M. the British found that there was only one German corps (IV. Reserve) left in the Ourcq valley. All this information was fully confirmed on the 4th. Gen. Joffre, however, did not at once change his plans. Three days previously on Sept. 1, by instruction No. 4, sent out by officers in motor cars at 2 P.M., he had provisionally fixed as the limit of the retirement the moment when his armies were situated as follows:—

"Sarrail's army north of Bar de Duc;
De Langle's army, behind the Ornain east of Vitry;
Foch's army behind the Aube, south of Arcis;
Lanrezac's army, behind the Seine, south of Nogent."

On the 2nd, at 11:40 P.M., he had by a note changed this limit and put the general line on which his forces as a whole should establish themselves considerably farther back on the right. It was defined by Joinville, Brienne, Arcis, Nogent and Pont sur Yonne.

[1]For the sake of clearness, the French Armies are called by the names of their commanders; the Germans by their numbers.



The British were to be behind the Seine, close to Paris, from Melun to Juvisy, their left in touch with Maunoury's Army, now part of the garrison of the entrenched camp of Paris. The Military Governor of Paris, Gen. Galliéni, who had been warned on Sept. 3 (apparently about 8 A.M.) that his troops in the eventual offensive would be required to act in the direction of Meaux, seems to have been the first to realize that there was no time to lose in taking advantage of the tremendous opportunity that the Germans were offering by their flank march past Paris. At 9 A.M. on the 4th he proposed to Gen. Joffre by telephone to use his forces at once to attack from north of Paris eastwards against the German flank. The French commander-in-chief replied at noon by telegraph approving of the idea, but preferring that the attack should be made south not north of the Marne, which meant postponement and loss of time. Joffre then set about ensuring the co-operation of the B.E.F., and about 4 P.M. received through the mission at Sir John French's headquarters at Melun, to which Galliéni had paid a visit, a definite assurance of the fullest support. Meantime he had been in communication with d'Esperey—now in command, vice Lanrezac of the V. Army—as to the condition of his troops and when they could attack. Between 5 P.M. and 8 P.M. two telegraph messages arrived from d'Esperey—the exact hour cannot be fixed, the times of receipt are not marked, but they are between letters received at 5 P.M. and 8 P.M. In these he stated that he could not attack before the 6th, and that Gen. H. Wilson, the sub-chief of the general staff of the British army, who was with him, agreed that the B.E.F. could be on the line Coulommiers–Changis on that date. Gen. Joffre had meantime fixed on the 7th. In the evening, however, Galliéni on return from British G.H.Q. again telephoned personally to him informing him of the measures taken for the eastward march of the Army of Paris and urging him that there was not a moment to be lost, with the result that Joffre definitely informed Galliéni that the general attack would take place on the 6th, and that he might attack north of the Marne as he wished, and gave him a summary of his orders, in which the destination of the B.E.F. as mentioned above was specified. Orders were then prepared, and telegraphed in cypher timed 11:15 P.M. on Sept. 4, to Maunoury and d'Esperey, 11:50 P.M. to Foch and Galliéni, and 12:10 A.M. on the 5th to British headquarters. Duplicates were sent by motor car

General Joffre's orders directed the forces on the left of his line to take up positions during Sept 5 ready to attack on the front and flank of the German I. and II. Armies on the morning of the 6th. Maunoury was to be north-east of Meaux, ready to cross the river Ourcq eastwards in the direction of Château Thierry; the B.E.F. to advance to the line Coulommiers–Changis, ready to move north-eastwards; d'Esperey to fall back to the line Sezanne-Courtacon, and then attack northwards; Foch was to cover the right of d'Esperey by holding the exits of the Marais de St. Gond.

In order to profit by the coolness of the night the troops of Foch, d'Esperey and Sir J. French had marched off before the orders arrived. Galliéni received his copy at 2:35 A.M., but, knowing Joffre's intentions after his telephone conversation, which closed before 10 P.M., had already passed the information on to Maunoury. Foch, whose headquarters were nearest to the Grand Quartier-Général, then at Chatillon, received his at 1:30 A.M. and between 5 and 6 A.M. he was able to stop the retirement of his corps. D'Esperey was not so fortunate; what time he received the telegram is not recorded, but his orders founded on it are timed 6 A.M. His corps, having moved off at midnight to continue their retirement, he could not do more than modify the halting places of some of them; his centre and left passed the line defined by Joffre, and the right detained by rear-guard fighting with the enemy did not reach it. The B.E.F. was in worse case. The orders carried by motor reached G.H.Q. before the telegram, at 3 A.M., and the corps had already started southwards, one of them five hours earlier. Thus the British made a march farther to the south than Joffre counted on, and had two marches to the front to reach the place assigned, instead of one. It was in all probability a fortunate circumstance that the B.E.F. was not in a position to obey and try to reach the line Coulommiers–Changis on the 5th. For if it had done so its five divisions and one cavalry division cut off from all help would have come isolated into collision with the greater part of eight divisions of the German I. Army and four cavalry divisions. Early on Sept. 5, Joffre issued orders to his centre: to de Langle to stay his retreat and attack northwards; to Sarrail to attack westwards against the German flank presented to the troops near Verdun.

Sept. 5: The First Contact.—The Germans, the exponents of envelopment, by thrusting forward between Verdun and Paris, had placed themselves in a position exposed to envelopment on both flanks. They had completely misunderstood the situation, over-estimated their initial successes and under-estimated the fighting powers of the Allies. Gen. von Kuhl, Kluck's chief of the staff, has written:—

"Neither the supreme command nor I. Army headquarters had the remotest idea of an immediately imminent offensive of the whole French Army. The continuation of the French retreat was accepted as settled. There was only a question of our flank being threatened from Paris. . . . The great offensive on the whole front of the forces came as a complete surprise. No sign, no prisoner's statement, no newspaper tattle had given warning of it."

But this was not the end of their mistakes. By Moltke's orders of the evening of Sept. 4, the I. and II. Armies were to face towards Paris. This might guard the flank of the German army as a whole, but would expose their own particular left flank in the new position to the oncoming French, and would leave an enormous gap in the original front towards the south. Yet this extraordinary order Bülow was proceeding to carry out, although Kluck was in no hurry to do so, seeing no necessity to be frightened at the "Paris bogey." Events of the 5th, however, were to scare the latter commander out of his optimism. Pressing on south-eastwards with four corps and taking no precautions to investigate the situation on his flank either by cavalry or aeroplane, his flank guard came in contact about 1:30 P.M. with an advanced guard of Maunoury's army, north-west of Meaux, and was forced back. This began the battle of the Ourcq. Owing to bad staffwork, or an attempt to conceal a defeat, news of this disaster—which meant that his right, now 6m. south of Meaux was completely uncovered—did not reach Kluck until "shortly after midnight." At last he set hurriedly about obeying the supreme command's orders to take position between the Marne and the Oise. But even now only partially. Early on the 6th he sent first the II. Corps (his right) and then the IV. back across the Marne to the assistance of his flank guard, leaving his other two corps with Bülow. Before dealing with the fighting on the Ourcq and in the British sector of the battle, where the decision fell, the events on the eastern flank and centre, where practically deadlock set in, will be summarized.

The Battle on the Eastern Flank and in the Centre.—The German VII. and VI. Armies, under Crown Prince Rupprecht, were "to attack against the Moselle between Toul and Epinal." That is, they were required to force the fortress line of the French eastern frontier. Yet it was to avoid the uncertainties and difficulties of this very task that the German Government had taken the momentous decision to allow their Armies to enter Luxembourg and violate Belgian neutrality. Until Moltke had "watered down" the plan of his predecessor, Field-Marshal Graf Schlieffen, it had been intended to enter Netherlands territory also. The enterprise proved beyond the powers of the Germans. Met by the stout defence of Dubail's and de Castelnau's armies, Rupprecht's armies were unable to make any progress and lost heavily, so that on Sept. 8 he stopped the offensive in order to spare the troops, and was ordered "to prepare to occupy a rear defensive position at once."

The German V. and IV. Armies did no better. Pushing on past the west side of Verdun, the V. (crown prince of Prussia) had to face eastwards towards the fortress. It prevented Sarrail from making any attempt to roll up the German line, but suffered most severely from French artillery fire and for three days was pinned to the ground. A diversion by small forces east of Verdun had no effect. At 2 P.M. on the 9th the Crown Prince, in desperation, ordered a night attack in the hope of capturing the French guns that were killing his men. This operation, owing to short notice, was a complete fiasco, the Germans firing on each other.

The German IV. Army, assisted by half of the III. Army, encountered de Langle, who stood on the defensive and then counter-attacked. After severe fighting on his flanks (actions of Revigny and Vitry), the Germans failed to make ground. By the morning of the 9th, the Germans were reduced by the French artillery fire to seeking what shelter they could in trenches and dead ground. Thus on the eastern half of the battlefield, where the Germans were the attackers, they had the worse of the fighting and there was no decision.

The II. Army (Bülow) and the other half of the German III. Army co-operating with it were at the opening of the battle facing nearly south, half-way between the Seine and Marne. Opposite them were Foch's army and the right of d'Esperey's. The former general—owing to his having received Joffre's orders of Sept. 4 in time to act on them—was actually in contact with the enemy. Severe fighting at once ensued near the Marais de St. Gond. But it was not Bülow's object to break through. He was merely pivoting on his centre so as to change from facing south to facing west towards Paris, between the Seine and the Marne, endeavouring to reach the line Montmirail-Marigny. Thus heavy pressure was brought on Foch, and he was forced back and had to call on d'Esperey for help. But, with the assistance of the X. Corps lent by d'Esperey and of the XVII. Corps sent by Joffre to fill the gap between his army and de Langle's, Foch was able to remain in the line and fulfil his task of guarding the flank of Joffre's main attack of the left wing—d'Esperey, French and Maunoury.

The Allied Left Wing.—It has been seen how on the morning of the 6th Kluck (I. Army) had withdrawn the II. and IV. Corps to succour his flank guard threatened by Maunoury on the Ourcq. This left in front of d'Esperey and French the right half of the German II. Army (the pivot of Bülow's wheel), the IX. and III. Corps of the I. Army, rear guards of the II. and IV. Corps, and two cavalry corps. During the day d'Esperey made no progress but the B.E.F. gained ground against a weakening opposition, about 5m. on the right, which had to wait for the French, and 12m. on the left. Maunoury also made an advance, and so dangerous did it appear that on the morning of the 7th Kluck summoned the IX. and III. Corps from their place in the line next to the II. Army, and sent them also back across the Marne to join the rest of his army on the Ourcq. These two corps were thus marching on the 7th and 8th, and were wasted so far as the battle went; for they only appeared opposite Maunoury on the 9th. In the great gap, some 30m. wide, left in the German front by the removal of the I. Army were now only two cavalry corps (which contained five *Jäger* battalions and extra machine-gun companies) and some infantry detachments, and no one was appointed to take command of them as a whole.

The way through the German front appeared almost open: the Germans themselves had created a gap in their front such as, in the succeeding years of trench warfare, each side strove in vain to batter through its opponent's line. Unfortunately Gen. Joffre's plan, like the famous Plan XVII. with which the campaign had been opened, took no account of ground. In Aug. 1914 the French were committed to an offensive into the defiles of the Vosges and the forests of the Ardennes, where they were ambushed by the enemy. Now the advance of d'Esperey and the B.E.F. was confronted by a series of transverse rivers, the Grand Morin, the Petit Morin and the Marne, all passable only at the bridges, some of which had been destroyed by the French in the retreat. Nevertheless, in very hot, dry and dusty weather, the Allies forced the passage of the Grand Morin on the 7th and of the Petit Morin on the 8th. The German resistance in the gap was practically broken, and there was every chance of cutting off Kluck and falling on his rear, although he hastily despatched first a composite brigade and then the 5th Division to stop the British. On the evening of the 8th Sir John French's five divisions were close up to the Marne. D'Esperey, having farther to go, was not within reach of the river; but his right had driven back the right of the German II. Army and widened the gap. Maunoury's army (of seven divisions, only two of which were active troops, the rest being reserve), had ceased to make any progress against the six divisions of the German I. Army, to reinforce which four more were now on the way.

Sept. 9th: The Passage of the Marne.—Early on Sept. 9 the British cavalry, driving off the Germans, seized two bridges over the Marne below Château Thierry; the 6th Infantry Brigade secured another, and by 7:30 A.M. the I. Corps (Haig), the right of the B.E.F. was beginning to cross the river. In the centre, the II. Corps (Smith-Dorrien) found two bridges intact and undefended, and by 9 A.M. the vanguards of both its divisions were across. Reports were now received from the Flying Corps that there were large masses of Germans north of Château Thierry (actually the German 5th Cavalry Division and infantry attached to it), and the I. Corps, as there were no French troops across the river on its right, halted and began to entrench to secure itself against a counter-stroke. As the French historian, Gen. Palat, has written, "our Allies were very notably ahead of Conneau's Cavalry Corps, which itself was bound to outpace the V. Army (d'Esperey)." The head of the 5th Division, the left of the II. Corps, met with considerable resistance after crossing from a German composite brigade, and the 3rd Division, learning this and finding the I. Corps on its right at a standstill, also halted.

On the left, the 4th Division (Snow) had started at 4:45 A.M. with the intention of crossing at La Ferté sous Jouarre. It found both bridges over the Marne, there nearly a hundred yards wide and very deep, broken (they had been blown up by the French in the retreat); the enemy were holding the farther bank at all likely points of passage. About 1 P.M., two battalions, followed later by a third, managed to cross by a weir a mile above La Ferté, and another battalion crossed at a railway viaduct 3m. above. But by this time, 2:30 P.M., the Germans had abandoned the defence of the passages, and were making off. Conneau's cavalry on the British right did not begin crossing the Marne at Azy just below Château Thierry until 1 P.M. (Palat), and did not get up level with the British I. Corps until the latter had halted for the night. Meanwhile, farther east, Foch was again heavily attacked, particularly on his right, but d'Esperey was making good progress, driving back Bülow's right, so that he was able to lend Foch a division. The latter therefore withdrew Grossetti's division from his left in order to restore the combat on his right by counter-attack.

On the British left, Maunoury's left was being forced back on the exterior defences of Paris, for he had against him the additional weight of the greater part of Kluck's III. and IX. Corps, which had now reached the battlefield, and also the fourth brigade of the IV. Reserve Corps which had appeared from Antwerp on his outer flank. But the farther the German I. Army advanced from the Ourcq the more it suffered from the fire of the heavy guns of the Paris defences, which had been brought into the field, and had already taken heavy toll of it in the previous three days' fighting. Where, therefore, the enemy seemed to be advancing—opposite Foch's right and against Maunoury—further progress was unlikely and a decision impossible. Kuhl goes even farther, and says:—

"Even a victory over Maunoury could not prevent us [I. Army] from having our left flank enveloped by superior force, and from being driven away from the main army. The I. Army stood isolated."

At this crisis, at 1 P.M., the Germans began their retirement from the battlefield.

The German Retirement.—What happened on the German side was the subject of a special enquiry in 1917, after Hindenburg had become chief of the general staff; numberless books have been written in Germany on the battle, and a strenuous endeavour has been made to show that the German retreat was unnecessary. One school would attribute it to a misunderstanding—the I. Army (Kluck) and the II. Army (Bülow) retiring because each thought the other was doing so. The German official history and an official monograph entitled *Das Marnedrama* issued by the *Reichsarchiv* take the view that the retreat was ordered by Lieut.-Col. Hentsch as the representative of the Supreme Command with full powers for the purpose. The monograph sums up the matter in the words:—

"Thanks to the initiative of the German Army and corps commanders, thanks to the ability of the regimental leaders right down to platoon and section leaders, thanks to the valour of the troops, the battle ended with the victory of the German arms at the decisive point. . . . Then the forces on the Western Front were called back from the victory they had won by the word of the representative of the supreme command."

This view does not, however, seem to be borne out by admitted facts. Gen. von Bülow (subsequently promoted to Field-Marshal) definitely claimed to have ordered a retirement of his army, and thereby to have saved the situation. The committee of enquiry found that Bülow came to this decision "independently." At 9 A.M. on the 9th he received definite air reports that six columns (five British and one French cavalry) were approaching the Marne, and, no news of any success of the I. Army reaching him, by 11 A.M. he had issued orders for the retreat to begin at 1 P.M. and so informed the I. Army; the movements took place accordingly, and the III. Army conformed to them.

What happened at I. Army (Kluck) headquarters is not quite so clear. There are two distinct versions, those of Lieut.-Col. Hentsch, the emissary of the supreme command, and Gen. von Kuhl, Kluck's chief of the staff. Hentsch had been despatched by Gen. von Moltke at midday on the 8th to visit the V., IV., III., II. and I. Armies in succession, a round trip of 400m. According to the court of enquiry, the proceedings of which Ludendorff promulgated to the general staff, Hentsch was given full powers to co-ordinate a retreat, "should rearward movements have been initiated"—and he was despatched by Moltke in full expectation that such movements had been begun. Hentsch found none had taken place in the V., IV. and III. Armies, and then spent the night of the 8th–9th at II. Army headquarters, where he observed a spirit of depression and pessimism. He left early on the morning of the 9th, before definite orders for the retreat had been given, but apparently convinced that they would soon be given. Owing to blocks and panic on the road, it was past midday when he arrived at I. Army headquarters, taking seven hours to go 60m.; he did not see Gen. von Kluck, dealing only with Kuhl. Hentsch states that he found orders for retirement had already been issued. Kuhl denies this, but admits that such orders had gone out by telephone owing to the overzeal of a subordinate officer, since dead, who had misunderstood him. What, according to Kuhl, had been ordered at 11:30 A.M., and was in course of execution in view of the British advance, was a wheel backwards of the left only of the I. Army. Thus Kuhl's contention is that Hentsch, in view of the situation of the II. Army, ordered the I. to retreat and quoted his full powers given for the purpose of co-ordinating a retirement. Hentsch's statement is to the effect that the retirement had been decided on, and that he merely gave Kuhl the direction in which the I. Army was to retire, north-eastwards, so as to join up with the II. Army. The court of enquiry accepted Kuhl's view, adding, however, that Hentsch was justified "as the case provided for in his instructions, the initiation of rearward movements, had arisen." A curious feature of the events at German I. Army headquarters is that Kuhl, by his own account, accepted Hentsch's verbal instructions without requiring that so important a decision should be in writing, and without taking him to see Kluck, the army commander. In one of the books that he has written on the battle he has admitted that:—

"The break-through of the British and the French V. Army which was threatening brought about the decision in the battle of the Marne."

At 2 P.M. the retirement of the I. Army in the general direction of Soissons was begun. Its preliminary movements having brought it from facing west to facing south-west, and all the roads having been cleared by sending back the transport and trains, it was a comparatively easy matter. But, owing to the direction of the British advance, the I. Army could not incline inwards towards the II. Army and retreated due north, still leaving a gap in the German line. The German withdrawal, covered by rear guards, was not immediately obvious. It was not until 3 P.M. that the British I. Corps resumed its advance, and then owing to its fatigue only a short one was made to a line 5m. from the Marne. The left (5th) division of the II. Corps remained in contact with the enemy until dusk. It was not until 9 P.M. that the 4th Division on the extreme left was able to begin a bridge over the Marne at La Ferté, ten of its 16 battalions (including the 19th Brigade) being then still south of the river. Conneau's Cavalry Corps had crossed the Marne at Château Thierry, and now came up alongside the I. Corps but none of d'Esperey's infantry had reached the Marne. In Foch's Army Grossetti's division brought from the left to counter-attack arrived too late to follow the enemy except with a few shells. It was not until 5 P.M. that Maunoury, after a hard day's fighting in which he had been reinforced by every man that Galliéni could send from the Paris garrison, was able to report that the Germans were in retreat, covered by their artillery.

The evening reports from the air confirmed that everywhere along the battle line retrograde movements of the enemy were taking place; but, his main bodies having got a good start during the day, and his rear guards being able to slip off in the darkness, there was no pursuit until next day, and then Joffre's instructions to Maunoury were to gain ground to the left and endeavour to envelop the enemy's right; the order to head the columns off by flanking them from the west was not issued until the 13th. The

German I. and II. Armies were thus able to pursue their way practically undisturbed back to the Aisne, there to make another stand. The gap between them was then filled by fresh troops released by the capitulation of Maubeuge. At 5 P.M. on the 10th orders were sent by the supreme command to the IV. Army to retire, and at noon on the 11th to the V. Army. The VI. and VII. Armies had ceased their attacks on the 9th and retired to a selected line.

The Victory.—At 8:15 P.M. on the 9th Sir John French's orders changed the word "advance" of the previous days to "pursuit"; Gen. d'Esperey, in an order issued from the historic field of Montmirail on the same evening, accurately summarized the battle:—

"Held on his flanks, his centre broken, the enemy is now retreating towards the east and north by forced marches."

The Germans had entered Belgium and France with 78 divisions, excluding cavalry divisions. Of these they only managed to bring 44 divisions on to the great front between Verdun and Paris, 22 divisions being engaged on the Alsace-Lorraine front, four sent back to East Prussia and eight (XV., III. Reserve, IX. Reserve Corps) kept from the battle at the investments of Antwerp, Maubeuge, etc. The French, with 23 divisions in Alsace-Lorraine against 22 German, had 51 divisions and five British divisions on the Verdun-Paris front. Thus there were 56 Allied divisions against 44 German. The French Reserve divisions were not up to the standard of the German Reserve formations, but all the Allied divisions in falling back had received reinforcement, whilst the Germans hampered by the destruction of the railways and handicapped by the very rapidity of their advance, had not been able to get up drafts to fill the gaps in their ranks, so that as regards actual combatants, numbers were still more in favour of the Allies. Neither the French nor the Germans have yet published their losses, but the Allies captured 38,000 prisoners and 160 guns besides other trophies including colours.

The moral effect of the victory both on the Allies and on the Germans was immense, for the legend of German invincibility was broken. That the material and tactical results were not more important is due partly to the immense fatigue of the Allies after the earlier battles, the long retreat of 13 days and a four-day battle in summer heat. But it would seem to be partly due to the direction of the main Allied attack having been frontal and across the courses of several rivers. Greater success would no doubt have been achieved had Maunoury's flank attack, between the rivers, been made stronger. Possibly his army would have done better even if it had been no stronger but composed of better troops; for it consisted of only two active divisions (7th and 14th), badly mauled in the frontier fighting, an Algerian division and four Reserve divisions shaken by fighting near Amiens. Had some of the 14 British Territorial Force Divisions and 14 mounted brigades with the 6th Division, still in England, been landed at the Channel coast ports to fall on the German communications and rear, a decisive tactical result might have been obtained and the war finished. In any case, with such addition to their forces, the Allies would have been better placed to have obtained a decision in the "Race to the Sea," in which actually they were always "an army corps too few and 24 hours too late."

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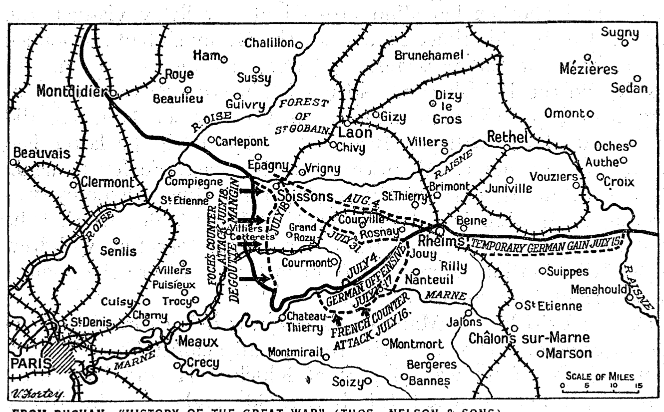
MARNE, SECOND BATTLE OF THE. This marked the turning of the tide in the final year of World War I (*q.v.*). On July 15, 1918, the Rheims district was the scene of the last German offensive on the Western Front, and three days later, when this was stemmed, the ebb began under pressure of the great Allied counterstroke. It was thus composed of two acts, which require separate analysis.

I. THE GERMAN OFFENSIVE IN CHAMPAGNE

This opened on July 15, 1918, and the German plan was to attack on either side of Rheims, the principal effort being made by the German I. and III. Armies towards Châlons, while the VII. Army sought to cross the Marne near Dormans and to converge with the main advance in the region of Épernay. But although this day marked the last German bid for victory, the actual attack was by no means the Germans' supreme effort, nor had it the decisive aims popularly ascribed to it at the time. For Ludendorff still adhered to his guiding idea that the British, severely shaken in the great battles of March and April, should be the



FROM BUCHAN, "HISTORY OF THE GREAT WAR" (THOS. NELSON & SONS)

PLAN OF SECOND BATTLE OF THE MARNE, WHICH DEVELOPED BETWEEN JULY 15 AND AUGUST 4, 1918

target for his decisive blow and that their front in Flanders should be the stage on which he would produce his final drama of victory.

The attack on May 27 (*see* CHEMIN-DES-DAMES, BATTLE OF THE, 1918) across the Aisne had been conceived merely as a diversion to draw the Allied reserves away from Flanders. So also with the June 9 attack, less bountiful in its fruits, that had been launched near Compiègne to break down the buttress of Allied territory that lay between the huge salients created by the German attacks of March and May. When, instead, this German attack was broken off by Ludendorff, with little gained but his own reserves still further drained, he considered "the enemy in Flanders still so strong that the German army could not attack" there yet. So he planned a further diversion—to be made by forty-seven divisions attacking on either side of Rheims.

But the sands of time were slipping out for the Germans, and American reinforcements, like the sands of the shore in potential number, were slipping in to become a cement for the Allied line of battle. Appreciating this, Ludendorff intended his Flanders attack, once more towards the nodal point of Hazebrouck, to follow on the 20th, only five days after the Rheims diversion. On July 16 actually, as soon as the Rheims attack was under way, artillery and aircraft were sent off by train to the Flanders front, and Ludendorff himself moved to Tournai to supervise the preparations.

But preparation was never to be completed by execution. For the Rheims diversion had not even the opening success of its predecessors, and on July 18 the Allied counterstroke so jeopardized the Germans' situation that Ludendorff felt compelled to postpone, if not yet to abandon, the fulfilment of his dream. One reason of the failure of the July 15 attack was that east of Rheims it was met by an "elastic defence" in face of which the German onslaught lost its momentum before it reached the real position of the French resistance. Much misplaced praise has been lavished on this "Gouraud manoeuvre." For this ascription of its origin is yet another of the many war legends. The manoeuvre was actually due to Pétain, that cool, unemotional military economist who, called to be commander-in-chief after the Nivelle fiasco of 1917, had systematically worked to rebuild the French army and to restore the stability of its man-power and *moral,* previously undermined by the extravagant offensives of 1914–1917. One illuminating illustration of the damage done is that cases of desertion alone had risen from 509 in 1914 to 21,174 in 1917.

Not content merely to reorganise, Pétain had set himself to insure against a recurrence of the trouble by tactics that should be an economy both of force and of the nervous force of the combatant. To this end, one method was an elastic defence in depth, to allow the initial shock and impetus of the enemy's attack to be absorbed by a thinly held forward position, and then to await him on a strong position in rear, when the enemy's troops would be beyond the range of the bulk of their supporting artillery. This method Pétain had sought to apply against the attack of June 9, but, although it was partially successful, its full effect was lost through the reluctance of the local commanders, still clinging to their old offensive dogmas, to reconcile themselves to a voluntary yielding up of a few square miles of worthless ground. And before July 15, when the coming German attack was definitely expected, a week's argument was required before Pétain could persuade the lion-hearted Gouraud, in command of the French IV. Army east of Rheims, to adopt this elastic manoeuvre. It was finally decided to leave nothing along the line of outposts (constituted by the Monts de Champagne) but "islands" of resistance, which would be required to sacrifice themselves for the purpose of dissipating the enemy attack and keeping it under the well-controlled fire of the main position established in the rear.

But even when we have ascribed it to the right source, the accumulation of historical error is not fully corrected. For the method was not the revolutionary innovation that it has been termed. The Germans, in fact, had used it on Sept. 25, 1915—nearly three years before—to discomfit the great French autumn offensive in Champagne. And the underlying idea can be traced back another 2,000 years—to Cannae, where Hannibal applied it against the Romans in a distinctly more subtle and decisive way. But it sufficed, even in the mild way of 1918, to thwart the German attack east of Rheims, where its effect was immeasurably strengthened by the German failure to achieve such a surprise as had marked their earlier offensives of 1918. Even the exact hour was discovered by an evening raid on July 14 which brought in 27 prisoners who, on being questioned, revealed the fact that the German attack was to be launched next morning, the artillery preparation being timed for 12.10 A.M. Before it began, the French counter-preparation and counter-battery fire opened on the whole of the enemy front. Between 4.15 and 5.30 A.M., the already shaken German infantry advanced to the attack on a 50 mile front, from Château-Thierry to Massiges (leaving out the Rheims Salient). To the east of Rheims the enemy infantry was broken up by French artillery fire and decimated by the machine-guns distributed along the outpost line before even reaching the main line of resistance, which, in spite of repeated assaults, they failed to break at a single point. To the west of Rheims the situation was less favourable for the French.

German Success at Dormans.—But the dramatic nature of this repulse east of Rheims has obscured the fact that it was not the whole battle. West of Rheims the front had only been stabilised for a month since the last German thrust, and the newly improvised position was a handicap to the execution of the elastic method by commanders who were slow to grasp it. In front of the French V. Army (Berthelot) the Germans made some progress between the Marne and the Ardre in the direction of Épernay, and the French centre (V. French Corps and II. Italian) was thrown back on the second position along the line Pourcy-Belval-Reuil-sur-Marne. Lastly, the right of the VI. Army (Degoutte) was not able to stop the attackers from crossing the Marne on either side of Dormans, between Jaulgonne and Verneuil. The VII. German Army thus established a bridgehead south of the river, in front of the V. Army's left and the VI. Army's right; it also regained touch with the I. German Army on the slopes of the Montagne de Reims. Thus here the German attack had deepened the corner of the great bulge made in May, and not only pushed across the Marne but behind Rheims, so that it threatened to cut under this pivot of the Allied resistance. If the threat had an important influence on the French plan for the counter-stroke, its physical progress was stopped on July 16. The German attack had degenerated into local actions, disconnected and therefore useless. By vigorous counter-attacks the French had even recaptured some of the lost ground, while their artillery and aircraft, by bombarding the Marne crossings, made it increasingly difficult for the Germans to obtain supplies. The only progress in the attack—to the south-west of Rheims between the Vesle and the Marne, on July 16—remained fruitless, for it had cost the enemy too dear for him to repeat such sacrifices. Next day a queer hush of expectation spread over the whole battlefield. The stage was set for the great "revanche."

II. THE COUNTER-OFFENSIVE

The Allied counter-offensive under Pétain's direction comprises two phases: (1) the first extends from July 18–28, and includes the victorious battles of Fayolle's main group of armies in the Soissonnais and on the Ourcq, and the closing stage of the defensive battle of Champagne and Rheims during the same period, in which the centre group under Maistre re-established its front and passed to the attack. This first phase, again, comprised three successive manoeuvres: the breaking of the enemy positions by the Reserve group of armies on July 18 and 19; the re-occupation of Château-Thierry and the south bank of the Marne by the centre group of armies, in combination with the right of the Reserve group, on July 20 and 21; and the co-ordination of the advance of the two groups of armies on both banks of the Ourcq in the general direction of Arcy-Sainte-Restitue and Fère-en-Tardenois on July 23 and 24. (2) The second phase, sometimes called the battle of Tardenois, July 29 to Aug. 4, which included the recapture of Soissons and the push towards the Vesle.

French Preparations.—Acting upon Pétain's instructions, Fayolle, commanding the Reserve group of armies, had prepared a counter-offensive against the west flank of the great German salient which protruded between Soissons and Rheims towards the Marne. These preparations were continued with the utmost secrecy while the centre group of armies (Maistre) were checking the last enemy offensive (July 15 and 16) and (from the 17th) arranging a riposte. This was entrusted to two armies, the V. and the IX.—which adjoined the right of the Reserve group of armies. The V. Army (Berthelot), which had been so heavily attacked at Rheims, had eight divisions in first line (including the Italian 3rd Div.), and one infantry and two cavalry divisions in second line. The British 51st and 62nd Divisions were on the move to reinforce it. The IX. Army (de Mitry) had five divisions, including the American 3rd Division in first line, one division in second line, and two reserve divisions, including the American 28th Division.

The Reserve group was to operate with the X. and VI. Armies. The X. Army, under Gen. Mangin, who was responsible for the principal attack, had 10 divisions in front line, including the American 1st and 2nd Divisions, placed on the flanks of the Moroccan Division in the centre of the army, and six divisions in second line, making a total of 16 infantry divisions—besides three cavalry divisions. In the rear of the army the British 15th and 34th Divisions were in reserve. In addition, the army was given a large number of tanks and strong artillery reinforcements. The task which Mangin set before his troops was "to break through the enemy front between the Aisne and the Ourcq and push straight on in the direction of Fère-en-Tardenois in *liaison* with the offensive of the VI. Army." On his right the VI. Army, commanded by Degoutte, whose own right was engaged in the defensive battle, had only seven divisions in front line—among them the American 4th and 26th Divisions (American I. Corps)—and one division in second line. Degoutte was to attack with his own resources only, reinforced, however, by tanks and by British bombing aircraft.

The attack had been prepared with infinite precautions for maintaining secrecy. The reinforcing divisions were only brought up to the front during the last two days, their movement being carried out by night, between July 14 and 16, the mounted elements marching and the unmounted carried by motor transport. A violent storm which burst during the night of the 17th–18th intensified the darkness and made movements in the woods difficult; but it was favourable to surprise and by 4 A.M. the attacking divisions of the X. and VI. Armies were in position and ready to move without any sign of uneasiness having been shown by the enemy. At 4.35, without a single preliminary round, the whole of the artillery opened fire from the Aisne to the Marne, and 16 front line divisions moved forward with the tanks, while all the air squadrons went up. In the X. Army the infantry and tanks advanced without an artillery preparation behind a rolling barrage, turning the enemy's strong defensive positions and quickly gaining a footing on the plateau north-east of the forest of Villers-Cotterets. In the VI. Army, on the contrary, the attacking divisions continued their artillery preparation against the enemy's defensive position for $1\frac{1}{2}$ hours, and only attacked at 6:15 A.M.

The Attack.—The surprise was complete, and along the whole front the enemy lost practically all his advanced units and batteries. His resistance was only effective in two localities—one on the front of the XI. Army Corps, which had no tanks, the other on that of the II. Corps, which came under oblique fire from the heights of Chouy. Mangin received information of the first results achieved towards 8 o'clock, and exploited them without delay by the judicious use of his reserves. Robillot's Cavalry Corps, however, had experienced extreme difficulty in debouching from the forest of Villers-Cotterets, as it was encumbered with troops and baggage, and could as yet operate only with dismounted squadrons. On the first day the enemy lost 12,000 prisoners and 250 guns. The battle raged throughout the night and the next day. The two French armies made substantial progress, even in the difficult region of Louatre-Chouy-Neuilly-Saint-Front, where the XI. and II. Corps combined their attacks to subdue the enemy resistance. The bombing aircraft attacked the Marne crossings and the enemy concentrations at Oulchy-le-Château and Fère-en-Tardenois.

Meanwhile the centre group was preparing to clear the south bank of the Marne. But its units were exhausted by resisting the German attacks of July 15–18, and to reinvigorate them the British XXII. Corps (51st and 62nd Divs.) was brought in to relieve the Italian Corps. Pétain took care to insist that it was not a question of a simple relief. "It will be carried out on the move—that is to say, it will take the form of a surprise attack, carried out with the co-operation of the French units on either side." Nevertheless it was not until the 20th that the Centre group was able to push forward. On that day its IX. Army reached the south bank of the Marne, evacuated by the enemy during the night, while in the V. Army the British XXII. Corps was heavily engaged in the Courton wood.

The fighting continued to be severe throughout July 21 and 22. On the two extreme wings the Germans offered a stubborn resistance to the attacks of the X. and V. Armies which pressed on their flanks. It was clear that they were seeking to gain time to evacuate the material and troops that had been pushed into the Marne "sack." On July 21 the French 30th Division reoccupied Château-Thierry, and the American 3rd Division crossed the Marne to the east of the town, and entered the Barbillon wood. In the VI. Army the American I. Corps and the French VII. and II. Corps advanced on the plateau of Etrepilly and Latilly, and on the 22nd, at noon, the VI. Army re-established its communications by way of Château-Thierry. On the same evening fractions of the V. and IX. Armies gained a footing north of the Marne.

The interest of the battle came to be focussed on the heights dominating the Ourcq valley from the north—Orme du Grand Rozoy and Butte Chalmont. Once these heights were captured the Germans could not hope to hold on to the line of the Ourcq. A pause occurred for the relief of tired divisions and the redistribution of the forces. The IX. Army was withdrawn from the front, and the convergence of the advance had so shortened the front that the IX. Army was withdrawn, and even the VI. Army, now reinforced by the fresh American 42nd division, closed up.

Advance Checked at Fère-en-Tardenois.—Some progress was made on July 27 and 28: the VI. Army reached the Ourcq and gained a foothold in Fère-en-Tardenois; the V. Army reoccupied its positions on July 15. But from the 28th at noon, the VI. and V. Armies met with a stubborn resistance that was solidly established from Fère-en-Tardenois to Ville-en-Tardenois. The II. Corps was unable to debouch from Fère. The American I. Corps, which had advanced as far as Sergy, was violently counter-attacked there by a Guards Division. The village was taken and retaken four times and finally held by the American 42nd Division, though only at the cost of heavy losses.

In the centre, therefore, the situation remained practically unchanged on July 29 and 30. Only the right of the X. Army made definite progress. On the 28th the XI. Corps took Butte Chalmont, and on the 20th the XXX. and XI. Corps with the British 34th Division occupied Grand Rozoy; but the divisions in line had reached the limit of their powers after several days of incessant fighting.

The Germans had solidly maintained their flanks as a safeguard to cover their line of retreat towards the Vesle. All that could be done was to hasten their retreat by convergent action against the plateaux of the Tardenois. The French counter-offensive had at least cleared the Marne valley and the Paris-Avricourt railway line. The second phase was now to begin, and the French armies, on July 29, received fresh instructions from Pétain. The VI. Army, reinforced by the III. Corps and charged with the main effort was to "push vigorously, and without stopping, in the general direction of Fismes and Bazoches with its whole front, its left to establish itself in the region of Saponay so as to facilitate the debouching of the right wing of the X. Army towards Cramaille." The X. Army was, by successive actions starting from its right (the south), to press in the general direction of Braine. The V. Army was to support the right wing of the VI. Army.

Reliefs were carried out within the armies. The VI. Army put considerable American forces into line: the 42nd and 32nd in the first line, the 4th and 28th in second line, while the 26th and 3rd were being reconstituted in the Marne valley. On the 31st the American 28th, 32nd and 4th Divisions entered Cierges and the Meunière wood. In this way the enemy's attention was drawn to the centre on the evening of the 31st, while the next morning (Aug. 1), at 4:45, the right of the X. Army attacked in its turn and, after severe fighting, occupied the whole crest that extends from L'Orme du Grand Rozoy to Saponay inclusive. On the same day the VI. Army, though it succeeded in capturing the Meunière wood, failed before Saponay on account of the extreme fatigue of its attacking divisions.

German Retirement to the Vesle.—But at dawn on Aug. 2 the three French armies found themselves facing void. The enemy had fallen back on the Vesle, where he intended to establish himself firmly. On the 3rd, the left of the X. Army, which had reoccupied Soissons unopposed the previous evening, reached the Aisne. Its right, together with the VI. and V. Armies, arrived in the immediate vicinity of the Vesle. Contact was reestablished everywhere. All along the front the German artillery and machine-guns were active. On Aug. 4 and 5 the Allied troops aligned themselves along the banks of the Vesle, the American 32nd Division entered Fismes and the advanced guards succeeded in crossing the river at some points. But the enemy counterattacked vigorously, and in view of this well-organized resistance and of the impending Allied operations elsewhere (*see* AMIENS, BATTLE OF, 1918, and WORLD WAR I), Foch decided to suspend the offensive.

III. A STRATEGICAL RETROSPECT

The clue to the course of this battle might aptly be put in terms of the old conundrum—"When is a counter-stroke not a counter-stroke?" Foch's faith in the offensive as a sovereign remedy for all troubles had not been shaken by his hard experience in 1915 and 1916. When the crisis of March 1918 called him to the supreme command of the Allied armies (*see* WORLD WAR I), he had scarcely set about his unenviable task of restoring the bent and battered front before he was contemplating an offensive. Even before the new collapse of the Aisne front on May 27 he had issued a "directive" to Haig and Pétain, commanders of the British and French field armies respectively, for attacks to free the lateral railways.

If this project showed his practical belief in this theory of freedom of action, it is also evidence that he had no idea of luring the Germans into vast salients which he could cut off in flank—as was the conception subsequently extolled by popular propagandists. Similarly, the truth of the great counter-stroke of July

18 is that it was not conceived, by Foch at least, as a counter-stroke. But the refrain *"attaquez"* was chanted so continually that sooner or later it was bound to coincide with a "psychological moment"—as on July 18.

In the meantime Ludendorff's keenness in pursuing a similar policy and the wariness of Pétain and Haig helped to prevent the Allied forces becoming seriously involved in a premature offensive before the balance of numbers changed. It was Pétain who had conceived the plan of the defensive-offensive battle as it was actually waged—first a parry to the enemy's thrust and then a riposte when he was off his balance. On June 4 he had asked Foch to assemble two groups of reserves at Beauvais and Épernay respectively with a view to a counter-stroke against the flank of any fresh German advance. The first group, under Mangin, had been used to break the German attack of June 9, and was then switched a little further east to a position on the west flank of the German salient between Soissons and Rheims which bulged towards the Marne.

Foch, however, planned to use it for the strictly offensive purpose of a push against the rail centre of Soissons. While this was being prepared, the intelligence service made it clear that the Germans were about to launch a fresh attack near Rheims. Foch thereupon determined to anticipate it, not retort to it, by launching his offensive on July 12. Pétain, however, had the contrary idea of first stopping and then smiting the enemy when the latter had entangled himself. And, perchance curiously, the French troops were not ready on July 12, so that the battle was fought rather according to Pétain's than to Foch's conception. But not altogether. For Pétain's plan had comprised three phases—first, to hold up the German attack; second, to launch counter-strokes against the flanks of the fresh pockets it was likely to make on either side of Rheims; third, and only third, when the German reserves had been fully drawn towards those pockets, to unleash Mangin's army in a big counter-offensive eastward along the baseline of the main bulge—the enemy's rear—and so close the neck of the vast sack in which the German forces south of the Aisne would be enclosed.

Events and Foch combined to modify this conception. When the Germans on July 15 and 16 pressed across the Marne west of Rheims, to avert the danger Pétain was driven to use most of the reserves he had intended for the second phase of the counter-stroke. And to replace them he decided to draw from Mangin's army, and postpone the latter's counter-offensive—already ordered by Foch for July 18.

When Foch—full of eagerness and with his spirit still more fortified, if that was possible, by Haig's promise to send British reserves—heard of Pétain's action he promptly countermanded it. Hence on July 18 Mangin and the French left wing launched their counter-offensive while the defensive battle was still in progress in the centre and on the right wing. This meant that the second phase of Pétain's plan had to be dropped out, and instead of the right wing attracting the Germans' reserves in order to enable the left wing to fall on their naked back, the left wing's offensive eased the pressure on the right wing.

To compensate as far as possible the initial passivity of the right wing the British reserves (51st and 62nd Divisions), which were sent thither, were used to relieve the defending troops "on the move," passing direct to an attack. In the centre American reserves were similarly used, and thus a general pressure began along the whole face of the great salient. But this convergent pressure did not begin until July 20, and by that time the opening surprise—due to the sudden release of a mass of tanks without any preparatory bombardment—of the left wing's attack was over and its impetus slackening. Thus the Germans, fighting hard for breathing space, gained the time they required to draw the bulk of their forces out of the sack, even though they left 30,000 prisoners and much material behind. And once they were safely back on a straight and much shortened line along the Vesle, Ludendorff felt able, on Aug. 2, to order preparations for fresh attacks in Flanders and east of Montdidier.

Six days later his offensive dreams were finally dissipated—but it is historically important to realise that it was not the second Battle of the Marne—"Foch's great counter-stroke"—which dissipated them. This July 18 counter-stroke, conceived as such by Pétain and amended by Foch, was by no means decisive in its result. It may be that Foch's impetuosity robbed him of such results; that Pétain's oft-derided "caution" would have reaped a larger harvest.

Nevertheless, if the battle had no clearly decisive material or even moral effect on the Germans, this first taste of victory after such deep and bitter draughts of defeat was an incalculable moral stimulant to the Allies, and perchance its depressing effect on the German morale was more insidiously damaging than was at first visible. So that Foch, who was ever concerned only with moral factors, which cannot be mathematically calculated, may well have been content. He had gained the initiative, and he kept it—that was enough; results mattered little. For his strategy was simple, not the complex masterpiece of art which legend has ascribed to him. It was best expressed in his own vivid illustration: "War is like this. Here is an inclined plane. An attack is like this ball rolling down it. It goes on gaining momentum and getting faster and faster on condition that you do not stop it. If you check it artificially you lose your momentum and have to begin all over again." (B. H. L. H.)

MAROCAIN. A ribbed or corded variety of dress fabric of comparatively light texture, constituting one of several varieties of the crepe or crimped type, of which crepe georgette, crepe-de-Chine and crepe voile are the more typical examples. Although fabrics of this class are usually woven on the principle of the simple plain weave and other elementary structures, the peculiar crepe effect which is the distinctive characteristic feature of these fabrics is not due to the weave, but results partly from the abnormal amount of twist in the warp, weft, or both series of threads, and partly from the employment of yarn spun with the twist in reverse directions. Hence, some threads are spun "twist-way," and others "weft-way," corresponding (in the worsted industry) to "crossband" (left twist) and "openband" (right twist), respectively. The threads of reverse twist are usually disposed in the fabric with a "two-and-two" thread disposition, *i.e.*, two threads spun "twist-way," and two threads spun "weft-way," in succession, uniformly. Also, the relative counts of warp and weft, as well as the relative number of warp-ends and picks per inch in the fabric, are factors which have a marked influence in the development of a more or less pronounced crepe or crimped effect.

This crepe or crimped effect, which characterizes fabrics of this class, results from the natural tendency of the highly-twisted threads of "reverse" twist to untwist in reverse directions, and thereby assume a wavy appearance resulting from their slight distortion from a perfectly straight line. Also, the ribbed or corded effect results from the disparity which exists in respect both of the relative counts and amount of twist in the warp and weft yarn, as well as in the relative number of warp and weft threads per inch, in the fabric.

Marocain fabrics are usually produced from a combination of two different classes of textile material consisting either of a silk or artificial silk warp, and worsted weft; whilst an inferior imitation marocain fabric is produced from all-cotton yarn both for warp and weft. They are also made in a variety of textures from various counts of yarn and with different proportions of warp-ends and picks per inch, according to quality.

A typical example of marocain fabric is woven either with a warp of silk, or else artificial silk, and highly twisted worsted weft of fine counts, with 170 warp threads of 150 denier silk, and 70 picks of 60's worsted weft, per inch, which produces a fabric having a distinctly fine-ribbed effect, with the ribs extending transversely across the width of the fabric, *i.e.*, in the direction of the hard-twisted and coarser picks of worsted weft.

An imitation marocain fabric of very light and open texture is woven from a cotton warp and artificial silk weft, with 56 warp threads of 2/80's highly-twisted cotton yarn (disposed in the fabric with a two-and-two end arrangement of "twist-way" and "weft-way" yarn, uniformly), and 80 picks of 120 to 150 denier artificial silk weft, per inch. Hence, the fine ribs extend lengthwise of the fabric, *i.e.*, in the direction of the warp threads.

(H. N.)

MAROCHETTI, CARLO, Baron (1805–1867), Italian sculptor, was born at Turin. His first systematic instruction was given him by Bosio and Gros in Paris, but between 1822 and 1830 he studied chiefly in Rome. From 1832 to 1848 he lived in France. His "Fallen Angel" was exhibited in 1831. In 1848 Marochetti removed to London, where he executed statues of Queen Victoria, Lord Clyde (the obelisk in Waterloo Place) and Richard Coeur-de-Lion (Westminster). His style was vigorous and effective, but rather popular than artistic. He died in London in 1867.

MARONITES, a Christian people of the Ottoman Empire in communion with the Papal Church, but forming a distinct denomination. The original seat and present home of the nucleus of the Maronites is Mt. Lebanon. It seems most probable that the Lebanon offered refuge to Antiochene Monothelites flying from the ban of the Constantinopolitan Council of A.D. 680; that these converted part of the old mountain folk, who already held some kind of Incarnationist creed; and that their first patriarch and his successors, for about 500 years at any rate, were Monothelite, and perhaps also Monophysite. Nevertheless the question of union with Rome became a practical one in the 12th century; but the local particularism of the Lebanon was averse to union, which was not effected until the 18th century. Clement XII. sent to Syria Assemanus, a Maronite educated at the Roman college of Gregory XIII.; and at last, at a council held at the monastery of Lowaizi on the 30th of September 1736, the Maronite Church accepted from Rome a constitution which is still in force, and agreed to abandon some of its more incongruous usages such as mixed convents of monks and nuns. It retained, however, its Syriac liturgy and a non-celibate priesthood. The former still persists unchanged, while the Bible is read and exhortations are given in Arabic; and priests may still be ordained after marriage. But marriage is not permitted subsequent to ordination, nor does it any longer usually precede it. The tendency to a celibate clergy increases, together with other romanizing usages, promoted by the papal legate in Beirut, the Catholic missioners, and the higher native clergy who are usually educated in Rome or at St. Sulpice. The legate exercises growing influence on patriarchal and other elections, and on Church government and discipline. The patriarch receives confirmation from Rome, and the political representation of the Maronites at Constantinople is in the hands of the vicar apostolic. Rome has incorporated most of the Maronite saints in her calendar, while refusing (despite their apologists) to canonize either of the reputed eponymous founders of Maronism.

The Maronites are most numerous and unmixed in the north of Lebanon. Formerly they were wholly organized on a clan system under feudal chiefs, of whom those of the house of Khazin were the most powerful; and these fought among themselves rather than with the Druses or other denominations down to the 18th century, when some Arabs began to stir up strife between Maronites and Druses (*see* Druses). The Maronite population has greatly increased at the expense of the Druses, and is now obliged to emigrate in considerable numbers. Increase of wealth and the influence of returned emigrants tend to soften Maronite character, and the last remnants of the barbarous state of the community—even the obstinate blood-feud—are disappearing.

See F. J. Bliss in *Pal. Expl. Fund Quarterly Statement* (1892); and authorities for Druses and Lebanon.

MAROONS. A *nègre marron* is defined by Littré as a fugitive slave who betakes himself to the woods; a similar definition of *cimarron* (apparently from *cima,* a mountain top) is given in the *Dictionary* of the Spanish Academy. The old English form of the word is *symaron* (*see* Hawkins's *Voyage,* § 68). The term "Maroons" was applied almost as a proper name to the descendants of those negroes in Jamaica who at the first English occupation in the 17th century fled to the mountains.

MAROT, CLÉMENT (1496–1544), French poet, was born at Cahors, the capital of the province of Quercy, some time during the winter of the year 1496–1497. His father, Jean Marot (*c.* 1463–1523), whose name appears as des Mares, Marais or Marets, was a Norman, a poet of considerable merit, and held the post of *escripvain* (apparently uniting the duties of poet laureate and historiographer) to Anne of Brittany. Clément appears to have been educated at the university of Paris, and to have then begun the study of law. Jean Marot took great pains to instruct his son in the fashionable forms of verse-making, after the complicated rules of the *rhétoriqueurs.* Clément himself practised with diligence this poetry (which he was to do more than any other man to overthrow), and he has left panegyrics of its coryphaeus Guillaume Crétin, the supposed original of the Raminagrobis of Rabelais, while he translated Virgil's first eclogue in 1512. He became page to Nicolas de Neuville, seigneur de Villeroy, and this opened to him the way to court life.

As early as 1514, before the accession of Francis I., Clément presented to him his *Judgment of Minos,* and shortly afterwards he was either styled or styled himself *facteur* (poet) *de la reine* to Queen Claude. In 1519 he was attached to the suite of Marguerite d'Angoulême, the king's sister, the great patron of letters. He was also a great favourite of Francis himself, attended the Field of the Cloth of Gold in 1520, and celebrated it in verse.

In 1524, Marot accompanied Francis on his disastrous Italian campaign. He was wounded and taken at Pavia, but soon released, and he was back again at Paris by the beginning of 1525. His luck had, however, turned. Marguerite for intellectual reasons, and her brother for political, had hitherto favoured the double movement of *Aufklärung,* partly humanist, partly Reforming, which distinguished the beginning of the century. Formidable opposition to both forms of innovation, however, was now manifested, and Marot, who was at no time particularly prudent, was arrested on a charge of heresy and lodged in the Châtelet, February 1526. A friendly prelate, acting for Marguerite, extricated him before Easter. His imprisonment is described in a vigorous poem entitled *Enfer.* His father died about this time, and Marot appears to have succeeded to his place of valet de chambre to the king. He was certainly a member of the royal household in 1528 with a stipend of 250 livres, besides which he had inherited property in Quercy. In 1530, probably, he married. Next year he was again in trouble, not it is said for heresy, but for attempting to rescue a prisoner, and was again delivered; this time the king and queen of Navarre seem to have bailed him themselves.

In 1532 he published (it had perhaps appeared three years earlier), under the title of *Adolescence Clémentine,* the first printed collection of his works. Of the many editions of this work Dolet's edition of 1538 is believed to be the most authoritative. Unfortunately, Marot was implicated in 1535 in the affair of "The Placards,"[1] and this time he was advised or thought it best to fly. He passed through Béarn, and then made his way to Renée, duchess of Ferrara. At her court he wrote his celebrated *Blasons* (a descriptive poem, improved upon mediaeval models), which set all the verse-writers of France imitating them. But the duchess Renée was not able to persuade her husband, Ercole d'Este, to share her sympathy with the Reformers, and Marot had to quit the city. He then went to Venice, but before very long the pope Paul III. remonstrated with Francis I. on the severity with which the Protestants were treated, and they were allowed to return to Paris on condition of recanting their errors. Marot returned with the rest, and abjured his heresy at Lyons. In 1539 Francis gave him a house and grounds in the suburbs.

It was at this time that his famous translations of the psalms appeared. The powerful influence which the book exercised on contemporaries is not denied by anyone. The psalms were sung in court and city, and they materially advanced the cause of the Reformation in France. Indeed, the vernacular prose translations of the Scriptures were in that country of little merit or power, and the form of poetry was still preferred to prose. At the same time Marot engaged in a literary quarrel with a bad poet named Sagon, who represented the reactionary Sorbonne. Half the verse-writers of France ranged themselves among the Marotiques or the Sagontiques. The victory, as far as wit was concerned, naturally rested with Marot, but probably a certain amount of odium was created against him, which may have had

[1] These "placards" were the work of the extreme Protestants. Pasted up in the principal streets of Paris on the night of Oct. 17, 1534, they vilified the Mass and its celebrants, and thus led to a renewal of the religious persecution.

something to do with his subsequent misfortunes.

The publication of the psalms gave the Sorbonne a handle, and the book was condemned by that body. In 1543 it was evident that he could not rely on the protection of Francis. Marot accordingly fled to Geneva; but he had, like most of his friends, been at least as much of a freethinker as of a Protestant, and the austere city of Calvin was no place for him. He had again to fly, and made his way into Piedmont, and he died at Turin in the autumn of 1544.

In character Marot seems to have been a typical Frenchman of the old stamp, cheerful, good-humoured and amiable enough, but probably not very much disposed to elaborately moral life and conversation or to serious reflection. With other poets like Mellin de Saint Gelais and Bordeau, with prose writers like Rabelais and Bonaventure Desperiers, he was always on excellent terms.

His importance in the history of French literature is very great, and was long rather under than over-valued. Coming immediately before a great literary reform—that of the Pléiade—Marot was both eclipsed and decried by the partakers in that reform. In the reaction against the Pléiade he recovered honour; but its restoration to virtual favour, a perfectly just restoration, again unjustly depressed him. Marot was a reformer, and a reformer on perfectly independent lines, and he carried his own reform as far as it would go. His early work was couched in the *rhétoriqueur* style, the distinguishing characteristics of which are elaborate metre and rhyme, allegoric matter and pedantic language. In his second stage he entirely emancipated himself from this, and became one of the easiest, least affected and most vernacular poets of France. In these points indeed he has, with the exception of La Fontaine, no rival, and the lighter verse-writers ever since have taken one or the other or both as model. In his third period he lost a little of this flowing grace and ease, but acquired something in stateliness, while he lost nothing in wit.

The most important early editions of Marot's *Oeuvres* are those published at Lyons in 1538 and 1544. In the second of these the arrangement of his poems which has been accepted in later issues was first adopted. In 1596 an enlarged edition was edited by François Mizière. Among modern editions are those of P. Jannet (1868–72; new ed., 1873–76); and of G. Guiffrey, only vols. ii. and iii. (1875–81) of which were issued. For information about Marot himself *see* the section concerning him in G. Saintsbury's *The Early Renaissance* (1901); A. Tilley, *Literature of the French Renaissance*, vol. i., ch. iv. (1904); P. Villey, *Recherches sur la Chronologie des oeuvres de Marot* (1921); P. A. Becker, *Clément Marot, Sein Leben und Seine Dichtung* (1926).

MAROT, DANIEL (1661–?), French architect, furniture designer and engraver, and the pupil of Jean le Pautre, was the son of Jean Marot (1620–1679), who was also an architect and engraver. He was born in Paris in 1661. He was a Huguenot, and was compelled by the Revocation of the Edict of Nantes in 1685 to settle in Holland. His earlier work is of the second period of Louis XIV., but eventually it became tinged with Dutch influence, and in the end the English style called "Queen Anne" owed much to his manner. In Holland he was taken into the service of the Stadtholder, who, when he became William III. of England, appointed him one of his architects and master of the works. He designed the great hall of audience for the States-General at The Hague and also decorated many Dutch country-houses. In England he concentrated upon the adornment of Hampton Court Palace. Among his plans for gardens is one inscribed: "Parterre d'Amton-court inventé par D. Marot." Much of the furniture—especially the mirrors, guéridons and beds—at Hampton Court bears unmistakable traces of his authorship. Splendour and elaboration are the outstanding characteristics of Marot's style, and he appears to have been responsible for some of the curious silver furniture which was introduced into England from France in the latter part of the 17th century. At Windsor Castle there is a silver table, attributed to him, which is an exceedingly fine example of its type. During his life in France Marot made many designs for André Charles Boulle (*q.v.*), more especially for long case and bracket clocks which were intended to be mounted in chased and gilded bronze. Marot designed practically every detail in the internal ornamentation of the house—carved chimney-pieces, ceilings, panels for walls, girandoles and wall brackets, and was also a prolific designer of gold and silver plate. Marot was still living in 1718, and the date of his death is unknown.

Much of our knowledge of his work is obtained from the volume of his designs published at Amsterdam in 1712: *Oeuvres du Sieur D. Marot, architecte de Guillaume III. Roi de la Grande Bretagne*, and to *Receuil des planches des sieurs Marot, père et fils*. In addition to decorative work these books contain prints of scenes in Dutch history, and engravings of the statues and vases, produced by Marot, at the Palace of Loo. *See* also *Das Ornamentwerk des Daniel Marot* with preface by P. Jenssen (1892).

MARPRELATE CONTROVERSY, a war of pamphlets waged in 1588 and 1589 between a puritan writer who employed the pseudonym "Martin Marprelate" and defenders of the Established Church. Martin's tracts are characterized by violent and personal invective against the Anglican dignitaries, and by a plain and homely style combined with pungent wit. The special point of his attack was the Episcopacy. The pamphlets were printed at a secret press established by John Penry, a Welsh puritan. After three tracts had been issued, it appeared to some of the ecclesiastical authorities that the only way to silence Martin was to have him attacked in his own railing style, and accordingly certain writers of ready wit, among them John Lyly, Thomas Nashe and Robert Greene, were secretly commissioned to answer the pamphlets. Among the productions of this group were *Pappe with an Hatchet* (1589), probably by Lyly, and *An Almond for a Parrat* (1590), which, with certain tracts under the pseudonym of Pasquil, has been attributed to Nashe (*q.v.*). Meanwhile, in July 1589, Penry's press, now at Wolston, near Coventry, produced two tracts purporting to be by "sons" of Martin, but probably by Martin himself, namely, *Theses Martinianae* by Martin Junior, and *The Just Censure of Martin Junior* by Martin Senior. Shortly after this the press was seized; Penry, however, was not found, and in September issued from Wolston or Haseley *The Protestation of Martin Marprelate,* the last work of the series, though several of the anti-Martinist pamphlets appeared later. Penry then fled to Scotland, but was later apprehended in London, charged with inciting rebellion, and hanged (May 1593).

Bibliography.—*See,* for list and full titles of the tracts, related documents and discussion of the authorship, E. Arber's *Introductory Sketch to the Martin Marprelate Controversy* (1880), which, however, gives no connected account of the matter. *See* also articles on John Penry and Job Throckmorton in *Dict. of Nat. Biography*. The more important tracts have been reprinted by Petheram in his series of *Puritan Discipline Tracts* (1842–60), in Arber's *English Scholar's Library* (1879–80), in R. W. Bond's edition of Lyly and in the editions of Nashe.

MARQUAND, HENRY GURDON (1819–1902), American philanthropist and collector, was born in New York city April 11, 1819. He was the first honorary member of the American Institute of Architects, and president (1889–1902) of the Metropolitan Museum of Art, to which he made valuable presents and loans from his collection of paintings. He died in New York city February 26, 1902.

MARQUARDT, JOACHIM (1812–1882), German historian and writer on Roman antiquities, was born at Danzig on April 19, 1812. He studied at Berlin and Leipzig and became in 1859 head of the gymnasium in Gotha, where he died on Nov. 30, 1882. He continued W. A. Becker's *Handbuch der römischen Alterthümer* which took 20 years to complete. Marquardt then embarked on a revised edition of the whole with Theodore Mommsen and other scholars. He himself contributed vols. iv.–vi. (*Römische Staatsverwaltung,* 1873–78; 2nd ed., 1881–85), and vol. vii. (*Das Privatleben der Römer,* 1879–82; 2nd ed., by A. Mau, 1886).

MARQUESAS or **MENDAÑA ISLANDS** (Fr. *Les Marquises*), an archipelago of the Pacific ocean lying between 7° 50′ and 10° 35′ S. and 138° 50′ and 140° 50′ W., and belonging to France. It extends over 250 mi. from southeast to northwest, and has a total area of 480 sq.mi. The southern or Mendaña group consists of the islands Fatuhiva or Magdalena, Motane or San Pedro, Tahuata or Santa Christina and Hivaoa or Dominica. With these is often included the rocky islet of Fatuhuku or Hood, lying in mid-channel to the north of Hivaoa. The northwestern or Washington group is formed of seven islands, the four largest being Huapu or Adams, Huahuna or Washington, Nukuhiva (70 mi. in circumference) and Eiao. Along the centre of each island is a ridge of mountains, attaining an altitude of 4,042 ft. in Huapu, whence rugged spurs forming deep valleys stretch towards the sea. The volcanic origin of the whole archipelago is proved by the principal rocks being of basalt, trachyte and lava. Vegetation is luxuriant in the valleys, which are well watered with streams and terminate seaward in small "bays." The flora includes about four hundred known species, many of them identical with those belonging to the Society Islands. The vegetable products comprise bananas, bread-fruit, yams, plantains, wild cotton, bamboos, sugar-cane, coco-nut and dwarf palms, and several kinds of timber trees. The land fauna however is poor; there are few mammals with the exception of dogs, rats and pigs; and amphibia and insects are also generally scarce. Of twenty species of birds more than half belong to the sea, where animal life is as abundant as about other subtropical Polynesian groups. The climate is hot and damp. During the greater part of the year moderate easterly winds prevail, and on the larger islands there are often both land and sea breezes. The rainy season accompanied by variable winds sets in at the end of November, and lasts for about six months. During this period the thermometer varies from 84° to 91° F.; in the dry season its average range is from 77° to 86°.

The Marquesas Islands were discovered in 1595 by Alvaro Mendaña, who, however, only knew of the southeastern group, to which he gave the name by which they are generally known (although they also bear his own), in honour of Don Garcia Hurtado de Mendoza, marquis of Cañete, viceroy of Peru, and patron of the voyage. Captain Cook pursuing the same track rediscovered this group, with the addition of Fatuhuku, in 1774. The northwestern islands were first sighted by the American Captain Ingraham in 1791, and given the name of Washington by him; the French Captain Marchand followed in the same year, and Lieut. Hergest in 1792. The Russian explorer, Adam Ivan Krusenstern, made an extensive investigation of the archipelago in 1804. In 1813 the American Commodore David Porter failed to establish a colony here; and in May 1842, after French Roman Catholic missionaries had prepared the way, Rear-admiral Dupetit-Thouars took formal possession of the archipelago for France. A complete settlement was not effected without bloodshed and about 1860–70 the colony was practically abandoned. At the time of the French annexation (1842) the population was 20,000 and this had fallen (1941 census) to 2,699. The archipelago, which has some small trade in copra, cotton and cotton seeds, is administered by a French resident. The natives, a pure Polynesian race, are usually described as physically the finest of all South Sea islanders, and therefore pre-eminent among many finely built races.

MARQUESS or **MARQUIS,** a title and rank of nobility. In the British peerage it is the second in order and therefore next to duke. In this sense the word was a reintroduction from abroad; but lords of the Welsh and Scottish "marches" are occasionally termed *marchiones* from an early date. The first marquess in England was Robert de Vere, the 9th earl of Oxford, who was created marquess of Dublin by Richard II, on Dec. 1, 1385, and assigned precedence between dukes and earls. On Oct. 13, following, the patent of this marquessate was recalled, Robert de Vere then having been raised to a dukedom. John de Beaufort, earl of Somerset, the second legitimatized son of John of Gaunt, was raised to the second marquessate as marquess of Dorset on Sept. 29, 1397, but degraded again to earl in 1399. The commons petitioned for the restoration of his marquessate in 1402, but he himself objected because "le noun de Marquys feust estraunge noun en cest Roialme." From that period this title appears to have been dormant till the reign of Henry VI, when it was revived (1442), and thenceforward it maintained its place in the British peerage. Anne Boleyn was created marchioness of Pembroke in 1532. A marquess is "most honourable," and is styled "my lord marquess." His wife, who is also "most honourable," is a marchioness, and is styled "my lady marchioness." The coronet is a circlet of gold on which rest four leaves and as many large pearls, all of them of equal height and connected. The cap and lining, if worn, are the same as in the other coronets (*see* CROWN and CORONET). The mantle of parliament is scarlet, and has three and a half doublings of ermine.

In France, so early as the 9th century, counts who held several counties and had succeeded in making themselves quasi-independent began to describe themselves as *marchiones,* this use of the word being due to the fact that originally none but the margraves, or counts of the marches, had been allowed to hold more than one county. The *marchio* or marquess thus came to be no more than a count of exceptional power and dignity, the original significance of the title being lost. In course of time the title was recognized as ranking between those of duke and count; but with the decay of feudalism it lost much of its dignity, and by the 17th century the savour of pretentiousness attached to it had made it a favourite subject of satire for Molière and other dramatists of the classical comedy. Abolished at the Revolution, the title of marquess was not restored by Napoleon, but it was again revived by Louis XVIII, who created many of Napoleon's counts marquesses. This again tended to cheapen the title, a process hastened under the republic by its frequent assumption on very slender grounds in the absence of any authority to prevent its abuse. In Italy too the title of *marchese,* once borne only by the powerful margraves of Verona, has shared the fate of most other titles of nobility in becoming common and of no great social significance. (*See* also MARGRAVE.) (J. H. R.)

MARQUETRY (Fr. *marqueterie,* from *marqueter,* to inlay, literally to mark, *marquer*), an inlay of ornamental woods, ivory, bone, brass and other metals, tortoise-shell, mother-of-pearl, etc., in which shaped pieces of different materials or tints are combined to form a design. It is a later development of the ornamental inlays of wood known by the name of Intarsia, and though in the main the latter was a true inlay of one or more colours upon a darker or lighter ground, while marquetry is composed of pieces of quite thin wood or other material of equal thickness laid down upon a matrix with glue, there are examples of Intarsia in which this mode of manufacture was evidently followed. In order to gain greater relief the wood was shaded or tinted. A combination of tortoise-shell and metal, the one forming the ground and the other the pattern upon it, which may be classed as marquetry also appears in the 17th century. The subjects of the *intarsiatori* are generally arabesques or panels with elaborate perspectives, either of buildings or cupboards with different articles upon the shelves seen through half-open doors. The later *marqueteurs* used a freer form of design for the most part, and scrolls and bunches of flowers appear in profusion, while if architectural forms occur they are generally in the shape of ruins amid landscape. The greater portion of the examples in England are importations, either from Holland (in which country very fine work was produced during the latter half of the 16th and 17th centuries) or from France. The reputation of the Dutch *marqueteurs* was so great that Colbert engaged two, named Pierre Gole and Vordt, for the Gobelins at the beginning of the 17th century. Jean Macé of Blois, the first Frenchman known to have practised the art, who was at work in Paris from 1644 (when he was lodged in the Louvre), or earlier, till 1672, as a sculptor and painter, learned it in the Netherlands. His title was "menuisier et faiseur de cabinets et tableaux en marqueterie de bois"; but as early as 1576 a certain Hans Kraus had been called "marqueteur du roi." Jean Macé's daughter married Pierre Boulle, and the greatest of the family, André Charles Boulle (*q.v.*), succeeded to his lodging in the Louvre on his death in 1672. The members of this family are perhaps the best known of the French *marqueteurs.* Their greatest triumphs were gained in the marquetry of metal and tortoise-shell combined with beautiful ormolu mountings. The names of Roentgen, under whom the later German marquetry perhaps reached its highest point, Riesener and Oeben, testify to their nationality. A good deal of marquetry was executed in England in the later Stuart period, mainly upon long-case clocks, cabinets and chests of drawers, and it is often of real excellence. Marquetry in a shallower form was also extensively used in the latter part of the 18th century. The most beautiful examples of the art in Italy are mainly panels of choir stalls or sacristy cupboards, though marriage coffers were also often sumptuously decorated in this manner. With the increase in luxury and display in the 17th and 18th centuries in France and Germany cabinets and escritoires became objects upon which extraordinary talent and expenditure were lavished. In south Germany musical instruments, weapons and bride chests were often lavishly decorated with marquetry. In modern practice as many as four or even six thicknesses are put together and so cut. When all the parts have been cut and fitted together face downwards, paper is glued over them to keep them in place and the ground and the veneer are carefully levelled and toothed so as to obtain a freshly worked surface. The ground is then well wetted with glue at a high temperature and the surfaces squeezed tightly together between frames called "cauls" till the glue is hard. There are several modes of ensuring the accurate fitting of the various parts, which is a matter of the first importance if the artistic effect is to be secured. (*See* INLAYING.)

MARQUETTE, JACQUES (1637–1675), French Jesuit missionary and explorer, re-discoverer (with Louis Joliet) of the Mississippi, was born at Laon, went to Canada in 1666, and was sent in 1668 to the upper lakes of the St. Lawrence. In 1673 he was chosen with Joliet for the exploration of the Mississippi, of which the French had begun to gain knowledge from Indians of the central prairies. The route taken lay up the northwest side of Lake Michigan, up Green bay and Fox river, across Lake Winnebago, over the portage to the Wisconsin river, and down the latter into the Mississippi, which was descended to within 700 mi. of the sea, at the confluence of the Arkansas river. Entering the Mississippi on May 17, Joliet and his companion turned back on July 17 and returned to Green bay and Michigan (by way of the Illinois river) at the end of Sept. 1673. On the journey Marquette fell ill of dysentery; and a fresh excursion which he undertook to plant a mission among the Indians of the Illinois river in the winter of 1674–75 proved fatal. He died on his way home to St. Ignace on the banks of a small stream (the lesser and older Marquette river) which enters the east side of Lake Michigan in Marquette bay (May 18, 1675). His name is now borne by a larger watercourse which flows some distance from the scene of his death.

See Marquette's *Journal,* first published in Melchissédech Thévenot's *Recueil de Voyages* (1681), and fully given in Martin's *Relations inédites*, and in Shea's *Discovery and Exploration of the Mississippi Valley* (1852); *cf.* also Pierre Margry's *Découvertes . . . des Français dans l'ouest et dans le sud de l'Amérique septentrionale (1614–1754), Mémoires et documents originaux* (1875), containing Joliet's *Détails* and *Relations;* Francis Parkman, *La Salle and the Discovery of the Great West* (1869); Agnes Repplier, *Père Marquette, Priest, Pioneer and Adventurer* (1929).

MARQUETTE, a city of the Upper Peninsula of Michigan, U.S.A., on the south shore of Lake Superior; a port of entry and the county seat of Marquette county. It is on Federal highway 41, and is served by the Duluth, South Shore and Atlantic and the Lake Superior and Ishpeming railways, and lake steamers. The population was 12,718 in 1920 (24% foreign-born white) and was 15,928 in 1940 by the federal census. Marquette has a beautiful location on a bluff 100 ft. above the lake, in a picturesque summer-resort region. It is the seat of the Northern State Teachers college (established 1899) and the Upper Peninsula State prison and house of correction (1885), and a diocesan centre of the Roman Catholic and the Protestant Episcopal churches. A state park lies just west of the city; there is a state fish hatchery 3 mi. E., and at Ruse, 20 mi. E., a United States forest experiment station.

Presque Isle, within the city, is a great natural park, nearly surrounded by the lake, with herds of deer on its heavily wooded hills.

Marquette is an important manufacturing, mining, ore-shipping and wholesale distributing centre. Its factories are chiefly woodworking and chemical plants. Both the railroads have their general offices and shops here.

Marquette was settled about 1845, incorporated as a village in 1859, and chartered as a city in 1871. For the first few years it was called Worcester.

MARQUIS, DONALD ROBERT PERRY (1878–1937), American poet and playwright, born on July 29, 1878, at Walnut, Illinois, U.S.A. He was educated at Knox college, Galesburg, Ill. Later he worked as a reporter on several newspapers and assisted Joel Chandler Harris in editing the *Uncle Remus* magazine. From 1912 to 1922 he conducted a column, "The Sun Dial," in the *New York Sun,* where his wit and wisdom attracted attention. Among his published collections of humorous poetry, satirical prose and plays the best known are *Danny's Own Story* (1912), *Dreams and Dust* (1915), *Hermione* (1916), *Prefaces* (1919), *The Old Soak,* a play (1921), *Sonnets to a Red Haired Lady* (1922), *The Dark Hours,* a play (1924), *Out of the Sea,* a play (1927).

MARR, CARL (1858–1936), U.S. painter, was born at Milwaukee, Wis., on Feb. 14, 1858. He was a pupil of Henry Vianden in Milwaukee, of Schauss in Weimar, of Gussow in Berlin, and of Otto Seitz, Gabriel and Max Lindenschmitt in Munich. His first work, "Ahasuerus, the Wandering Jew," received a medal in Munich. One of his pictures, "Germany in 1806," received a gold medal in Munich and is in the Eichendorfschule of Königsberg. A large canvas, "The Flagellants," in the Milwaukee Auditorium building, received a gold medal at the Munich exposition in 1889. Another canvas, "Children's Party," in the Phoebe Hearst collection at the University of California, Berkeley, was exhibited in Munich. Marr became a professor in the Munich academy in 1893, and in 1895 a member of the Berlin academy of arts.

MARRADI, GIOVANNI (1852–1922), Italian poet, was born at Leghorn, and educated at Leghorn and Florence. His principal volumes of verse are *Canzoni moderne* (1879), *Fantasie marine* (1881), *Ricordi lirici* (1884), *Poesie* (1887), *Nuovi canti* (1891), *Ballate moderne* (1895) and a *Rapsodia Garibaldina* (3 parts, 1894, 1902 and 1903), *Canzoni e fantasie* (1917). He was much influenced by Carducci, and became well known not only as a critic but also as a charming descriptive poet.

See G. Mazzoni, *L'Ottocento,* 2nd ed., Milan, 1934.

MARRAKESH (erroneously MOROCCO or MAROCCO CITY), southern capital and largest town of Morocco. It lies in a spacious plain—Blad el Hamra, "The Red"—about 15 mi. from the northern underfalls of the Atlas, and 96 mi. E.S.E. of Safi, at a height of 1,500 ft. Ranking during the early centuries of its existence as one of the greatest cities of Islam, Marrakesh has long been in a state of grievous decay, but it is rendered attractive by the exceptional beauty of its situation, the luxuriant groves and gardens by which it is encompassed and interspersed, and the magnificent outlook which it enjoys toward the mountains. Open spaces of great extent are numerous within the walls. *Tabiya* or rammed concrete of red earth and stone is the almost universal building material, and the houses are consequently seldom more than two stories in height. The great square, Djemaâ-el-Fna, situated in the middle of Marrakesh, is crowded daily; the very extensive *suks* are situated on the edges of the square. The palace of the sultan covers an extensive area, and beyond it lie the imperial parks of Agudal, 2 mi. long and about 5,000 feet wide, planted with fruit trees of all sorts; the palm grove which surrounds Marrakesh stretches as far as the Tensift; it covers 32,000 acres and contains 90,000 palm trees.

The ramparts of Marrakesh are pierced by monumental gateways; the most beautiful is the Kasba gate, Bab-Aguenaou. The chief religious buildings are the mosque of Koutoubiya, or Mosque of the Scribes (12th century), with its monumental tower 221 ft. high, the most beautiful monument of Marrakesh; the mosque of Kasba or Djama-Moulay-Yazid, near to which are the tombs of the Sa'adi sharifs, fine monuments in which are buried the sovereigns of the last-but-one Moroccan dynasty (16th–17th centuries); Djama-el-Mouasine; Djama-Bab-Doukkala, the sanctuary of Sidi-ben Slimane-el-Djazouli, that of Sidi-bel-Abbés, patron of Marrakesh; the *medersa* Ben-Youssef (16th century). There are three beautiful monumental fountains, those of El-Mouasine, of Sidi-el-Hassan or Ali and of Sekkaia Echrob ou-Chouf. The palace of Bahia, built from 1894 to 1900, serves as a residency.

A European town was built $1\frac{1}{2}$ mi. from the original one, at the foot of the hill of Gueliz (1,728 ft.), which is crowned by a military camp. Founded in 1913, it is traversed by wide avenues bordered with trees. The pop. (1944) of Marrakesh was 184,400 of which 181,800 were Moslems and 2,600 Europeans. The natives are a mixture of the descendants of Andalusian Moors of original Rehemna of the neighbouring plains, of Chleuh mountaineers and of Sahara Draoua. Marrakesh is the chief town of the region of Marrakesh, the residence of a khalif of the sultan and the centre of action of the grand Kaïd Glaoui. It is connected by good roads with Mazagan, Mogador, Safi Taroudant, Warzazat and Casablanca; a broad-gauge railway (56.7 inches), finished in 1928, joins Marrakesh to Casablanca (158 miles).

Marrakesh, designated Morocco by the old European authors, was founded in 1062 by Youssef-ben-Tachfin, founder of the dynasty of the Almoravides. It was from Marrakesh that Abd-el-Moumen, the first sovereign of the dynasty of the Almohades, set out to conquer all northern Africa, and it was that town that he made the capital of his empire (1147). From 1184 to 1198, the sultan Yakout-el-Mansour built there the mosque and the tower of Koutoubiya, at the same time that he caused to be built the Giralda at Seville and the mosque of the tower of Hassan at Rabat, the most famous monuments of the Almohade period and the best built of the Maghreb. The Merinide sultans preferred Fez to Marrakesh, but the Saadi sharifs again made it the chief Moroccan capital. The Alaouite sharifs of the reigning dynasty, from time to time, stay there for more or less prolonged periods. After a violent combat at Sidi-bou-Othman, where he put to flight the bands of the insurgent El-Hiba, Col. Mangin entered Marrakesh with the French troops on Sept. 7, 1912.

An important airport was constructed there in 1940 which was subsequently greatly enlarged by the U. S. army after the North Africa landings in Nov. 1942.

See A. Chevrillon, *Marrakesh dans les palmes* (Paris, 1919); Z. and I. Tharaud, *Marrakesh ou les seigneurs de l'Atlas* (Paris, 1919).

MARRAM-GRASS (*Ammophila arundinacea*), an important sand-binding grass, called also beach-grass, and sea marram, native to sandy sea coasts of Europe and North America from North Carolina northward and to the shores of the Great Lakes. It is an erect somewhat coarse perennial, with hard, tough, scaly, creeping rootstocks; long, involute leaf-blades; and a pale, dense, spikelike flowering panicle. Marram is employed in Europe to hold in place the barrier dunes along coasts, as in Holland; also with like success on Cape Cod, Mass., and at San Francisco, Calif.

MARRIAGE. Human beings, like all higher animals, multiply by the union of the two sexes. But neither conjugation, nor even the production of offspring, is as a rule sufficient for the maintenance of the species. The further advanced the animal in the order of evolution, the longer the immaturity and the helplessness of the young and the greater the need for prolonged parental care and training. It is thus the combination of mating with parenthood which constitutes marriage in higher animals, including man. Even in its biological aspect, "marriage is rooted in the family rather than the family in marriage" (Westermarck).

1. **The Biological Foundations of Human Mating.**—In human societies, however, there are added to the sexual and parental sides of marriage other elements: marriage is given the hall-mark of social approval; it becomes a legal contract; it defines the relations between husband and wife and between parents and children, as well as the status of the latter; it imposes duties of economic co-operation; it has to be concluded in a public and solemn manner, receiving, as a sacrament, the blessings of religion and, as a rite, the good auspices of magic.

Human marriage also appears in a variety of forms: monogamy, polygyny and polyandry; matriarchal and patriarchal unions; households with patrilocal and matrilocal residence. Other forms, such as "group-marriage," "promiscuity," "anomalous" or "gerontocratic" marriages have been assumed by some writers as an inference from certain symptoms and survivals. At present these forms are not to be found, while their hypothetical existence in prehistoric times is doubtful; and it is important above all in such speculations never to confuse theory with fact.

Marriage again is in no human culture a matter of an entirely free choice. People related by descent or members of certain classes are often debarred from marrying each other, or else they are expected to marry. The rules of incest, of exogamy, of hypergamy and of preferential mating form the sociological conditions of marriage. To these are added in certain societies such preparatory arrangements and conditions as initiation, special training for marriage, moral and economic tests, which have to be satisfied before marriage can be entered upon. The aspects, the forms and the conditions of marriage have to be discussed in turn, though it is not possible to draw a sharp line of division between these subjects.

2. **Love and Marriage.**—Love and marriage are closely associated in day-dreams and in fiction, in folk-lore and poetry, in the manners, morals and institutions of every human community—but marriage is more than the happy ending of a successful courtship. Marriage as an ideal is the end of a romance; it is also the beginning of a sterner task, and this truth finds an emphatic expression in the laws and regulations of marriage throughout humanity.

Love leads to sexual intimacy and this again to the procreation of children. Marriage on the whole is rather a contract for the production and maintenance of children than an authorization of sexual intercourse. The main reason why marriage has not been regarded as establishing an exclusive sexual relationship lies in the fact that in many human societies sexual relations have been allowed under certain conditions before marriage, while marriage did not necessarily exclude the continuance of similar relations.

Marriage, however, remains the most important form of lawful intercourse, and it dominates and determines all extra-connubial liberties. In their relation to marriage the forms of licence can be classified into prenuptial liberty, relaxations of the marriage bond, ceremonial acts of sex, prostitution and concubinage.

3. **Prenuptial Intercourse.**—In the majority of savage tribes unmarried boys and girls are free to mate in temporary unions, subject to the barriers of incest and exogamy and of such social regulations as prevail in their community. But there are other tribes where chastity of the unmarried is regarded as a virtue, especially in girls, and any lapse from it severely censured or even punished. Many of the lowest savages, such as the Veddas, Fuegians, Kubu of Sumatra, Senoi and other Malayan negritos, do not tolerate sexual intercourse before marriage. Among the Bushmen and the Andamanese instances of prenuptial unchastity do occur, but they are not condoned, still less provided for by custom and moral approval. The Australians, however, allow prenuptial freedom, except perhaps a few of the South-eastern tribes.

On a higher level we find considerable variety in this respect. All over the world, in Oceania, in Asia, in Africa and in both Americas, examples could be quoted of peoples who demand continence more or less stringently, and of their neighbours who allow full freedom. In a few cases only can we find the demand of chastity expressed in very definite usages, which physically prevent incontinence, such as infibulation, practiced among the N.E. African, Hamitic and Semitic peoples and reported also from Siam, Burma and Java. The testing of the bride by a publicly exhibited token of defloration, which forms part of certain marriage ceremonies and which expresses the value of virginity, is carried out more or less thoroughly and naturally lends itself to deception and circumvention. It is found sporadically throughout the world, in the noble families of Oceania (Tonga, Samoa, Fiji), in Asia (Yakuts, Koryaks, Chuwash, Brahui of Baluchistan, Southern Celebes), in America (Chichimec of Mexico), in Africa (Mandingo, Kulngo, Ruanda, Yoruba, Swahili, Morocco, Algeria and Egypt) and likewise among many Semitic and Hamitic peoples. In other parts of the world we are merely informed that chastity is praised and prenuptial intercourse censured (Bantu, Kavirondo, Wa Giyama, Galla, Karanga, Bechuana of Africa; Dobu, Solomon Islanders, of Melanesia; Omaha, Mandan, Néz-Pércé, Apache, Takelma of N. America; Canelas and Kanaya of S. America, Bódo and Dhimál of Indo-China, Hill Dyaks of Borneo).

Freedom to mate at will may be fully allowed and even enjoined and provided for by such institutions as the mixed houses for bachelors and girls (Trobriand Islanders. Nandi, Masai, Bontoc

Igorot). In some communities prenuptial intercourse is not meant to lead to marriage, and there are even cases (as among the Masai, Bhuiya and Kumbi of India, Guaycuru and Guana of Brazil), where two prenuptial lovers are not supposed to marry. Elsewhere prenuptial mating is a method of courtship by trial and error, and it leads gradually into stable unions, and is finally transformed into marriage. Thus among the Trobriand Islanders "sexual freedom" is considerable. It begins very early, children already taking a great deal of interest in certain pursuits and amusements which come as near sexuality as their unripe age allows. This is by no means regarded as improper or immoral, is known and tolerated by the elders and abetted by games and customary arrangements. Later on, after boys and girls have reached sexual maturity, their freedom remains the same, with the result that there is a great deal of indiscriminate mating. In fact, at this age both sexes show a great deal of experimental interest, a tendency to vary and to try, and here again a number of arrangements and customs play into the hands of these juvenile lovers. As time goes on, however, and the boys and girls grow older, their intrigues naturally and without any outer pressure, extend in length and depth, the ties between lovers become stronger and more permanent. One decided preference as a rule develops and stands out against the lesser love affairs. It is important to note that such preferences are clearly based on genuine attachment resulting from real affinity of character. The protracted intrigue becomes a matter of public notice as well as a test of mutual compatibility, the girl's family signify their consent and marriage is finally concluded between the two lovers. (Malinowski). Similar forms of prenuptial selection are found in other tribes (Igorot of Luzon, Akamba of E. Africa, Munshi of N. Nigeria).

In no instance, however, is prenuptial liberty regarded by the natives as a negation or substitute for marriage. In fact it always is in such communities in the nature of a preliminary or preparation to marriage; it allows the young people to sow their wild oats, it eliminates the cruder forms of sex impulse from matrimonial selection and it often leads youths and girls to exercise a mature choice based on attraction of personality rather than on sexual appeal.

4. **The Principle of Legitimacy.**—Perhaps the most important fact in the consideration of prenuptial unchastity is the rule that freedom of sexual intercourse does not generally extend to freedom of procreation. One of the symptoms of this is that in all communities where chastity is demanded and enforced, the lapse from it entails more censure on girls than on boys, while prenuptial pregnancy is penalised much more severely than mere wantonness. But even where prenuptial unchastity becomes an institution not merely condoned but enjoined by tribal law, pregnancy is often regarded as a disgrace.

Among the aristocratic fraternities of Polynesia, the *areoi* of Tahiti and the *ulitao* of the Marquesas, licence between the men and the women was universal, but children of such unions were killed, unless adopted by a married couple. Among the Melanesian communities of New Guinea and the adjacent archipelago which allow of full sex liberty before marriage the occurrence of pregnancy under such circumstances is a grave disgrace to the mother and entails disabilities on the child. The Masai punish a girl for prenuptial pregnancy, although with them the free unions of unmarried boys and girls are an institution. A similar combination of prenuptial full licence with severe punishment of illegitimate childbirth is recorded from several African tribes (Wapore, Bakoki, Banyankole, Basoga, Akikuyu, Nandi, Beni Amer), from America (Indians of Brit. Guiana, Guaycuru and Guana of Brazil, Creeks and Cherokees), from Asia (Lisu of Burma, Nias Islanders of Malay Archipelago), from Melanesia (Mekeo and N. Solomon Islanders) and from Siberia (Aleut). In all such cases pregnancy is no doubt prevented by contraceptive practices, which however have been reported from very few savage tribes by trustworthy informants; or by abortion, which is far more frequent; or expiated by a punishment of the mother, and sometimes also of the father.

The main sociological principle embodied in these rules and arrangements is that children should not be produced outside a socially approved contract of marriage. In several tribes, the remedy for the disgrace of a prenuptial child consists therefore in an obligation of the presumptive father to marry the girl (S.E. Bantu, Madi, Bavuma, Kagoro of Africa; Tepehuane and Hupa of America; Kacharis, Rabhas, Hajongs and Billavas of India and Assam; Kayans and Punans of Borneo). In some cases again a child of a free union is desired and expected to come, indeed it is a condition to marriage, which is concluded upon its arrival (Sea Dyak, Hill Dyak, Iruleas, Moi, Bontoc Igorot of Asia; natives of Bismarck Archipelago; Lengua, Guarayos and Pueblo Indians of America; Wolofs and Bambata of Africa). Such cases, although they are in a way the opposite of those in which a prenuptial child is a disgrace, involve the same principle: the provision of a father for the child, that is the elimination of illegitimate offspring. As a matter of fact, in all instances where a prenuptial pregnancy is welcomed, the reason for it is that children are regarded in that community as an advantage. The father consequently need not be forced to marry the mother, he does so of his own accord because fruitful marriage is desirable. Thus in all human societies a father is regarded as indispensable for each child, *i.e.*, a husband for each mother. An illegitimate child—a child born out of wedlock—is an anomaly, whether it be an outcast or an unclaimed asset. A group consisting of a woman and her children is a legally incomplete unit. Marriage thus appears to be an indispensable element in the institution of the family. (*See* Malinowski, *Sex and Repression*, pp. 212–217.)

5. **Relaxations of the Marriage Bond.**—Among tribes where chastity is demanded from unmarried girls and youths, marital fidelity is also usually enjoined. As a rule adultery is regarded as a grave offence and more severely penalised than prenuptial incontinence, though exceptions to this rule do exist. In many communities where freedom is granted before marriage, once the matrimonial knot is tied both partners or the wife at least are bound to remain faithful, under more or less serious penalties (Trobrianders, Mailu, Nukuhiva, Maori of Oceania; Land and Sea Dayaks, Kukis, Hajongs, Saorias, Ceramese of Indonesia; Botocudos and Guarayos of S. America: Illinois, Comanche, Iroquois, Pawnee, Californian Indians of N. America; Timne, Ashanti, Konde, Zulu, Kafirs and Thonga of Africa). The penalty inflicted upon an adulterous wife is invariably much graver than upon an unfaithful husband, and considerable differences obtain according to the circumstances of the offence, the status of the third party, the husband's anger and his attachment to his wife.

There are, however, a number of communities in which the marriage bond is broken as regards the exclusiveness of sex with the consent of both partners and with the sanction of tribal law, custom and morality. In some societies the only occasion on which the wife is allowed connection with other men, nay, has to submit to their embraces, is at the very beginning of marriage. This custom has apparently been known in mediaeval Europe under the name of "ius primae noctis." It certainly exists in many savage cultures (Brazilian Indians, Arawaks, Caribs, Nicaraguans, Tarahumare of S. and C. America; Ballante, Bagele, Berbers of Africa; Bánaro and S. Massim of Melanesia; Aranda, Dieri and other Australian tribes). Such customs are to be regarded not so much as the abrogation of matrimonial exclusiveness, but rather as expressing the superstitious awe with which sexual intercourse, and above all defloration, is regarded by primitive peoples (Crawley, Westermarck). As such they should be considered side by side with the numerous instances in which girls are artificially deprived of their virginity, without the intercourse of any man; with prenuptial defloration by strangers; with temporary prostitution of a religious character, and with sexual intercourse as a puberty rite.

A greater encroachment upon sexual exclusiveness in marriage is found in the custom of wife-lending as a form of hospitality. This is very widely distributed over the world (*see* the comprehensive references in Westermarck, *History of Human Marriage*, vol. 1, pp. 225–226). It must be realised that this practice is not an infringement of the husband's rights, but rather his assertion of authority in disposing of his wife's person. Very often indeed a man will offer his sister, daughter, slave or servant instead, a fact which indicates that this custom is not so much the right of another man to infringe upon the matrimonial bond as the right of the head of the household to dispose of its female inmates.

Very often sexual hospitality is exercised in anticipation of future reciprocal benefits, and must be considered side by side with the custom of wife-exchange (Gilyak, Tungus, Aleuts of N. E. Asia; Bangala, Herero, Banyoro, Akamba, Wayao of Africa; various Himalayan and Indian tribes; S. Massim of Melanesia; Marquesas, Hawaii, Maori of Polynesia; and various Australian tribes). At times there is an exchange of wives at feasts, when general orgiastic license prevails (Araucanos, Bororo, Keres of S. America; Arapahos, Gros Ventres and Lower Mississippi tribes of N. America; Dayaks and Jakun of Indonesia; Bhuiyas, Hos, Kotas of India; Ashanti, Ekoi and various Bantu tribes of Africa; Kiwai Papuans). On such festive and extraordinary occasions not only are the sexual restrictions removed, and the sexual appetite stimulated, but the ordinary discipline is relaxed, the normal occupations abandoned and social barriers over-ridden, while at the same time people indulge in gluttony, in desire for amusement and social intercourse. Sexual license, as well as the other relaxations, liberties and ebullitions at such feasts fulfils the important function of providing a safety-vent which relieves the normal repressions, furnishes people with a different set of experiences, and thus again tends to safeguard ordinary institutions.

These cases where wives are exchanged for sexual intercourse only must be distinguished from the less frequent instances of prolonged exchange, with common habitation, more or less legalised. Among the Eskimo of Repulse Bay, "If a man who is going on a journey has a wife encumbered with a child that would make travelling unpleasant, he exchanges wives with some friend who remains in camp and has no such inconvenience. Sometimes a man will want a younger wife to travel with, and in that case effects an exchange, and sometimes such exchanges are made for no special reason, and among friends it is a usual thing to exchange wives for a week or two about every two months" (Gilder, *Schwatka's Search,* p. 251). Analogous forms of prolonged exchange are found among certain tribes of S. India, while among the Siberian Chukchi a man will often enter on a bond of brotherhood with those of his relatives who dwell in other villages, and when he visits such a village his relative will give him access to his wife, presently returning the visit in order to make the obligation mutual; sometimes cousins will exchange wives for a prolonged period.

Again, among the Dieri, Arabana and cognate tribes of C. Australia, a married woman may be placed in the so-called *pirrauru* relationship to a man other than her husband. Such a man may, with the husband's permission, have access to her on rare occasions. Or if the husband be absent and give his consent the woman may join her paramour for some time at his camp, but this is apparently rare. In order to lend his wife in this way a man must wait until she is allotted by the tribal elders as the *pirrauru* to another man. Then he may consent to waive his marital rights for a short time, though we are expressly told he is under no constraint to do so. Circumstances, jealousy, even the disinclination of the woman are obstacles all of which must make the carrying-out of *pirrauru* rights extremely rare. This custom has been adduced as a present-day occurrence of group marriage, but this is obviously incorrect. It is always a temporary and partial surrender of marital rights consisting of a long and permanent connubium with occasional rare episodes of extra-marital liaison.

It is important to remember that we have come to regard marriage as defined primarily by parenthood. Now social parenthood in native ideas, behaviour, custom and law is not affected by these various forms of relaxation just described. The children are reckoned as belonging to the legal husband, and in this as in many other ways—economic, legal and religious—these temporary relaxations do not seriously disturb the marriage relationship. It must be realised with regard to fatherhood that even where the main principles of physiological procreation are known, savages do not attribute an undue importance to actual physiological paternity (*see* KINSHIP). It is almost always the husband of the woman who is considered the legal father of her children, whether he be their physiological father or not..

6. **Concubinage.**—This can be defined as a legalised form of cohabitation, which differs from marriage in that it implies a considerably lower status of the female partner and her offspring, than that enjoyed by the legal wife. It is a terminological confusion to speak of concubinage, when there is temporary access to a woman, or exclusively sexual rights in her. On primitive levels of culture real concubinage does not exist. Some similarity to it can be found in the institution of subsidiary wives. In certain polygynous communities there is one principal wife and the subsidiary ones have a much lower status, as is the case among the Guarani, Central Eskimo, Araucanians, Apache, Chippewa (America); Chukchi, Koryak, Yakut (N.E. Asia); Marquesas Islanders, Tongans, Tahitians, Maori, Marshall Islanders (Polynesia); Awemba, Wafipa, S.E. Bantu, Herero, Nandi, Yoruba, Ewhe (Africa); Ossetes, Kadaras, Khambis (India); Battas, Bagobo, Kulaman (Indonesia).

It is not correct to regard the institutions of temporary and limited partnership described above, such as the *pirrauru* of C. Australia or the protracted exchange of partners among the Eskimo, as concubinage.

7. **Prostitution.**—The institution of commercial eroticism or prostitution has a very limited range among primitive peoples. It has been reported from Melanesia (Santa Cruz, Rossel Island), Polynesia (Line Islands, Caroline Islands, Easter Island, Hawaii), Greenland, N. America (Omaha), S. America (Karaya, Uitoto, Boro), W. Africa, E. Africa (Banyoro). In its relation to marriage it begins to play a very important part only in higher cultures (*see* PROSTITUTION). On the one hand it provides an easy satisfaction for the sexual appetite to unmarried men or those who for some reason cannot cohabit with their wives. It thus constitutes an institution complementary to marriage. On the other hand, in certain communities, of which Ancient Greece is a notable example, *i.e.,* "hetairism," prostitution in a higher and more refined form, allowed some women to devote themselves to cultural pursuits and to associate with men more freely than was possible to those legally married.

On the whole it is rather a subsidiary institution than either a relaxation or a form of sexual preparation. Unlike the other forms of sexual licence, prostitution is neither directly correlated with marriage nor does it affect its integrity so seriously as do the forms of matrimonial relaxation which involve both husband and wife.

8. **The Economics of the Household and Family.**—We are thus led at all stages of our argument to the conclusion that the institution of marriage is primarily determined by the needs of the offspring, by the dependence of the children upon their parents. More specially, the mother since she is handicapped at pregnancy and for some time after birth, needs the assistance of a male partner. The rôle of male associate and helpmate is almost universally played by the husband exclusively, though in some extremely matrilineal societies the wife's brother shares with the husband in some of the responsibilities and burdens of the household. The economic as well as the biological norm of a family is thus mother, child and husband—or exceptionally both the husband and the wife's brother.

In the vast majority of human societies the individual family, based on monogamous marriage and consisting of mother, father and children, forms a self-contained group, not necessarily however cut off from society. Within the household there is a typical scheme of division in functions, again almost universal. By virtue of natural endowment the wife has not only to give birth to and nourish the children, but she is also destined to give them most of the early tender cares: to keep them warm and clean, to lull them to sleep and soothe their infantile troubles. Even in this the husband often helps to a considerable degree, prompted by natural inclination as well as by custom. This latter often imposes upon him duties and ritual manifestations such as taboos during the pregnancy of his wife and at childbirth, and performances at the time of confinement, of which the couvade (*q.v.*) is the most striking example. All such obligations emphasize the father's responsibility and his devotion to the child. Later on in the education of offspring both parents have to take part, performing their respective duties, which vary with the society and with the sex of the children.

Apart from the special task of producing and rearing the children, the wife normally looks after the preparation of the food, she almost invariably provides the fuel and the water, is the actual attendant at the hearth or fireplace, manufactures, tends and owns the cooking-vessels, and she is also the main carrier of burdens. In the very simplest cultures the woman also erects the hut or shelter and looks after camp arrangements (Australians, Bushmen, Andaman Islanders). The husband is the protector and defender of the family, and he also performs all the work which requires greater strength, courage and decision, such as hunting game, fishing, heavy building of houses and craft, and clearing the timber.

The division of labour between husband and wife outside the household follows the line of men's and women's occupations which differ with the community, but on the whole make fighting, hunting, sailing, metal work purely male occupations; collecting, agriculture, pottery, weaving predominantly female; while fishing, cattle-tending, making of clothing and utensils are done by one sex or the other according to culture.

The division of labour outside the household does not mean merely that husband and wife collect food and manufacture goods for their family each in a different manner. It means also as a rule that each has to collaborate with other members of the community of the same sex in some wider collective enterprise, from which the family benefits only partially and indirectly. In spite of repeated theoretical assertions as to the existence of the "closed household economy" or even of individual search for food among primitive peoples, we find in every community, however simple, a wider economic collaboration embracing all members and welding the various families into larger co-operative units (*cf.* B. Malinowski, "Primitive Economics of the Trobriand Islanders," *Econ. Journal,* 1921; "Labour and Primitive Economics," *Nature,* December, 1925).

The fuller our knowledge of relevant facts, the better we see on the one hand the dependence of the family upon the rest of the community, and on the other hand the duty of each individual to contribute not only to his own household but to those of others as well. Thus in Australia a great part of a man's yield in hunting has to be divided according to fixed rules among his relatives, own and classificatory. Throughout Oceania a network of obligations unites the members of the community and overrules the economic autonomy of the household. In the Trobriand Islands a man has to offer about half of his garden produce to his sister and another part to various relatives, only the remainder being kept for his own household, which in turn is supported substantially by the wife's brother and other relatives. Economic obligations of such a nature cutting across the closed unity of the household could be quoted from every single tribe of which we have adequate information.

The most important examples however come from the communities organised on extreme mother-right, where husband and wife are in most matters members of different households, and their mutual economic contributions show the character of gifts rather than of mutual maintenance.

9. **The Split Household Under Matrilocal Mother-right.**—Most of what has been said so far refers to the marriage based on a united household and associated as a rule both under father-right and mother-right with *patrilocal* residence. This means that the bride moves to the husband's community, when she either joins his family house or camp, or else inhabits a house built for the new couple and owned in the husband's name. Patrilocal marriages are by far the most prevalent all over the world.

Matrilocal marriage consists in the husband's joining the wife's community, taking up residence in her parents' house and often having to do some services for them. Matrilocal residence may be permanent; or it may be temporary, the husband having to remain for a year or two with his parents-in-law, and having also possibly to work for them. (Eskimo, Kwakiutl, Guaycuru, Fuegians of America; Bushmen, Hottentots, Bapedi, Bakumbi, Nuer of Africa; negrites of Philippines; Ainu of Japan.) (*See* also Westermarck, *History of Human Marriage,* vol. ii., 360–364; Briffault, *The Mothers,* vol. i. pp. 268–302.)

In a few cases which might be regarded as the extreme development of mother-right combined with matrilocal conditions, the wife remains at her mother's residence and the husband does not even take up a permanent abode there, but simply joins her as a frequent and regular but still temporary visitor (Menangkabau Malays of Sumatra, Pueblo and Seri Indians of N. America, Nairs of Malabar). Such extreme cases of mother-right are an exception. They are the product of special conditions found as a rule at a high level of culture and should never be taken as the prototype of "primitive marriage" (as has been done by Bachofen, Hartland and Briffault).

The most important fact about such extreme matriarchal conditions is that even there the principle of social legitimacy holds good; that though the father is domestically and economically almost superfluous, he is legally indispensable and the main bond of union between such matrilineal and matrilocal consorts is parenthood. We see also that the economic side can have a symbolic, ritual significance—the gift-exchange functions as token of affection—it marks thus a sociological interdependence, while it has hardly any utilitarian importance.

10. **Marriage as an Economic Contract.**—This last point, together with the foregoing analysis of the household and family economics, allows us to frame the conclusion that while marriage embraces a certain amount of economic co-operation as well as of sexual connubium, it is not primarily an economic partnership any more than a merely sexual appropriation. It is as necessary to guard against the exclusively economic definition of marriage as against the over-emphasis of sex. This materialistic view of marriage, to be found already in older writers such as Lippert, E. Grosse, Dargun, appears again in some recent important works. Criticising the exaggeration of sex, Briffault says about marriage: "The institution, its origin and development, have been almost exclusively viewed and discussed by social historians in terms of the operation of the sexual instincts and of the sentiments connected with those instincts, such as the exercise of personal choice, the effects of jealousy, the manifestations of romantic love. The origin, like the biological foundation, of *individual marriage being essentially economic,* those psychological factors are the products of the association rather than the causes or conditions which have given rise to it." And again: "Individual marriage has its *foundation* in *economic* relations. In the vast majority of uncultured societies marriage is regarded almost *exclusively* in the light of *economic* considerations, and throughout by far the greater part of the history of the institution the various changes which it has undergone have been *conditioned by economic causes.*" (*The Mothers,* vol. ii., p. 1; the italics are those of the present writer.)

This is a distortion of a legitimate view. Marriage is not entered upon for economic considerations, exclusively or even mainly; nor is the primary bond between the two parties established by the mutual economic benefits derived from each other. This is best shown by the importance of matrimonial bonds even where there is neither community of goods nor co-operation nor even full domesticity. Economics are, like sex, a means to an end, which is the rearing, education and dual parental influence over the offspring. Economic co-operation is one of the obligations of marriage and like sexual cohabitation, mutual assistance in legal and moral matters it is prescribed to the married by law and enjoined by religion in most cultures. But it certainly is not either the principal end or the unique cause of marriage.

11. **"Marriage by Purchase."**—As erroneous as the over-emphasis on economics and its hypostasis as the *vera causa* and essence of marriage is also the tearing out of some one economic trait and giving it a special name and thus an artificial entity. This has been done notably with regard to the initial gifts at marriage, especially when given by the husband. More or less considerable gifts from the husband to his wife's family at marriage occur very widely (*see* the comprehensive list of references in Westermarck, *History of Human Marriage,* vol. II., chap. xxiii.).

The term "marriage by purchase" applied to such gifts usually serves to isolate them from their legal and economic context, to introduce the concept of a commercial transaction, which is nowhere to be found in primitive culture as a part of marriage, and to serve as one more starting point for fallacious speculations about the origin of marriage.

The presents given at marriage should always be considered as a link—sometimes very important, sometimes insignificant—in the series of services and gifts which invariably run throughout marriage. The exchange of obligations embraces not only the husband and the wife, but also the children, who under mother-right are counted as one with the mother while under father-right they take over the father's obligations. The family and clan of the wife, and more rarely of the husband, also become part of the scheme of reciprocities. The presents offered at marriage by the husband are often made up of contributions given him towards this end by his relatives and clansmen (Banaka, Bapuka, Thonga, Zulu, Xosa, Bechwana, Madi of Africa; Toradjas, Bogos of Indonesia; Buin, Mekeo, Roro, Trobrianders of Melanesia), and are not all retained by the girl's parents but shared among her relatives and even clansmen (Achomawi, Delaware, Osage, Araucanians of America; S.E. Bantu, Swahili, Pokomo, Turkana, Bavili, Ewhe, Baganda, Masai, Lotuko of Africa; Ossetes, Samoyeds, Aleut, Yakut, Yukaghir of Siberia; Koita, Mekeo, S. Massim, Buin of Melanesia). The giving of presents is thus a transaction binding two groups rather than two individuals, a fact which is reflected in such institutions as the inheritance of wives, sororate, levirate, etc. A correct understanding of the initial marriage gift can be obtained only against the background of the wider economic mutuality of husband and wife, parents and children, maternal and paternal families and clans.

Another type of marriage gift is the *lobola* found among the patrilineal and patrilocal communities of the S.E. Bantu, who live by combined agriculture and cattle-raising. The wife and children are here regarded as a definite economic and sociological asset. The wife is the main agricultural and domestic worker, while the children are valuable because the boys continue the line and the girls bring in wealth at marriage. Marriage is concluded by the payment of cattle, the amount varying greatly according to tribe, rank and other considerations from a couple of head to a few score. These cattle are known as *lobola,* or "bride-price," as is the current but incorrect anthropological expression. The *lobola* in fact is not the motive for the transaction, nor is there any bidding on any market, nor can the cattle be disposed of at will by the receiver, *i.e.,* the girl's father. Some of them have to be distributed by him according to fixed tribal custom among particular relatives of the girl; the rest he has to use for the provision of a wife for his son, *i.e.,* the girl's brother, or else, if he has no male heir, he contracts another wife for himself, in order to obtain the desired male descendants. In case of divorce the marriage gift has to be returned as the identical cattle given and not merely in an equivalent form. The *lobola* is thus rather a symbolic equivalent representing the wife's economic efficiency, and it has to be treated as a deposit to be spent on another marriage.

In Melanesia the husband's initial gift at marriage is a ritual act, and is always reciprocated by the wife's family. This is the case also among certain American tribes (Tshimshian, Coast Salish, Bellacoola, Delaware, Ojibway, Navaho, Miwok); in Siberia (Mordwin, Ainu, Buryat, Samoyed, Koryak), and in Polynesia (Samoa). This return gift may take the form of a dowry given to the bride by her father or parents or other relatives but also directly or indirectly benefiting her husband (Greenlanders, Brazilian aborigines, Yahgans of America; Ibo, Ovambo, S.E. Bantu, Banyoro, Masai of Africa; Buryat, Yukaghir, Samoyed of Siberia; Toda of India; Banks Islanders, Buin, Maori of Oceania). In some communities the balance of gifts is so much in favour of the husband that instead of wife purchase we could speak of buying a husband for the girl (N. Massim; coast tribes of Br. Columbia; Tehuelches of Patagonia; Yakut). Both concepts, however, that of "wife purchase" and "husband purchase" are obviously inadmissible.

12. **Property and Inheritance Within Marriage.**—As a rule, whatever the manner of economic inauguration of marriage, and whatever the mutual services exchanged between the partners, the latter have not only their own sphere of activity but their own possessions. The wife usually claims the title and right of disposing of her articles of apparel, of the domestic utensils and often of the special implements and fruits of her pursuit. The importance of woman's work in agriculture, her social influence due to this and her specific claims to the agricultural produce —not the ownership of the land, which is generally vested in man—have given rise to the economic theory of mother-right (*see* below, 13 and 14).

Very often the possessions of the husband and wife are inherited by their respective kindred, and not by the surviving partner. The inheritance of the wife by the husband's brother (the custom of levirate *q.v.*), which is known from the Old Testament, but has a fairly wide range of distribution (*see* the extensive lists given by Westermarck, *loc. cit.* vol. iii., pp. 208–210; Briffault, *The Mothers,* vol. i., pp. 767–772) is not to be regarded as an economic transaction. Like the inheritance of a widow under mother-right and like the custom of killing the widows and the *suttee* of India, it is the expression of the matrimonial bonds outlasting death, and defining the widow's behaviour afterwards (*see* below, 20).

13. **Marriage as a Legal Contract.**—Marriage is never a mere cohabitation, and in no society are two people of different sex allowed to share life in common and produce children without having the approval of the community. This is obtained by going through the legal and ritual formalities which constitute the act of marriage, by accepting in this the obligations which are entailed in marriage and the privileges which it gives, and by having later on to submit to the consequences of the union as regards children.

The legal side of marriage is therefore not made up of special activities, such as constitute its sexual, economic, domestic or parental aspect. It is rather that special side in each of these aspects, which makes them defined by tradition, formally entered upon, and made binding by special sanctions.

First of all, the whole system of obligations and rights which constitute marriage is in each society laid down by tradition. The way in which people have to cohabit and work together is stipulated by tribal law: whether the man joins his wife or vice versa; whether and how they live together, completely or partially; whether the sexual appropriation is complete, making adultery in either partner an offence, or whether, subject to certain restrictions, there may be waiving of the sexual rights; whether there is economic co-operation and what are its limits. The details and the typical rules and variations of all this have already been discussed, as well as, incidentally, the ways in which the rules are enforced. But it must be added that in no other subject of anthropology is our knowledge so limited as in the dynamic problems of why rules are kept, how they are enforced, and how they are evaded or partially broken. (*Cf.* B. Malinowski, *Crime and Custom in Savage Society,* 1926.)

Only on one or two points are we habitually informed by ethnographic observers, as to what penalties attach to a breach of law and custom and what premiums are set on their careful and generous observance. Thus, we are often informed how adultery is dealt with, though we usually get exaggerated accounts of the severity of the law on this point. Again, to anticipate, incest and exogamy are usually surrounded with definite sanctions, some social and some supernatural. The manners and morals of daily contact within the household are usually laid down and enforced by that complicated and imponderable set of forces which governs all human behaviour in its everyday aspects and makes people distinguish between "good" and "bad form" in every human society. The validity of the economic duties of husband and wife are as a rule based on the fact that the services of the one are conditional on the services of the other, and that a very lazy or unscrupulous partner would eventually be divorced by the other.

14. **Divorce.**—This brings us to the subject of the dissolution of marriage. Marriage is as a rule concluded for life—at times

beyond death, as mentioned above. It is questionable whether the short period "marriages" reported from isolated districts (Eskimo of Ungava district, some tribes of the Indian Archipelago, Arabia, Persia, Tibet) deserve the name of marriage, *i.e.,* whether they should not be put into a different sociological category; but our accounts of them are too slight to allow of deciding this question. In some tribes we are told that marriage is indissoluble (Veddas, Andamanese, certain tribes of the Indian Archipelago and Malay Peninsula). The general rule, however, is that divorce (*q.v.*), is possible, but not easy, and entails damages and disabilities to both partners. Even where divorce is said to be easy for husband and for wife, we find on further enquiry that a considerable price has to be paid for the "liberty to divorce," that it is easy only to exceptionally powerful or successful men and women, and that it involves in most cases loss of prestige and a moral stigma. Often also divorce is easy only before children have been born, and it becomes difficult and undesirable after their arrival. In fact the main ground for divorce, besides adultery, economic insufficiency or bad temper, is sterility in the wife or impotence in the husband. This emphasises the aspect of marriage as an institution for the preservation of children.

The threat of divorce and of the disabilities which it entails is one of the main forces which keep husband and wife to their prescribed conduct. At times the husband is kept in check by the payment he gave at marriage and which he can reclaim only when the union is dissolved through no fault of his. At times the considerable economic value of the wife is the motive of his good and dutiful conduct.

15. **The Status of Husband and Wife.**—The duties of the wife towards the husband are apparently in some communities enforced to a considerable extent by his personal strength and brutality, and by the authority given him by custom. In others, however, husband and wife have an almost equal status. Here again, unfortunately, we find too often in ethnographical accounts generalities and stock phrases such as that "the wife is regarded as the personal property of the husband," as "his slave or chattel," or else again we read that "the status of the wife is high." The only correct definition of status can be given by a full enumeration of all mutual duties, of the limits to personal liberty established by marriage, and of the safeguards against the husband's brutality or remissness, or, on the other hand, against the wife's shrewishness and lack of sense of duty. It is often held that mother-right and the economic importance of woman's work, especially in agricultural communities, go with a high social status of the wife, while in collecting, nomadic and pastoral tribes her status is on the whole lower (E. Grosse, in *Die Formen der Familie und die Formen der Wirtschaft;* Schmidt and Koppers, in *Völker und Kulturen*).

Marriage not only defines the relations of the consorts to each other, but also their status in society. In most tribes, marriage and the establishment of an independent household are a condition for the attainment of the legal status of full tribesman in the male and of the rank and title of matron in the woman. Under the system of age grades (*q.v.*) the passage through certain initiation rites is a condition of marriage and this is as a rule concluded soon after it is permitted (*cf.* Webster, *Primitive Secret Societies;* Schurtz, *Altersklassen und Männerbünde*). In all tribes, however, all normal and healthy tribesmen and women are married, and even widows and widowers remarry if they are not too old, under the penalty of losing some of their influence. The attainment of a full tribal status is always a powerful motive for marriage.

16. **The Laws of Legitimate Descent.**—Marriage affects not only the status of the consorts and their relations, but imposes also a series of duties on the parents with regard to children, and defines the status of children by reference to the parents.

As we know already in virtue of the universal principle of legitimacy, the full tribal or civil status of a child is obtained only through a legal marriage of the parents. Legitimacy is at times sanctioned by penalties which devolve on the parents, at times by the disabilities under which illegitimate children suffer, at times again by inducements for the adoption of children or for their legitimisation by the presumptive father or some other man.

In connection with this latter point it is necessary to realise that the children have invariably to return in later life some of the benefits received earlier. The aged parents are always dependent on their children, usually on the married boys. Girls at marriage often bring in some sort of emolument to their parents and then continue to help them and look after them. The duties of legal solidarity also devolve on the children, uniting them to father or mother according to whether we deal with a matrilineal or a patrilineal society.

One of the most important legal implications of marriage is that it defines the relation of the children to certain wider groups, the local community, the clan, the exogamous division and the tribe. The children as a rule follow one of the parents, though more complex systems are also in existence, and the unilateral principle of descent is never absolute. This however belongs to the subject of Kinship (*q.v.; cf.* also MATRIARCHY).

17. **Modes of Concluding Marriage.**—In studying the legal aspect of marriage, it is extremely important to realise that the matrimonial contract never derives its binding force from one single act or from one sanction. The mistake has often been made in discussing the "origin of marriage," of attributing to this or that mode of concluding it a special genetic importance or legal value. Marriage has in turn been derived from mere subjugation by brutal force (the old patriarchal theory); from appropriation by capture in foreign tribes (McLennan's hypothesis); from feminine revolt against hetairism (Bachofen); from economic appropriation or purchase (the materialist interpretation of early marriages); from pithecanthropic patriarchy (Atkinson, Freud); and from *matria potestas* (Briffault). All these views overstate the importance of one aspect of marriage or even of one element in the modes of its conclusion; some even invent an imaginary state or condition.

In reality marriage is the most important legal contract in every human society, the one which refers to the continuity of the race; it implies a most delicate and difficult adjustment of a passionate and emotional relationship with domestic and economic co-operation; it involves the cohabitation of male and female, perennially attracted and yet in many ways for ever incompatible; it focuses in a difficult personal relationship of two people the interest of wider groups: of their progeny, of their parents, of their kindred, and in fact of the whole community.

The validity of the marriage bond derives its sanctions from all these sources. This expresses one of the most important truths concerning marriage. The complexity of motives for which it is entered, the utility of the partners to each other, their common interest in the children's welfare, last, not least, the interest which the kindred and the community have in the proper upbringing of the offspring—these are the real foundations of marriage and the source of its legally binding character.

All this finds an expression in the modes of contracting marriage. These always contain the element of public approval; the collaboration of the families and the kindred of each partner; some material pledges and securities; some ritual and religious sanctions; last, not least, the consent of the parties concerned.

In the old manuals and statements concerning marriage an important place is usually taken by the classical list of the various "modes of concluding" it: marriage by capture, by purchase and by service, by infant betrothal, elopement, exchange, mutual consent, and so on (*cf.* even such an excellent and recent account as the article on "Marriage," by Rivers, in Hastings' *Enc. of Religion and Ethics*).

This classification is unsatisfactory. It exaggerates as a rule one aspect out of all proportion, and attributes to this one aspect an overwhelming influence upon the whole institution which it never possesses. "Marriage by purchase" we have already dismissed as a crude misnomer, while "service" is but a detail in the economics of certain marriages. "Marriage by capture," which has played such a prominent part in speculation and controversy from McLennan onward, never could have been a real institution: though a man may occasionally wed a woman captured by force in a war, such an occurrence is always an exception; it never was a rule, still less a "stage in human evolution." Tribal endogamy (*see* below, 22) is the universal rule of mankind. Ceremonial fights and ritual capture occur at wedding ceremonies over a wide area (*see* Westermarck, *History of Human Marriage,* ii., 254–277; Crawley, ii., 76–100; Briffault, ii., 230–250). They are capable of interpretation in terms of actual psychology and of existing social conditions (Westermarck, Crawley, Briffault, Havelock Ellis). To regard them as survivals of "marriage by capture" is erroneous, and on this point there is now an almost universal agreement. Capture and violence, as well as purchase from other tribes, or on the slave-market, lead to concubinage, and at times supply prostitutes, but only very rarely legal wives.

Like the contract itself, so also the modes of concluding it contain a great variety of binding and of determining factors. But a real and relevant distinction can still be made between those marriages which are contracted primarily by rules of tradition; those which are arranged for by the families or the kindred of the consorts; and those which arise from free and spontaneous choice of the mates. In no type of marriage is any of these three elements —tradition, arrangement by families or their consent, and free choice—completely absent. But one or other may be conspicuously predominant.

The most usual type of traditionally prescribed union is cross-cousin marriage (*see* Cousin Marriage), with a wide distribution, practised very extensively all over Oceania, Australia and S. India, and sporadically in Africa, N. America and Asia. The marriage of parallel cousins is less frequent, and found notably among Semitic peoples (*cf.* Frazer, *Folk-Lore in the Old Testament,* vol. ii., pp. 145 *sqq.;* B. Z. Seligman, "Studies in Semitic Kinship," *Bull. School Oriental Studies,* 1923–24). Even less common are marriages prescribed between other classes of relatives, *e.g.,* between a man and his brother's daughter (N. Australia, some parts of Melanesia), or his sister's daughter (S. India), or his father's sister (certain parts of Melanesia, Dene of N. America). Another type of prescribed marriage is by inheritance, of which the levirate and sororate (*q.v.*) are the most notable.

Besides such traditionally defined unions, there are also marriages recognised as convenient and desirable by the respective families and arranged for by them. Infant betrothal (prevalent in Australia and Melanesia), where a definite claim is established; or infant marriage (reported especially from India), where the bond is effectively concluded, are two of the most usual forms of these. The main motive for infant unions is the determination of the families to secure a convenient union. In Australia, where an infant is often allotted to a mature male, the power of old men and their keenness to secure young wives, are at the root of this institution. Whether similar conditions existed, or even still survive in Africa, is an interesting problem (*see* B. Z. Seligman, "Marital Gerontocracy in Africa," *Journal of the Royal Anthropological Institute,* 1924).

In many communities, including some advanced nations of Europe, marriage is mainly determined by social or financial considerations, and in this the parents of bride and bridegroom have as much to say as the two people directly concerned. In some primitive tribes two brothers exchange sisters (Australia), or a man's matrilineal uncle or patrilineal aunt has some say (Melanesia). Where the initial payments are very heavy and where they are used to secure a wife for the bride's brother, marriage is usually also a matter for an arrangement rather than free choice.

With all this free choice still remains the most important element. Very often an infant betrothal or some other form of arranged union is broken by one of the people directly affected, and marriage by elopement, with the subsequent consent of family and kindred, overrules all other considerations. Invariably in all communities the majority of unions come from the initiative of the partners. Marriage by free personal choice is the normal marriage, and the choice is mainly determined by personal attraction, which does not mean merely a sexual or erotic attraction. In general the physical appeal combines with compatibility of character, and such social considerations as suitability of rank and of occupation and of economic benefits, also influence the choice. Here again the nature of marriage entails a complexity of motives, and its stability has always to be secured by a suitable compromise between conflicting interests.

18. **The Religious and Ceremonial Side of Marriage.**—The sanctity of the marriage bond is not found merely in the Christian religion, nor is it a prerogative of the higher cultures. The supernatural sanction, derived from a solemn, publicly celebrated, spiritually as well as ethically hallowed ceremony, adds to the binding forces of mere law. Marriage is valid as a legal contract in so far as its breach is visited by worldly retributions and its generous fulfilment carries worldly benefits. As a sacrament, marriage in primitive and civilised societies alike, is protected by spiritual powers, rewarding those who observe matrimonial duties meticulously and piously, and punishing those who neglect them.

The religious aspect of marriage is therefore closely akin to the legal, in that it adds to the validity and sanctity of other functions, rather than establishes new ones. It finds expression in the acts of establishment and those of dissolution: religious rites are to be found at betrothal and wedding, while divorce is often religiously defined and qualified, and at death the breach of the bond finds its spiritual expression in the duties, observances and ceremonies incumbent on the surviving partner. Besides these ceremonial manifestations in which the bonds of marriage are religiously tied or dissolved, religious ethics establish those rules of matrimonial conduct which are sanctioned supernaturally or felt binding through their appeal to moral sense rather than to self-interest.

19. **Ceremonies of Betrothal and Wedding.**—Betrothal can be defined as an act preliminary to marriage, establishing mutually presumptive claims. The period between betrothal and marriage varies, and where it is short, it is often difficult or even impossible to decide whether we deal with an act of betrothal or an inaugural wedding rite. It is also unprofitable to draw a very sharp line of distinction between infant betrothal and infant marriage. Where betrothal imposes real obligations and a valid tie, the rites then observed usually fulfil in their religious bearing the same function as those of marriage, and consist of the same or similar actions, both as regards ritual technique and symbolic meaning. It will be best therefore to discuss the binding rites of marriage and betrothal together.

These rites and ceremonies cover a very wide range, from the simplest act, such as a meal openly taken in common, to complex and elaborate tribal festivities, extended over a considerable period of time. But in every human society marriage is concluded by a ritual enactment. It might be disputed whether such rites in their simplest form present a genuine religious character; but most sociologists would agree that they always possess some religious elements in that they are solemn and public; in their more developed form and in higher cultures they become definitely religious. It will be best in discussing the nature of wedding rites not to draw too pedantic a distinction between their legal and religious aspects, since the two often merge or shade into each other imperceptibly.

"The most general social object" of a wedding rite is "to give publicity to the union" (Westermarck). By this the legal as well as the religious sanction of the union is established. The contract is made binding in that all the members of the community bear witness to it; it is hallowed in that the two mates solemnly and openly declare before man, God or other spiritual powers that they belong to each other.

20. **The Symbolism of Marriage Ritual.**—A marriage rite is as a rule also a ritual act with a symbolic significance, and as such it is often conceived to possess a magical efficacy, it contains a moral precept or expresses a legal principle.

A. Biological Symbolism.—Thus the fundamental purpose of marriage, the continuity of the race, is indicated in wedding ceremonies by ritual, intended to make the union fruitful, to obviate the dangers associated with sexual intercourse, especially with defloration, and to facilitate the various stages of the process of generation from the first act to delivery. Among the fertility rites a prominent place is taken by the use of fruit or grain or other cereals, which are sprinkled over the newly-wedded couple or on or round the nuptial bed, or handed to them or brought into contact with them in some other way. Rites, such as the accompaniment of the bride by a little child, the use of various symbols of generation, and the direct offering of prayers and sacrifices, are all intended to make the union fruitful. The breaking of some object at the wedding serves to avert the dangers of defloration and to facilitate the consummation of the union. The undoing of knots and laces, found in many wedding rites, makes for easy delivery at childbirth. In all these acts we see the ritual expression of the biological nature of marriage.

B. Marriage as a Crisis.—As an official and public recognition of a biological fact, as the most important contract ever entered by two individuals, and as the act which creates a new social entity, the family, marriage is a crisis. Now a crisis in human life is always surrounded by powerful emotions: forebodings and hopes, fears and joyful anticipations. Innumerable wedding rites are in existence which are obviously intended to remove the dangers associated with the crisis of marriage.

Dangers apprehended in subjective forebodings are usually conceived in the form of evil agencies: demons or ghosts or malevolent spirits, forces of black magic, mysterious concatenations of ill-luck. These have to be kept at bay or counteracted, and we find innumerable rites intended to avert ill fortune and bring happiness and good chance to the new household. Among these are the avoidance of certain days and places as unlucky, or on the other hand the selection of certain days as being of good omen; the shutting out of evil influences from the place where the wedding is being celebrated; the making of noises, the firing or brandishing of some weapon; the bathing or washing of bride and bridegroom or sprinkling them with water; the lighting of fires and waving of torches; the circumambulation of the bridegroom's tent or of the church; the beating of the bridegroom's tent, and the observance by the bride and bridegroom of various kinds of abstinences with regard to action and eating. Other forms in which bad luck can be side-tracked are: the disguising of the real actors, who may dress in the clothes of the opposite sex, cover themselves, or paint their faces.; the substitution for them of effigies; marriage by proxy; and the contracting of mock marriages with trees or animals or inanimate objects. Finally an important antidote against all supernatural dangers is the state of spiritual invulnerability which is achieved by moral purity and the observance of those mixed ethical and ritual rules which in primitive culture often surround important acts of human life. The most important tabu of this kind, in connection with marriage is obviously the tabu of sex-continence. The principle that the bride and the bridegroom have to abstain from intercourse for some time after the wedding, is known all over the world from primitive savagery to the most refined ethics of the Christian church, from Australia to the New World (*cf.* Westermarck, II., 547–564), while on the wedding night there are occasionally other minor abstinences.

It is characteristic that while the bride and the bridegroom are often considered in a state dangerous not only to themselves but also to others, they are at the same time a source of blessing and of beneficent influences. Thus certain rites are supposed to influence favourably the welfare of other persons even independently of their relations to the principals; joining in at a wedding is sometimes believed to produce benefit; a wedding is looked upon as a potential cause of other weddings; while good luck is often expected from contact with the bride or bridegroom or something worn by them.

C. Marriage as a Sociological Change.—Marriage is a crisis not merely in the spiritual sense. It is also an actual sociological transition from one state to another, both partners forsaking their old families to form a new one. The rupture with the parental family, clan, local community or tribe is expressed in a number of interesting wedding rites. Sham fighting between the bridegroom or his party and the bride's family, or some other kind of resistance made by the latter; the barring of the wedding procession; weeping and other ritual expressions of grief and unwillingness on the part of the bride and her relatives; and the mimic enactment of capture or abduction of the bride—these are mostly the dramatic expression of the fact that the bride has to be torn from her old home, that this is a violent and critical act, a final one.

D. Marriage as a New Bond.—But the most important type of wedding rite is that which lays down that marriage is a sacramental bond. Here again the symbolism is wide and varied, from the most direct expression of union by the joining of hands or of fingers, the tying of garments, the exchange of rings and chains, to complicated dramatic enactments of the separation and union. An important symbolism of the new ties to be established consists in the performance of some act which in future will constitute one of the normal duties or privileges of married life. Such acts in a way define the nature and exclusiveness of marriage by anticipation in ritual performances. Among them, naturally the most important are the ceremonial performance of the sexual act and the ceremonial participation in a common meal. In certain ceremonies the symbolism lays down the relative domains of marital influence. Thus in some cases the assertion of the husband's power is prominent: he is presented with a whip, or he boxes the bride's ears, or mimically beats her, and so on. In others again the wife may attempt by similar acts to mark her independence and her power over her husband. The economic aspect of marriage is often also expressed in some magical act, intended to ensure prosperity to the future household, *e.g.*, by the smearing of butter and honey by the bride over the pole of the tent to ensure abundance of staple food. Again, the division of economic functions is expressed in other rites, as where the wife tends the fire, prepares and cooks food for her husband, etc.

E. The General Function of Wedding Symbolism.—These examples cover the most important though by no means all the ideas expressed in wedding rites. It is easy to see that the symbolism is extremely rich and varied, and that it embraces almost all the aspects of marriage. There are rites which bear directly upon sex and upon gestation; there are rites with a clear domestic and those with an economic significance; there are rites referring to emotional attitudes at marriage and to moral ideas as to its ends. In technique they are all legal, magical or religious. In short, the ceremonial of marriage covers and expresses all the relevant sides of the institution of marriage, and as such it has been a most fruitful and revelatory subject of anthropological study. It also has been the main source of errors and pitfalls.

In order to avoid them it is important to realise that all ritual symbolism is necessarily vague. Speaking of the marriage ceremonies, Professor Westermarck rightly lays down that "Anthropologists are often apt to look for too much reasoning at the bottom of primitive customs. Many of them are based on vague feelings rather than on definite ideas" (*History of Human Marriage,* II., 563). The ritual symbolism at marriage also expresses as a rule mixed and compound meanings in most of the acts. Thus the spilling of corn over the couple may mean fecundity, prosperity, good husbandry as well as union, and probably it vaguely expresses all these elements. Sham fights and captures, tree marriages or marriages by proxy have obviously a plurality of meanings.

Nor is the function of symbolism exhausted by its direct and literal meaning. A ritual act, fixed by tradition, defining the relevant manner of concluding a contract, impresses by pomp and circumstance its social importance and its binding force in the moral sense. The ethical rules and tabus which usually go hand in hand with ritual add to this spiritualising function of wedding ceremonies. The public and official nature of the marriage act, often marked by the presence of an officiating priest, ruler or magician; heralded by banns and public announcements; sealed by witnesses and documents; enhanced by the sacredness of place and of time constitutes the widest and most general function of the rite, and that is to make marriage public, binding, sacred and morally impressive.

21. **The Dissolution of Marriage in Ritual.**—The binding forces of the marriage contract, and its ritual and moral character, are expressed as clearly at the dissolution by divorce or death as at its inception. Unfortunately our information is so defective on this point that a brief survey only can be given.

Divorce in higher cultures is a religious matter, to be carried out under the supervision of the church, and with the observance of certain formalities which express and safeguard the sanctity of the sacrament. From lower cultures we find only a few examples of divorce rites, where such symbolic acts as the breaking of a rod, the tearing of a leaf, or the casting away of some object are publicly performed (Kacharis, Hajongs, Khasis of N.W. India; Bagobo of Mindanao; Tumbuka of C. Africa; certain Canadian Indians; Maori of New Zealand).

Far more material is at our disposal referring to the persistence of the matrimonial bonds at death. They are never dissolved automatically by the decease of either partner, and their tenacity is greater for the widow than for the widower. But in either case the death of one consort imposes a number of ritual and moral observances on the other, the fulfilment of which is an essential part of the marriage contract.

The widow, or widower, usually plays the most prominent part among all mourners. Thus among certain peoples the widow has to perform various duties, extending over a more or less considerable period, at the grave of her husband. She has to sleep beside or over it; to supply it with provisions; to keep a fire burning there perpetually (Takulli, Kutchin, Mosquito, Pima Indians of America; Minas, Nsakara, Baganda of Africa; Pentecost Islanders and certain Papuans of Oceania; Kukis of India). Even more telling are the long series of tabus and duties to be observed by the widow before she is allowed to remarry: she must remain chaste, refrain from bathing or renewing her garments, avoid certain foods, etc. (Omaha, Stlathlumh, Creek, Chickasaw, Algonkin, Iroquois, Dakota, Eskimo of N. America; Angoni, Bakoba, Baya, Bawele, Baganda, Akamba, Herero, BaThonga, Zulu of Africa; Amoor tribes and Kukis of India; Bontoc Igorot of the Philippines; Maori of New Zealand; Ainu, Yakuts, Kamchadal of N.E. Asia).

Similar regulations prevent the widower from entering into a new alliance immediately after he has been set free by his wife's death. Thus among many peoples (Greenlanders, Eskimo, Aleut; Dakota, Omaha, Shawnee of N. America; Herero, Bushmen, BaThonga, Zulu of Africa; certain Papuan tribes; the Bontoc Igorots and the Ainu) the surviving husband has to live single for a time during which he is subjected to various restrictions and observances, such as refraining from sexual intercourse.

The most definite affirmation of the persistence of marital bonds is found among those people who completely forbid remarriage to widows (Tikopians, Rotumans, Marquesans, Line Islanders in Polynesia; Chinese; Ainu of Japan; Formosans; Brahmans of India) or to widowers (Ainu, Formosans, Biduanda Kallang of Malay Peninsula).

Even this is overshadowed by the institution of *suttee,* the sentence of death passed by religious tradition over the widow at her husband's death so that her spirit might follow his into the next world. This institution is found not only in India, from where we have borrowed its name, but also among the Comanche, Cree and certain Californian tribes of N. America; in Dahomey and among the BaFiote of Africa; in the New Hebrides, Fiji, Solomon Islands, Pentecost Island and New Zealand of Oceania.

22. **The Social Conditions of Marriage. Endogamy.**—With this we have finished the analysis of the various aspects of marriage, biological, domestic, economic, legal and religious. It will be necessary still briefly to consider marriage in relation to other modes of grouping, and to discuss certain barriers to and qualifications for matrimony, connected with membership in wider groups.

Marriage is never free in the sense that any man would be at liberty to marry any woman. Natural and physical impediments obviously do not come here under consideration, since we are only concerned with social rules. Thus it is clear that in order to marry, two people must come into contact with each other, and under primitive conditions this is possible only when they belong to the same tribe, or to tribes who meet in peaceful commerce or in warfare. Tribal or natural endogamy (*q.v.*), is thus the first condition of marriage, but it is of secondary interest to the sociologist, and must be distinguished from strict endogamy.

Endogamy proper is the rule which allows marriage only between members of a section of a tribe and forbids unions between members of two sections. Strict endogamy is rare. It occurs mainly in India where members of the same caste only are allowed to marry (*see Caste and Endogamy*). In other parts of India we find a system called *hypergamy* (*q.v.*) in which a man is allowed to marry a woman of a lower section in his caste. He may also marry a woman of the same section if other conditions allow this. But a woman may not marry a man of a lower section on penalty of loss of status of her whole family. In some communities there is competition to secure husbands of high sections.

In primitive communities endogamy is not very widespread. It occurs in tribes where there is a degraded class of artisans or else stratification by rank (Polynesia; Korea, Japan; Trobriand Islands of Melanesia; Algonkin, Salish of N. America; Masai, Banyankole, Karanga and other tribes of E. and S. Africa). In such cases we often find endogamy in what might be called an approximate form. Indeed such approximate endogamy, as a tendency to marry within the profession, class or rank, is, as an unwritten law, well-nigh universal in primitive and civilized communities.

Another type of endogamy which is widespread is that associated with religion. In few religions is marriage outside the group of the faithful permitted. Islam, Judaism, Christianity and Hinduism are cases in point. Primitive religion as a rule need not be intolerant as regards mixed marriages, because there the tribal barriers and lack of communication act with sufficient stringency.

23. **The Prohibition of Incest.**—The most widely spread and most rigidly enforced qualification to marriage is the set of rules which prohibit unions between the members of the same family. These are known as the rules of incest (*q.v.*), and play a great part in the constitution of the family (*q.v.*) and in the regulation of primitive kinship (*q.v.*). Incest has become also of great importance in modern psychology through the speculations of Freud and the psychoanalytic school (*see* PSYCHOANALYSIS: FREUDIAN SCHOOL).

Although incestuous unions between near relatives are universally abhorred and prohibited, the rules differ greatly from one society to another as regards the prohibited degrees as well as the stringency and character of the sanctions. Marriages between mother and son and between father and daughter are universally prohibited by law, custom and moral sentiment. Statements can be quoted, it is true, of tribes among whom more or less irregular unions between parents and children do occur. Thus marriages between mother and son have been reported from the Caribs, Eskimo, Pioje, Tinne of America; Minahassa of Celebes and Kalang of Java; New Caledonians; and the Banjoro of Africa. Again unions between father and daughter are said to occur among the Minahassa of Celebes, Karens of Burma, and in the Solomon, Marshall and Pelew Islands of Oceania. Even better attested are the marriages between brother and sister (Marshall Islands and Hawaii; ancient Irish, Egyptian and Inca royal families).

When we go beyond the family group, the prohibitions of marriage between uncles and nieces, aunts and nephews, first and second cousins, and so on, vary greatly. In some communities certain of these unions are explicitly encouraged and regarded as desirable; in others forbidden. About preferential marriages between relatives we have already spoken (*see* above, 17). Extensive prohibitions of marriage between distant kindred exist, besides the Western Christian civilizations also among a number of other tribes and cultures (Salish, Eskimo, Pipites of Salvador, Aztecs, Araucanians, Abipones, Ona, Yahgan of America; Koryak, Yukaghir, Kalmuck of N.E. Asia; Torres Straits Islanders, Mekeo, Polynesians of Oceania; S.E. Bantu of Africa).

24. **Exogamy.**—This is the system under which far larger groups of people are regarded as related to each other and their members forbidden to intermarry. It is found mainly in association with the classificatory nomenclature of kinship terms and the clan organisation (*cf.* also EXOGAMY, KINSHIP, RELATIONSHIP TERMS). Whether exogamy is genetically connected with incest, *i.e.,* whether it is an extension of the tabu on intercourse and marriage within the family, or an independent institution, is a

debated question (*see* Westermarck, *H.H.M.*, II., pp. 192–218; Frazer, *Totemism and Exogamy*, vol. IV., *passim;* Malinowski, *Sex and Repression in Savage Society*, part IV.).

Exogamy embraces the widest number of people, where it is based on the dual organisation and debars from intercourse or marriage one half of the tribesmen and tribeswomen (*cf.* DUAL ORGANIZATION). Normally exogamy is an attribute of clan, *i.e.*, of the group of people who trace their descent to a common ancestor, have in most cases the same totem, and fulfill a number of functions together (*see* CLAN, TOTEMISM, KINSHIP). The clans are sometimes a subdivision of the tribe, based numerically on the dual principle, as where we have two, four or eight clans. At times there is an odd and more or less considerable number of clans, and exogamy is enforced only within each of these divisions. The prohibitions as a rule apply unilaterally (Iroquois, Huron, Lenape, Mohegan, Miami, Shawnee, Creek, Sauk, Fox, Kickapoo, Blackfoot, Dakota, Seminole of N. America; Arawak and Goajiro of S. America; Tungus, Yakut, Samoyed, Ostyak, Tartars of N.E. Asia; various aboriginal peoples of India; Torres Straits Islanders, Papuans, Melanesians, Polynesians and Micronesians of Oceania; Hottentot, S.E. Bantu, Anyanja, Wayao, Awemba, Makololo, Akonde, Masai, Akamba, Baganda and other E. African tribes; Ashanti and other W. African tribes). Only in a few cases has exogamy to be observed with regard to the clans of both parents (Omaha, Osage of N. America; certain Naga tribes of Assam; S. Massim of Melanesia; Herero, Lango of Africa).

A specially complex set of conditions prevails in the tribes of C. Australia, where there is a twofold division into (a) totemic clans, which are not strictly exogamous; and (b) matrimonial classes, which strictly correspond to kinship divisions, and which are not only exogamous, but regulate marriage to the extent that a member of one of them has to marry into one and one only of the remaining three or seven classes, as the case may be (*see* AUSTRALIA: *Ethnology*).

25. **The Forms of Marriage.**—From the foregoing description it will be clear that there is a considerable range within which the constitution of marriage can vary. For as we have seen there can be many different arrangements in the domestic, legal, economic and ceremonial sides of marriage, and each of their manifold combinations constitutes a distinct form of marriage.

The term "form of marriage" has been as a rule applied to what might be called the *numeric variation* in marriage, *i.e.*, the variation according to the number of consorts united to each other; and the main "forms of marriage" usually listed are monogamy, polygyny, polyandry and group-marriage. To deal with this classification adequately it is necessary to distinguish hypothetical assumptions from actually existing social arrangements. From this point of view we can at once eliminate "group-marriage," since our previous analysis (*see* above, 5) has shown that the *pirrauru* relationship of Australia and similar institutions among the Eskimo and in Siberia can not in their parental, economic, legal or religious functions be regarded as a form of marriage.

26. **Polyandry.**—This is the name given to a union in which several men are legally bound in marriage to one woman. Polyandry is the rarest of the numeric varieties of marriage, and unfortunately the one on which, in spite of its great theoretical importance, we possess but very meagre and inadequate information. Polyandry is not found among any of the more primitive peoples, and its distribution is almost completely confined to the highlands of S. India and C. Asia, with isolated exceptions, such as one African tribe (Bahima) and some Eskimo, among whom it occurs, but infrequently.

In Tibet and the adjacent countries there exists polyandry of the fraternal type, *i.e.*, several brothers share the wife in common. All the husbands live together with their common wife as members of the same household, and cohabit successively with her. Children born of these marriages are sometimes regarded as the legal descendants of the eldest brother-husband only; in other cases it appears that when a child is born it is attributed to him by whom the mother asserts that she has conceived it.

Among the Nayars of S.W. India there is a so-called form of polyandry which has played an important though rather deceptive part in the theories of marriage. A girl goes through a form of marriage with a man, but then really consorts with a number of men who need not be related to one another. She lives apart from her partners, who cohabit with her successively by agreement among themselves. Owing to the matrilineal institutions of this people, the children of such marriages inherit from their mother's brother, but the social importance of fatherhood is seen in the fact that the woman, when pregnant, always nominates one or other of the men as the father of the child, and he is obliged to provide for it and to educate it.

Another account is that by Dr. Rivers, of the Toda polyandry, which can be taken as the representative of the simpler type of this institution in S. India. Among the Toda, several men, usually two or three brothers, share the wife, but it is the rule that they cohabit with her in succession. Again, the children are not owned in common by the husbands, but each child is allotted individually to one, not with reference to any presumption of physical paternity, but in virtue of a ritual act performed by the man over the child, an act which establishes social paternity and confers legitimate descent on the child (*see* above, 4).

Polyandry is thus a compound marriage, in which cohabitation is usually successive, and not joint, while children and property are not shared by the husbands.

27. **Polygyny.**—This is a form of marriage in which several wives are united to one man, each having the status of legal consort, while her offspring are regarded as the legal descendants of the husband. As an institution polygyny (*q.v.*) exists in all parts of the world. There are very few primitive tribes about whom we are informed that a man is not allowed, if he can, to enter into more than one union. Many peoples have been said to be monogamous, but it is difficult to infer from the data at our disposal whether monogamy is the prevalent practice, the moral ideal, or an institution safeguarded by sanctions. It must be remembered at once that polygyny is never practised throughout the community: there cannot exist a community in which every man would have several wives, since this would entail an enormous surplus of females over males (*cf.* however the important contribution to this subject by G. Pitt-Rivers, *The Clash of Cultures and the Contact of Races*, 1927). The second important point with regard to polygyny, which is seldom brought out clearly, is that in reality it is not so much a form of marriage fundamentally distinct from monogamy as rather a multiple monogamy. It is always in fact the repetition of a marriage contract, entered individually with each wife, establishing an individual relationship between the man and each of his consorts. As a rule each relationship is little affected legally or economically by the others.

Where each wife has her separate household and the husband visits them in turn, polygynous marriage resembles very closely a temporarily interrupted monogamy. In such cases there is a series of individual marriages in which domestic arrangements, economics, parenthood as well as legal and religious elements do not as a rule seriously encroach on each other. The polygyny with separate households is more universally prevalent. Among the great majority of the Bantu and Hamitic peoples of Africa, where the number of wives, especially in the case of chiefs, is often considerable, each wife commonly occupies a separate hut with her children, and manages an independent household with well-defined legal and economic rights. Where, on the other hand, as among many N. American tribes, two or more wives share the same household, polygyny affects the institution of matrimonial life much more deeply.

In most cases the motive for polygyny is economic and political. Thus in the Trobriand Islands (Melanesia) the chief's income is due to his wives' annual endowment. In many African communities the chief derives his wealth from the plurality of his wives, who by means of the produce of their agricultural labour enable him to exercise the lavish hospitality upon which so much of his power rests. A multitude of wives, however, may increase not only a man's wealth but also his social importance, reputation and authority, apart from the influence of the number of his children. Hence we find in many Bantu communities of Africa that the desire to have many wives is one of the leading motives in the life of every man; while the fact that in many Melanesian and Polynesian communities polygyny is a prerogative of the chief testifies to the social prestige attaching to it.

28. **Monogamy.**—Monogamy is not only the most important form of marriage, not only that which predominates in most communities, and which occurs, statistically speaking, in an overwhelming majority of instances, but it is also the pattern and prototype of marriage.

Both polyandry and polygyny are compound marriages, consisting of several unions combined into a larger system, but each of them constituted upon the pattern of a monogamous marriage. As a rule polygamous cohabitation is a successive monogamy and not joint domesticity; children and property are divided, and in every other respect the contracts are entered individually between two partners at a time.

Monogamy as the unique and exclusive form of marriage, in the sense that bigamy is regarded as a grave criminal offence and a sin as well as a sacrilege, is very rare indeed. Such an exclusive ideal and such a rigid legal view of marriage is perhaps not to be found outside the modern, relatively recent development of Western Culture. It is not implied in Christian doctrine even. Apart from such isolated phenomena as the recent Church of Latter Day Saints (Mormons) and the heretical sect of Anabaptists (16th century), polygyny was legally practised and accepted by the Church in the middle ages, and it occurs sporadically as a legal institution accepted by Church and State as recently as the middle of the 17th century (Westermarck, *H.H.M.*, III., 50–51).

Monogamy as pattern and prototype of human marriage, on the other hand, is universal. The whole institution, in its sexual, parental, economic, legal and religious aspects, is founded on the fact that the real function of marriage—sexual union, production and care of children, and the co-operation which it implies—requires essentially two people, and two people only, and that in the overwhelming majority of cases two people only are united in order to fulfil these facts.

Conjugation necessarily takes place only between two organisms; children are produced by two parents only, and always socially regarded as the offspring of one couple; the economics of the household are never conducted group-wise; the legal contract is never entered upon jointly; the religious sanction is given only to the union of two. A form of marriage based on communism in sex, joint parenthood, domesticity, group-contract and a promiscuous sacrament has never been described. Monogamy is, has been and will remain the only true type of marriage. To place polygyny and polyandry as "forms of marriage" co-ordinate with monogamy is erroneous. To speak about "group-marriage" as another variety shows a complete lack of understanding as to the nature of marriage.

29. **Theories of Marriage.**—The last conclusions reveal once more the important truth of scientific method that a full knowledge of facts cuts the ground from under most hypothetical speculations. The theories of human marriage have mainly been concerned with its "origins" and "history," and attempts were made at ranging the various "forms of marriage" into an evolutionary series. Once we come to recognise that marriage is fundamentally one, and that its varieties correspond not to stages of evolution, but are determined by the type of community, its economic and political organisation, and the character of its material culture, the problem becomes one of observation and sociological analysis, and ceases to move on the slippery plane of hypothesis.

The view that marriage originated in "promiscuity," "hetairism" or "matrimonial communism," and that monogamy is a product of gradual development through a multitude of stages, has been advanced by Bachofen, Morgan and McLennan; has found wholehearted or partial support by a number of eminent writers (Lord Avebury, Fison, Howitt, Tylor, Spencer and Gillen, Post, Kohler, Kovalevsky, Lippert, Schurtz, Frazer and others); and has been criticised and combated by Darwin, Westermarck, Lang, Grosse and Crawley.

The writings of Morgan's school suffer from an over-emphasis of the sexual aspect, often coupled with prudish reticences; from a misinterpretation of linguistic evidence (*see* KINSHIP); from a neglect of the parental and economic aspect of marriage. They are full of fantastic and meaningless concepts such as "promiscuity," "group-marriage," "primitive communism," which as a rule are not even laid down with sufficient concrete details to give hold to our imagination and remain mere words on paper. The German writers of this school, who have contributed a voluminous output, especially in the *Zeitschrift für vergleichende Rechtswissenschaft,* have certainly not neglected the legal side of marriage, but in applying to primitive societies the dry legal formalism of modern jurisprudence, and in ruthlessly forcing all facts into the cut and dried scheme of "marriage stages," they have contributed but little which will have lasting value.

The recent advocates of Morgan's and Bachofen's view, notably Sumner, Rivers, Keller, Briffault, have given a much better and more concrete outline of the hypothetical early stages of marriage. But even this last stand of the "group-marriage" theory is based on an inadequate analysis of the institution and an unwarranted assumption of early sexual and economic communism as well as of group-motherhood

Modern theories of marriage follow closely the lead of Darwin on the biological side, of Westermarck in his sociological analysis, and of Crawley in some of his psychological suggestions. Such writers as Lowie, Kroeber and Howard in America; Thurnwald, W. Schmidt and Koppers in Germany; A. R. Brown, Malinowski, and Pitt-Rivers in Great Britain, both in their theories and in their field work show a far greater interest in the sociological analysis of marriage, in its relation to the family, in the correlation of its aspects, in the sociological working of sexual customs, whether these be tabus, relaxations or excesses, in their reference to marriage.

Some new light on marriage has been thrown by those psychoanalysts, notably J. C. Flügel, who are prepared to give serious consideration to facts in their bearing upon the Freudian doctrine (*cf.* Malinowski, *Sex and Repression in Savage Society*). Finally important contributions to the theory of marriage have been made by those students who approach the problem in its practical applications: the eugenists (see *Eugenics Review*): students of population (*see* Raymond Pearl's *Journal of Human Biology*); and scientific aspects of social hygiene (*American J. of Social Hygiene*).

Marriage like most problems of anthropology is ceasing to be a subject of speculation and becoming one of empirical research.

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MARRIAGE, LAW OF. Marriage may be defined either (*a*) as the act, ceremony, or process by which the legal relationship of husband and wife is constituted; or (*b*) as a physical, legal, and moral union between man and woman in complete community of life for the establishment of a family. It is possible to discriminate between three stages, taking marriage in the latter sense as an institution—the animal or physical stage, the proprietary or legal stage, and the personal or moral stage. In the first or physical stage the relation of the sexes was unregulated, and in many cases of brief duration. In the second or legal stage greater permanence was secured in marriage by assigning the husband a property right in his wife or wives. In the last stage the proprietary relation falls more and more into the background, and the relation of husband and wife approximates that of two individuals entirely equal before the law. Although in the history of marriage these three stages have been roughly successive, the order of their entering the conscious experience of the individual is usually the reverse of their order in the development of the race; and in the solemnization of a marriage based upon affection and choice the growth of the relation begins with the moral, advances to the legal, and culminates in the physical union, each one of these deriving its meaning and its worth from the preceding. In most legal systems marriage, in the sense of a ceremony, takes the form of a contract—the mutual assent of the parties being the prominent and indispensable feature. While the consent of parties is universally deemed one of the conditions of a legal marriage, all the incidents of the relationship constituted by the act are absolutely fixed by law. The jurist has to deal with marriage in so far as it creates the legal status of husband and wife. It should be added that, while marriage is generally spoken of by lawyers as a contract, its complete isolation from all other contracts is invariably recognized. Its peculiar position may be seen at once by comparing it with other contracts giving rise to continuous relationships with more or less indefinite obligations, like those of landlord and tenant, master and servant, etc. In these the parties may in general make their rights and duties what they please, the law only intervening when they are silent. In marriage every resulting right and duty is fixed by the law.

Inferior Forms of Union.—Besides true marriage, inferior forms of union have from time to time been recognized, and may be briefly noticed here. These have all but disappeared from modern society, depending as they do on matrimonial restrictions now obsolete.

The institution of slavery is a fruitful source of this kind of debased matrimony. In Roman law no slave could contract marriage whether with another slave or a free person. The union of male and female slaves (*contubernium*) was recognized for various purposes; a free woman entering into a union with a slave incurred under the S.C. Claudianum the forfeiture of her own liberty; but the bond-woman might be the concubine of a freeman. In the United States, where slavery was said to be regulated by the principle of the civil law, the marriage of slaves was so far recognized that on emancipation complete matrimony took effect and the children became legitimate without any new ceremony.

In Roman law no legal marriage could be contracted unless there was *connubium* between the parties. Originally there was no connubium between plebs and patricians, and in later times between the Latini and Peregrini, unless it had been expressly conferred. The Lex Julia et Papia Poppaea introduced restrictions depending on the condition of the parties which later legislation extended and perpetuated. Senators under that law were forbidden to marry freedwomen or women of inferior rank, and the husband of a freedwoman becoming a senator was set free from his marriage. In the canon law new restrictions were developed. The order of the clergy were forbidden to marry. And disparity of faith was recognized by the early church as a bar to matrimony, *e.g.*, between Christians and pagans and between orthodox and heretics. (See *Dictionary of Christian Antiquities,* art. "Marriage".)

Concubinage, which such restrictions tended to develop, is noticed under a separate heading. In the left-handed or "morganatic" marriages of the German royal families we have the nearest approach ever made by concubinage to true marriage, the children being legitimate, but neither they nor the wife acquiring any right to the rank or fortune of the husband. The marriage of persons of different religions frequently requires the intervention of the law as to the faith of the children, more particularly in Europe as between Roman Catholics and Protestants. English law gives the father, except under special circumstances, the right to dictate the faith of his children. (*See* Infant.) The practice on this point varies in Europe—the question being ignored in French law, Germany following in some parts the same rule as England, in others giving effect to ante-nuptial stipulations. In Ireland mixed marriages (*i.e.,* between Roman Catholic and Protestant) were by 19 Geo. II. c. 13 null and void if celebrated by a Roman Catholic priest. This act was repealed by 33 & 34 Vict. c. 110, which permits mixed marriages to be validly celebrated by an Episcopalian or Roman Catholic clergyman, subject to conditions set forth in s. 38.

Roman Law.—The three primitive modes of marriage were *confarreatio, coemptio in manum,* and *usus,* all of which had the effect of placing the woman in the "power" (*manus*) of her husband, and on the same footing as the children. The first was a religious ceremony before ten witnesses, in which an ox was sacrificed and a wheaten cake broken and divided between the spouses by the priest. *Coemptio* was a conveyance of the woman by *mancipatio,* and might be described as a fictitious sale *per aes et libram. Usus* was the acquisition of the wife by prescription, through her cohabiting with the husband for one year, without having been absent from his house three continuous nights. But a true marriage might be concluded without adopting any of these modes, which all fell into desuetude and with them the subjection of the wife to the *manus.* Marriage without *manus* was contracted by consent, without writing or formality of any kind. The restrictions as to age, relationship by consanguinity and affinity, previous marriage, etc., were in the main those which have continued to prevail in modern Europe with one important exception. The consent of the *paterfamilias* to the marriage of the children under his power was essential.

Canon Law.—The canon law of marriage is based partly on the Roman law, the validity of which the Church from the first recognized, partly on the Jewish law as modified by the new principles introduced by Christ and his apostles, developed by the fathers of the Church and mediaeval schoolmen, and regulated and defined by popes and councils. The most important of these principles was that of the indissolubility of marriage, proclaimed by Christ without qualification according to Mark x. 11, 12, and with the qualifying clause "saving for the cause of fornication" according to Matt. v. 32. This lofty view of marriage, according to which man and wife are made "one flesh" by the act of God ("What therefore God hath joined together, let no man put asunder," Mark x. 9) was, however, modified by the idea of the consummating act of marriage as in itself something unholy, a result of the Fall. Christ himself, indeed, did not teach this. It is to St. Paul that the idea of marriage as a sacrament is to be traced, in the mystic comparison of the relations of husband and wife to those of Christ and his Church. (Eph. v. 23–32.) Marriage, from being no more than a terminable civil contract, became a thing holy, a mystic union of souls and bodies never to be divided; valid, indeed, but not spiritually complete, without the public blessing of the Church (Tertullian, *Ad uxorem,* lib. ii. cap. 9); and from Augustine's time onward it was reckoned as a sacrament. But at the same time there was a tendency to restrict its rights and its range. So far as marriage was a physical union, this had for its object solely the perpetuation of the race and the avoidance of fornication; the most that was conceded was that the intention of having offspring not only made the conjugal act blameless, but even gave to the desire that inspired it an element of good. (Augustine, *de nupt. et conc.* 3.) But the ideal married life was that attributed to Mary and Joseph. Thus Augustine cited this as an example that a true marriage may exist where there is a mutual vow of chastity (*op. cit.* 12), and held that the sooner this relation was established the better. (*De bono conjug.* 22.) Marriage being then an inferior state, to be discouraged rather than the reverse, the tendency was rapidly to narrow the field within which it might be contracted. Remarriage (bigamy) was only allowed after many struggles, and then only to the laity; St. Paul had laid down that a "bishop" must be "the husband of one wife," and to this day the priests of the Orthodox Eastern Church may not remarry. Clerical celibacy, at first a counsel of perfection, was soon to become the rule of the Church, though it was long before it was universally enforced in the West; in the East it still applies only to monks, nuns and bishops. (*See* Celibacy.) The marriage of the laity was hampered by the creation of a number of impediments. The few and definite prohibitions of the Roman and of the Jewish law (Lev. xviii. 6–18; xx.) in the matter of marriage between kindred, were indefinitely extended; until in 506 the Council of Agde laid it down that any consanguinity or affinity whatever constituted an impediment. Moreover, man and wife being "one flesh," the Church exaggerated relationship by affinity into equal importance with that of consanguinity as an impediment to matrimony; and, finally, to all this added the impediments created by "spiritual affinity," *i.e.,* the relations established between baptizer and baptized, confirmer and confirmed, and between godparents, their godchildren, and their godchildren's relatives.

All this resulted in hopeless confusion and uncertainty, and it was early found necessary to modify it. Thus Pope Gregory I. limited the impediment to the 7th degree of relationship inclusive (civil computation) which was afterwards made the law of the empire by Charlemagne. Later still Innocent III., by a decree (4th Lateran Council), permitted marriages between a husband and the relations of his wife, and vice versa, beyond the 4th degree inclusive. (Canonical computation.) This remains the canonical rule of the Roman Catholic Church. Impediments due to spiritual affinity were limited by the Council of Trent to the relation of the baptizer and baptized; the baptizer and the parents of the baptized; the baptizer and the godfather and godmother; the godparents and the baptized and its parents: *i.e.,* a godfather may not marry the mother of the child he has held at the font, nor the godmother the father of such child.

In the fully developed canon law impediments to marriage are of two kinds, public and private; near relationship, for instance, is a public impediment, impotence and force are private impediments. Impediments are further divided into separating or merely suspensive; to the first class belongs, *e.g.,* a previous marriage not dissolved by death, which involves the nullification of the marriage even where through ignorance the crime of bigamy is not involved; to the second belongs the case of one or both of the contracting parties being under the age of puberty. Impediments, moreover, are absolute or relative; near relationship, for instance, is an absolute impediment, difference of religion between the parties a relative impediment. In addition to consanguinity and affinity, impuberty and existing marriage, the canon law lays down as public and absolute impediments to marriage the taking of holy orders and the vows of chastity made on entering any of the religious orders approved by the Holy See. In these impediments the canon law further distinguishes between those which are based on the law of nature (*jus naturae*) and those which are based on the law of the Church (*jus ecclesiae*). From impediments based on the law of nature, or of God, there is no power even in the pope to dispense; *e.g.,* marriage of father and daughter, brother and sister, or remarriage of husband or wife during the lifetime of the wife or husband of another marriage, which is held to be a violation of the very nature of marriage as an indissoluble union. From impediments arising out of the law of the Church dispensations are granted, more or less readily, either by the pope or by the bishop of the diocese in virtue of powers delegated by the pope. (*See* DISPENSATION.) Thus dispensations may be granted for marriage between persons related by consanguinity in any beyond the 2nd degree and not in the direct line of ascent or descent; *e.g.,* between uncle and niece (confined by the Council of Trent to the case of royal marriages for reasons of State) and between cousins-german, or in the case of marriage with a heretic. In this latter case a dispensation is now (*i.e.,* since the papal decrees *ne temere* of Aug. 2, 1907, which came into force at Easter 1908) only granted on condition that the parties are married by a Catholic bishop, or a priest accredited by him, that no religious ceremony shall take place except in a Catholic church, and that all the children shall be brought up in the Roman Catholic faith.

In the absence of any impediment a marriage is according to the canon law completed between baptized persons by the facts of consent and consummation; the principle is still maintained that the parties to the marriage, not the priest, are the "ministers of the sacrament." From the first, however, the Church, while recognizing the validity of private contracts, enjoined the addition of a public religious ceremony. (1 Tim. iv. 5.) Tertullian (*de pudicitia,* cap. iv.) says that clandestine marriages, not professed in the Church, were reckoned among Christians as all but fornication, and he speaks of the custom of seeking permission to marry from the bishop, priests and deacons. (*De monogamia,* cap. xi.) This latter precaution became increasingly necessary as impediments were multiplied, and Charlemagne, in a capitulary of 802, forbade the celebration of a marriage until "the bishops, priests and elders of the people" had made diligent inquiry into the question of the consanguinity of the parties. This was the origin of the publication of banns which, long customary in France, was made obligatory on the whole Church by Pope Innocent III. In the Eastern Church the primitive practice survives in the ceremonial blessing by the priest of the betrothal, as distinguished from the marriage ceremony. The ecclesiastical recognition of clandestine marriages, however, survived until the crying evil was remedied by a decree of the Council of Trent (Sess. xiv. *de matrim.*), which laid it down that for a valid marriage it was at least necessary that consent should be declared before a priest and in the presence of three witnesses.

Divorce, *i.e.,* the annulment of marriage for any cause but an impediment which makes the marriage *ipso facto* void, is unknown to the Roman Catholic Church. Separation *a vinculo matrimonii* is only possible under the canon law by a judicial decree of nullity (*annullatio matrimonii*), which implies, not the severing of the ties of a real marriage, but the solemn declaration that such marriage has never existed. There may, however, be a "separation from bed and board" (*a thoro et mensa*), even perpetual, which does not however give either party the right to remarry during the lifetime of the other. But, marriage not being regarded as a sacrament until consummated, it may be dissolved, if non-consummation be proved, by one or both parties taking the religious vows, or by papal dispensation. The Church claims exclusive control over marriage, and the Council of Trent anathematized the opinion held by Luther and other reformers, that it was properly a subject for the civil courts (*si quis dixerit causas matrimoniales non spectare ad judices ecclesiasticos anathema sit,* Sess. xxiv. cap. 2). This attitude became of extreme political importance when even in Catholic countries the codes established civil marriage as the only legally binding form.

England.—Marriage may be the subject of an ordinary contract on which an action may be brought by either party. It is not necessary that the promise should be in writing, or that any particular time should be named. Contracts in restraint of marriage, *i.e.,* whose object is to prevent a person from marrying anybody whatever, are void, as are also contracts undertaking for reward to procure a marriage between two persons. These latter are termed marriage brocage contracts.

Any man and woman are capable of marrying, subject to certain disabilities, some of which are said to be canonical as having been formerly under the cognisance of the ecclesiastical courts, others civil. The effect of a canonical disability as such was to make the marriage not void but voidable. The marriage must be set aside by regular process, and sentence pronounced during the lifetime of the parties. Impotence at the time of the marriage is a canonical disability. So was relationship within the prohibited degrees, which has been made an absolute avoidance of marriage by the Marriage Act 1835. Civil disabilities are (1) the fact that either party is already married and has a spouse still living (a decree *nisi* does not enable the parties to marry until it is made absolute); (2) the fact that either person is a party of unsound mind; (3) want of full age which, after remaining for centuries as in the Roman Law, viz., males 14, females 12, was, by the Age of Marriage Act, 1929, fixed at 16 for both sexes; (4) relationship within the prohibited degrees.

The statute which lawyers regard as establishing the rule on this last point is the 32 Hen. VIII. c. 38 (repealed in part by 2 & 3 Edw. VI. c. 23, in whole by 1 & 2 P. and M. c. 8, but revived by 1 Eliz. c. 1, and so left as under the act of Edward), which enacts that "no prohibition, God's law except, shall trouble or impeach any marriage without the Levitical degrees." The forbidden marriages, as more particularly specified in previous statutes, are those between persons in the ascending and descending line *in infinitum,* and those between collaterals to the third degree inclusive, according to the computation of the civil law. The prohibitions extend not only to *consanguinei* (related by blood) but to *affines* (related by marriage), now altered so far as a deceased wife's sister is concerned. (*See* p. 947.) The act of

1835 enacted that "all marriages which shall hereafter be celebrated between persons within the prohibited degrees of consanguinity or affinity shall be absolutely null and void to all intents and purposes whatsoever." They had previously been only voidable. The act at the same time legalized marriages within the prohibited degrees of affinity (but not consanguinity) actually celebrated before Aug. 31, 1835.

For many years an active and ceaseless agitation was carried on on behalf of the legalization in England of marriage with a deceased wife's sister. In all the self-governing colonies, with the exception of Newfoundland, the restriction had ceased to exist. The first act legalizing marriage with a deceased wife's sister was adopted by South Australia. The royal assent, however, was not given till the parliament of that state had five times passed the bill. In quick succession similar statutes followed in Victoria, Tasmania, New South Wales, Queensland, New Zealand, West Australia, Barbados, Canada, Mauritius, Natal and Cape Colony. As regards the Channel Islands, marriages of the kind in question were made legal in 1899, and in 1907 in the Isle of Man. In England, the bill to render marriage with a deceased wife's sister valid was first adopted by the House of Commons in 1850, and only became law by the Deceased Wife's Sister Marriage Act 1907. The act contains a proviso justifying clergymen in refusing to solemnize marriages with a deceased wife's sister, and it preserves the peculiar status of the wife's sister under the Matrimonial Causes Act 1857, under which adultery with her by the husband is incestuous adultery.

The celebration of marriages is now regulated wholly by statutory legislation. A complete list of the acts regulating the solemnization of marriage or confirming marriages, which through some defect might be void, will be found in Phillimore's *Ecclesiastical Law,* 2nd ed. (1895). The most important acts in force are the Marriage Acts 1823, 1836, 1886 and 1898. The first of these regulates marriages within the Church of England, but was intended to be of universal application, Jews and Quakers only being excepted by sec. 31. It requires either the previous publication of banns, or a licence from the proper ecclesiastical authority. As to banns, the rule of the rubric, so far as not altered by the statute, is required to be observed. They must be published on three successive Sundays at morning service after the second lesson, in the church of the parish in which the parties dwell; the bishop may, however, authorize the publication of banns in a public chapel. Seven days' notice must be given to the clergyman of the names of the parties, their place of abode, and the time during which they have lived there. If either party is under age, the dissent of the parents or guardians expressed at the time of publication of banns renders such publication null and void. Licence in lieu of banns may only be granted by the archbishop, bishop or other authority, for the solemnization of a marriage within the church of the parish in which one of the parties shall have resided for 15 days before. Before a licence can be granted an oath must be taken as to the fact of residence and that the necessary consent has been obtained in the case of persons under age. The father, or lawful guardian, is the proper person to consent to the marriage of a minor, and the place of any such person incapacitated mentally is taken by the lord chancellor. The absence of such consent does not, however, avoid a marriage once solemnized. But if persons wilfully intermarry (unless by special licence) in a place not being a church or public chapel, or without due publication of banns or proper licence, or before a person not in holy orders, the marriage is null and void to all purposes. Marriage must be celebrated within three months after banns or licence, and between the hours of eight in the morning and six in the afternoon.

For the relief of the great body of Dissenters the act of 1836 was passed. It permits marriage to be solemnized in two additional ways—viz., (1) by certificate of the superintendent registrar of a district without licence, and (2) by such certificate with licence. In the first case, notice must be given to the registrar of the district or districts within which the parties have resided for seven days previous, which notice is inscribed in a marriage-notice book, open to public inspection at all reasonable times, and thereafter suspended for 21 days in some conspicuous place in the registrar's office. Any person whose consent is necessary to an ecclesiastical licence may forbid the issue of a certificate, but in default of such prohibition the certificate will issue at the end of the 21 days. The marriage may then take place on any day within three months of the entry of notice, and in one of the following ways: (1) in a certified place of religious worship, registered for the solemnization of marriage; in that case a registrar of the district with two witnesses must be present, and the ceremony must include a mutual declaration of assent by the parties and a disavowal of any impediment; (2) at the superintendent registrar's office, with the same declaration, but with no religious service; (3) in a church according to the usual form, the consent of the minister thereof having been previously obtained; (4) according to the usages of Jews and Quakers. The place of marriage in all cases must have been specified in the notice and certificate.

In the second case, when it is desired to proceed by licence, notice must be given to the registrar of the district in which one of the persons resides, together with a declaration that he or she has resided for 15 days therein, that there is no impediment, and that the necessary consents if any have been obtained. The notice is not exhibited in the registrar's office, and the certificate may be obtained at the expiration of one whole day after entry, together with the licence. No registrar's licence can be granted for a marriage in church or according to the forms of the Church of England—the ecclesiastical authorities retaining their jurisdiction in that respect. It is also provided that in the case of persons wilfully intermarrying in a place other than that mentioned in the notice and certificate, or without notice or certificate, etc., the marriage shall be null and void. The various rules as to consent of parents, etc., to the marriages of minors are regulations of procedure only. The absence of the necessary consent is not a disability invalidating a marriage actually solemnized.

The Act 26 Geo. II. c. 33, commonly known as Lord Hardwicke's Act, which forbids the solemnization of marriage without banns or licence, also enacts that "in no case whatsoever shall any suit or proceeding be had in any ecclesiastical court in order to compel a celebration *in facie ecclesiae,* by reason of any contract of matrimony whatsoever whether *per verba de presenti* or *per verba de futuro.*" Blackstone observes that previous to this act "any contract made *per verba de presenti,* or in words of the present tense, and in case of cohabitation *per verba de futuro* also, was deemed valid marriage to many purposes; and the parties might be compelled in the spiritual courts to celebrate it *in facie ecclesiae.*"

Royal marriages in England have been subject to special laws. The Royal Marriage Act of 1772 (12 Geo. III. c. 11), passed in consequence of the marriages of the dukes of Cumberland and Gloucester, enacted that "no descendant of his late majesty George II. (other than the issue of princesses married or who may marry into foreign families) shall be capable of contracting matrimony without the previous consent of his majesty, his heirs and successors, signified under the Great Seal. But in case any descendant of George II., being above 25 years old, shall persist to contract a marriage disapproved of by his majesty, such descendant, after giving 12 months' notice to the privy council, may contract such marriage, and the same may be duly solemnized without the consent of his majesty, etc., and shall be good except both Houses of Parliament shall declare their disapprobation thereto."

In 1886 an act was passed in the British parliament to remove doubts which had been entertained as to the validity of certain marriages solemnized in England when one of the parties was resident in Scotland. The Summary Jurisdiction (Married Women) Act of 1895 enabled a wife whose husband is convicted of an assault on her, or who has been deserted by him, or been obliged owing to his cruelty to live apart from him, to apply to the justices, who are empowered by the act to make an order for separation and for payment by the husband to his wife of such weekly sum, not exceeding two pounds, as they may consider reasonable. The Marriage Act 1898 authorized the celebration of marriages in places of worship duly registered for the solemnization of marriages under the Marriage Act of 1836 without the presence of the registrar, on condition of their being solemnized in the presence of a person duly authorized by the governing body of the place of worship in question. It also made further provision for the due recording of all marriages in the general registers. The Marriages Validity Act of 1899 removed doubts as to the validity of marriages in England on Irish banns and in Ireland on English banns. Lastly, the Marriage with Foreigners Act 1906 enabled a British subject desirous of marrying a foreigner in a foreign country to comply with the foreign law by obtaining from a registrar a certificate that no legal impediment to the marriage has been shown. Similar certificates, by arrangement between His Majesty and foreign countries, are issued in the case of a foreigner desirous of marrying a British subject in Great Britain.

The Foreign Marriage Act 1892 has consolidated the English law relating to marriages celebrated abroad, and brings it into harmony with the current tendencies of marriage law reform generally. Under it a marriage between British subjects abroad is as valid as a marriage duly solemnized in England (as heretofore), if celebrated in accordance with the local law or in the presence of diplomatic or consular agents who are appointed to act as "marriage officers." The old fiction of assimilation of a British embassy to British soil can no longer be relied upon to uphold a marriage at a British embassy solemnized by an ordained clergyman. An order in Council of Oct. 28, 1892, moreover, provides that in the case of any marriage under the act, if it appears to the marriage officer that the woman about to be married is a British subject, and that the man is an alien, he must be satisfied that the marriage will be recognized by the law of the foreign country to which the alien belongs.

A marriage may be solemnized on board one of His Majesty's ships at a foreign station, provided a warrant of a secretary of State has authorized the commanding officer to be a marriage officer. At sea, marriages on British public or private ships seem still valid at common law, if performed by an episcopally ordained minister. The Merchant Shipping Act 1894 (s. 240) provides that the master of a ship for which an official log is required shall enter in it every marriage taking place on board, with the names and ages of the parties.

Again, under the Foreign Marriage Act all marriages solemnized within the British lines by a chaplain or officer or other person officiating under the orders of the commanding officer of a British army serving abroad, are as valid in law as if they had been solemnized in Great Britain subject to due observance of all forms required by law. The Naval Marriages Act 1908 authorizes, for the purpose of marriages in Great Britain, the publication of banns and the issue of certificates on board His Majesty's ships in certain cases, or when one of the parties to a marriage intended to be solemnized in Great Britain is an officer, seaman or marine, borne on the books of one of His Majesty's ships at sea.

The principle of the English law of marriage, that a marriage contracted abroad is valid if it has been solemnized according to the *lex loci,* may be now taken to apply just as much to a marriage in a heathen as in a Christian country. Whether the marriage has or has not been celebrated according to Christian laws has no bearing upon the question, providing it is a monogamous marriage —a marriage which prevents the man who enters into it from marrying any other woman while his wife continues alive.

Scotland.—The chief point of distinction, as compared with English law, is the recognition of irregular marriages. (1) "A public or regular marriage," says Fraser, "is one celebrated, after due proclamation of banns, by a minister of religion; and it may be celebrated either in a church or in a private house, and on any day of the week at any hour of the day." The ministers of the National Church at first alone could perform the ceremony; but the privilege was extended to Episcopalians by 10 Anne c. 7 (1711), and to other ministers by 4 and 5 Will. IV. c. 28 (1834). (2) A marriage may also "be constituted by declarations made by the man and the woman that they *presently* do take each other for husband and wife." These declarations "may be emitted on any day at any time and without the presence of witnesses," and either by writing or orally or by signs, and in any form which is clearly expressive of intention. Such a marriage is as effectual to all intents and purposes as a public marriage. The children of it would be legitimate; and the parties to it would have all the rights in the property of each other, given by the law of Scotland to husband and wife. (3) A promise followed by *copula* does not constitute marriage, unless followed either by solemnization *in facie ecclesiae* or declarator. Lord Moncreiff's opinion in the case of *Brown* v. *Burns* is admitted to be good law, viz. that declarator is essential to the constitution of a marriage of this kind, so that, if no such declarator be brought in the lifetime of both parties, the marriage can never be established afterwards. The *copula* is presumed to have reference to the promise, but evidence may be adduced to show that such was not the case.

By the Marriage (Scotland) Act 1856 it is enacted that no *irregular* marriage shall be valid in Scotland, unless one of the parties has lived in Scotland for the 21 days next preceding the marriage, or has his or her usual residence there at the time. "Habit and repute" has sometimes been spoken of as constituting marriage in the law of Scotland, but it is more correctly described as evidence from which marriage may be inferred. The repute must be the general, constant, and unvarying belief of friends and neighbours, not merely the controverted opinion of a section of them. The cohabitation must be in Scotland, but in one case proof of cohabitation in another country was allowed, as tending to throw light on the nature of the cohabitation in Scotland. The consent of parents is not necessary to the validity of the marriage, even of minors, but marriage under the age of puberty with or without such consent is void.

United States.—The absence of ecclesiastical courts has suggested difficulties as to the extent to which the law of England on this subject continued to prevail after the revolution. Bishop holds it to be the universal fact running through all the cases that everywhere in the country the English decisions on marriage and divorce are referred to with the same apparent deference which is shown on other subjects to the decisions of the English common law and equity tribunals. The same author observes that "all our marriage and divorce laws, and of course all our statutes on the subject, in so far as they pertain to localities embraced within the limits of particular States, are State laws and State statutes, the national power with us not having legislative or judicial cognizance of the matter within those localities." Some of the States have extended the ages below which marriage cannot take place. The common law of the States is assumed to be that "a contract *per verba de presenti,* or *per verba de futuro cum copula,* constitutes a complete marriage." Conditions, however, may be imposed by the various State legislatures, and as to these the rule has established itself in American jurisprudence that "a marriage good at common law is good notwithstanding the existence of any statute on the subject, unless the statute contains express words of nullity." Thus in Pennsylvania, where a statute provided that all marriages "should be solemnized before 12 witnesses," marriages not so celebrated were nevertheless held to be good. In New Hampshire justices and ministers of the gospel are authorized to solemnize marriage, and all other persons are forbidden to do so under penalties; yet a marriage by consent, as at common law, without justice or minister, has been held valid. On the other hand, under a very similar statute in Massachusetts, it was held that "parties could not solemnize their own marriage," and that a marriage by mutual agreement, not in accordance with the statute, was void. Bishop regards this as an isolated exception to the general course of the decisions. So when State legislation requires any particular form to be used the want thereof only invalidates the act if the statute expressly so enacts. Many of the State codes inflict penalties on ministers or justices for celebrating the marriage of minors without the consent of the parents or guardians. The original law as to prohibited degrees has been considerably modified in the States. The prohibition of marriage with a deceased wife's sister has been abolished in the United States. But New Hampshire, Ohio, Indiana, Kansas, Arkansas, Nevada, Washington, the Dakotas and Montana have for long forbidden marriages between first cousins by blood, and Louisiana, Oregon, Pennsylvania, Michigan, Nebraska, Utah and Wisconsin have since adopted the same principle. Virginia prohibits the marriage of a woman with the husband of her brother's or sister's daughter.

Attention is also being paid to the question of marriage from a physical point of view. New Jersey prohibits the marriage of any person who has been confined in any public asylum as an epileptic, insane or feeble-minded patient, without a medical certificate from two physicians of complete recovery, and that there is no probability of the transmission of such defects. This prohibits the granting of a marriage licence where either party is an habitual drunkard, epileptic, imbecile or insane, or where the applicant at the time of making application is under the influence of any intoxicant or narcotic drug. In Michigan, Minnesota, Kansas, New Hampshire and Oregon, marriage is prohibited to epileptics, etc., except when the woman is over 45. In Michigan, also, marriage is forbidden to anyone who has suffered from a venereal disease and has not been cured. The equality of property rights between husband and wife is fully established in America. Indeed, in many States the movement has gone so far as to give the wife in matters of property and in reference to divorce greater privileges than the husband. Thus a husband is often liable for a wife's debts where a wife would not be, *mutatis mutandis,* for a husband's; and a wife may usually obtain a decree of divorce for any ground on which one may be awarded to the husband, and, in addition, for neglect to provide sustenance or support. Emphasis on the personal or moral relation of the parties in marriage tends to throw into the background the legal aspects and requirements; and it tends also to minimize, so far as the State is concerned, the religious and sacramental aspect of marriage. Marriage tends to become a relation established by parties between themselves, and one in which the consent of the parties becomes the only constitutive element. In the theory of American law no ceremony is essential to create the marriage relation. But this position has never been endorsed by any considerable proportion of the community, and in fact probably $\frac{9}{10}$ and perhaps $\frac{99}{100}$ of the marriages in the United States are contracted through some ceremony.

Other Countries.—In France, articles 144–226 of the Code Napoléon, as amended by an act of 1907, prescribe the qualifications and conditions of marriage. The man must be 18 and the woman 15 years of age. A son and daughter under 21 cannot marry without consent of the father and mother, or of the father only if they disagree, or of the survivor if one be dead. If both are dead grandfather and grandmother take their place. Between the ages of 21 and 30 the parties must still obtain the consent of their parents, but if this be refused it can be regulated by means of a "respectful and formal act" before a notary. If the consent is not given within 30 days the marriage may take place without it. If neither parents nor grandparents be alive, parties under 21 require the consent of the family council. These rules apply to natural children when affiliated; those not affiliated require the consent of a specially appointed guardian. Marriage is prohibited between all ascendants and descendants in the direct line, and between persons related by marriage in the same line, between brother and sister, between uncle and niece, and brother-in-law and sister-in-law. Before the solemnization of marriage banns are required to be published for a period of ten days, which must include two Sundays, containing the names, occupations, and domiciles of the parties and their parents. There must be an interval of three days before the marriage can take place, and if a year is allowed to elapse fresh banns must be put up. On the day appointed by the parties, and in the parish to which one of them belongs, the marriage is celebrated by the civil officer or registrar reading over to them the various necessary documents, with the chapter of the code relating to husband and wife, receiving from each a declaration that they take each other for husband and wife, and drawing up the act of marriage. All this has to be done in the presence of four witnesses. Marriages contracted abroad between French subjects or between French subjects and foreigners are valid in France if celebrated according to the forms of the foreign law, provided the French conditions as to consent of parents have been observed. (*See* also Marriage with Foreigners Act, *supra.*)

The code of 1900 lays down rules applicable to the celebration of all marriages in Germany. Civil marriage alone is recognized by the code. It is effected by the declaration of the parties before a registrar in the presence of each other of their intention to be married. Two witnesses of full age must be present. The registrar asks each of the parties whether he or she will marry the other, and on their answer in the affirmative declares them duly married and enters the marriage in the register. The marriage must be preceded by a public notice. Marriages are void between descendants and ascendants; relatives by marriage in the ascending or descending line; brother and sister of the whole or half blood.

In the great majority of the other European countries civil marriage is obligatory. In Roman Catholic countries the parties usually supplement the obligatory civil marriage by a religious ceremony, more especially since the papal decree *Ne temere* of Aug. 2, 1907 (which came into force at Easter 1908), which requires marriages between Roman Catholics, or between Roman Catholics and those not professing that faith, to be celebrated before a bishop or priest duly authorized for the celebration thereof.

Bibliography.—E. A. Westermarck, *History of Human Marriage,* 3rd ed. (1901), with other works cited in the article Family. M. Neustadt, *Kritische Studien zum Familienrecht des bürgerlichen Gesetzbuchs* (1907); O. D. Watkins, *Holy Matrimony* (1895), a comprehensive study of the history and theory of Christian marriage, from the High Anglican point of view; J. Wickham Legg, "Notes on the Marriage Service in the Book of Common Prayer of 1549," in *Ecclesiological Essays* (1905), a valuable comparative study of Christian marriage rites, with numerous references; the articles "Ehe, Christliche," by Gottschick, and "Eherecht" (many references), by Sehling, in Herzog-Hauck, *Realencyklopädie,* 3rd ed., vol. v. (Leipzig, 1898); Abbé André, *Cours de droit canon,* 3rd ed. (1901), art. "Marriage," "Affinité," etc.

See also Age; Divorce; Family; Husband and Wife; Legitimacy and Legitimation; Morganatic Marriage.

MARRIAGE-RATE. In its most usual form, the marriage-rate is expressed as the number of marriages occurring in a community during a calendar year per thousand of total population living in the community in that year. For example, it is estimated that there were 1,426,000 marriages in the United States during 1937. Since the total population for that year was 129,-257,000, the number of marriages per thousand of population was 11·0. This rate would be doubled if the number of persons marrying, instead of the number of marriages, were related to the total population. By expressing annual marriages of communities in terms of a common unit, namely per thousand of population, it is possible to make comparisons between communities of different size, or in the same community over different periods of years. However, the marriage-rate computed in this way is not entirely satisfactory as a measure for comparison. Thus two communities may differ in their marriage-rates simply because one of them happens to have a larger proportion of its total population within the marriageable ages than the other. Even if two communities had the same proportion of their total populations at the marriageable ages, the marriage-rates computed in the manner indicated above might differ markedly if one of them should have a greater proportion of single, widowed, or divorced marriageable persons than the other. Furthermore, the marriage-rates are influenced by the ratio of the number of marriageable men to the number of marriageable women in the community. Obviously, if a community had very few marriageable men, the marriage-rate would be very low. For these reasons, marriage-rates have, on occasion, been computed on bases other than total population, such as total population at ages 15 and over, single population at ages 15 and over, and total females comprised within the ages from 15 to 45 years. Unfortunately, these more refined bases are not in common use and it therefore becomes necessary to make some mental allowance for the foregoing factors in comparing marriage-rates based upon total population.

International Comparisons.—The marriage-rate for the United States is high as compared to that for most other countries of the world for which records are available. None of the European countries had marriage-rates as high as that of the United States, where the rate was 10·7 per 1,000 in 1935–37. The closest approaches were made by Denmark, Germany and Rumania, all with rates over 9 per 1,000 during 1936–38. The next three European countries in order of approach were Austria, England and Wales, and Sweden, with marriage-rates per 1,000 of 8·8, 8·7, and 8·7 respectively.

Of the European countries listed in Table I, Eire had the lowest marriage-rate of all, namely 5·0 per 1,000 during 1936–38. The marriage-rate for Eire was exceeded, in order, by those of Greece, Portugal, Spain, France and Northern Ireland, all of which had rates below 7 per 1,000. The marriage-rate in the United States was barely surpassed by that for white persons in the Union of South Africa, where the rate was 10·8 per 1,000 in the period 1935–36, but it was substantially under that for Egypt, with a rate of 13·5 per 1,000 during 1935–37.

Trend.—The marriage-rates for the United States, England and Wales, and the countries of continental Europe do not show the marked trends toward lower levels exhibited in their birth-rates and death-rates. In fact, the marriage-rate is a relatively stable figure, and notable variations from the usual marriage-rates for each country appear only during great wars or in periods of economic depression.

The United States, in the years since 1901, has had a comparatively stable marriage-rate with figures usually not varying far from 10 per 1,000. (See Table II). The level of the marriage-rates in England and Wales during the period from 1851 to the outbreak of war in 1914 was not appreciably below that for the years since 1921, when they fluctuated around 8 per 1,000. In France there appears to be a downward tendency in the marriage-rate. Whereas the rate in that country was at an average not far under 8 per 1,000 from 1851 to the outbreak of the 1914 war—during which it fell sharply—the resurgence in the rate during the post-war years up to 1930 thereafter gave way to a period of decline which reached a low point of 6·5 per 1,000 in 1938.

The marriage-rate in Germany in the post-war years since 1919 lies, on the whole, at a higher level than it did during the pre-war period from 1851 to 1913. With the advent of the National Socialist regime in 1933, the downward movement in the marriage-rate in Germany of the late '20s was halted and a higher level was then established by active measures to stimulate marriage. In Sweden, marriage-rates have been moving consistently upward in the post-war years since 1921 to a level appreciably higher than during the pre-war years. On the other hand, the marriage-rate in Italy appears to be easing downward since 1921. However, its level in the years 1936–38 was not far different from that during the period 1871 to 1913.

Factors Influencing the Marriage-Rate.—1. *War.*—The outbreak of war in 1914 initiated precipitous declines in the marriage-rates for France and Germany. In France, the rate fell from a pre-war average of 7·7 per 1,000 in 1911–13 to a low point of 2·3 in 1915. The experience of Germany was not quite as bad; from a level of 7·8 per 1,000 in 1911–13, the rate fell to 4·1 in 1915 and 1916. The entrance of Italy into the war in 1915 was signalized by a fall in the marriage-rate to 5·1 per 1,000 for that year from a rate of 7·0 for the previous year. The low point in Italy's marriage-rate during the war, 2·7 per 1,000, was reached in 1917. The situation in England and Wales and in the United States was not as severe as in the other countries. The marriage-rate in England and Wales actually rose from a pre-war level of about 8 per 1,000, extending as far back as 1881, to a high point of 9·7 in 1915, before it fell to its low of 6·9 in 1917. In the United States during the war period, the marriage-rate was at its minimum in 1918. In the immediate years following the close of hostilities in 1918, the marriage-rates rose sharply in the warring countries to peaks in 1920, a situation arising from an accumulation of several years of postponed marriages.

TABLE I.—*Average Annual Marriages per 1,000 Total Population in Certain Countries for the Period 1936 to 1938*

Country	Marriages per 1,000 1936 to 1938	Country	Marriages per 1,000 1936 to 1938
North America		*Europe (Continued)*	
United States	10·7*	Ireland, Northern	6·9
Canada	7·4*	Italy	7·8
Mexico	6·3	Latvia	8·3
South America		Lithuania	7·6
Argentina	7·1	Netherlands	7·6
Chile	8·0	Norway	8·1
Colombia	4·8	Poland	8·1
Uruguay	6·1*	Portugal	6·5
Europe		Rumania	9·2
Austria	8·8	Scotland	7·7
Belgium	7·6	Spain	6·5†
Bulgaria	8·1	Sweden	8·7
Czechoslovakia	7·8	Switzerland	7·3
Denmark	9·1	Yugoslavia	7·4*
Eire	5·0	*Asia*	
England and Wales	8·7	Japan	8·4*
Estonia	8·5	*Other Countries*	
Finland	8·5*	Australia	8·8
France	6·6	Egypt	13·5*
Germany	9·2	New Zealand	9·7
Greece	6·3*	Union of South Africa (Whites)	10·8‡
Hungary	8·5		

*Average for 1935 to 1937. †Average for 1931 to 1934. ‡Average for 1935 and 1936.

TABLE II.—*Average Annual Marriages per 1,000 Total Population in Selected Countries for Specified Periods and Years from 1851 to 1938*

Period or Year	United States	England and Wales	France	Germany	Italy	Sweden
1851–60	*	8·5	8·0	7·8	*	7·6
1861–70	*	8·3	7·8	8·5	*	6·6
1871–80	*	8·1	8·1	8·6	7·7	6·8
1881–90	*	7·5	7·4	7·8	8·0	6·3
1891–00	9·0	7·8	7·4	8·2	7·3	6·0
1901–10	10·0	7·7	7·8	8·0	7·7	6·0
1911–13	10·5	7·8	7·7	7·8	7·5	5·9
1914	10·5	7·9	5·1	6·8	7·0	5·8
1915	10·1	9·7	2·3	4·1	5·1	5·8
1916	10·7	7·5	3·3	4·1	2·9	6·1
1917	11·2	6·9	4·8	4·7	2·7	6·2
1918	9·7	7·7	5·5	5·4	3·0	6·7
1919	11·0	9·9	14·0	13·4	9·2	6·9
1920	12·0	10·1	16·0	14·5	14·0	7·3
1921–25	10·6	7·8	9·6	9·5	8·9	6·3
1926–30	9·9	7·7	8·4	8·7	7·2	6·7
1931–35	9·2	8·1	7·4	9·3	6·8	7·3
1936	10·7	8·7	6·7	9·1	7·4	8·5
1937	11·0	8·8	6·6	9·1	8·7	8·7
1938	*	8·7	6·5	9·4	7·4	9·0

*Not available.

2. *Business.*—A study of American marriage-rates for a group of industrial States (Connecticut, Massachusetts, Michigan and Rhode Island, and the city of New York), in relation to an index of business failures, for the period from 1868 to 1935, established a remarkably close correspondence between the two series. The years of economic depression—1878, 1884, 1893, 1896, 1907–08, 1921–22, and 1932—were also years of low marriage-rates. The phenomenon noted for this group of States has also been observed in other countries.

3. *Social Factors.*—Several European countries have introduced measures to stimulate the marriage-rate in an effort to stem the rapid decline in birth-rates which they have been experiencing. These measures are usually in the form of marriage loans, extra taxes on bachelors, and preferential employment to married men. A factor of some importance in influencing the marriage-rate in the United States is the high divorce rate. Remarriages following divorce bolster the marriage-rate, but do not increase the proportion of married persons in the population.

In practically all countries there is a marked seasonal incidence in the marriage-rate. In the United States and Canada, June is the predominant month. The fall seems to be preferred by agricultural countries. Greek Orthodox countries prefer February, before Lent, while Roman Catholic countries have high marriage-rates in April, after Lent. The influencing factors in the seasonal distribution of marriages seem to be climate, religious customs, and occupation.

Marriage-Rate and Birth-Rate.—An examination of data for New York State from 1919 to 1937 showed that, in any three-year period, an increase in the marriage-rate from the first year to the second was followed, in turn, by an increase in the birth-rate of first children from the second year to the third year. Similarly, a decrease in the marriage-rate was followed by a corresponding decrease in the birth-rate of first children. This correspondence is not usually found when birth-rates in which all children are included are compared with marriage-rates. (A. J. Lo.)

MARRUCINI, an ancient tribe which occupied a small strip of territory round about Teate (mod. Chieti), on the east coast of Italy. It is first mentioned in history as a member of a confederacy with which the Romans came into conflict in the second Samnite War, 325 B.C., and it entered the Roman Alliance as a separate unit at the end of that war (*see* PAELIGNI). The language of the Marrucini is known from an inscription called the "Bronze of Rapino," which belongs to about the middle of the 3rd century B.C. It is written in Latin alphabet, but in a dialect which belongs to the North Oscan group (*see* PAELIGNI). The name of the city or tribe which it gives us is *touta marouca,* and it mentions also a citadel with the epithet *tarincris.* Several of its linguistic features, both in vocabulary and in syntax, are of considerable interest. The earliest Latin inscriptions are of Ciceronian date.

The form of the name shows the suffix -NO- superimposed upon the suffix -CO-, a change which probably indicates some conquest of an earlier tribe by the invading Safini (or Sabini, *q.v.*).

For further details as to Marrucini inscriptions and place-names *see* R. S. Conway, *The Italic Dialects,* p. 253 *et seq.*

MARRYAT, FREDERICK (1792–1848), English sailor and novelist, born at Westminster on July 10, 1792, was the grandson of Thomas Marryat (physician, author of *The Philosophy of Masons,* and writer of verse), and son of Joseph Marryat, agent for the island of Grenada, who wrote pamphlets in defence of the Slave Trade. Young Marryat ran away to sea more than once; at 14 he entered the navy. He served with great distinction in many parts of the world until his retirement in 1830.

Marryat brought ripe experience and unimpaired vivacity to his work when he began to write novels. *Frank Mildmay, or the Naval Officer,* was published in 1829, and *The King's Own* followed in 1830. The freshness of the new field which was opened up to the imagination—so full of vivid lights and shadows, light-hearted fun, grinding hardship, stirring adventure, heroic action, warm friendships, bitter hatreds—was in exhilarating contrast to the world of the historical romancer and the fashionable novelist. Moreover Marryat had an admirable gift of lucid, direct narrative, and an unfailing fund of incident, and of humour, sometimes bordering on farce. Of all his portraits of adventurous sailors, "Gentleman Chucks" in *Peter Simple* and "Equality Jack" in *Mr. Midshipman Easy* are the most famous, but he created many other types which take rank among the characteristic figures in English fiction. He went on, through a quick succession of tales, *Newton Forster* (1832), *Peter Simple* (1834), *Jacob Faithful* (1834), *The Pacha of Many Tales* (1835), *Japhet in Search of a Father* (1836), *Mr. Midshipman Easy* (1836), *The Pirate and the Three Cutters* (1836), till he reached his high-water mark of constructive skill in *Snarley-yow, or the Dog Fiend* (1837). The best of his books after this date are those written expressly for boys, the especial favourites being *Masterman Ready* (1841); *Percival Keene* (1842); *Monsieur Violet* (1842); *The Settlers in Canada* (1844), and *The Children of the New Forest* (1847). Among his other works are *The Phantom Ship* (1839); *A Diary in America* (1839); *Olla Podrida* (1840), a collection of various papers; *Poor Jack* (1840); *Joseph Rushbrook* (1841); *Privateer's Man* (1844); *The Mission, or Scenes in Africa* (1845); *The Little Savage* (1848–49), published posthumously; and *Valerie,* not completed (1849). His novels form an important link between Smollett and Fielding and Charles Dickens.

Captain Marryat had retired from the naval service in 1830, becoming equerry to the duke of Sussex. He edited the *Metropolitan Magazine* from 1832 to 1835, and some of his best stories appeared in that paper. He spent a great part of his time in Brussels. He visited Canada during Papineau's revolt and the United States in 1837, and gave a disparaging account of American institutions in a *Diary* published on his return to England. In 1843 he settled at Langham Manor, Norfolk. He indulged in costly experiments in farming, so that in spite of the large income earned by his books he was not a rich man. He died at Langham on Aug. 9, 1848, his death being hastened by news of the loss of his son by shipwreck.

His daughter, Florence Marryat, herself a novelist, published his *Life and Letters* in 1872. *See* also David Hannay, *Life of Marryat* (1889).

MARS, MLLE. [ANNE FRANÇOISE HYPPOLYTE BOUTET] (1779–1847), French actress, was born in Paris on Feb. 9, 1779, the natural daughter of the actor-author named Monvel (*q.v.*), and Mlle. Mars Salvetat. In 1799, after the rehabilitation of the Comédie Française, she and her sister (Mars *aînée*) joined that company in which she remained for 33 years. She was incomparable in *ingénue* parts, and equally charming as the coquette; she was for many years the darling of Parisian audiences and a favourite with Napoleon I. She retired in 1841; she was then inspectress of dramatic studies at the Conservatoire. She died in Paris on March 20, 1847.

See R. de Beauvoir, *Mémoires de Mlle. Mars,* 2 vols. (1849), and *Confidences de Mlle. Mars,* 3 vols. (1855).

MARS (MAVORS, MARMAR, MARSPITER or MASPITER), after Jupiter the most important deity of the Roman state, and never so much affected by foreign influences as to lose his essentially Roman and Italian character. Traces of his worship are found in all parts of central and southern Italy, and in several communities, as we learn from Ovid (*Fasti,* 3. 93 *seq.*), he gave his name to a month, as at Rome to the first month of the old Roman year. We know little of the character of his cult except at Rome, and even at Rome it has been variously interpreted. In historical times his chief function at Rome was to protect the state in war; it is as a god of war that he is known to all readers of Roman literature,[1] and Wissowa holds this to have been his original and only function.

Until the time of Augustus Mars had but two temples at Rome. One of these was originally only an altar; it was in the Campus Martius, the exercising ground of the army. The other was outside the Porta Capena: here each year the Equites met in order to start in procession through the city (*Dion. Hal.* 6. 13). Each of these sites was outside the *pomerium,* and this has been explained to mean that the war-god "must be kept at a distance" (Carter, *Religion of Numa,* p. 19). But in the heart of the city there was a *sacrarium* of Mars in the *regia,* originally the king's house, in which the sacred spears of Mars were kept, or rather, Mars in spear form (*Mars Hasta*); for on the outbreak of war the consul had to shake these spears, saying as he did it, *Mars vigila* ("Mars, wake up!"). If the spears moved of themselves, the omen was bad and called for expiation. The *ancilia,* or sacred shields, also formed part of this symbolic armoury of the Roman state: they were carried in procession by the Salii (*q.v.*), or dancing warrior-priests of Mars on several occasions during the month of March up to the 23rd (*tubilustrium*), when the military trumpets (*tubae*) were lustrated; and again in October to the 19th (*armilustrium*), when both the *ancilia* and the arms of the exercitus were purified and put away for the winter. During the four months of the Italian winter the worship of Mars seems at a standstill; his activity is all in the warm season, *i.e.,* in the season of warfare. It is only at the end of February that we find indications of the coming Mars-cult; Quirinalia, Feb. 17 (Quirinus closely resembled Mars); first Equirria, Feb. 27. This, like the second Equirria (Mar. 14) was no doubt a rite intended to benefit the war-horses accompanied with sacrifice to Mars, preparatory to the opening of the season of arms.

There is thus abundant evidence that Mars was always a deity especially connected with warfare; and it is hardly necessary to add proof of a less convincing kind, *e.g.,* that Nerio, his feminine cult-partner, seems to be etymologically "the strong one," or that he is in legend the father of Romulus, the warlike king and founder of the Roman army. In founding his famous temple of Mars Ultor (the avenger of Caesar) in the Forum Augusti, Augustus gave a new turn to this worship, and for a time it seems to have been a rival of that of the Capitoline Jupiter (*see* Carter, *Religion of Numa,* p. 174 *seq.*), and by about A.D. 250 Mars became the most prominent of the *di militares* worshipped by the Roman Legions.

There are, however, certain features in the Mars cult which

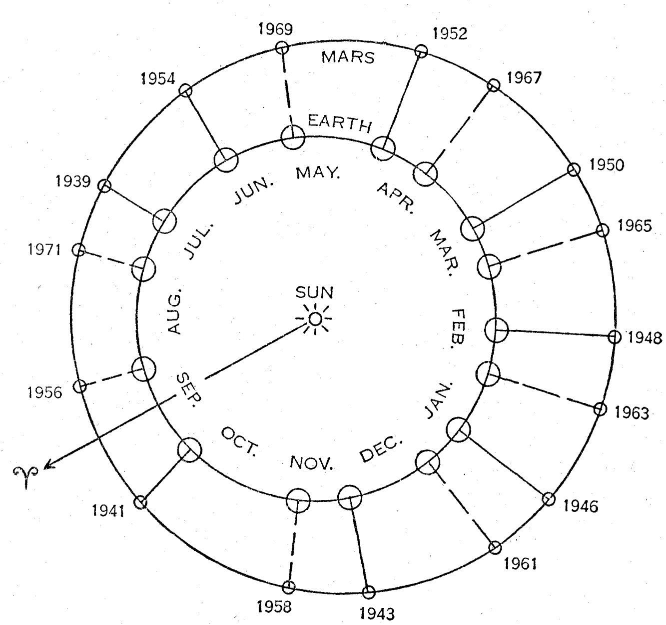
[1]Mars-*bellum* by metonymy; but this could be explained as a Hellenism.

make it probable that this god was in early times, at least, also associated with agriculture; and this is in harmony with the facts: (1) that the season of arms is also the season of the growth, ripening and harvesting of the crops; (2) that the early Roman community was an agricultural as well as a military one, as is indicated in its religious calendar (Fowler, *Roman Festivals,* p. 334). Thus Mars was invoked in the ancient hymn of the Arval Brothers, whose religious duties had as their object to keep off enemies of all kinds from crops and herds (Henzen, *Acta Fratr. Arv.* p. 26), and his association here with the Lares (*q.v.*) proves that he is not regarded as a war-god who could avert the raid of an enemy. Still more striking is the invocation of Mars (with the cult-title Silvanus) in the yearly lustration of his land by the Roman farmer (Cato, *De agric.* 141), where Mars's help is besought against disease and famine, not war. Three times the procession went round the land, reciting prayers and driving the victims to be sacrificed, viz., pig, sheep and ox (*suovetaurilia*), representing the farmer's most valuable stock. We can hardly doubt that in the state ceremony of the Ambarvalia, *i.e.,* the *lustratio* of the ager Romanus in its earliest form, the same god was invoked and the same ritual used (Fowler, *op cit.* p. 124 *seq.*). Again in the curious ritual of the sacrifice to Mars of the October horse (Oct. 15: Fowler *op. cit.* 241), though the animal was undoubtedly a war-horse, the head was cut off and decked with cakes, as we are told (Paul. Diac. 220) *ob frugum eventum.* Quirinus also is not without an association with agricultural perils, for it was his *flamen* who sacrificed the victims at the Robigalia on April 25, when the spirit of the mildew (Robigus) was invoked to spare the corn (Ovid, *Fasti,* 4. 901 *seq.*).[1]

The most reasonable conclusion seems to be that Mars, whatever his ultimate origin, became early a "high god" of the Italic peoples, and hence reflects their activities (1) in clearing forests (Mars Silvanus; *cp.* the fact that wolves and woodpeckers are sacred to him), (2) in agriculture, (3) in war.

See Roscher in *Myth. Lex. s.v.,* (bibl.); W. Warde Fowler, *Roman Festivals* (1908) and *Religious Experience* (1911); Wissowa, *Religion und Kultus der Römer* (1912). (W. W. F.)

MARS, in astronomy, the fourth planet in the order of distance



FROM "EARTH, MOON AND PLANETS," BY FRED L. WHIPPLE (THE BLAKISTON COMPANY)

OPPOSITIONS OF MARS FROM THE EARTH

From 1939 to 1971. The relative distances are shown by the straight lines joining the orbits. The seasonal dates on the earth are indicated. Mars is north of the equator for oppositions from September to March

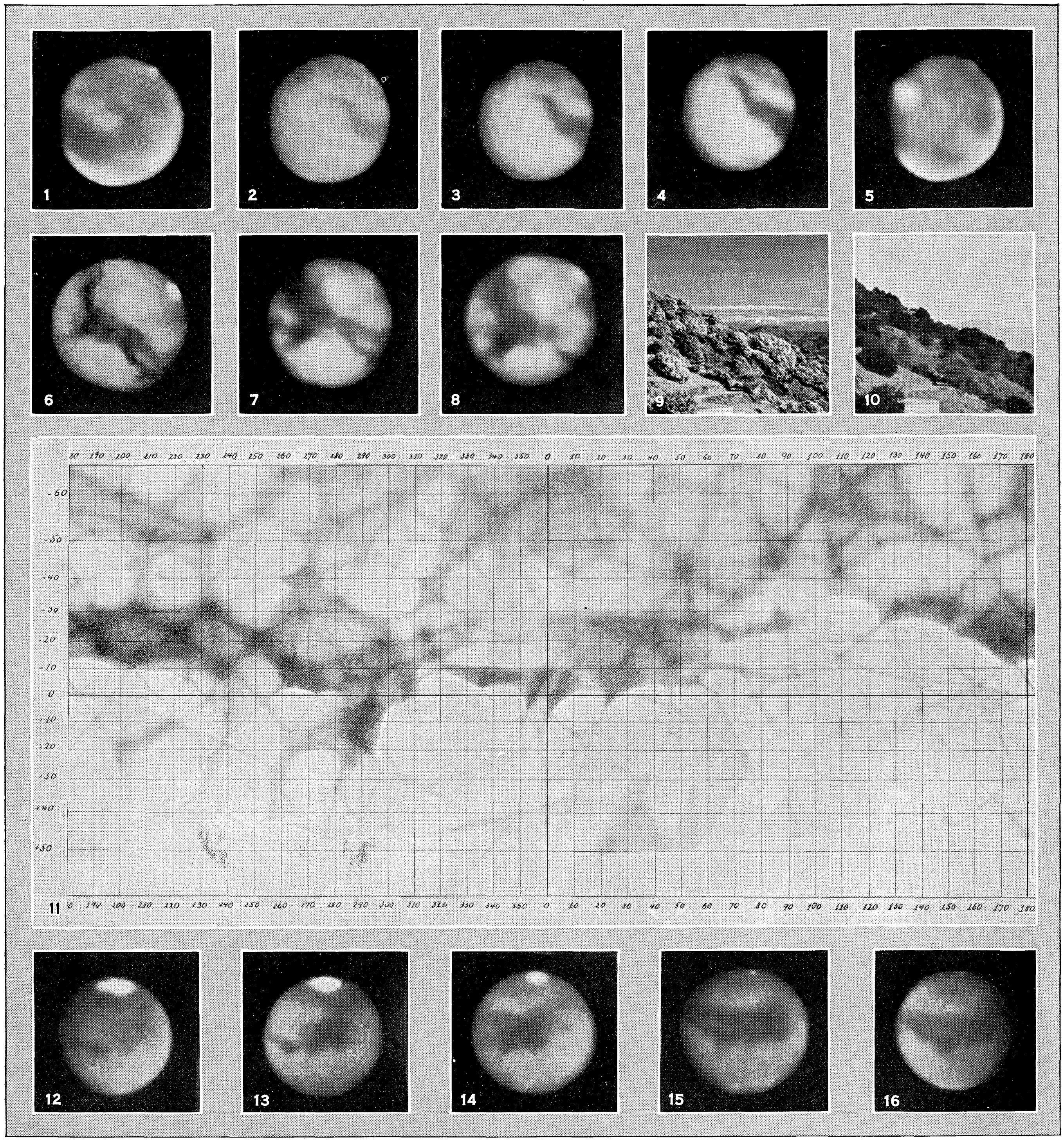
from the sun, and the next outside the earth. To the naked eye it appears as a bright star of a decidedly reddish or lurid tint, which contrasts strongly with the whiteness of Venus. At opposition it is brighter than a first magnitude star, sometimes outshining even Sirius. It is by virtue of its position the most favourably situated of all the planets for observation from the earth. The eccentricity of its orbit, 0.0933, is greater than that of any other major planet except Mercury. The result is that at an opposition near perihelion Mars is markedly nearer to the earth than at an opposition near aphelion, the one distance being about 35,000,000 miles; the other 63,000,000. These numbers express only the minimum distances at or near opposition, and not the distance at other times. The time of revolution of Mars is 686.98 days. The mean interval between oppositions is 2 years 49½ days, but, owing to the eccentricity of the orbit, the actual excess over two years ranges from 36 days to more than 2½ months. Its period of rotation is 24 h. 37 m. 22.6 s.

Motions.—The accompanying diagram illustrates the order in which the oppositions of the planet follow each other. The outer circle represents the orbit of Mars, the inner that of the earth. Around the inner circle, representing the earth's orbit, are marked the months during which the earth passes through the different parts of the orbit. It will be seen that the distance of Mars at the time of any opposition depends upon the month in which opposition occurs. The least possible distance would occur in an opposition about the end of August, a little before Mars reached the perihelion, because the eccentricity of the earth's orbit throws our planet a little farther from the sun and nearer the orbit of Mars in July than it does in August. From the diagram it is seen that the points of opposition travel around the orbit in about 16 years, so that oppositions near perihelion, when Mars is therefore nearest the earth, occur at intervals of 15 or 17 years.

The axis of rotation of the planet is inclined between 23° and 24° to the pole of the orbit, and the equator of the planet has the same inclination to the plane of the orbit. The north pole is directed toward a point in longitude 355°, in consequence of which the projection of the planet's axis upon the plane of the ecliptic is nearly parallel to the line of our equinoxes. The aspect of the planet at opposition, especially the hemisphere which is visible, varies with the month of opposition, the general rule being that the northern hemisphere of the planet is entirely seen only near aphelion oppositions, and therefore when farthest from us, while the southern hemisphere is best seen near perihelion oppositions. The distances of the planet from the sun at aphelion and at perihelion are nearly in the ratio 6:5. The intensity of the sun's radiation on the planet is as the inverse square of this ratio. It is therefore more than 40% greater near perihelion than near aphelion. It follows from all this that the southern hemisphere is subjected to a more intense solar heat than the northern, and must therefore have a warmer summer season; but the length of the seasons is the inverse of this, the summer of the northern hemisphere being longer and the heat of the southern hemisphere shorter in proportion.

Diameter and Ellipticity.—The accurate determination of the diameter of Mars presents peculiar difficulties which have not as yet been satisfactorily resolved. Ordinary telescopic measurements of diameter give results which are too great as a consequence of several disturbing factors all of which act in a positive sense. Especially to be mentioned is irradiation, a subjective disturbance of vision which causes a bright object to appear larger than it is. The effects of most of these factors can be evaluated and allowed for, but there remains the influence of the planet's atmosphere, which possesses a certain amount of visibility, especially when it contains haze, and is seen in increased thickness at the planet's edge. This latter aspect of the problem has recently excited some discussion, and will be further alluded to in the subsection relating to photography by light of different colors. The equatorial diameter of Mars resulting from what are regarded as the most reliable telescopic measures is 6,740 km. (4,190 miles). Photographs made in yellow light by R. J. Trumpler give 6,820 km. (4,240 miles). Independent determinations of the solid surface by Trumpler and by W. H. Wright indicate a diameter approximately 180 km. (112 mi.) less than this. If this difference is interpreted in terms of the atmospheric overlayer it provides a value of 90 km. (55 mi.) for the atmospheric thickness, a result which

[1]*See* H. J. Rose in *Class. Rev.* xxxvi, p. 15.



PHOTOGRAPHS, (6) E. E. BARNARD, BY COURTESY OF YERKES OBSERVATORY; (12-16) E. C. SLIPHER, LOWELL OBSERVATORY, (11) R. J. TRUMPLER, LICK OBSERVATORY; (1-5, 7-10) W. H. WRIGHT, LICK OBSERVATORY

TELESCOPIC PHOTOGRAPHS OF THE PLANET MARS

1–5. Show changes obtained by varying the colour of light employed in photographing: 1. was taken by ultra-violet light; 2, yellow; 3, red; 4, infra-red; 5, violet. Surface markings shown in varying strength in 2, 3. and 4. are not found in 1. and 5. Note clouds in 1. and 5

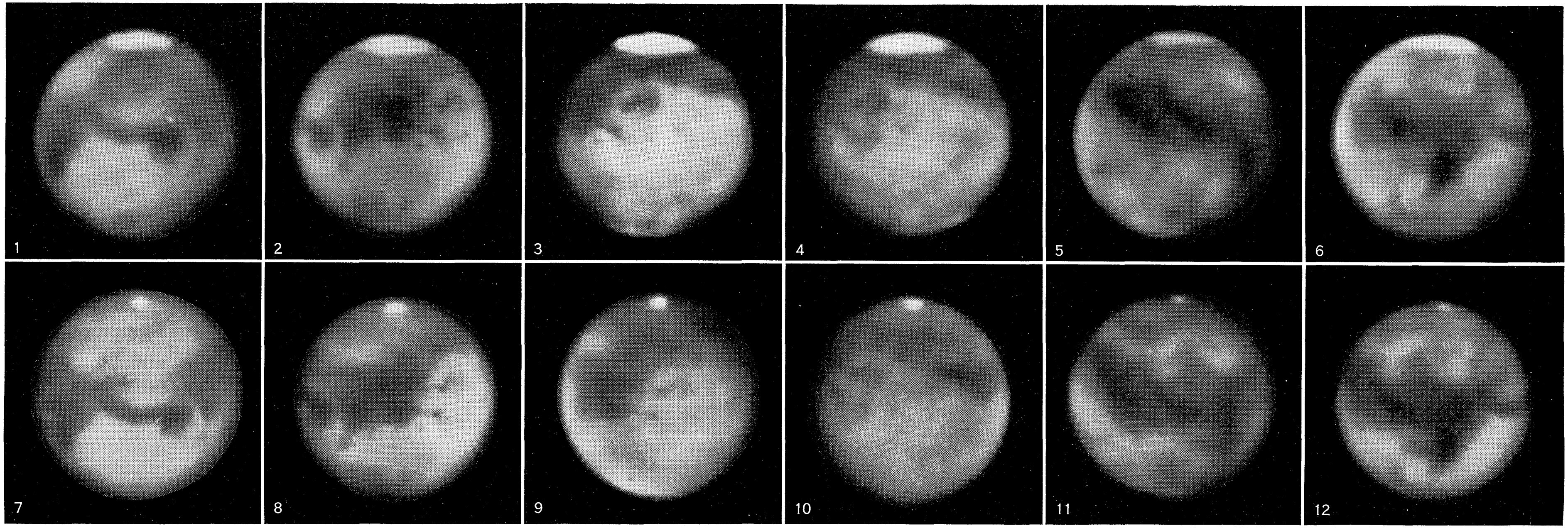
6–8. For full description see the text

9 and 10. Photographs of a terrestrial landscape using the same colours as for 4. and 5. above. Obscuration of the distant snow-covered mountains is caused by the earth's atmosphere, and the comparison suggests that obliteration of the surface markings in 5. is due to an atmosphere on Mars that is practically impenetrable by violet or ultra-violet light. Such an atmosphere explains the varying visibility of surface features in 2. to 4., also occurrence of clouds in 1. and 5.

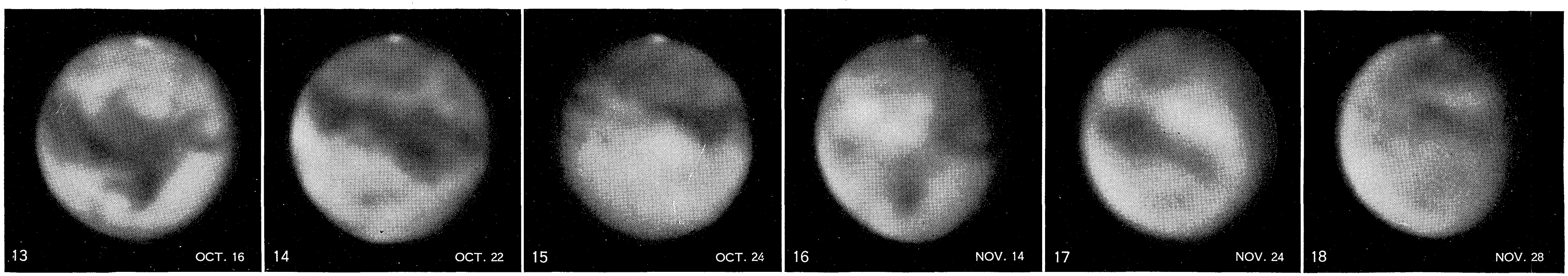
11. Chart of Mars at opposition of 1924. In comparing photographs with the chart the former should be viewed with the polar cap straight up. South is upward

12–16. Photographs of Mars showing seasonal changes during the progress of the planet's summer. The Martian seasonal dates are: 12., May 13; 13., May 29; 14., June 23; 15., July 31; 16., Aug. 20. Note the shrinking of the polar cap and darkening of the equatorial regions with advance of the season

PHOTOGRAPHS OF MARS



CLOUDS ON MARS



PHOTOGRAPHS BY COURTESY OF E. C. SLIPHER.

1–12. Photographs of Mars, showing various faces of the planet in 1939 (upper row figs. 1-6) and the same faces in 1941 (beneath figs. 7-12). In 1939 the southern hemisphere was in its springtime, in 1941 in its summer. (The 1939 photographs were made at Lamont-Hussey observatory, Bloemfontein, South Africa, the others at Lowell observatory)

13–18. Clouds on Mars. Photographs in 1941 displaying rare examples of widespread cloudiness in the atmosphere of Mars obscuring the familiar dark markings. Figures 13, 14, 15, show the planet normally clear, figures 16, 17, 18, taken within a few weeks of the same face of the planet, display the cloudy condition. Such Martian storms are often observed to move across the surface, but generally dissipate in a day or so may be very much in error, and is mentioned here principally for the purpose of illustrating a difficulty encountered in determining the diameter of the planet.

Measurements of the polar and equatorial diameters indicate an ellipticity of figure greater than can reasonably be accounted for by the planet's rotation, and greater also than seems compatible with the observed motion of the satellites. The usually adopted measure of ellipticity or "flattening" is the fractional excess of equatorial over polar diameter. This quantity, as derived from the measurements, is 0.010 (Trumpler, *Lick Obs. Bull.*, vol. 13, p. 31); and as calculated from the dynamical considerations just indicated, 0.005. It appears likely at the present time that the smaller, or calculated ellipticity is correct, and that the discrepancy in the observed value is to be ascribed to phenomena of the Martian atmosphere.

Some of the more important dynamical data not specified elsewhere in this article are:

Mean distance of Mars from the sun	228 million km. (141,650,000 mi.)
Mean orbital velocity	24.1 km. (15.5 mi.) per sec.
Mass	0.108 that of the earth.
Volume	0.150 that of the earth.
Density	4.0 times that of water.
Surface gravity	0.38 that of the earth.

The above are calculated for a mean Martian diameter of 6,770 km. If the diameter of the solid planet is taken to be 180 km. smaller (as explained above) the last three constants become: volume, 0.141; density, 4.2; gravity, 0.40.

Surface Features.—The fascination of the study of the Martian surface arises from a number of circumstances. Mars is the nearest and most favourably situated for observation of all the planets. Venus it is true comes closer to us, but at the time of its least distance the illuminated hemisphere is turned away, and consequently cannot be seen. Furthermore, Mars is one of the few heavenly bodies on which we see a solid surface, like that of the earth. Its solidity is shown by the substantial permanency of its configurations; the only other astronomical objects of consequence which present to our view surfaces of a like character are the Moon, and possibly Mercury; otherwise, perhaps with such inconsiderable exceptions as the asteroids and the satellites of planets, our telescopes reveal only fluid masses or bodies surrounded by clouds or impenetrable vapour. In the case of the Moon, the only real rival of Mars in the display of surface detail, we have the advantage of greater proximity, which enables us to distinguish mountains, plains and minor features of topography, but we encounter a sameness of aspect, due in part to its apparent rotational immobility and in part to the absence of an atmosphere, which is not altogether relieved by its phase variations. And whereas we see only slightly more than half the lunar surface, Mars—although its distance is such that, even at closest approach, the ultimate nature of its markings can only be inferred—has the advantage of rotation and all parts of the planet are therefore brought successively before us; it is, besides, surrounded by an atmosphere that provides diversified phenomena of climate and weather. Mars stimulates a unique and compelling interest, as a subject both of scientific investigation and popular theorizing.

In the telescope the planet presents a ruddy or orange coloured disk relieved by darker markings of a greenish blue hue which occupy about three-eighths of the area of the planet, and are, for the most part, distributed in a belt just south of the equator. There is one considerable projection into the northern hemisphere, known as the *Syrtis Major,* and a few isolated dark regions occur in the northern latitudes, as shown on the chart (*see* PLATE I, fig. 11). It should perhaps be explained, in respect to the charts and other illustrative material relating to astronomical subjects, that the usual practice is followed of placing them with the south side uppermost, to correspond with the appearance in the field of an inverting telescope. The dark markings of Mars are permanent features, although some of them undergo variations in size and appearance. Extending from the dark areas into the regions of greater brightness are a number of wisp-like filaments, the so-called and much discussed "canals." It seems to be generally agreed among observers who have the use of powerful telescopes that their occurrence is not limited to the bright regions (though they are, naturally, more easily seen there), but that they traverse the dark areas as well, forming a network which completely enmeshes the planet. At the poles of rotation are usually seen brilliant white patches, termed polar caps. These have not the quasi-permanent character of the dark markings, for each of them waxes and wanes with the coming and going of winter in the hemisphere to which it belongs, all but disappearing in the summer, as shown in figs. 12 to 16 of PLATE I. The striking parallelism between this phenomenon and the yearly variation of the winter areas of ice and snow in our higher terrestrial latitudes suggested to early observers that the Martian caps are polar snow-fields, and this view of their constitution appears to be the one most generally held at the present time, although an alternative explanation in terms of frozen carbon dioxide has been suggested. Another feature presented in the telescopic view of the planet is the so-called "limb light," a narrow band of bluish green tint that outlines the bright limb or fully illuminated edge of the planet.

The more conspicuous Martian phenomena have been known since the early days of telescopic observation. In 1610 the phases were observed by Galileo. The first sketches of surface detail were made by Huygens in 1659. Huygens suggested a rotation period of 24 hours, and Cassini seven years later independently estimated 24 hours and 40 minutes, which is very close to the actual value. The latter observer also described the polar caps. The drawings of Huygens and of Hooke (1660), though crude when judged by modern standards, have permitted the rotation period to be determined with a high degree of accuracy; the value $24^h\,37^m\,22.6^s$ for the sidereal revolution cannot well be in error as much as a tenth of a second. Little of value was accomplished for a century or more but in 1783 Sir William Herschel detected seasonal variation in the sizes of the polar caps, and determined the position of the axis of rotation. During the 19th century, especially its second half, with the increase in power and quality of telescopes, further details were revealed. In 1877 Asaph Hall discovered the two satellites. The outstanding observer of this period was G. V. Schiaparelli, who in 1877 made the first comprehensive triangulation of the surface, and added greatly to the number of known line-like markings which he was the first to designate "canals." Schiaparelli also reported a phenomenon with respect to the reality of which his successors have not been uniformly in agreement, namely, the "gemination" or doubling of the canals at certain seasons of the Martian year. Because of the pioneer nature of his work, the excellence of his observations and the philosophical character of his deliberations, Schiaparelli is undoubtedly to be regarded as the pre-eminent student of the Martian surface; in more recent years the names of E. E. Barnard, P. Lowell, E. M. Antoniadi, W. H. Pickering and many others have been associated with the telescopic study of Mars, and noteworthy photographs have been made, especially by E. C. Slipher at Lowell and by R. J. Trumpler at the Lick observatory. Finally, inquiries of two kinds, which may be regarded as departures from the traditional methods of telescopic observation, have been undertaken during recent oppositions. One of these has for its object the determination of the planet's temperature through analysis of its thermal radiation; the other consists in the study of the planet by light of different colours. Both will be discussed.

Before undertaking a more detailed description of the planet than is provided above it will be appropriate to refer to the Martian atmosphere, since it is through this gaseous envelope that the planet must be viewed, and some modification in appearance might reasonably be anticipated on this account. Photographic observations indicate that the effect of atmosphere on the visibility and appearance of the surface depends on the colour of light used in observation, and that for colours to which the eye is most sensitive (yellow and spectrally contiguous colours) modification of the appearance of the surface of Mars is not, except perhaps at the polar caps, very serious; so that it is permissible to approach the study of the planet by way of its telescopic appearance.

In fig. 6 of PLATE I is a photograph taken by Barnard with the great telescope of the Yerkes observatory. It was made by yellow light, a colour to which the eye is specially sensitive, and it illustrates, as well as a monochrome representation can, the appearance of the planet when seen in the telescope under good observing conditions. The south polar cap lies on the upper right edge of the disk. To the eye the cap is normally a brilliant white, while the remainder of the lighter toned area is deep yellow or orange; the dark parts are, as has already been said, normally of a bluish green tinge. The region shown is that of the Syrtis Major, the dark triangular portion resembling the Indian peninsula, extending downward to the left. On the chart (*see* PLATE I) the Syrtis will be found in long. 290°, lat. +10°. In correlating photograph and chart it is necessary to bear in mind that in the former the direction of the axis is inclined upward to the right, as is shown by the position of the polar cap. The lower of the two dark strips, which, on the photograph, reach out to the right, is the *Sabaeus Sinus,* approximately in long. 345°, lat. −7°. The small excrescence, or downward projection at the extremity of the strip, is the so-called forked bay; the bifurcation is not visible in the photographs because of the disadvantageous position near the planet's edge, but will be readily recognized on the chart. The meridian passing through the point of bifurcation has been arbitrarily chosen as the one from which areographic longitudes are measured (*"areographic,"* with respect to Mars, = "geographic" in relation to the earth; "areography" is Martian "geography").

The dark areas of the planet were regarded by the early observers as expanses of water, and were called *"maria"* or "seas." Even so recent an observer as Schiaparelli held this view, but it has now been generally abandoned, at least with respect to most of the dark markings, though a number of the smaller and more variable are by some observers still regarded as lakes. Despite this change in interpretation the names *mare* and "sea" have continued in general use as designations of the dark areas. Conclusive proof that these areas are not bodies of water is found in the fact that we do not see the reflection of the sun in them, as we certainly should, at times of proper presentation, if they exposed free surfaces of water; other indications are that the dark markings are far from uniform in strength, that detail is visible in them, and that some are subject to marked alterations, as may be seen by intercomparing the illustrations of groups 6 to 8 and 12 to 16 of PLATE I. The several photographs of each group were taken at approximately equivalent presentation, and either group provides ample proof of alteration in surface markings. For the purpose of discussing some of these alterations without dependence on the rather cumbersome classical names by which they are ordinarily designated, advantage will be taken of the suggestion which fig. 7 affords of the outline of a stag's head and antlers. The resemblance will be more apparent if the plate is turned to the left through a right angle. It will now be seen that the antlers in figs. 6 and 7 are conformable but that in fig. 8 the object which serves as the antler on the reader's left is not the comparatively erect one that functions in the first two cases. A closer examination of fig. 8 will reveal a vestige of the old antler (*Pandorae Fretum*), while the new one can be discerned in reduced strength in fig. 7, and as a trace in fig. 6. Other differences are found at the back of the stag's neck, and in the appendage to the chin (*Thoth*). In fact the disparities are so great that fig. 6 bears little resemblance to a head of any kind. It seems doubtful whether the earth would exhibit, to a planetary observer, alterations of surface features comparable in magnitude with those shown in these photographs. In drawing conclusions from such phenomena as these it is necessary to assure oneself that they are not the consequences of passing clouds, or of atmospheric obscurations of one kind or another, and fig. 7 shows, in fact, in the light spot at the stag's throat, what is in all likelihood a cloud, while temporary obscurations of one part or another of the surface have occasionally been observed that are most readily accounted for as effects of mists or other atmospheric abnormalities. There seems to be little ground, however, for doubting that much of the variation seen on Mars is real, and it becomes a matter of importance to inquire whether it synchronizes with the Martian seasons. Schiaparelli seems to have been the first to suspect seasonal variations, and, while evidence on this point can be supplied only by observations extending over many years, experienced observers consider that some of the changes are seasonal and others not, though the evidence is not altogether consistent (*Publ. Astron. Soc. Pacific,* vol. 39, 11, 108–109). Many observers of the planet, especially Lowell and members of the group of astronomers who were at one time or another associated with him at the observatory which he established, have reported seasonal alterations of a specific character. They find the dark areas to be stronger in the spring and summer of the hemisphere in which they are situated, the intensification starting in high latitudes, close to the shrinking cap, and working toward the equator, sometimes crossing it. They also report changes in shade or colour accompanying these alterations in intensity, the colour usually passing from bluish green to yellow, as the darkening is reduced, though a change from blue-green to chocolate-brown is stated to be characteristic of a certain region of the planet lying to the south of the *Syrtis Major.* The photographs in figs. 12 to 16 of PLATE I, taken by E. C. Slipher at the Lowell observatory, have kindly been provided by him to illustrate seasonal alterations in the strength of certain of the markings.[1] A seasonal effect, the significance of which has been emphasized in interpretations of the phenomena of the caps, is a dark margin said to surround the shrinking cap. This has been explained as flooding consequent upon the melting of the cap. The relationship of areographic mutation to the yearly cycle has been the subject of painstaking inquiry on the part of nearly every observer of the planet; the literature relating to it is, as a consequence, very voluminous, and from its nature, difficult to abridge or summarize; for fuller information the reader is referred to W. H. Pickering, *Popular Astron.* vol. 35, p. 195 (1927) and Antoniadi, *Bull. Soc. Astron. France,* vol. 38, p. 199; vol. 40, 278.

The generally bluish green colour of the dark markings, taken in conjunction with seasonal changes to which they appear to be subject, has provided the suggestion that they are areas of vegetation, an interpretation that has been accorded warm advocacy by certain astronomers, more especially, perhaps, those whose interest is centred in habilitating an hypothesis of close parallelism between organic phenomena on Mars and on the earth. While the present writer is, to borrow a phrase of Schiaparelli from a passage quoted elsewhere in this article, "very careful not to combat this supposition, which includes nothing impossible," he has recently pointed out that a high content of blue and violet light is to be expected in the image of dark surface areas, as a consequence of the superposition upon them of the Martian sky. That the planet's sky probably influences the colour and appearance of the surface has long been recognized, but the evidence of recent photographic observations, to be referred to later, suggesting as it does that a very large proportion of the blue and violet light from even the brighter parts of the planet is due to the overlying atmosphere, seems to require an alteration in the apparent colour (in the spectral direction green to blue) of surface markings, as a consequence merely of their darkness; in other words, the dark areas might be expected to appear bluish green whether that is their real colour or not. The change from blue-green to yellow, found to accompany the seasonal fading of the dark areas, would, according to this view, be merely a consequence of their fading; but changes from green to chocolate-brown, observed by Lowell in 1903 and 1905, cannot be so regarded.

The Canals.—If comment were confined to what is universally agreed upon with respect to the finer markings which pass under this designation very little could be said. That such markings exist there can be no question, and A. E. Douglass's discovery of similar features on the dark areas themselves appears to have been generally confirmed. Their visibility, like that of the seas, is variable, some appearing at one time and some at another, so that their appearance in the telescopic view is not to be inferred from

[1]The description sent by Mr. Slipher with the photographs is as follows: "Actual photographs of the planet Mars displaying the gradual decrease of the snow at the south pole and the darkening of the planet's tropics with the advance of Martian summer. This gradual darkening of certain regions of the planet in his summer season and their subsequent fading in winter seems best explained by assuming that these dark areas are due to vegetation." The responsibility for the interpretations rests, of course, with Mr. Slipher.

the network shown on one or another chart which usually includes all that have been seen, at least in a given season, by the person drawing it. Some observers report the canals as of sensible width, others as extremely fine, hair-like lines, while still others record canals of both descriptions. Schiaparelli, whose pioneer study of them is specially valuable, described them as straight, direct and continuous, and numerous observers have confirmed this impression of their appearance (Lowell, *Mars and its Canals,* p. 29), though astronomers of at least comparable skill and experience have reported deviations from rectilinearity, and have suggested that some of the more difficult of them may be merely the consequence of grouping by the eye of minute markings which are not separately visible, the apparent continuity being a subjective effect. (Pickering, *Mars,* chap. xiv; Trumpler, *Publ. Astron. Soc. Pacific,* vol. 39, p. 106; *Annual Rep. Mt. Wilson Obs.,* 1925, p. 103.) Schiaparelli reported a gemination, or doubling of certain of the canals at stated seasons, and very positive statements have been made in confirmation of this, notably by Lowell and his followers. On the other hand, skilled observers, among whom may be mentioned Barnard and Pickering, have failed to observe such conditions, despite long continued and careful scrutiny of the planet. These diverse findings would seem to prove that a study of the finer structure of the canals is beyond our present means of observation.

The impression of straightness and geometrical regularity made by the canals has stimulated the imaginations of certain astronomers to see in them the works of intelligent beings. Why this should be so is not altogether apparent. The remarkable systems of streaks which radiate from some of the craters of the Moon are not so interpreted, while the works of man which might be regarded as of sufficient magnitude to be visible to a well equipped celestial observer are not distinguished by geometrical regularity. A world-encompassing phenomenon suggests the action of geological forces, and Schiaparelli was among those to suggest the play of these in the formation of the canals. His reflections on the suggestion that they are the work of intelligent inhabitants of the planet are of interest, and we are indebted to a translation of one of his essays (*Mars,* pp. 92–94) by Prof. W. H. Pickering for the following passages:—

> Their [the canals'] singular aspect, and their being drawn with absolute geometrical precision, as if they were the work of rule or compass, has led some to see in them the work of intelligent beings, inhabitants of the planet. I am very careful not to combat this supposition, which includes nothing impossible. . . . Let us add further that the intervention of intelligent beings might explain the geometrical appearance of the gemination, but it is not at all necessary for such a purpose. The geometry of nature is manifested in many other facts, from which are excluded the idea of any artificial labour whatever. The perfect spheroids of the heavenly bodies and the ring of Saturn were not constructed in a turning lathe, and not with compasses has Iris described within the clouds her beautiful and regular arch. And what shall we say of the infinite variety of those exquisite and regular polyhedrons in which the world of crystals is so rich! In the organic world, also, is not that geometry most wonderful which presides over the distribution of the foliage upon certain plants, which orders the nearly symmetrical, starlike figures of the flowers of the field; as well as of the animals of the sea, and which produces in the shell such an exquisite conical spiral that excels the most beautiful masterpieces of gothic architecture? In all these objects the geometrical form is the simple and necessary consequence of the principles and laws which govern the physical and physiological world. That these principles and these laws are but an indication of a higher intelligent power, we may admit, but this has nothing to do with the present argument.

The remarkable paper from which this excerpt is taken contains a summary of Schiaparelli's views, and a complete reading of it is to be recommended.

Since Schiaparelli's time a number of astronomers both in Europe and America have been industrious observers of the canals, but it seems questionable whether the ground gained has been commensurate with the toll of labour its winning has exacted.

The surface of Mars is believed to be freer from topographical irregularities than that either of the earth or the Moon. This is an inference from the observed smoothness of the terminator, which would quite certainly present a more or less ragged appearance were irregularities comparable with terrestrial or lunar mountains upon or near it. It is, however, unreasonable to suppose that substantial differences in level do not exist, and the polar eccentricity and irregularity of outline of the southern cap, when shrinking, find a plausible explanation in the assumption that they are caused by local differences in the level of the ground. The relatively high temperatures of the dark areas, reported by Coblentz and Lampland, presently to be referred to, have led those observers to suggest that these areas lie at a lower level than the brighter ones. This is, however, an aspect of the Martian problem which is still in the speculative stage.

Atmosphere.—To a celestial observer of the earth the detection of its atmosphere would offer no difficulty whatever, since the clouds, which are a part of it, would continually be seen. The discovery of the Martian atmosphere was not so easy a matter, for clouds, in the ordinary sense of the word, are rare, and few evidences of the obstructive effects of an atmosphere are encountered in observing the planet with a telescope. Nevertheless, that Mars has an atmosphere of some kind has long been known from the phenomena of the polar caps; for while it is easy to understand how a cap could disappear simply by melting, its formation must quite certainly be the result of precipitation, and it was consequently inferred that there necessarily exists on the planet a considerable amount of vapour, the cap material, which would itself, even in the absence of other gases, constitute an atmosphere. Furthermore, projections from the terminator of Mars have occasionally been seen, for which the most satisfactory explanation known is that they are clouds at elevations of several miles. A cloud at such an altitude, illuminated by the rising or setting sun, would be seen in projection against an unilluminated part of the planet, a circumstance specially favourable for its observation. On other occasions temporary obscuration, partial or complete, of familiar surface markings has been interpreted in terms of obscuring mists, while, infrequently, very striking patches, whose mobility has left little doubt of their cloud-like nature, have been seen and photographed upon the planet. Thus, while the meteorological phenomena of Mars are not so conspicuous as those of the earth, their observation years ago gave ample proof of Mars's possession of an atmosphere. During recent oppositions a considerable amount of photographic evidence was obtained which appears to relate to the planet's meteorology.

Attempts have not been lacking to analyze the Martian atmosphere through spectroscopic examination of the planet's light. Since this light comes originally from the sun, and is merely deflected in our direction by the planet, a casual examination of the spectrum reveals merely the composition of the sun. However, the light, or more strictly speaking that part of it by which we see the planet's surface, must of necessity have traversed the planet's atmosphere both on entering and leaving, and some modification of the Fraunhofer, or dark line, spectrum might reasonably be anticipated as a consequence of this circumstance. Such modification is in fact known to be effected by the earth's atmosphere which adds to the numerous lines belonging properly to the spectrum of the sun a number of so-called "telluric" lines due to its own constituent gases. The presence of these lines of atmospheric origin adds enormously to the difficulty of a spectroscopic study of a planet's atmosphere, for they are precisely the lines that one would first seek in the planet's spectrum. Observations undertaken for the purpose of detecting on Mars any of the constituent gases of our own atmosphere therefore present peculiar difficulties, which have only partially been overcome by the adoption of very elaborate precautions. The observations of Huggins (1867) were for many years taken to indicate the existence of water vapour in considerable quantities in the atmosphere of Mars, and among later investigations those carried out under the auspices of the Lowell observatory by V. M. Slipher and F. W. Very are to the same effect. The latter observers estimated the Martian atmosphere to contain approximately 1.75 times as much water vapour, area for area, as existed in the atmosphere above their observing station at Flagstaff, Arizona, at the time of observation, that is to say 14 mm. of precipitable water for the Martian atmosphere. W. W. Campbell at the Lick observatory was however, unable to detect evidence of water vapour, and concluded that if any is present it does not exceed one fifth of the amount in the earth's atmosphere. Observations made with the powerful equipment of the Mount Wilson Observatory fail to show any trace of oxygen or water vapour in the spectrum of Mars. From his observations at Mount Wilson Dr. W. S. Adams estimated that an upper limit of one percent of the amount of terrestrial oxygen and water vapour would appear liberal for the Martian atmosphere.

From the most refined spectroscopic observations made thus far, it seems, therefore, that there is no appreciable effect of the atmosphere of Mars on the Fraunhofer spectrum. There is however a very marked change in the *distribution* of light through the spectrum. All observers agree that the more refrangible part of the spectrum is relatively weak, and to this fact is due the planet's ruddy colour. Exceptions are to be noted in the cases of the polar caps, and dark areas, for the spectrum of the caps continues in great strength into the ultra-violet, and the bluish green colour of the dark areas is due to the predominance of light of short wavelength. In view of the generally negative spectroscopic revelations of an atmosphere, and the ease with which features of the planet's surface, more especially the polar caps, are seen in the telescope, it would appear that the atmosphere of Mars is extremely tenuous. Evidence not altogether corroborative of this view is supplied by photographs taken by light of different colours.

Photographs by Light of Different Colours.—The study of Mars by the method just referred to involves a kind of analysis that has had some use in general scientific observation, and which may be said to occupy a place between precise spectroscopy, on the one hand, and the more versatile means of analysis provided through the perception of both form and colour by the eye, on the other. A series of photographs taken with approximately homogeneous light of distinct spectral regions has an advantage over the coloured presentation provided by ordinary visual perception in that its several images are separate, but its testimony, like ocular evidence, must be interpreted in the light of independently derived knowledge. Moreover, it is a matter of common knowledge that any object of diversified colour will suffer an apparent alteration in the contrasts of its several parts if the colour of the light by which it is viewed is changed. This is a natural consequence of the phenomenon of colour. Photography provides a specially suitable means for observing such alterations because it renders them in uniform terms of photographic density. Very marked differences are occasionally found when the colour used in photographing is altered, and it is sometimes possible, through a study of these differences, to learn something of the body under observation. Differences in the aspect of Mars when observed in this way appear first to have been described by de la B. Pluvinel and F. Baldet, and by G. Tikhoff, in 1909, but their important observations seem generally to have been overlooked. The phenomena were rediscovered and more completely described by later observers, especially on the planet's approach in 1924. A series of photographs, taken by light of five different regions of the spectrum, is shown in figs. 1 to 5 of PLATE I. The spectral positions of these regions are sufficiently well defined by the names of colours attached to the illustrations, except in the ultra-violet and infra-red, where the wave-lengths are approximately 3700A and 7600A respectively. The photographs are arranged in the order in which they were taken, which is, except in respect to fig. 5, also the spectral sequence of the colours used. It will be noted that there are progressive changes throughout the series 1 to 4. Those which relate to the position of the markings are readily recognized as being due to the planet's rotation on its axis. The axis passes upward to the right, and approximately through the centre of the polar cap, which is seen on some of the photographs as a small white dot on the planet's edge; and the effect of rotation is to displace the markings of successive images upward to the left. After allowing for these displacements, there remain differences of a more fundamental character which will now be considered. Figures 4 and 5 were taken so closely together in point of time that they provide substantially identical presentations of the planet, and the disparity in their appearance is one that it would be very difficult to explain as a consequence of the different colours of its several parts. Reduced contrast of markings against the bright background would be expected in a violet photograph because of their bluish green colour, but the total obliteration of all structure shown in the infra-red image, and the substitution of something of an entirely different kind, seems difficult to explain as a colour effect. Before attempting an interpretation it will be well to summarize some of the more remarkable peculiarities which pictures of this kind exhibit when taken, as during recent favourable approaches of the planet, with refined instruments and great precision of method.

(1) Excepting the polar caps and limb light, the familiar features of the planet are invisible in the ultra-violet photographs, but appear, and become increasingly conspicuous, as the wave-length of the light used in observation increases.

(2) The polar caps and limb light are, on the other hand, strong in the ultra-violet photographs, and weaken with increasing wave-length.

(3) Ultra-violet and violet photographs record at times whitish areas and mottlings which have been found to be temporary. These, like the polar caps and limb light, decrease in strength with increasing wave-length.

(4) When the planet is near opposition there is a pronounced fading, or darkening, at the limb in the red and infra-red images. The violet and ultra-violet images are, on the contrary, usually brightest at the limb.

(5) The ultra-violet and violet images are noticeably larger than those taken by red and infra-red light.

A tentative explanation of these characteristics has been made by W. H. Wright.

The theory may conveniently be approached through a consideration of figs. 9 and 10, which show small sections of a distant landscape photographed by light of the colours used in 4 and 5 directly above them. Obliteration of the distant part of the landscape in 10 is known to be due to the earth's atmosphere, and the comparison of the two pairs of photographs is suggestive of the presence of an atmosphere of considerable optical density on Mars. The light in the upper half of 10 comes from the atmosphere intervening between the camera and the distant snow-capped mountains. This part of the picture therefore is, in a sense, an image of the atmosphere, and if the analogy with the Martian pictures is correct the violet photograph, fig. 5, is an image of the Martian atmospheric shell. The infra-red photograph, fig. 4, is quite obviously one of the planet's surface. Under this interpretation the excess in size of the violet and ultra-violet images referred to in (5), is explained, because a shell must be larger than the body which it contains. Half of the difference between the diameters of the two images should obviously be the height of the Martian atmosphere, or rather the height to which it can be photographed, and this height has been provisionally estimated from the measures of the diameters as being of the order of 60 miles, though a discussion of all available material may greatly alter this estimate; indeed, a number of writers are averse to accepting so high an estimate of the atmospheric thickness (*see* Menzel, *Astrophysical Journ.*, vol. 63, p. 58, 1926; Fessenkoff, *Astrom. Nach.*, vol. 228, p. 25, 1926). The principal source of uncertainty in such a determination is encountered in the measurement of the infra-red image, which at the favourable time of opposition presents a very weak edge, especially if a dark marking falls on a part of it which may be selected for measurement. An implication of the foregoing theory, that has been seriously disputed, relates to the polar caps. These features are larger and stronger in the violet and ultra-violet photographs than in those taken by the infra-red light, and if the former are, in fact, pictures of the atmosphere, it seems difficult to escape the conclusion that the caps are in part, atmospheric phenomena. This is a conclusion that a number of excellent observers of the planet are unwilling to accept, for the reason that they regard it as incompatible with the telescopic appearance of the caps, and with their observed behaviour.

A word must be said about Martian clouds. These have been known for a great many years, but so much light has been shed upon them by the recent photographs that they may properly be discussed under this head. There is substantial evidence leading to the belief that Mars has clouds of two kinds. What we shall call the first kind (*see* figs. 1 and 5 of PLATE I) are specially conspicuous on photographs taken by light of the violet end of the spectrum, and are not seen on the red photographs; those of the second kind (*see* fig. 7 at the "stag's throat") have an exactly contrary behaviour, being strong in the red photographs and invisible in the violet. The term cloud is here used in a very general sense and is meant to designate merely an area of atmospheric unhomogeneity which registers a cloudlike impression on a photograph, though there is reason to believe that clouds of the second class may actually be aqueous clouds. The writer has suggested that clouds of the first class lie high in the Martian atmosphere, and those of the second at a lower level.

Temperature.—That the temperature on the surface of Mars is comparable with that of the earth was long ago inferred from the behaviour of the polar caps, under the supposition that the latter are composed of ice or snow; and this inference, whatever the validity of the premise from which it was drawn, has been corroborated by analyses of the planet's thermal radiation. The determination of the temperature of a planet through measurement of the heat it sends us presupposes a refinement of technique which, until recently, seemed quite unattainable, for small as is the amount of heat received, it consists of two parts, that which came originally from the sun and is reflected by the planet, and that which originates in the planet's own warmth. The second of these parts, called the planet's intrinsic radiation, is alone the index of the planetary temperature, and in order to be utilized as such it must either be isolated from the first part, or sufficiently separated from it to permit certain characteristics of thermal radiation to be recognized. The most practicable procedure that has until now been developed is to compare the total heat received from the planet with that part of it which falls within certain limited regions of the spectrum. The spectral limitations are secured by passing the beam through various substances, notably water, of known transmissive properties. The logic of the method will be suggested by the consideration that, since the bulk of the intrinsic radiation of a body well below the temperature of incandescence, such as a planet, lies far in the infra-red, a great falling off in the amount of heat received when this region is excluded by the interposition, for example, of a water cell, will indicate a substantial contribution by the planet itself, and therefore a relatively high temperature. The actual analysis, while it is not in its present approximate form very complex, involves many factors, and cannot be presented here. Of surpassing interest is the delicate electrical thermometer with which the heat measurements are made. The sensitive element is a thermo-couple of such small dimensions that the surface of the planet can be explored and the radiation of its several parts measured. These first successful measurements of planetary radiation from Mars were made in 1922 by W. W. Coblentz and C. O. Lampland at the Lowell observatory, but those undertaken at the Martian apparitions of 1924 and 1926 by these observers, and by E. Pettit and S. B. Nicholson of Mount Wilson, are of such superior quality that only they will be considered. Temperatures of several parts of the disk, depending on these measurements, are given in the table to the nearest 10°:

	Sunrise edge	Centre	Sunset edge	S. polar cap	N. polar region
(1924)* Mount Wilson	−10°C.	+30°C.	−10°C.	−70°C.	..
(1924)†Lowell	−20° to −60°	−10° to +20°	0°	0° to +10°	−70°
(1926)†Lowell	−20°	+20° to +30°	+10°	−10° to +10°	−30° to −40°

**Annual Report*, Mt. Wilson Obs.; Carnegie Inst. (Washington, 1925).
†*Sci. Papers Bureau Standards: No. 553* (Washington, 1927).

Considering the difficulty of the observations, the independent estimates by the Lowell and Mount Wilson observers are remarkably accordant, especially when it is remembered that the quantity determined is the absolute temperature (or temperature measured from the absolute zero point, −273° C.) and not the difference between this and the comparatively close number which has arbitrarily been chosen as the zero of the Centigrade scale. The fall in temperature from the centre to the edge of the disk is beautifully shown; and the polar temperatures as well as those at sunrise and sunset seem painfully low to dwellers on the earth. Two outstanding points of difference are presented by the estimates made at the two observatories. The Lowell observers find the Martian afternoons to be warmer than the mornings, as is indicated by higher temperatures at sunset than at sunrise. The Mount Wilson results on the other hand show equal temperatures for morning and afternoon. Our terrestrial experience is that it is usually warmer in the afternoon than in the morning, a fact which is due to the considerable water vapour content of the earth's atmosphere, and the Mount Wilson observers explain the symmetry of their morning and afternoon temperature curve to be a consequence of the known scarcity of water vapour in the atmosphere of Mars. The second discrepancy relates to the temperature of the south polar cap, which alone was visible at these oppositions. The Mount Wilson observations place the temperature at −70° C., those made at Lowell indicate approximately 0° C., the temperature of melting ice. This is a matter that bears critically on the question of the constitution of the polar caps. An interesting indication of the Lowell observations is that the dark parts of the planet are warmer than the bright ones, the estimated difference being 10° or 15° C., a fact which would appear to be better in accord with the supposition that they are merely areas of comparatively high optical absorption than that they are regions of vegetation. Optical absorption by a dark surface results in a rise of temperature, while expanses covered with vegetation are cooler than desert areas under like conditions.

The estimates of temperature provided by these observations have been generally accepted with confidence, and there seems to be no ground for questioning their substantial accuracy in so far as the central part of the planet's disk is concerned. The calculations through which they were derived do not, however, take into account the properties of the Martian atmosphere, though the possible effects of an atmosphere were made the subject of conjecture by both groups of investigators. Whatever the magnitude of these effects, they must of necessity increase as the edge of the planet is approached, because of the greater amount of atmosphere intervening between us and the planet's surface at points remote from the centre. Furthermore the optical properties of the atmosphere are quite certainly affected by the lower temperature of the terminator, which at the most favourable time for general observation is close to the edge. That the atmosphere of Mars is not altogether negligible seems a fair inference from photographic evidence already discussed, but we are not in possession of sufficient knowledge of its optical properties to permit a reliable estimate to be made of its effect on the planet's radiation. For such reasons the temperatures derived for the polar caps and other parts of the edge are not regarded with the same confidence as those obtained for the centre. With these and other considerations in mind, Messrs. Coblentz, Lampland and Menzel have summed up their conclusions in the following words:

"We can say with some assurance that our measurements and deductions indicate that the temperature of the surface of Mars, under a noonday sun, rises considerably above the freezing point of water—a question that had been under discussion for years." (*Publ. Astron. Soc. Pacific*, vol. 39, p. 100; 1927).

Satellites and Pole.—At the opposition of Mars which occurred in Aug. 1877, the planet was unusually near the earth. Asaph Hall, then in charge of the 26-in. telescope at the Naval observatory in Washington, D.C., took advantage of this favourable circumstance to make a careful search for a visible satellite of the planet, and on the night of Aug. 11 found a faint object near the planet. Cloudy weather intervened, and the object was not again seen until the 16th, when it was found to be moving with the planet, leaving no doubt as to its being a satellite. On the night following an inner satellite much nearer the planet was observed. This discovery, apart from its intrinsic interest, is also noteworthy as the first of a series of discoveries of satellites of the outer planets. Hall named the outer satellite Deimos and the inner Phobos, from the horses that drew the chariot of the god Mars. A remarkable feature of the orbit of Phobos is that it is so near the planet as to perform a revolution in less than one-third that of the diurnal rotation of Mars. The result is that to an inhabitant of Mars this satellite would rise in the west and set in the east, making two apparent diurnal revolutions every day. The period of Deimos is only six hours greater than that of a Martian day; consequently its apparent motion around the planet would be so slow that more than two days elapse between rising and setting, and again between setting and rising. Lowell estimates the diameter of Deimos to be about 10 mi. and that of Phobos slightly more.

Long and careful series of observations have been made upon these bodies by other observers. At the very favourable oppositions of 1892 and 1894, observations were made by Hermann Struve at Poulkova, who later subjected all the data up to 1909 to a very careful discussion. He showed that the inclination of the planes of the orbits to the equator of the planet is quite small, thus making it certain that these two planes can never wander far from each other. The relations of the several planes can be best conceived by considering the points at which lines perpendicular to them, or their poles, meet the celestial sphere. By theory, the pole of the orbital plane of each satellite revolves round the pole of a certain fixed plane, differing less from the plane of the equator of Mars the nearer the satellite is to Mars. The observations of Lowell and Slipher, and of Trumpler, agree in placing the axis of Mars in position R.A. 316°.0; Dec. +54°.5 (Equinox of 1925). The tilt of the Martian equator to the Martian ecliptic calculated from this position is 23°.4.

Bibliography.—Camille Flammarion, *La Planète Mars,* etc. (2 vols., Paris, 1892–1909), a copious résumé of all publications and drawings of Mars up to 1901; W. H. Pickering, *Mars* (Boston, 1921), a collection of papers giving a brief account of the planet; Percival Lowell, *Mars and its Canals* (N.Y., 1911), a summary of this author's views of the planet; T. J. J. See, "Preliminary Investigation of the Diameter of Mars," *Astronomische Nachrichten,* vol. 157, 97 (1901), a condensed summary of the principal measurements made between 1651 and 1901; R. J. Trumpler, "Observations of Mars at the opposition of 1924," *Lick Obs. Bull.* vol. 13, p. 19 (Berkeley, Calif. 1927), a general discussion based principally on photographs, of its surface features, diameter and other constants, including the calculation of the diameter of the solid surface from timed measurements of the markings; Trumpler, "Visual and photographic observations of Mars made at the opposition of 1926," *Publ. Astron. Soc. Pacific,* vol. 39, p. 103 (1927); W. H. Wright, "Photographs of Mars made with light of different colours," three papers in *Publ. Astron. Soc. Pacific,* vol. 36, p. 239 (San Francisco, 1924), *Lick Obs. Bull.,* vol. 12, p. 48 (1925), and vol. 13, p. 50 (Berkeley, Calif., 1927); a discussion of marked variations in the appearance of Mars when photographed by light of different colours, with suggested explanation; among subjects dealt with are the atmosphere of Mars, some of its optical properties, its extent, the phenomena of clouds and those of the polar caps; E. Pettit and S. B. Nicholson, "Measurements of the Radiation of the Planet Mars," *Pop. Astron.,* vol. 32, p. 601, a radiometric determination of the temperature of Mars.

The temperature of Mars, as derived from radiometric observations made at the Lowell Observatory, is discussed in papers contributed individually or jointly by W. W. Coblentz, C. O. Lampland and D. H. Menzel to the *Journ. Franklin Institute,* vol. 199, p. 785; vol. 200, p. 103 (Philadelphia, 1925); *Sci. Papers,* Bureau of Standards, Nos. 512, 553 (Washington, 1925–26); *Astrophysical Journ.* vol. 63, p. 177 (1926); and *Publ. Astron. Soc. Pacific,* vol. 39, p. 97 (1927).

Among important sources of general information may be mentioned the *Monthly Notices and Memoirs* of the Roy. Astronom. Soc.; the *Journal and Memoirs* of the Brit. Astronom. Ass.; the *Bulletin* of the Soc. Astronom. de France, especially papers by E. M. Antoniadi. *Popular Astronomy* contains important articles by various authors, among which may be mentioned those by E. C. Slipher, and a series of reports by W. H. Pickering, beginning in vol. 22 (1914), and numbered consecutively; the latter constitute a running comment, with numerous references, on contemporary observations of the planet. Observations made at Lowell observatory are recorded in extenso in its *Annals* and *Bulletins.* Schiaparelli's memoirs are collected in *Le Opere di G. V. Schiaparelli* (Milano, 1929–30). *See* also E. M. Antoniadi, *La Planète Mars* (Paris, 1930); and F. L. Whipple, *Earth, Moon and Planets* (Philadelphia, 1941). (W. H. Wr.; X.)

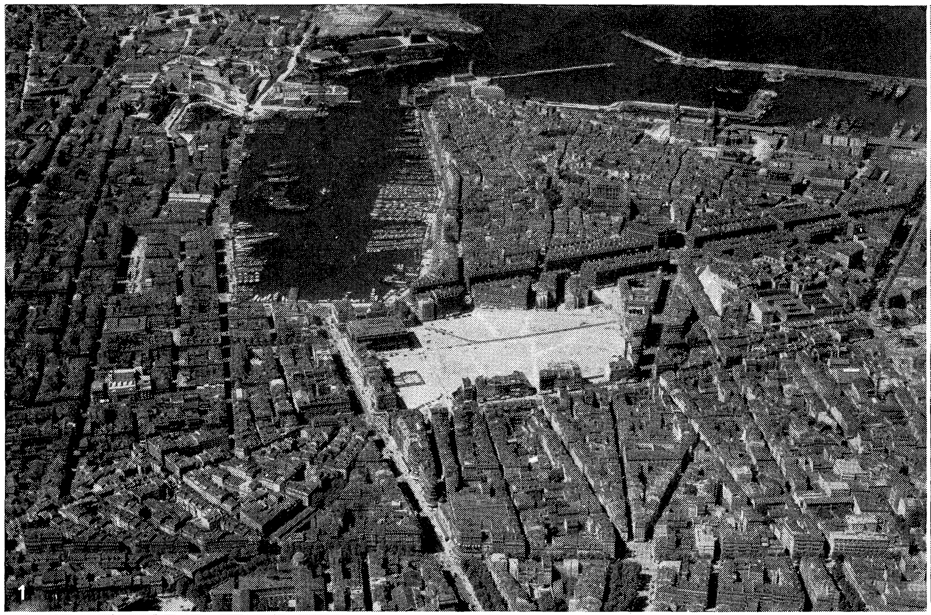
MARSALA, seaport, Sicily, province of Trapani, 19 mi. by rail S. of Trapani. Pop. (1936) 24,650 (town), 62,171 (commune). It is situated on the low westernmost point of the island. The cathedral, dedicated to St. Thomas of Canterbury, contains 16 grey marble columns. The town trades in Marsala wine.

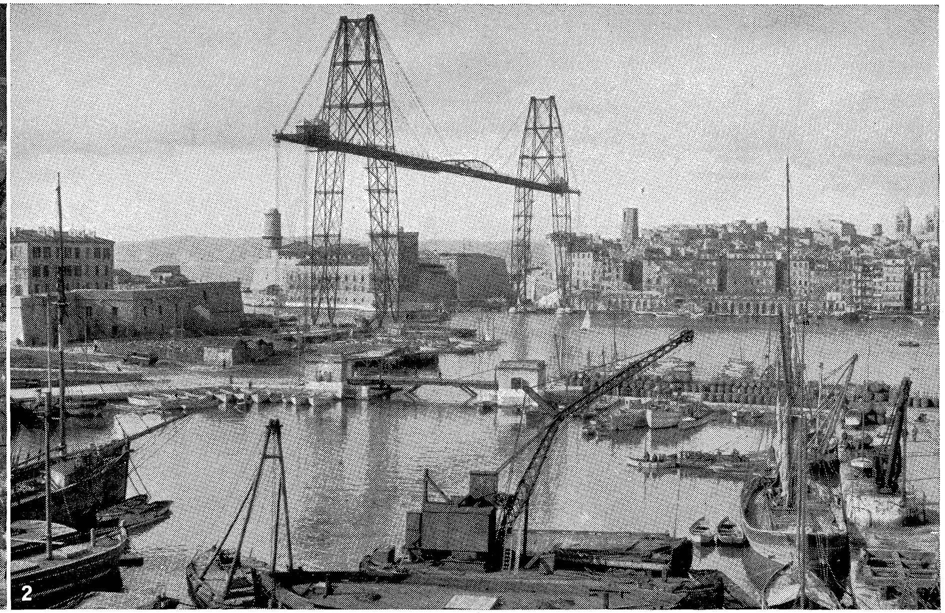
Marsala occupies the site of Lilybaeum, the principal Carthaginian stronghold in Sicily, founded by Himilco after the abandonment of Motya. Neither Pyrrhus nor the Romans were able to reduce it by siege, but it was surrendered to the latter in 241 B.C. In the later wars it was a starting point for the Roman expeditions against Carthage. The Saracens named it *Marsa Ali,* port of Ali. The harbour on the northeast was destroyed by Charles V to prevent its occupation by pirates. The modern harbour lies to the southeast. In 1860 Garibaldi landed at Marsala with 1,000 men and began his campaign in Sicily. Scanty remains of the ancient Lilybaeum, including fragments of the city walls, are visible. During World War II Marsala was heavily bombed by the Allies.

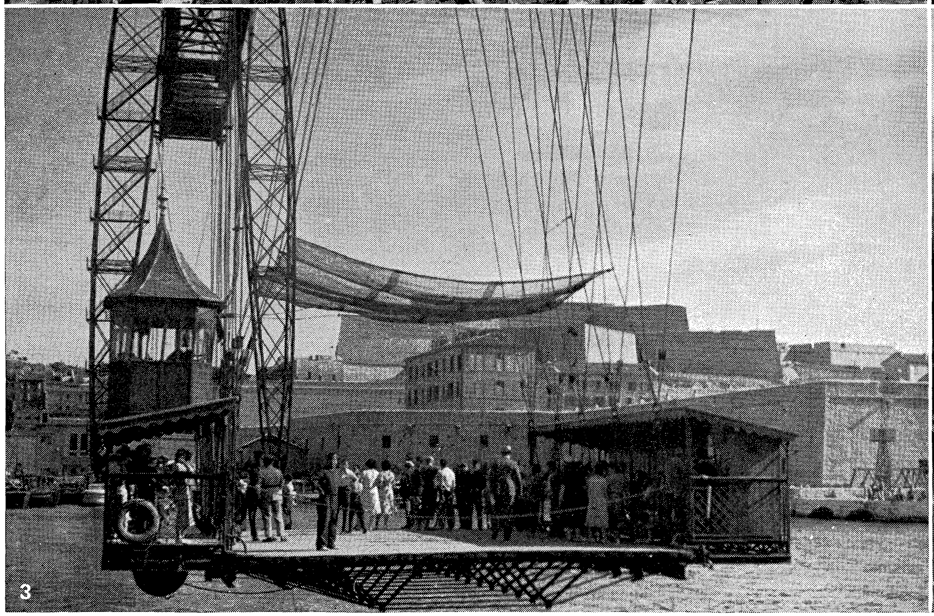
MARSCHALL VON BIEBERSTEIN, BARON ADOLF VON (1842–1912), German diplomatist, was born at Neuershausen, Baden, on Oct. 12, 1842. His grandfather, Karl Wilhelm, Baron Marschall von Bieberstein, ambassador of Baden in Stuttgart, represented Baden at the Congress of Vienna in 1815. Adolf was educated at Frankfort-on-Main, and at the universities of Heidelberg and Berlin. He held various administrative offices in the grand duchy of Baden, sitting from 1875–83 in the upper chamber of the Baden diet. In 1883 he was sent to Berlin as minister for Baden in the Federal council, and from 1884–90 he represented the council in the imperial insurance office. In 1890 he entered the imperial service, and succeeded Count Herbert Bismarck as state secretary for foreign affairs under Caprivi, continuing in that office under Prince von Hohenlohe; but he had incurred the enmity of Prince Bismarck by refusing his advice and the result was a fierce press campaign against him which finally obliged him to speak out when he appeared as witness at the trial of certain journalists in 1896 for *lèse-majesté.* He was opposed by the Agrarians for advocating the reduction of corn duties, and in 1897 resigned office, being appointed German ambassador in Constantinople, where he remained for nearly 15 years. He created a commanding position for himself and a growing ascendancy in Turkish affairs for his government. To him was largely due the promotion of the Baghdad railway. During his foreign secretaryship he took a strongly imperialist attitude. After the Krüger telegram, in the drafting of which Baron Marschall bore a leading part, it was he who declared in the reichstag that the maintenance of the independence of the Boer republics was a "German interest." He was an advocate of a strong naval policy for Germany. In 1907 he was principal German delegate in The Hague conference, and was the exponent of Germany's resolute and successful opposition to any practical discussion of the question of restriction of armaments. In May 1912 he succeeded Count Wolff-Metternich as ambassador to Great Britain, but his health broke down after a short time, and he died at Badenweiler on Sept. 24, 1912.

MARSCHNER, HEINRICH AUGUST (1795–1861), German composer and director, was born at Zittau, Saxony on Aug. 16, 1795. He studied music under Schicht at Leipzig, and in 1816 travelled to Pressburg and Vienna where he became acquainted with Košeluh and Beethoven. Weber produced his *Heinrich IV und Aubigné* at Dresden in 1820 and in 1824 Marschner was made musikdirector of the opera in that city. In 1827 he was appointed kapellmeister of the theatre in Leipzig, where he produced his highly successful romantic opera *Der Vampyr* in 1828, and in the following year his *Der Templer und die Jüdin.* In 1831 he became kapellmeister of the court at Hanover, and in May 1833, produced at Berlin his best and most successful opera, *Hans Heiling.* As a result of the performance of this work under his direction at Copenhagen in 1836, he was offered the position of musikdirector in Denmark. Marschner, however, returned to Hanover where, in 1859, he was given a pension and, after his death on Dec. 14, 1861, a monument was dedicated to his memory.

MARSDEN, WILLIAM (1754–1836), English orientalist, the son of a Dublin merchant, was born at Verval, Co. Wicklow, on Nov. 16, 1754. He was educated in Dublin, and having obtained an appointment in the civil service of the East India company went to Benkulen, Sumatra, in 1771. There he soon rose to the office of principal secretary to the government, and acquired







PHOTOGRAPHS, (1) SIR ALAN COBHAM FROM EWING GALLOWAY, (2) EWING GALLOWAY, (3) PIX, (4) SCHALL-PIX

VIEWS OF THE HARBOUR OF MARSEILLES

1. Air view of Marseilles, showing the Old Harbour (Vieux Port) at the left centre, and the new harbours at the upper right

2. The Old Harbour, with the Pont Transbordeur (Transportation bridge) at the mouth

3. Close-up view of the Pont Transbordeur

4. A view of the hill of Notre-Dame de la Garde, taken from the upper level of the Pont Transbordeur

a knowledge of the Malay language and country. Returning to England in 1779 with a pension, he wrote his *History of Sumatra,* published in 1783. In 1795 Marsden was appointed second secretary and afterwards first secretary to the admiralty. In 1807 he retired and published, in 1812, his *Grammar and Dictionary of the Malay Language,* followed in 1818 by his translation of the *Travels of Marco Polo.* He was a member of many learned societies, and treasurer and vice-president of the Royal society. In 1834 he presented his collection of oriental coins to the British museum, and his library of books and oriental manuscripts to King's college, London. He died on Oct. 6, 1836. Other published works by him include *Numismata orientalia* (London, 1823–25), and *Catalogue of Dictionaries, Vocabularies, Grammars and Alphabets* (1796).

MARSEILLAISE, LA, the French national anthem, of a curiously fortuitous origin. It was composed—almost, it might be said, improvised—as to both words and music, in one night (April 24, 1792) by Claude Joseph Rouget de Lisle, a French captain of engineers who happened also to be a musical amateur. The need of a marching song for the French had been expressed by the mayor of Strasbourg, where de Lisle was then quartered, and the world-famous hymn was his patriotic response. It derived its name subsequently from the fact of its having been sung with indescribable enthusiasm by the troops on setting out from Marseille for Paris. Rouget de Lisle's actual authorship of the music was long disputed but may now be taken as established beyond dispute although his work undoubtedly underwent certain improvements at the hands of various composers (including Grétry and Gossec) before it reached its existing form.

MARSEILLES (Fr. MARSEILLE), a city of southern France, chief seaport of France and of the Mediterranean, 219 mi. S. by E. of Lyon and 534 mi. S.S.E. of Paris, by the P.L.M. railway. Pop. (1936) 814,679. It is capital of the department of Bouches-du-Rhône.

History.—The Greek colony of Massalia (Lat. *Massilia*) was founded by the mariners of Phocaea in Asia Minor, about 600 B.C.; probably Phoenicians settled at Marseilles before the Greek period. The name of the town is the Phoenician for "settlement." In 542 B.C. the fall of the Phocaean cities before the Persians probably sent new settlers to the Ligurian coast and cut off Massalia from close connection with the mother country. Isolated amid alien populations, the Massaliots made their way by prudence and by vigilant administration of their oligarchical government. Their colonies spread east and west along the coast from Monaco to Cape St. Martin in Spain, carrying with them the worship of Artemis; the inland trade, in which wine was an important element, can be traced by finds of Massalian coins across Gaul and through the Alps as far as Tirol. In the 4th century B.C. the Massaliot Pytheas visited the coasts of Gaul, Britain and Germany, and Euthymenes is said to have sailed down the west coast of Africa as far as Senegal. The great rival of Massalian trade was Carthage, and in the Punic Wars the city took the side of Rome, and was rewarded by Roman assistance in the subjugation of the native tribes of Liguria. In the war between Caesar and Pompey Massilia took Pompey's side and in A.D. 49 offered a vain resistance to Caesar's lieutenant Trebonius. In memory of its ancient services the city was left as a *civitas libera,* but her power was broken and most of her dependencies taken from her. From this time Massilia has little place in Roman history; it became for a time an important school of letters and medicine, but its commercial and intellectual importance declined. The town appears to have been Christianized before the end of the 3rd century, and at the beginning of the 4th century was the scene of the martyrdom of St. Victor. Its reputation partly revived through the names of Gennadius and Cassian, which give it prominence in the history of Semi-Pelagianism and the foundation of western monarchism.

After the ravages of successive invaders, Marseilles was repeopled in the 10th century under the protection of its viscounts. The town gradually bought up their rights, and at the beginning of the 13th century was formed into a republic, governed by a *podestat,* appointed for life, who exercised his office in conjunction with 3 notables, and a municipal council, composed of 80 citizens, 3 clerics and 6 principal tradesmen. Later in the middle ages, however, the higher town was governed by the bishop, and had its harbour at the creek of La Joliette which at that period ran inland to the north of the old town. The southern suburb was governed by the abbot of St. Victor, and owned the Port des Catalans. Situated between the two, the lower town, the republic, retained the old harbour, and was the most powerful of the three divisions. In 1245 and 1256 Charles of Anjou, count of Provence, whose predecessors had left the citizens a large measure of independence, established his authority above that of the republic. In 1423 Alphonso V of Aragon sacked the town. King René, who had made it his winter residence, however, caused trade, arts and manufactures again to flourish. On the embodiment of Provence in the kingdom of France in 1841, Marseilles preserved a separate administration directed by royal officials. Under Francis I. Charles de Bourbon vainly besieged the town with the imperial forces in 1524. During the wars of religion, Marseille took part against the Protestants, and long refused to acknowledge Henry IV. The loss of the ancient liberties of the town brought new disturbances under the Fronde, which Louis XIV came in person to suppress. He entered the town by a breach in the walls and afterwards had Fort St. Nicolas constructed. Marseilles repeatedly suffered from the plague, notably in 1720–1721.

During the Revolution the people rose against the ruling aristocracy. In the Terror they rebelled against the Convention, but were promptly subdued. The wars of the empire, by dealing a blow to their maritime commerce, excited the hatred of the inhabitants against Napoleon, and they hailed the return of the Bourbons and the defeat of Waterloo. The prosperity of the city received a considerable impulse from the conquest of Algeria and from the opening of the Suez canal. During World War I part of the harbour became a British base, and many Indian, Australian, and African troops passed through, and, after the armistice, an American embarkation camp was established.

The Town.—Marseilles is situated on the Golfe du Lion on the eastern shore of a bay protected to the south by Cape Croisette but open towards the west. The city is built on undulating ground and the south-western and most aristocratic quarter covers the slopes of the ridge crowned by a fort and the church of Notre-Dame de la Garde and projecting westward into the bay to form a protection for the harbour. The newest portion lies on the south-eastern slope of the ridge, which is better protected than most of the other quarters from the mistral, and where in summer the temperature is always a little lower than in the centre of the town. The old harbour of Marseilles opens on the west to the Golfe du Lion, the famous Rue Cannebière prolonged by the Rue Noailles leading east-northeast from its inner end. These two streets are the centre of the life of the city.

The old town of Marseilles is bounded west by the Joliette basin and the sea, east by the Cours Belsunce, south by the northern quay of the old port, and north by the Boulevard des Dames. It consists of a labyrinth of steep, dark and narrow streets inhabited by a seafaring population. The entrance to the old harbour is defended by Fort St. Jean on the north and Fort St. Nicolas on the south. Behind the latter is the Anse (Creek) de la Réserve. Beyond this again, situated in succession along the shore, come the Château du Pharo, which was given by the empress Eugénie to the town, the Anse du Pharo, the military exercising ground, and the Anse des Catalans. The harbour of Marseilles is deep enough for the largest vessels, and is being enlarged at the northern end, and a canal has been constructed to join the Rhone for inland traffic. A small port has been built at its opening into the Gulf of L'Estaque; land has been assigned for industrial development, and industrial suburbs are arising along the bank of the canal where, protected by embankments, it runs along the coast and reaches the Lave by a tunnel about 4½ mi. long. A new port was constructed at Etang de Berre. It is hoped that improved navigation on the Rhone, and the extension of the port to include the lake of Caronte, will bring a larger influx of trade to Marseilles.

In the roads to the southwest of the port lie the islands of

Ratonneau and Pomègue, united by a jetty forming a quarantine port. Between them and the mainland is the islet of Château d'If, in which the scene of part of Dumas' *Monte Cristo* is laid.

Marseilles possesses few remains of either the Greek or Roman periods of occupation and is poor in mediaeval buildings. The old cathedral of la Major (Sainte-Marie-Majeure), dating chiefly from the 12th century and built on the ruins of a temple of Diana, is in bad preservation. The chapel of St. Lazare (late 15th century) in the left aisle is early Renaissance. Beside this church and alongside the Joliette basin is the modern church begun in 1852, which has taken the place of the old Cathedral. It is a Byzantine basilica, in the form of a Latin cross, 460 ft. long built in green Florentine stone blended with white stone from the neighbourhood of Arles. The four towers which surmount it are roofed with cupolas. Near the cathedral stands the bishop's palace, and the Place de la Major. The celebrated Notre-Dame de la Garde, the steeple of which is surmounted by a gilded statue of the Virgin, 30 ft. in height, rises 150 ft. above the summit of the hill on which it stands. The present chapel is modern and occupies the site of one built in 1214.

On the south side of the old harbour near the Fort St. Nicolas stands the church of St. Victor, built in the 13th century and once attached to an abbey founded early in the 4th century. With its lofty crenellated walls and square towers built of large blocks of uncemented stone, it resembles a fortress. St. Victor is built above crypts dating mainly from the 11th century but also embodying architecture of the Carolingian period and of the early centuries of the Christian era. Tradition relates that St. Lazarus inhabited the catacombs under St. Victor; and the black image of the Virgin, still preserved there, is popularly attributed to St. Luke. The spire, which is the only relic of the ancient church of Accoules, marks the centre of Old Marseilles. Notre-Dame du Mont Carmel, also in the old town, occupies the place of what was the citadel of the Massaliots when they were besieged by Julius Caesar.

Of the civil buildings of the city, the prefecture, one of the finest in France, the Palais de Justice, and the Exchange, all date from the latter half of the 19th century. The Exchange, built at the expense of the Chamber of Commerce, includes the spacious hall of that institution with its mural paintings and gilding. The *hôtel-de-ville* (17th century) stands on the northern quay of the old harbour. The Palais Longchamp (1862–1870) is a museum and art gallery. The museum of antiquities, established in the Château Borély (1766–1778) includes a Phoenician collection (containing the remains that support the hypothesis of the Phoenician origin of Marseilles). The city also has a colonial museum and a laboratory of marine zoology. The triumphal arch of Aix, originally dedicated to the victors of the Trocadéro, was in 1830 appropriated to the conquests of the empire.

The *canal de Marseille,* constructed from 1837 to 1848, which has metamorphosed the town and its arid surroundings by bringing to them the waters of the Durance, leaves the river opposite Pertuis. It has a length of 97 miles (including its four main branches) of which 13 are underground, and irrigates some 7,500 acres. After crossing the valley of the Arc, between Aix and Rognac, by the magnificent aqueduct of Roquefavour, it purifies its waters, charged with ooze, in the basins of Réaltort. It draws about 2,200 gallons of water per second from the Durance, supplies 2,450 horse-power to works in the vicinity of Marseilles, and ensures a good water-supply and efficient sanitation to the city.

Marseilles is the headquarters of the XV Army Corps and the seat of a bishop and a prefect. It has tribunals of first instance and of commerce, a chamber of commerce, and a board of trade arbitration. The educational institutions include a faculty of science, a school of medicine and pharmacy, and a faculty (*faculté libre*) of law, these three forming part of the university of Aix-Marseilles and a school of navigation.

Trade and Industry.—Marseilles is the western emporium for the Levant trade and the French gate of the Far East. It suffers, however, from the competition of Genoa, which is linked with the Rhine basin by the Simplon and St. Gotthard railway routes, and from lack of communication with the inland waterways of France. In Jan. 1902 the chamber of deputies voted £3,656,000 for the construction of a canal from Marseilles to the Rhone at Arles. This scheme was designed to overcome the difficulties of egress from the Rhone and to make the city the natural outlet of the rich Rhone basin. Much of the activity of the port is due to the demand for raw material created by the industries of Marseilles itself.

The imports include wines, spirits, coal, tallow, copper, iron machinery, metals, cattle, sheep, copra, grain, cotton oil, palm oil, petroleum, oil seeds and nuts, coffee, cotton, hides, rice, maize and sugar. The exports include wines, spirits, liqueurs, tiles, bricks, metals, hides, ochre, oil cakes, soap, refined sugar, olive oil, dried vegetables, and glycerine.

The port is the centre for numerous lines of steamers which ply to the eastern Mediterranean, the east coast of Africa, Australia, India, Indo-China, Algeria, Tunis, Malta, Morocco, Antilles, as well as Great Britain and the French ports on the western coast. In addition many important foreign lines call at the port. Soap making was introduced in antiquity from Savona and Genoa and utilizes the products of the oil distilleries and of the chemical works, the latter being also an important adjunct to the manufacture of candles. A large quantity of iron, copper and other ores is smelted in the blast furnaces of Saint Louis and other foundries, and the Mediterranean Engineering Company and other companies have workshops for the construction or repair of marine steam engines, etc.

There are also important oil factories, flour mills, refineries, glassworks, tile works and tobacco factories, as well as the manufacturing of semolina, casks and rope, tanning, distilling, brewing, and State match factories.

Before World War I housing conditions were very bad, and manufacturers in consequence found it difficult to procure labour. During the war there was an influx of workers, and there was considerable industrial development, especially in the provision of foodstuffs and in metal manufacture.

MARSH, ADAM (Adam de Marisco) (d. *c.* 1258), English Franciscan, scholar and theologian, was born about 1200 in the diocese of Bath, and educated at Oxford under Grosseteste. Before 1226 Adam received the benefice of Wearmouth from his uncle, Richard Marsh, bishop of Durham; but between that year and 1230 he entered the Franciscan order. About 1238 he became the lecturer of the Franciscan house at Oxford. Roger Bacon, his pupil, speaks highly of his attainments in theology and mathematics. Consulted as a friend by Grosseteste, as a spiritual director by Simon de Montfort, the countess of Leicester and the queen, as an expert lawyer and theologian by the primate, Boniface of Savoy, he did much to guide the policy both of the opposition and of the court party in all matters affecting the interests of the Church. He shrank from office, and never became provincial minister of the English Franciscans, though constantly charged with responsible commissions. Henry III and Archbishop Boniface unsuccessfully endeavoured to secure for him the see of Ely in 1256.

In 1257 Adam's health was failing, and he appears to have died in the following year. He sympathized with Montfort as with a friend of the Church and an unjustly treated man; but on the eve of the baronial revolution he was on friendly terms with the king. He rebuked both parties in the state for their shortcomings, but he did not break with either.

See his correspondence, with J. S. Brewer's introduction, in *Monumenta franciscana,* vol. i. (Rolls ser., 1858); the biographical notice in A. G. Little's *Grey Friars in Oxford* (Oxford, 1892), where all the references are collected. On Marsh's relations with Grosseteste, see *Roberti Grosseteste epistolae,* ed. H. R. Luard (Rolls ed., 1861), and F. S. Stevenson, *Robert Grosseteste* (London, 1809). (H. W. C. D.)

MARSH, GEORGE PERKINS (1801–1882), American diplomatist and philologist, was born at Woodstock, Vt., on March 15, 1801. He graduated at Dartmouth college in 1820, was admitted to the bar in 1825, and practised law at Burlington, Vt., devoting himself also to philological studies. From 1843 to 1849 he was a Whig representative in Congress. In 1849 he was made United States minister resident in Turkey, returning to Vermont in 1854. In 1861 he became the first United States minister to the kingdom of Italy, and died in that office at Vallombrosa on July 23, 1882. Marsh was an able linguist, a scholar of great breadth, and a remarkable philologist for his day. His chief published works are: *A Compendious Grammar of the Old Northern or Icelandic Language* (1838); *The Camel, his Organization, Habits, and Uses, with Reference to his Introduction into the United States* (1856); *Lectures on the English Language* (1860); *The Origin and History of the English Language* (1862; revised ed., 1885); *Man and Nature* (1864); *The Earth as Modified by Human Action* (1874, 1885); and *Mediaeval and Modern Saints and Miracles* (1876).

See Mrs. C. Marsh's *Life and Letters of George Perkins Marsh* (1888).

MARSH, OTHNIEL CHARLES (1831–1899), American palaeontologist, was born in Lockport, N.Y., on Oct. 29, 1831. He graduated at Yale college in 1860, and studied geology and mineralogy in the Sheffield scientific school, New Haven, and afterwards palaeontology and anatomy in Berlin, Heidelberg and Breslau. Returning to America in 1866 he was appointed professor of vertebrate palaeontology at Yale college, and there began the researches of the fossil vertebrata of the western States, whereby he established his reputation. He was aided by a private fortune from his uncle, George Peabody, whom he induced to establish the Peabody Museum of Natural History (especially devoted to zoology, geology and mineralogy) in the college. In May, 1871, he discovered the first pterodactyl remains found in America, and in subsequent years he brought to light from Wyoming and other regions many new genera and families, and some entirely new orders of extinct vertebrata, which he described in monographs or periodical articles. These included remains of the Cretaceous toothed birds *Hesperornis* and *Ichthyornis*, the Cretaceous flying-reptiles (*Pteranodon*), the swimming reptiles or Mosasauria, and the Cretaceous and Jurassic land reptiles (*Dinosauria*) among which were the *Brontosaurus* and *Atlantosaurus*. The remarkable mammals which he termed Brontotheria (now grouped as Titanotheriidae), and the huge Dinocerata, one being the *Uintatherium*, were also brought to light by him. Among his later discoveries were remains of early ancestors of horses in America. He repeatedly organized and often accompanied scientific exploring expeditions in the Rocky mountains, and their results tended in an important degree to support the doctrine of evolution. He published many papers on these, and found time—besides that necessarily given to the accumulation and care of the most extensive collection of fossils in the world—to write *Odontornithes: A Monograph on the Extinct Toothed Birds of North America* (1880); *Dinocerata: A Monograph on an Extinct Order of Gigantic Mammals* (1884); and *The Dinosaurs of North America* (1896). His work is full of accurately recorded facts of permanent value. He was long in charge of the division of vertebrate palaeontology in the United States Geological Survey. He died in New Haven on March 18, 1899.

See obituary by Henry Woodward (with portrait) in *Geol. Mag.* (1899), p. 237; and Charles E. Beecher, "Memoir of Othniel Charles Marsh," *Bull. Geol. Soc. of Amer.*, vol. xi., pp. 531–537 (1900).

MARSH, an area of low-lying watery land. The significance of a marsh area lies in the peculiar chemical and physical results which accompany it, and in its ecological relations. Chemically it is productive of those transitory gases which arise from decomposing vegetation and also of hydrated iron oxide, which floats as an iridescent scum at the edge of rusty, marshy pools. This, sinking into the soil, forms a powerful cement to many sandstones, binding them into a hard local mass, while the surrounding sandstones remain loose and friable. Later, the former marsh area becomes the hard cap of a hill while the surrounding sandstones are more rapidly eroded. (*See* MESA.) Salt marshes characterise many low-lying sea-coasts and inland drainage areas.

MARSHAL, a title given in various countries to certain military and civil officers, usually of high rank. The origin and development of the meaning of the designation is closely analogous with that of constable (*q.v.*). Just as the title of constable is traceable to the style and functions of the Byzantine count of the stable, so that of marshal was evolved from the title of the *marescalci*, or masters of the horse, of the early Frankish kings. In this original sense the word survived down to the close of the Holy Roman empire in the titular office of *Erz-Marschalk* (arch-marshal), borne by the electors of Saxony. Elsewhere the meaning of office and title was modified. The importance of cavalry in mediaeval warfare led to the marshalship being associated with military command; this again led to the duty of keeping order in court and camp, of deciding questions of chivalry, and to the assumption of judicial and executive functions. The marshal, as a military leader, was originally a subordinate officer, the chief command under the king being held by the constable; but in the 12th century, though still nominally second to the constable, the marshal has come to the forefront as commander of the royal forces and a great officer of State. In England after the Conquest the marshalship was hereditary in the family which derived its surname from the office, and the hereditary title of earl-marshal originated in the marriage of William Marshal with the heiress of the earldom of Pembroke (*see* EARL MARSHAL). Similarly, in Scotland, the office of marischal (from the French *maréchal*), probably introduced under David I., became in the 14th century hereditary in the house of Keith. In 1485 the Scottish marischal became an earl under the designation of earl-marischal, the dignity coming to an end by the attainder of George, 10th earl-marischal, in 1716. In France, on the other hand, though under Philip Augustus the marshal of France (*marescalcus Franciae*) appears as commander-in-chief of the forces, care was taken not to allow the office to become descendible; under Francis I. the number of marshals of France was raised to two, under Henry III. to four, and under Louis XIV. to 20. Revived by Napoleon, the title fell into abeyance with the downfall of the Second empire.

In England the use of the word marshal in the sense of commander of an army appears very early; so Matthew Paris records that in 1214 King John constituted William, earl of Salisbury, *marescalcus* of his forces. The modern military title of field marshal, imported from Germany by King George II. in 1736, is derived from the high dignity of the *marescalcus* in a roundabout way. The *marescalcus campi*, or *maréchal des champs*, was originally one of a number of officials to whom the name, with certain of the functions, of the marshal was given. The marshal, being responsible for order in court and camp, had to employ subordinates, who developed into officials often but nominally dependent upon him. On military expeditions it was usual for two such marshals to precede the army, select the site of the camp and assign to the lords and knights their places in it. In time of peace they preceded the king on a journey and arranged for his lodging and maintenance. In France *maréchal des logis* is the title of superior non-commissioned officers in the cavalry.

Similarly at the king's court the *marescalcus aulae* or *intrinsecus* was responsible for order, the admission or exclusion of those seeking access, ceremonial arrangements, etc. Such "marshals" were maintained, not only by the king, but by great lords and ecclesiastics. The more dignified of their functions, together with the title, survive in the various German courts, where the court marshal (*Hofmarschall*) is equivalent to the English lord chamberlain. Just as the *marescalcus intrinsecus* acted as the vicar of the marshal for duties "within" the court, so the *marescalcus forinsecus* was deputed to perform those acts of serjeanty due from the marshal to the Crown "without." Similarly there appears in the statute 5 Edw. III. cap. 8, a *marescalcus banci regii*, or marshal of the king's bench, who presided over the Marshalsea court, and was responsible for the safe custody of prisoners bestowed in the Marshalsea prison. The office of marshal of the queen's bench survived till 1849 (*see* LORD STEWARD; and MARSHALSEA). The official known as a judge's marshal, whose office is of considerable antiquity, and whose duties consisted of making abstracts of indictments and pleadings for the use of the judge, still survives, but no longer exercises the above functions. He accompanies a judge of assize on circuit and is appointed by him at the beginning of each circuit. His travelling and other expenses are paid by the judge, and he receives an allowance of two guineas a day, which is paid through the Treasury. He introduces the high sheriff of the county to the judge of assize on his arrival, and swears in the grand jury. For the French *maréchaussée see* FRENCH LAW AND INSTITUTIONS.

In the sense of executive legal officer the title marshal survives in the United States of America in two senses. The United States marshal is the executive officer of the Federal courts, one being appointed for each district, or exceptionally, one for two districts. His duties are to open and close the sessions of the district and circuit courts, serve warrants, and execute throughout the district the orders of the court. There are United States marshals also in Alaska, Hawaii, Porto Rico and the Philippines. They are appointed by the president, with the advice and consent of the Senate, for a term of four years, and, besides their duties in connection with the courts, are employed in the service of the internal revenue, public lands, post office, etc. The temporary police sworn in to maintain order in times of disturbance, known in England as special constables, are also termed marshals in the United States. In some of the southern and western States of the Union the title marshal has sunk to that of the village policeman, as distinct from the county officers known as sheriffs and those of the justices' courts called constables.

In England the title of marshal, as applied to an executive officer, survives only in the army, where the provost marshal is chief of the military police in large garrisons and in field forces. Office and title were borrowed from the French *prévôt des maréchaux*, the modern equivalent of the mediaeval *praepositus marescalcorum* or *guerrarum.*

MARSHALL, ALFRED (1842–1924), British economist, was educated at Merchant Taylors' school and at St. John's college, Cambridge, where he read mathematics, being second wrangler in 1865, and elected to a fellowship in the same year. From mathematics he turned to the study of metaphysics, from that to ethics and finally to political economy, to which he himself was later to give the name economics. Having married in 1871, he had to vacate his fellowship, and he accepted the post of first principal of University college, Bristol, where he did a great deal of valuable administrative work, but had to resign in 1881 owing to ill-health. From 1883–85 he was a fellow and lecturer in political economy at Balliol college, Oxford; in the latter year he returned to Cambridge as professor of political economy in succession to Henry Fawcett. He was a member of the royal commission on labour from 1891–94 and subsequently rendered important services to a number of Government enquiries. In 1903, after years of struggle, he succeeded in calling into being an economics tripos at Cambridge, separate and distinct from the moral sciences tripos. He retired from the chair of political economy in 1908 and thenceforward gave himself up entirely to his writings until his death in 1924.

Marshall published the *Principles of Economics* in 1890, his first big work, and in many ways his most important contribution to economic literature. His next volume *Industry and Trade,* a realistic study of industrial organization, did not appear until 1918, but in the meanwhile he had devoted much time and energy to bringing out successive editions of his *Principles.* In 1923 he published his last volume, *Money, Credit and Commerce.* Marshall may be said to have been in the lineal descent of the great English economists—Adam Smith, Ricardo and J. S. Mill. Like their chief works, his *Principles of Economics* has become a classic. It was distinguished by its profound and systematic methods of analysis, and by the introduction of a number of new concepts, such as elasticity of demand, consumer's surplus, quasi-rent, the representative firm, etc., which have played a great rôle in the subsequent development of economics. Writing at a time when the economic world was hopelessly divided on the theory of value, he succeeded, largely by introducing the element of time as a factor in analysis, in reconciling the classical cost of production principle with the marginal utility principle formulated by Jevons (*q.v.*) and the Austrian school. He did much to rescue economics from the rigid dogmatism, which had alienated so many of the best minds of the 19th century, by insisting that economic reasoning and laws were not themselves a body of concrete truth, but an engine for the discovery of concrete truth.

Although so many years elapsed between the publication of the *Principles of Economics* and that of his next two works, much that was most important in them, especially in regard to the theory of money, had been transmitted orally in his lectures at Cambridge, and had appeared in the evidence which he gave before the gold and silver commission in 1887 and the Indian currency commission in 1899. In this way he had influenced thought far outside the confines of Cambridge, not only in England but also in foreign countries.

While Marshall never set himself to found a school of economic doctrine, his genius for stimulating the minds of a long succession of pupils, and the example of his methods of reasoning, had a profound effect upon the development of economics in England, the United States, and many European countries.

(C. W. G.)

MARSHALL, JOHN (1755–1835), American jurist, chief-justice of the U.S. Supreme Court, was born on Sept. 24, 1755, at Germantown (now Midland), in what four years later became Fauquier county, Va. He was of English descent, the son of Thomas Marshall (1732–1806) and his wife, Mary Isham Keith. Marshall served first as lieutenant and, after July 1778, as captain in the Continental army during the Revolutionary War. He resigned his commission early in 1781; was admitted to the bar after a brief course of study, first practised in Fauquier county, and after two years began to practise in Richmond. In 1786 we find him counsel in a case of great importance, *Hite* v. *Fairfax,* involving the original title of Lord Fairfax to that large tract of country between the headwaters of the Potomac and Rappahannock, known as the northern neck of Virginia. Marshall represented tenants of Lord Fairfax and won his case. From this time, as is shown by an examination of Call's *Virginia Reports* which cover the period, he maintained the leadership of the bar of Virginia. He was a member of the Virginia assembly in 1782–91 and again in 1795–97; and in 1788, he took a leading part in the Virginia convention called to act on the proposed Constitution for the United States, with Madison ably urging the ratification of that instrument. In 1795 Washington offered him the attorney-generalship, and in 1796, after the retirement of James Monroe, the position of minister to France. Marshall declined both offers because his situation at the bar appeared to him "to be more independent and not less honourable than any other," and his "preference for it was decided." He spent the autumn and winter of 1797–98 in France as one of the three commissioners appointed by President John Adams to adjust the differences between the young republic and the directory. The commission failed, but the course pursued by Marshall was approved in America, and with the resentment felt because of the way in which the commission had been treated in France, made him, on his return, exceedingly popular. To this popularity, as well as to the earnest advocacy of Patrick Henry, he owed his election as a Federalist to the House of Representatives in the spring of 1799, though the feeling in Richmond was overwhelmingly in favour of the opposition or Republican Party. His most notable service in Congress was his speech on the case of Thomas Nash, alias Jonathan Robbins, in which he showed that there is nothing in the U.S. Constitution which prevents the Federal Government from carrying out an extradition treaty. He was secretary of State under President Adams from June 6, 1800, to March 4, 1801. In the meantime he had been appointed chief-justice of the Supreme Court, his commission bearing date Jan. 31. Thus while still secretary he presided as chief-justice.

At the time of Marshall's appointment it was generally considered that the Supreme Court was the one department of the new Government which had failed in its purpose. John Jay, the first chief-justice, who had resigned in 1795, had just declined a reappointment to the chief-justiceship on the ground that he had left the bench perfectly convinced that the court would never acquire proper weight and dignity, its organization being fatally defective. The advent of the new chief-justice was marked by a change in the conduct of business in the court. Since its organization, following the prevailing English custom, the judges had pronounced their opinions seriatim. But beginning with the

December term 1801, the chief-justice became practically the sole mouthpiece of the court. For 11 years the opinions are almost exclusively his, and there are few recorded dissents. The change was admirably adapted to strengthen the power and dignity of the court. The chief-justice embodied the majesty of the judicial department of the Government almost as fully as the president stood for the power of the executive. That this change was acquiesced in by his associates without diminishing their good will towards their new chief is testimony to the persuasive force of Marshall's personality; for his associates were not men of mediocre ability. After the advent of Mr. Justice Joseph Story the practice was abandoned. Marshall, however, still delivered the opinion in the great majority of cases, and in practically all cases of any importance involving the interpretation of the Constitution. During the course of his judicial life his associates were as a rule men of learning and ability. During most of the time the majority were the appointees of Democratic presidents, and before their elevation to the bench supposed to be out of sympathy with the federalistic ideas of the chief-justice. Yet in matters pertaining to constitutional construction, they seem to have had hardly any other function than to add the weight of their silent concurrence to the decision of their great chief. Thus the task of expounding the Constitution during the most critical period of its history was his, and it was given to him to preside over the Supreme Court when it was called upon to decide four cases of vital importance: *Marbury* v. *Madison, M'Culloch* v. *Maryland, Cohens* v. *Virginia* and *Gibbons* v. *Ogden.* In each of these cases it is Marshall who writes the opinion of the court; in each the continued existence of the peculiar Federal system established by the Constitution depended on the action of the court, and in each the court adopted a principle which is now generally perceived to be essential to the preservation of the United States as a Federal State.

In *Marbury* v. *Madison,* which was decided two years after his elevation to the bench, he decided that it was the duty of the court to disregard any act of Congress, and, therefore, *a fortiori* any act of a legislature of one of the States, which the court thought contrary to the Federal Constitution.

In *Cohens* v. *Virginia,* in spite of the contention of Jefferson and the then prevalent school of political thought that it was contrary to the Constitution for a person to bring one of the States of the United States, though only as an appellee, into a court of justice, he held that Congress could lawfully pass an act which permitted a person who was convicted in a State court, to appeal to the U.S. Supreme Court, if he alleged that the State act under which he was convicted conflicted with the Federal Constitution or with an act of Congress.

In *M'Culloch* v. *Maryland,* though admitting that the Federal Government is one of delegated powers and cannot exercise any power not expressly given in the Constitution, he laid down the rule that Congress in the exercise of a delegated power has a wide latitude in the choice of means, not being confined in its choice of means to those which must be used if the power is to be exercised at all.

Lastly, in *Gibbons* v. *Ogden,* he held that when the power to regulate interstate and foreign commerce was conferred by the Constitution on the Federal Government, the word "commerce" included not only the exchange of commodities, but the means by which interstate and foreign intercourse was carried on, and therefore, that Congress had the power to license vessels to carry goods and passengers between the States, and an act of one of the States making a regulation which interfered with such regulation of Congress was, *pro tanto,* of no effect.

It will be seen that in the first two cases he established the Supreme Court as the final interpreter of the Constitution.

The decision in *M'Culloch* v. *Maryland,* by leaving Congress unhampered in the choice of means to execute its delegated powers, made it possible for the Federal Government to accomplish the ends of its existence. "Let the end be legitimate," said Marshall in the course of its opinion, "let it be within the scope of the Constitution, and all means which are appropriate, which are plainly adapted to that end, which are not prohibited, but consist with the letter and spirit of the Constitution, are constitutional."

If the decision in *M'Culloch* v. *Maryland* gave vigour to all Federal power, the decision in *Gibbons* v. *Ogden,* by giving the Federal Government control over the means by which interstate and foreign commerce is carried on, preserved the material prosperity of the country. The decision recognizes what the framers of the Constitution recognized, namely that the United States is an economic unit, and that business which is national should be under national, not State, control.

Though for the reasons stated, the four cases mentioned are the most important of his decisions, the value of his work as an expounder of the U.S. Constitution is not to be measured by these cases alone. In all he decided 44 cases involving constitutional questions. Nearly every important part of the U.S. Constitution as it existed before the amendments which were adopted after the Civil War, is treated in one or more of them. The Constitution in its most important aspects is the Constitution as he interpreted it. He did not work out completely the position of the States in the Federal system, but he did grasp and establish the position of the Federal legislature and the Federal judiciary. To appreciate his work, however, it is necessary to see that it was the work not of a statesman but of a judge. Had Marshall been merely a far-seeing statesman, while most of his important cases would have been decided as he decided them, his life-work would have been a failure. It was not only necessary that he should decide great constitutional questions properly, but also that the people of the United States should be convinced of the correctness of his interpretation of the Constitution. His opinions, therefore, had to carry to those who studied them a conviction that the constitution as written had been interpreted according to its evident meaning. They fulfilled this prime requisite. Their chief characteristic is the cumulative force of the argument. The ground for the premise is carefully prepared, the premise itself is clearly stated; nearly every possible objection is examined and answered; and then comes the conclusion. There is little or no repetition, but there is a wealth of illustration, a completeness of analysis, that convinces the reader, not only that the subject has been adequately treated, but that it has been exhausted. His style, reflecting his character, suits perfectly the subject matter. Simple in the best sense of the word, his intellectual processes were so clear that he never doubted the correctness of the conclusion to which they led him. Apparently from his own point of view, he merely indicated the question at issue, and the inexorable rules of logic did the rest. Thus his opinions are simple, clear, dignified. Intensely interesting, the interest is in the argument, not in its expression. He had, in a wonderful degree, the power of phrase. He expressed important principles of law in language which tersely yet clearly conveyed his exact meaning. Not only is the Constitution interpreted largely as he taught the people of the United States to interpret it, but when they wish to express important constitutional principles which he enunciated they use his exact words. Again, his opinions show that he adhered closely to the words of the Constitution; indeed no one who has attempted to expound that instrument has confined himself more strictly to an examination of the text. In the proper, though not in the historical, sense he was the strictest of strict constructionists, and as a result his opinions are practically devoid of theories of government, sovereignty and the rights of man.

A single illustration of his avoidance of all theory and his adherence to the words of the Constitution will suffice. In the case of the *United States* v. *Fisher* the constitutional question involved was the power of Congress to give to the United States a preference over all other creditors in the distribution of the assets of a bankrupt. Such an act can be upheld on the ground that all governments have necessarily the right to give themselves priority. Not so Marshall. To him the act must be supported, if supported at all, not on any theory of the innate nature of the government, national or otherwise, but as a reasonable means of carrying out one of the express powers conferred by the Constitution on the Federal Government. Thus, he upholds the act in question because of the power expressly conferred on the Federal Government to pay the debts of the Union, and, as a necessary consequence of this power the right to make remittances by bills or otherwise and to take precautions which will render the transactions safe.

It is important to emphasize the fact that Marshall adhered in his opinions to the Constitution as written, not only because it is a fact which must be recognized if we are to understand the correct value of his work in the field of constitutional law, but also because there exists to-day a popular impression that by implication he stretched to the utmost the powers of the Federal Government. This impression is due primarily to the ignorance of many of those who have undertaken to praise him. During his life he was charged by followers of the State's rights school of political thought with upholding Federal power in cases not warranted by the Constitution. Later, however, those who admired a strong national Government, without taking the trouble to ascertain whether the old criticism by members of the State's rights party was just, regarded the assumption on which it was founded as Marshall's best claim to his country's gratitude.

As a constitutional lawyer, Marshall stands without a rival. His work on international law and admiralty is of first rank. But though a good, he was not a great, common law or equity lawyer. In these fields he did not make new law nor clarify what was obscure, and his constitutional opinions which to-day are found least satisfactory are those in which the question to be solved necessarily involves the discussion of some common-law concept, especially those cases in which he was required to construe the restriction imposed by the Constitution on any State impairing the obligation of contracts. His decision in the celebrated case of *Dartmouth College* v. *Woodward,* in which he held that a State could not repeal a charter of a private corporation, because a charter is a contract which a subsequent act of the State repealing the charter impairs, though of great economic importance, does not touch any fundamental question of constitutional law. The argument which he advances lacks the clearness and finality for which most of his opinions are celebrated. It is not certain with whom he thought the contract was made: with the corporation created by the charter, with the trustees of the corporation, or with those who had contributed money to its objects.

Of the wonderful persuasive force of Marshall's personality there is abundant evidence. His influence over his associates, already referred to, is but one example though a most impressive one. From the moment he delivered the opinion in *Marbury* v. *Madison* the legal profession knew that he was a great judge. Each year added to his reputation and made for a better appreciation of his intellectual and moral qualities. The bar of the Supreme Court during his chief-justiceship was the most brilliant which the United States has ever known. Leaders, not only of legal, but political thought were among its members; one, Webster, was a man of genius and commanding position. To a very great degree Marshall impressed on the members of this bar and on the profession generally his own ideas of the correct interpretation of the Constitution and his own love for the Union. He did this, not merely by his arguments but by the influence which was his by right of his strong, sweet nature. Statesmen and politicians, great and small, were at this time, almost without exception, members of the bar. To influence the political thought of the bar was to a great extent to influence the political thought of the people.

Though the direct influence of Marshall's constitutional arguments was largely confined to the members of the bar, the influence of his personality was felt by practically all classes of people. When he was appointed he was perhaps the most popular Federalist in the country. His supreme fitness for the judicial office was, however, probably not generally recognized until after the trial of Aaron Burr. Over this trial, the most dramatic in American history, he presided with a dignity, impartiality and ability never surpassed. Burr, himself brilliant, erratic, casts a certain fascination over each succeeding generation of historical students. In his character there is something alluring. Its dominant note is mystery. He was, next to Thomas Jefferson and perhaps James Madison, the leading Democrat of his day. When Jefferson became president he was elected vice-president, holding that office from 1801 to 1805. In 1804 he killed Alexander Hamilton, his great political antagonist, in a duel. Burr was the challenging party. His enemy's death ended his own political career in the United States. His restless energy and great ambition led him to organize an armed expedition which assembled on the Ohio in 1806 on Blennerhasset's island. Though Burr lived many years after the trial, and though everything in connection with his ill-starred expedition has been subjected to the most painstaking investigation, the real nature of his aims, whether to attack Mexico, or detach from the Union the portion of the United States west of the Alleghenies, or both, remains uncertain. To dream of conquest or of the dismemberment of the country is not treason. The Constitution provides that: "Treason against the United States shall consist only in levying war against them, or in adhering to their enemies, giving them aid and comfort." And it is also provided that: "No person shall be convicted of treason unless on the testimony of two witnesses to the same overt act, or on confession in open court." The trial took place in the Federal circuit court for the district of Virginia; the island, though in the Ohio river, being at that time, in the State of Virginia. It began on Aug. 10, 1807. Though Burr was indicted for treason on Blennerhasset's island, it was known to everyone that, at the time the alleged acts of levying war had been committed, Burr was not only not on the island, but hundreds of miles away in another State. The Government had evidence of a conspiracy to raise an armed force, perhaps to attack New Orleans, in which conspiracy Burr was the prime mover. It probably had evidence that, subsequent to the meeting on Blennerhasset's island, a small force under Burr had joined the small force which had previously assembled on the island, making in all about 100 men, and proceeded down the Ohio and Mississippi rivers to a few miles above Natchez, where Burr had voluntarily surrendered himself to George Mead, the acting governor of Mississippi, who, on the alarm created by the denunciation of Burr's plans, had assembled a small force of militia to oppose him. But the Government could not even prove that Burr had caused the force mentioned in the indictment to assemble on the island.

Looking back to-day, we see a succession of errors on the part of Jefferson that might have resulted in a drama ending in a tragedy—the execution of Burr as a result of a conviction for treason, which would probably have been improper in any event, certainly improper in view of the law, the wording of the indictment, and the character of the acts which the United States alleged it stood ready to prove. Jefferson had blundered in not arresting Burr and stopping his preparations when he first had evidence of the nature of his plans. His negligence had permitted those plans to go far towards maturity when he received a letter from Gen. Wilkinson, the commander at New Orleans, denouncing Burr as contemplating the detachment of the Western country from the Union. Instead of merely publishing the information and ordering Burr's arrest, Jefferson inflamed the popular mind by denouncing Burr as a traitor. From the moment this proclamation was issued, the president, instead of standing for the calm and efficient execution of the law, used his immense popularity in the country to excite the popular mind. By the time the prisoner was brought to trial, though he had become a hero to the few, the many had already made up their minds that only by legal chicanery could he escape the gallows. With one voice they clamoured for conviction. In Richmond, the local prejudice was so strong that it was impossible to secure an unprejudiced jury. Fortunate was it for Burr, but still more fortunate for the United States, that the trial was presided over by a man who combined as did Marshall, ability, courage and absolute control of nerves and temper.

More than one hundred years have elapsed since the curtain descended on the last scene of the trial. When we recall the trial, though we see Wirt, the able and eloquent attorney for the prosecution, and Luther Martin, the leader of Burr's forensic forces, drunken, rollicking, devoid of good taste, but as a lawyer unsurpassed; though the mind calls up before it the dignified figure of Aaron Burr, and fills in the background of the court-room with portraits more or less distinct of the other actors in those memorable scenes, the form which stands out as the central figure is that of the chief-justice, the one really great man in that brilliant throng. We feel the power of expression in his wonderful eyes and the calm dignity which emanated from his personality. As we read the following passage which practically closes his principal opinion, the opinion which, excluding all remaining testimony which the Government had to offer, necessarily brought the case to an end favourable to the prisoner, we seem to hear the even tones of his voice; and, realizing the excitement in the country, and the strain of the days that preceded, there comes to us as there came to his audience, the thrill of confidence in the man and pride in the majesty of the law.

"Much has been said in the course of the argument on points on which the court feels no inclination to comment particularly; but which may, perhaps not improperly, receive some notice.

"That this court dares not usurp power is most true.

"That this court dares not shrink from its duty is not less true. No man is desirous of placing himself in a disagreeable situation. No man is desirous of becoming the peculiar subject of calumny. No man, might he let the bitter cup pass from him without self-reproach, would drain it to the bottom. But if he have no choice in the case, if there be no alternative presented to him but a dereliction of duty, or the opprobrium of those who are denominated the world, he merits the contempt as well as the indignation of his country who can hesitate which to embrace."

Jefferson might rage as he read the opinions of the court; the excited inhabitants of Baltimore on learning the result of the trial might burn the judge in effigy along with Burr and his leading counsel, thus giving the latter the opportunity to deliver to them an immortal piece of sarcasm. But the brilliant throng which had crowded the rooms from day to day, had seen the judge whose calmness was in strange contrast to their half expressed excitement; moved by the impelling force of his personality, they had realized that this man held the scales of justice with impartial balance; that his known dislike and distrust of the president who wanted the conviction did not affect his judgment, any more than the fact that the prisoner at the bar had slain in the course of a career full of little but harm, one of his dearest friends. Furthermore, they had listened to his analysis of the legal questions arising in the case and with few exceptions they knew the result was correct. Thus, as they went out from the court-room to all parts of the country they carried with them the impress of the personality of the great judge.

In 1782 Marshall married Mary Willis Ambler, the daughter of the then treasurer of Virginia. They had ten children, six of whom grew to full age. For the greater part of the 48 years of their married life Mrs. Marshall suffered intensely from a nervous affection. Her condition called out the love and sympathy of her husband's deep and affectionate nature. Judge Story tells us: "That which, in a just sense, was his highest glory, was the purity, affectionateness, liberality and devotedness of his domestic life." For the first 30 years of his chief-justiceship his life was a singularly happy one. He never had to remain in Washington for more than three months. During the rest of the year, with the exception of a visit to Raleigh, which his duties as circuit judge required him to make, and a visit to his old home in Fauquier county, he lived in Richmond. His house on Shockhoe Hill is still standing.

On Christmas Day, 1831, his wife died. He never was quite the same again. On returning from Washington in the spring of 1835 he suffered severe contusions, from an accident to the stage-coach in which he was riding. His health, which had not been good, now rapidly declined and in June he returned to Philadelphia for medical attendance. There he died on July 6. His body, which was taken to Richmond, lies in Shockhoe Hill cemetery under a plain marble slab, on which is a simple inscription written by himself. In addition to his decisions Marshall wrote a famous biography of George Washington (5 vol., 1804–07; 2nd ed., 2 vol., 1832), which, though prepared hastily, contains much material of value.

Bibliography.—The principal sources of information are: Albert J. Beveridge, *Life of John Marshall* (1919); an essay by James B. Thayer (1904); *Great American Lawyers* (Philadelphia, 1908), ii. 313–408, an essay by Wm. Draper Lewis; and Allan B. Magruder, *John Marshall* (Boston, 1885), in the "American Statesmen Series." The addresses delivered on Marshall Day, February 4, 1901, are collected by John F. Dillon (Chicago, 1903). In the "Appendix" to Dillon's collection will be found the "Discourse" by Joseph Story and the "Eulogy" by Horace Binney, both delivered soon after Marshall's death. For a study of Marshall's decisions, the *Constitutional Decisions of John Marshall*, edit. by Joseph P. Collon, Jr. (1905), is of value.

(W. D. L.)

MARSHALL, STEPHEN (*c.* 1594–1655), English Nonconformist divine, was born at Godmanchester in Huntingdonshire, and was educated at Emmanuel college, Cambridge (M.A. 1622, B.D. 1629). After holding the living of Wethersfield in Essex he became vicar of Finchingfield in the same county, and in 1636 was reported for "want of conformity." He was a preacher of great power, and influenced the elections for the Short parliament of 1640. Clarendon esteemed his influence on the parliamentary side greater than that of Laud on the royalist. In 1642 he was appointed lecturer at St. Margaret's, Westminster, and delivered a series of addresses to the Commons in which he advocated episcopal and liturgical reform. He had a share in writing *Smectymnuus,* was appointed chaplain to the earl of Essex's regiment in 1642, and a member of the Westminster Assembly in 1643. He represented the English parliament in Scotland in 1643, and attended the parliamentary commissions at the Uxbridge Conference in 1645. He waited on Archbishop Laud before his execution, and was chaplain to Charles I. at Holmby House and at Carisbrooke. A moderate and judicious presbyterian, he prepared with others the "Shorter Catechism" in 1647, and was one of the "Triers" 1654. He died in November 1655 and was buried in Westminster abbey, but his body was exhumed at the Restoration.

MARSHALL, THOMAS RILEY (1854–1925), American politician, born at North Manchester, Ind., on March 14, 1854. He was educated at Wabash college (A.B. 1873; A.M. 1876), and was admitted to the bar in 1875. From 1876 to 1909 he practised law in Columbia City, Ind., and from 1909 to 1913 was governor of Indiana. He was nominated for vice-president on the ticket with Woodrow Wilson at the Democratic national convention in 1912 and was elected. He was again nominated with President Wilson in 1916 and elected for the term 1917–21. For almost two years after the outbreak of the World War he urged strict neutrality, but in 1918 publicly expressed regret for this attitude. In 1919 he welcomed the king and queen of Belgium on their visit to Washington during the illness of President Wilson. He was a strong advocate of the League of Nations, but did not favour woman suffrage. He served on the U.S. coal commission in 1922. He died in Washington, D.C., on June 1, 1925. His memoirs, *Recollections of Thomas R. Marshall,* were published posthumously in 1925.

MARSHALL, a city of southern Michigan, U.S.A., on the Kalamazoo river, federal highways 12 and 27 and the Michigan Central railroad; the county seat of Calhoun county. It has a municipal airport. The population was 5,019 in 1930 and 5,253 in 1940 by federal census. Its industries include a large automobile tappet factory, furnace factory and state highway garage plant.

The Michigan school system was founded there. The city was founded in 1831 and incorporated in 1837.

MARSHALL, a city of Missouri, U.S.A., 85 mi. E. of Kansas City, on the Salt Fork of La Mine river; the county seat of Saline county. It is on federal highway 65, and is served by the Alton and the Missouri Pacific railways. Pop. (1920) 5,200 (12% Negroes); 1930, 8,103; 1940, 8,533, federal census. There are salt springs, coal mines and stone quarries in the vicinity. The city has an aeroplane factory, flying school, shoe factory, milk condensing works and other industries. It is the seat of the Missouri Valley college (Presbyterian; 1888) and of the state colony for the feeble-minded and epileptic (1899). Marshall was founded and made the county seat in 1839, was incorporated as a town in 1866 and as a city in 1878.

MARSHALL, a city of eastern Texas, U.S.A., 38 mi. W. of Shreveport, on federal highways 59 and 80; the county seat of Harrison county. It is served by the Texas and Pacific railway.

Population (41% Negroes) in 1940, 18,410, by the federal census. It is the trade centre for agricultural products, including an annual cotton crop for the county of about 40,000 bales; and has railway shops employing 2,000 men and other important manufacturing industries, with an output in 1940 valued at approximately $6,000,000. The city's products include 50,000 car wheels, 30,000,000 brick, 3,000,000 baskets, 15,000 tons of cotton-seed and 6,000 tons of fertilizer annually; 70 different articles of stoneware; chairs and crates, powdered milk, butter, and deodorizing and decolorizing carbon made from lignite. There are three gas fields within 40 mi. of the city. Marshall is the home of the Central East Texas fair, and the seat of Bishop college (founded 1881) and Wiley college for Negroes, and the College of Marshall (1914), a junior Baptist college. Rosborough Springs (9 mi. S.) and Caddo lake (16 mi. N.E.) are popular resorts. Marshall was settled in 1842, incorporated in 1843, and chartered as a city in 1848. Since 1909 it has had a commission-manager form of government.

MARSHALL ISLANDS: *see* PACIFIC ISLANDS.

MARSHALLTOWN, a city of central Iowa, U.S.A., on the Iowa river and the Lincoln highway, at an altitude of 890 ft.; the county seat of Marshall county. It is served by the Chicago and North Western, the Chicago Great Western, and the Minneapolis and St. Louis railways. Pop. (1920) was 15,731 (88% native white), and 1940 federal census 19,240. It is the seat of the Iowa Soldiers home; has a large wholesale business; manufactures furnaces, engines, machinery, building trowels, automobile accessories, canned foods, and other commodities; and is an important market and shipping point for grain and livestock. The city was laid out in 1853, became the county seat in 1860, was incorporated as a town in 1863 and chartered as a city in 1868. County and city were named after Chief Justice Marshall of the U.S. supreme court.

MARSHALSEA, a prison formerly existing in Southwark and attached to the court of that name held by the steward and marshal of the king's house (*see* LORD STEWARD and MARSHAL). It existed as early as the reign of Edward III. It was consolidated in 1842 with the queen's bench and the Fleet, and was then described as "a prison for debtors and for persons charged with contempt of Her Majesty's courts of the Marshalsea, the court of the queen's palace of Westminster, and the high court of admiralty, and also for admiralty prisoners under sentence of courts martial." It was abolished in 1849. The Marshalsea prison is described in Charles Dickens' *Little Dorrit*.

MARSHFIELD, a city of Coos county, Oregon, U.S.A., on Coos bay, 220 mi. S.W. of Portland; a port of entry, with the largest natural harbour between the Columbia river and San Francisco. A rapidly growing commercial and industrial centre. It is on federal highway 101, and is served by the Southern Pacific railway lines, bus lines and by ocean steamers. Population 1930, 5,287; 1940, 5,259. Coos bay, with a fine natural harbour, had a traffic in 1940 amounting to 448,086 tons (chiefly lumber), valued at $5,152,000. The city has several sawmills and fish-packing plants, and manufactures veneer, battery separators, and in 1940 manufactured 947,523 lb. of cheese. Marshfield was founded in 1860 and incorporated in 1874.

MARSHFIELD, a city of Wood county, Wisconsin, U.S.A., in the central part of the state. It is on federal highway 10, and is served by the Chicago and North Western, the Chicago, St. Paul, Minneapolis and Omaha, and the Soo Line railways. Pop. (1920) 7,394 (85% native white); 1940 federal census 10,359. It is the trade centre and shipping point for a rich dairy region, and has numerous and varied manufactures (notably hardwood veneer) amounting to $4,250,000 annually in value. The site of Marshfield was in the tract granted by the United States to the Fox River Improvement company, organized to construct a waterway from the Mississippi river to Green Bay. It was settled about 1870; named after one of the original owners, Samuel Marsh, of Massachusetts; and chartered as a city in 1883.

MARSH GAS (methane), the first and simplest member of the paraffin hydrocarbons, owes its name to the fact that it is a constituent of the gas which arises in marshy districts from the decomposition of vegetable matter under the surface of water. It occurs also as a component of "fire damp" of coal mines. It is found in volcanic gases, in petroleum and in human intestinal gases, and is a product of the destructive distillation of complex organic matters (coal, lignite, bituminous shale, peat, wood, etc.) so that it is present to the extent of 30 to 40% in coal gas.

Methane, CH_4, is a colourless, inodorous gas of specific gravity 0·559 (air=1). At $-160°$ C it has been condensed to a colourless liquid, specific gravity 0·415 (water=1). It boils at $-164°$ C/736 mm. and freezes at $-186°$ C to white needles. One volume of water at $t°$ C absorbs $0{\cdot}05449-0{\cdot}001807t$ volumes of methane, and it is nearly ten times as soluble in alcohol.

The preparation of industrial methane is effected by passing a mixture of hydrogen with carbon dioxide or, preferably, carbon monoxide over a heated nickel catalyst. With the dioxide the reaction requires temperatures between 300° and 400° C, but with the monoxide the change proceeds to completion at 230–250° C. As the other product is steam, which can be condensed, the methane can be obtained almost pure.

Other methods of preparation are of scientific interest. Pure methane is obtained on decomposing aluminium or beryllium carbide with water (*see* CARBIDES) and also by the action of water on zinc dimethyl (E. Frankland) or on magnesium methyl iodide. (*See* GRIGNARD REAGENTS.) The removal of sulphur by red-hot copper from a mixture of sulphuretted hydrogen and carbon disulphide vapour leads to the formation of methane $CS_2+2H_2S+8Cu=4Cu_2S+CH_4$, and is a classical instance of an early organic synthesis (M. Berthelot, 1856). In the laboratory, methane is often prepared by heating dry sodium acetate with soda-lime but the product is contaminated with hydrogen and ethylene. Methane has been obtained by direct combination of carbon and hydrogen at 1,200° C (Bone, Jerdan, and Coward, 1897–98). Methane forms with air an explosive mixture of gas, the "fire damp" of the coal mines and a frequent cause of colliery explosions. (*See* Publications of the Safety in Mines Research Board, vol. ii., 1926, H.M. Stationery Office, London.)

The oxidation of methane may be caused to occur in stages, and methyl alcohol and formaldehyde have been identified as intermediate products of its combustion. Successive chlorination of methane leads to methyl chloride, methylene chloride, chloroform, and finally carbon tetrachloride.

MARSH MALLOW (*Althaea officinalis*), a European plant allied to the hollyhock (*q.v.*), found in Great Britain and sparingly naturalized in the eastern U.S.A. It grows in marshes, especially near the sea. Sweetmeats were formerly made from the root. In the U.S.A. a marshmallow is a confection of sugar, syrup, starch, and gelatin.

MARSHMAN, JOSHUA (1768–1837), English Baptist missionary and orientalist, was born on April 20, 1768, at Westbury Leigh, in Wiltshire. In 1799 he was sent by the Baptist Missionary Society to join their mission at Serampore. Here he translated the Bible into various dialects, and, aided by his son, established newspapers and founded Serampore college. He received the degree of D.D. from Brown university, U.S.A., in 1810. He died at Serampore on Dec. 5, 1837. Marshman translated into Chinese the book of Genesis, the Gospels, Romans and Corinthians; in 1811 he published *The Works of Confucius, containing the Original Text, with a Translation,* and in 1814 his *Clavis Sinica.*

See J. C. Marshman, *Life and Times of Carey, Marshman and Ward* (2 vols., 1859).

MARSH-MARIGOLD (*Caltha palustris*), a plant of the buttercup family (Ranunculaceae), the "winking Mary-buds" of Shakespeare (*Cymb.*, ii., 3), common in wet places on both sides of the Atlantic. In America it is usually called cowslip, and is often known as kingcup in Great Britain. The stem is thick and hollow; the leaves are shining and kidney-shaped; and the flowers, which bloom in March or April, have five yellow sepals. The early shoots and leaves are used like spinach and the flower-buds preserved in salted vinegar form a substitute for capers. A double-flowered variety is often cultivated and is occasionally found wild. *C. natus,* a large species with white or pink flowers, occurs in ponds from Minnesota north. *C. leptosepala,* with white or bluish, usually solitary flowers, native to the

Rocky Mountain region from Alaska to New Mexico, is an excellent potherb. The genus contains 20 species, confined to temperate climates. (*See* RANUNCULACEAE.)

MARSI, an ancient people of Italy, whose chief centre was Marruvium, on the eastern shore of Lake Fucinus. They are first mentioned as members of a confederacy with the Vestini, Paeligni, and Marrucini (Liv. viii. 29, *cf.* viii. 6, and Polyb. ii. 24, 12). They joined the Samnites in 308 B.C. (Liv. ix. 41), and became allies of Rome in 304 B.C. (Liv. ix. 45). They were renowned for their magicians, who had strange remedies for various diseases.

The Latin colony of Alba Fucens near the north-west corner of the lake was founded in the adjoining Aequian territory in 303 B.C., so that from the beginning of the 3rd century the Marsians were in touch with a Latin-speaking community, to say nothing of the Latin colony of Carsioli (298 B.C.) farther west. The earliest pure Latin inscriptions of the district seem to be *C.I.L.* ix. 3,827 and 3,848 from the neighbourhood of Supinum; their character generally is of the Gracchan period, though it might be somewhat earlier.

Mommsen (*Unteritalische Dialekten,* p. 345) pointed out that in the social war all the coins of Pompaedius Silo have the Latin legend "Italia," while the other leaders in all but one case used Oscan.

The chief record of the dialect or patois we owe to the goddess Angitia, whose chief temple and grove stood at the south-west corner of Lake Fucinus, near the modern village of Luco. She (or they, for the name is in the plural in the Latin inscription next cited) was widely worshipped in the central highlands (Sulmo, *C.I.L.* ix. 3,074, Furfo Vestinorum, *ibid.* 3,515) as a goddess of healing, especially skilled to cure serpent bites by charms and the herbs of the Marsian woods. Her worshippers naturally practised the same arts—as their descendants do (*see* A. de Nino's collection of *Usi e costumi abruzzesi*), their country being in Rome counted the home of witchcraft; *see* Hor., *Sat.* 1, 9, 29, *Epod.* 17, 28, etc.

The earliest local inscriptions date from about 300 to 150 B.C. and include the bronze of Lake Fucinus, which seems to record a votive offering to Angitia. The language of these inscriptions differs very slightly from Roman Latin of that date. The older form of the name of the tribe (dat. plur. *Martses* =Lat. *Martiis*) shows its derivation and exhibits the assibilation of *-tio-* into *-tso-* proper to many Oscan dialects (*see* OSCAN), but strange to classical Latin.

See R. S. Conway, *The Italic Dialects.*

MARSIGLI [MARSILIUS], **LUIGI FERDINANDO,** COUNT (1658–1730), Italian soldier and scientific writer, was born at Bologna on July 10, 1658. After a course of scientific studies in his native city he travelled through Turkey collecting data on the military organization and natural history. On his return he entered the service of the emperor Leopold (1682) and fought with distinction against the Turks, by whom he was wounded and captured in an action on the river Raab, and sold to a pasha whom he accompanied to the siege of Vienna. His release was purchased in 1684 and he afterwards took part in the war of the Spanish succession. In 1703 he was appointed second in command under Count Arco in the defence of Alt-Breisach. The fortress surrendered to the duke of Burgundy, and both Arco and Marsigli were court martialled; the former was condemned to death and the latter cashiered, although acquitted of blame by public opinion. Marsigli devoted the rest of his life to scientific investigations, in the pursuit of which he made many journeys through Europe, spending a considerable time at Marseilles to study the nature of the sea. In 1712 he presented his collections to his native city, where they formed the nucleus of the Bologna Institute of Science and Art. He died at Bologna on Nov. 1, 1730.

BIBLIOGRAPHY.—A list of his works, over twenty in number, is given in Niceron's *Memoirs;* his *Breve ristretto del saggio fisico intorno alla storia del mare* was published at Venice in 1711, and again at Amsterdam (in French) in 1725; the *Stato militare dell' impero ottomano* was published at Amsterdam and the Hague in Italian and French (1732), the *Osservazioni intorno al Bosforo Tracio* in Rome (1681) and the *Danubius pannonico-mysicus,* a large work in six volumes containing much valuable historic and scientific information on the Danubian countries, at the Hague (1725). *See* Fontenelle, "Éloge" in the *Mém. de l'acad. des sciences* (Paris, 1730); Quincy, *Mémoires sur la vie de M. le comte Marsigli* (Zurich, 1741), and Fantuzzi's biography of Marsigli (Bologna, 1770).

MARSILIUS OF PADUA [MARSIGLIO MAINARDINO] (1270–1342), Italian mediaeval scholar, was born at Padua, and went to Paris about 1311. He became rector of the university (for the first term of the year 1313). With the philosopher John of Jandun, he composed the famous *Defensor pacis* (1324,) one of the most extraordinary political and religious works which appeared during the 14th century. The work set out to demonstrate at a crisis in the quarrel between pope and emperor, the supremacy of the Empire, its independence of the Holy See, and the emptiness of the prerogatives "usurped" by the sovereign pontiffs—a demonstration naturally calculated to give them a claim on the gratitude of the German sovereign.

Marsilius denies, not only to the pope, but to the bishops and clergy, any coercive jurisdiction or any right to pronounce on their own authority excommunications and interdicts, or in any way to impose the observation of the divine law. He is not opposed to penalties against heretics, but he would have them pronounced only by civil tribunals. Desiring to see the clergy practise a holy poverty, he proposes the suppression of tithes and the seizure by the secular power of the greater part of the property of the church. The clergy, thus deprived of its wealth, privileges and jurisdiction, is further to be deprived of independence, for the civil power is to have the right of appointing to benefices, etc. The supreme authority in the church is to be the council, but a council summoned by the emperor. The pope, no longer possessing any more power than other bishops (though Marsilius recognizes that the supremacy of the Church of Rome goes back to the earliest times of Christianity), is to content himself with a pre-eminence mainly of an honorary kind, without claiming to interpret the Holy Scriptures, define dogmas or distribute benefices; moreover, he is to be elected by the Christian people, or by the delegates of the people, *i.e.,* the princes, or by the council, and these are also to have the power to punish, suspend or depose him. To overthrow the ecclesiastical hierarchy, to deprive the clergy of all their privileges, to reduce the pope to the rank of a kind of president of a Christian republic, which governs itself, or rather submits to the government of Caesar—such is the dream formed in 1324 by two masters of the university of Paris.

When the two authors of the book arrived at Nuremberg in 1326, Louis of Bavaria, king of the Romans, to whom the book was dedicated, and in whose cause it was written, was at first inclined to treat them as heretics. He soon changed his mind, however, and loaded them with favours. Marsilius accompanied Louis of Bavaria to Italy, where he preached or circulated written attacks against the pope, especially at Milan, and where he came within the sight of the realization of his wildest utopias. To see a king of the Romans crowned emperor at Rome, not by the pope, but by those who claimed to be the delegates of the people (Jan. 17, 1328), to see John XXII. deposed by the head of the Empire (April 18), and a mendicant friar, Pietro de Corbara, raised by an imperial decree to the throne of St. Peter (as Nicholas V.) after the sham of a popular election (May 12), all this was merely the application of principles laid down in the *Defensor pacis.* The two authors of this book played a most active part in the Roman Revolution. Marsilius, appointed imperial vicar, abused his power to persecute the clergy who had remained faithful to John XXII. In recompense for his services, he seems to have been appointed archbishop of Milan, while his collaborator, John of Jandun, obtained from Louis of Bavaria the bishopric of Ferrara.

Marsilius of Padua also composed a treatise *De translatione imperii romani,* which is merely a rearrangement of a work of Landolfo Colonna, *De jurisdictione imperatoris in causa matrimoniali,* intended to prove the exclusive jurisdiction of the emperor in matrimonial affairs. In an unpublished work preserved at Oxford, the *Defensor minor,* Marsilius completed and elaborated in a curious manner certain points in the doctrine laid down in the

Defensor pacis. In it he deals with ecclesiastical jurisdiction, penances, indulgences, crusades and pilgrimages, vows, excommunication, the pope and the council, marriage and divorce. Here his democratic theory still more clearly leads up to a proclamation of the imperial omnipotence.

Marsilius of Padua does not seem to have lived long after 1342. But the scandal provoked by his *Defensor pacis,* condemned by the court of Avignon in 1326, lasted much longer. Benedict XII. and Clement VI. censured it in turn; Louis of Bavaria disowned it. Translated into French, then into Italian (14th century) and into English (16th century), it was known by Wycliffe and Luther, and was not without an influence on the Reform movement.

See J. Sullivan, *American Historical Review,* vol. ii. (1896–97), and *English Historical Review* for April 1905; *Histoire littéraire de la France* (1906), xxxiii. 528–623; Sigmund Riezler, *Die literarischen Widersacher der Päpste zur Zeit Ludwig des Baiers* (Leipzig, 1874). There are numerous manuscripts of the *Defensor pacis* extant. We will here mention only one edition, that given by Goldast, in 1614, in vol. i. of his *Monarchia sacri imperii;* an unpublished last chapter was published by Karl Müller, in 1883, in the *Göttingische gelehrte Anzeigen,* pp. 923–925. Count Lützow in *The Life and Times of Master John Hus* (London and New York, 1909), pp. 5–9, gives a good abstract of the *Defensor pacis* and the relations of Marsilius to other precursors of the Reformation.

MARSIVAN or MERZIFON (anc. *Phazemon?*), a town in the Amasia vilayet of Turkey, situated at the foot of the Tavshan Dagh. Pop. (1940) 13,301. Before World War I, it was best known as a centre of American missionary and educational enterprise, and the seat of Anatolia college, a theological seminary, and schools.

MARS-LA-TOUR, a village of Lorraine, which formed part of the battlefield of Aug. 16, 1870. The battle is often called the battle of Mars-la-Tour, though it is alternatively named after Vionville or, by the French, after Rezonville. (*See* METZ; and FRANCO-GERMAN WAR.) At Mars-la-Tour occurred the destruction of the German 38th brigade.

MARSTON, JOHN (*c.* 1575–1634), English dramatist and satirist, eldest son of John Marston of Coventry, at one time lecturer of the Middle Temple, was born in 1575 or early in 1576. His mother was the daughter of an Italian physician, Andrew Guarsi. He entered Brasenose College, Oxford, in 1592, taking his B.A. degree in 1594. He married Mary Wilkes, daughter of one of the royal chaplains, and Ben Jonson said that "Marston wrote his father-in-law's preachings, and his father-in-law his sermons." His first work was *The Metamorphosis of Pigmalions Image, and certaine Satyres* (1598). "Pigmalion" is an erotic poem in the metre of *Venus and Adonis,* and Joseph Hall attached a rather clumsy epigram to every copy that was exposed for sale in Cambridge. In the same year Marston published, under the pseudonym of W. Kinsayder, already employed in the earlier volume, his *Scourge of Villanie,* eleven satires, in the sixth of which he asserted that Pigmalion was intended to parody the amorous poetry of the time. Both this volume and its predecessor were burnt by order of the archbishop of Canterbury.

The satires, in which Marston avowedly took Persius as his model, are coarse and vigorous. In addition to a general attack on the vices of his age he avenges himself on Joseph Hall who had assailed him in *Virgidemiae.* He had a great reputation among his contemporaries. John Weever couples his name with Ben Jonson's in an epigram; Francis Meres in *Palladis Tamia* (1598) mentions him among the satirists; a long passage is devoted to "Monsieur Kinsayder" in the *Return from Parnassus* (1606), and Dr. Brinsley Nicholson has suggested that *Furor poeticus* in that piece may be a satirical portrait of him.

On Sept. 28, 1599, Henslowe notices in his diary that he lent "unto Mr. Maxton, the new poete, the sum of forty shillings," as an advance on a play which is not named. Another hand has amended "Maxton" to "Mastone." The earliest plays to which Marston's name is attached are *The History of Antonio and Mellida. The First Part;* and *Antonio's Revenge. The Second Part* (both entered at Stationers' Hall in 1601 and printed 1602). These were written for the Paul's Boys, for whom he also probably revised the anonymous *Histriomastix,* and finally wrote *What you Will* (which was certainly written before 1607), while he was doubtless part author of *Jacke Drums Entertainment* (1600).

The melodrama and the exaggerated expression of these two plays offered an opportunity to Ben Jonson, who had already twice ridiculed Marston, and now pilloried him as Crispinus in *The Poetaster* (1601). The quarrel was patched up, for Marston dedicated his *Malcontent* (1604) to Jonson, and in the next year he prefixed commendatory verses to *Sejanus.* Far greater restraint is shown in *The Malcontent* than in the earlier plays. It was printed twice in 1604, the second time with additions by John Webster. *The Dutch Courtezan* (1605) and *Parasitaster, or the Fawne* (1606) followed. In 1605 *Eastward Hoe,* a gay comedy of London life, which gave offence to the king's Scottish friends, caused persons concerned in its production—Marston with others—to be imprisoned. (*See* JONSON, BEN.) In the preface to *The Wonder of Women, or the Tragedie of Sophonisba* (1606), Marston mocks at those authors who make a parade of their authorities and their learning, and the next play, *What you Will* (printed 1607; but probably written much earlier), contains a further attack on Jonson. Marston's undoubted dramatic work was completed in 1607. It is uncertain at what time he exchanged professions, but in 1616 he was presented to the living of Christchurch, Hampshire. He formally resigned his charge in 1631, and when his works were collected in 1633 the publisher, William Sheares, stated that the author "in his autumn and declining age" was living "far distant from this place." Nevertheless he died in London, in the parish of Aldermanbury, on June 25, 1634. He was buried in the Temple Church.

Marston's works were first published in 1633, once anonymously as *Tragedies and Comedies,* and then in the same year as *Workes of Mr. John Marston. The Works of John Marston* (3 vols.) were reprinted by Mr. J. O. Halliwell (Phillipps) in 1856, and again by Mr. A. H. Bullen (3 vols.) in 1887. His *Poems* (2 vols.) were edited by Dr. A. B. Grosart in 1879. For an account of the quarrel of Dekker and Marston with Ben Jonson *see* Dr. R. A. Small, *The Stage Quarrel between Ben Jonson and the so-called Poetasters;* in E. Koelbing, *Forschungen zur englischen Sprache und Litteratur,* pt. i. (1899). *See* also three articles *John Marston als Dramatiker,* by Ph. Aronstein in *Englische Studien* (vols. xx. and xxi., 1895), and "Quellenstudien zu den Dramen Ben Jonsons, John Marstons . . ." by Emil Koeppel (*Münchener Beiträge zur roman. und engl. Philologie,* pt. xi. 1895); also M. S. Allen, *The Satire of John Marston* (Columbia, 1920).

MARSTON, PHILIP BOURKE (1850–1887), English poet, was born in London on Aug. 13, 1850. His father, JOHN WESTLAND MARSTON (1819–1890), of Lincolnshire origin, the friend of Dickens, Macready and Charles Kean, wrote a series of metrical dramas which held the stage in succession to the ambitious efforts of John Tobin, Talfourd, Bulwer and Sheridan Knowles. The son, Philip Bourke, was born in a literary atmosphere. At his father's house near Chalk Farm he met authors and actors of his father's generation, and subsequently the Rossettis, Swinburne, Arthur O'Shaughnessy and Irving. Owing to an accident in infancy, he gradually became almost totally blind. Marston's verse became more and more melancholy. The idylls of flower-life, such as the beautiful "The Rose and the Wind" were succeeded by dreams of sleep and the repose of death. Melancholy pervades his three published collections, *Songtide* (1871), *All in All* (1875) and *Wind Voices* (1883). His popularity in America far exceeded that in his own country.

MARSTON MOOR, BATTLE OF, was fought on July 2, 1644 on a moor (now enclosed) seven miles west of York, between the Royalist army under Prince Rupert and the Parliamentary and Scottish armies under the earl of Manchester, Lord Fairfax and Lord Leven. For the operations that preceded the battle see GREAT REBELLION. Rupert had relieved York and joined forces with the marquess of Newcastle's army that had defended that city, and the Parliamentarians and Scots who had besieged it had drawn off south-westward followed by the Royalists. On the morning of July 2, however, Rupert's attack on their rearguard forced them to halt and deploy on rising ground on the south edge of the moor, their position being defined on the right and left by Long Marston and Tockwith and divided from the Royalist army on the moor by a lane connecting these two villages. The respective forces were—Royalists about 18,000, Parliamentarians and Scots about 27,000. The armies stood front to front. On the Royalist right was half the cavalry under Rupert; the infantry was in the centre in two lines and the left wing of cavalry was under General (Lord) Goring. The lane along the front was held by skirmishers. On the other side the cavalry of the Eastern Association under Lieut.-General Cromwell and that of the Scots under Major-General Leslie formed the left; the infantry of the Eastern Association under Major-General Crawford, of the Scots under Lord Leven, and of the Yorkshire Parliamentarians under Lord Fairfax was in the centre; and the Yorkshire cavalry under Sir Thomas Fairfax was on the right wing.

During the afternoon there was a desultory cannonade, but neither side advanced. At last, concluding from movements in the enemy's lines that there would be no fighting that day, Rupert and Newcastle strolled away to their coaches and their soldiers dismounted and lay down to rest. But seeing this Cromwell instantly advanced his wing to the attack (5 P.M.). His dragoons drove away the skirmishers along the lane, and the line cavalry crossed into the moor. The general forward movement spread along the Parliamentary line from left to right, the Eastern Association infantry being the first to cross the road. In Rupert's momentary absence, the surprised Royalist cavalry could make no head against Cromwell's charge, although the latter was only made piecemeal as each unit crossed the lane and formed to the front. Rupert soon galloped up with his fresh second line and drove back Cromwell's men, Cromwell himself being wounded, but Leslie and the Scots Cavalry, taking ground to their left, swung in upon Rupert's flank, and after a hard struggle the hitherto unconquered cavalry of the prince was broken and routed. Then, being unlike other cavalry of the time, a thoroughly disciplined force, the Eastern Association cavalry rallied, leaving the pursuit to the Scots light horse. On the Parliamentary right, Goring had swept away the Yorkshire horse, and although most of his troopers had followed in disorderly pursuit, Sir Charles Lucas with some squadrons was attacking the exposed right of Leven's infantry. At the same time the Parliamentary infantry had mostly crossed the lane and was fighting at close quarters and suffering severely, Newcastle's north-country "White-Coat" brigade driving back and finally penetrating their centre. Lord Leven gave up the battle as lost and rode away to Tadcaster. But the Scots on the right of the foot held firm against Lucas's attacks, and Cromwell and Leslie with their cavalry passed along the rear of the Royal army, guided by Sir Thomas Fairfax (who though wounded in the rout of his Yorkshire horse had made his way to the other flank). Then, on the ground where Goring had routed Fairfax, Cromwell and Leslie won an easy victory over Goring's scattered and disordered horsemen. The Eastern Association infantry had followed the horse and was now in rear of the Royalists. The original Parliamentary centre of foot, a remnant, but one containing only the bravest and steadiest men, held fast, and soon the Royalist infantry was broken up into isolated regiments and surrounded by the victorious horse and foot of the enemy. The White-Coats retreated into an enclosure and there defended themselves to the last man. The rest were cut down on the field or scattered in the pursuit and at nightfall the Royalist army had ceased to exist. Some of Rupert's foot regiments made their way to York, but the dispirited garrison only held out for a fortnight. Rupert rallied some six thousand of the men and escaped over the hills into Lancashire, thence rejoining King Charles in the south. But the Northern army, the main hope of the Royalist cause, was destroyed.

MARSUPIALIA, a subclass of Mammalia (*q.v.*) in which (with some exceptions) the young for some time after birth are kept in a pouch (marsupium) or bag of skin on the under side of the body of the female. Outstanding examples of the group are the kangaroos of Australia and the opossums of America. The marsupials are exceptionally important and interesting to the student of evolution for reasons which will appear later.

Discovery.—The South American opossums were seen and described by the first explorers of the New World, the Pinzons having taken a live one in Brazil in 1500, which was exhibited in Granada and described in a work by Trivigiano published in 1504. As to the North American opossums, Captain John Smith in his *Description of Virginia* (1612) states that: "An opossum hath a head like a Swine, and a taile like a Rat, and is of the bignesse of a Cat." Apart from the description by a Dutch voyager Pelsart (1629) of wallabies seen on islands off western Australia, the Australian marsupials remained practically unknown until Captain J. Cook's voyage. In 1770 Captain Cook saw kangaroos in the region now known as North Queensland. The kangaroo was at first regarded as a gigantic leaping rodent. The discovery of other Australian marsupials such as the marmot-like wombat, the rabbit-like bandicoot, the wolf-like thylacine, at first brought confusion into the gradual process of classifying the mammals of the world. Even Baron Cuvier did not at first realize that the marsupials formed an independent series, having only a general and superficial resemblance to the carnivorous, insectivorous and gnawing animals of the northern world, and separated from them by profound differences in the mode of reproduction. It remained for Henri M. D. De Blainville in 1816 and 1834 to take the steps of putting the marsupials by themselves in a subclass of mammals which he named Didelphia, co-ordinate in rank with the Ornithodelphia (the egg-laying mammals or monotremes) and with the Monodelphia, which are the placentals or ordinary mammals of the northern world.

Reproduction.—The most famous character of typical marsupials is the pouch in which the females carry their young. In its extreme form, as in the kangaroo, the pouch consists of a capacious elastic bag, lined with fur. The fold which grows up to form the pouch may be compared to a gigantic teat surrounding the entire mammary field. In some Australian dasyures the pouch-fold arises only around the front end of the mammary field; the presence of a scrotal pouch in the male thylacine shows how easily the abdominal wall sinks in. In its complete form the pouch has a circular aperture opening downward. As the number of nipples increases the mammary field becomes an elongate oval and the pouch gives place to low longitudinal ridges and finally disappears. It has been suggested that the lack of a pouch is really a primitive character and that we can trace many stages in the evolution of the pouch among living members of the group. Since the pouch is reduced or wanting in members of different families of marsupials, the foregoing hypothesis must assume also that when it is present the pouch has arisen independently in different families. However, before such an hypothesis can be seriously considered it would be necessary to disprove the older view that marsupials, like all other mammals, are subject to the occasional degeneration or loss of even highly evolved structures, that the pouch is normally an important part of the marsupial mode of caring for the young but that in special circumstances, such as a marked increase either in the number of young at a birth or in their size, the pouch becomes unnecessary and is reduced or eliminated. The newer view seems to rest in part also on the erroneous assumption that the banded anteater (*Myrmecobius*) is a little modified survivor of the Mesozoic mammals. In the marsupials of the polyprotodont division (*see* below) the pouch frequently opens downward or backward but in the kangaroos and phalangers, which rest in a sitting position, the pouch opens forward or upward.

Hardly less striking in appearance than the pouch are the pair of flat rod-like bones called the epipubic or marsupial bones, which lie in the deepest part of the muscular abdominal wall and are attached to the front or pubic border of the pelvis. These marsupial bones are present in both sexes and therefore are not exclusively related to the support of the female's pouch but seem rather to be remnants of the skeletal floor of the abdomen, which in primitive reptiles extends from the pubis to the sternum. Similar epipubic bones are found in the monotremes or egg-laying mammals. In some marsupials (including the thylacine or marsupial wolf) the epipubic bones are reduced to vestiges or completely lost.

At least in the larger marsupials the new-born animals are very small and in general poorly developed but it is remarkable that at this stage their fore-limbs are very large and tipped with strong claws, while the hind legs are hardly more than embryonic buds. In the case of the Virginia opossum, immediately after birth the young animal uses these large fore-limbs and claws in climbing along the under-side of the mother's body from the cloaca to the mammary field, where it attaches itself to one of the teats. The teat then swells and becomes fastened firmly in the mouth of the young; the windpipe of the young becomes prolonged upward and forward to fit into the back part of the nasal tunnel; thus the milk is prevented from getting into the windpipe and the air is delivered directly to the lungs. The teats vary in number from two in certain diprotodonts to 27 in *Monodelphis*.

The large size of the maternal teat and the prolonged attachment of the young to it may have crowded the tooth-forming part of the jaws to such an extent that the milk teeth are delayed in formation, only the hinder upper and lower premolars, at the back of the jaw, having room to develop in most marsupials, while even these milk teeth become reduced in size in the marsupial wolf (*Thylacinus*) and completely eliminated in the dasyures, wombats, koalas and marsupial anteaters. In this connection it is interesting to note that tiny vestiges of deciduous incisors and premolars, which never break through the gum, have been found in some marsupials.

At birth the young of the large forms are about an inch in length, entirely naked, blind, the ears hardly visible, the hind limbs small and the fore limbs more robust and with well-developed claws. The period of gestation in large kangaroos is about three weeks. At parturition the female sits with her tail brought forward between her legs and spends some of her time scratching at her pouch with the fore-paws and licking it. When the young animal emerges from the cloaca of the female it climbs by its clawed fore-limbs into the pouch, reaching the teats, one of which it eventually seizes with its mouth, the more easily as the teats at this time are pointed and rather turgid.

Shortly after the teat is received in the mouth of the young animal, lactation begins and the teat becomes somewhat flaccid. The body of the little kangaroo increases in size but the mouth that holds the teat does not at this time enlarge. The tip of the teat expands within the mouth so that the young cannot be released without rupturing the sides of its mouth. Numerous striated muscle fibres pass between the lobes of the mammary gland, indicating that the milk is forcibly expressed from it.

By the end of the Australian winter, September or October, the young kangaroo has grown considerably and is ready to leave the pouch. For some time before finally leaving the pouch it has been free from the teat and has eaten vegetation that it reached by leaning from the pouch while its mother was feeding.

The female reproductive organs of marsupials differ markedly from those of higher or placental mammals in the following respects: the vaginal tubes of the right and left sides always have at least a kink or sharp bend, one on each side, just above the place where the ureters pass downward to open into the bladder. These kinks usually join in the mid-line and from the point of junction is developed a cul-de-sac of varying lengths, leading backward toward the cloaca or short passage to the exterior. In females that have never produced young the median cul-de-sac ends blindly at the lower end. After the egg has passed down from the ovary into the oviduct it is fertilized by some of the sperm which has been kept in the vaginal caecum or kink above described. During parturition (in members of several families) the embryo passes down into the median cul-de-sac, which becomes prolonged backward, forming a median canal. A hole is formed in the median canal and the young escapes into the cloaca without going through the lateral canals. Thus the typical marsupials have a contorted vaginal canal with one median and two lateral passages, the median one being formed from the coalescence of part of the two laterals. In placental mammals, on the other hand, no traces of the three-way vaginal canal or of the kinks in the vaginal canals are ever formed but the lower part of the right and left oviducts tend to unite in a single median uterus. It is therefore inferred that the marsupial arrangement is a peculiar specialization not developed in the common ancestors of marsupials and placentals.

Another remarkable feature of the reproductive system of marsupials is the peculiar relation of the two sacks or outgrowths from the ventral wall of the embryo, either one of which forms the functional placenta or organ of contact of the embryo with the uterus. In certain marsupials a double contact with the uterine wall is formed both by the true or allantoic placenta and by the omphalopleure or yolk-sack wall. In the bandicoots the true or allantoic placenta forms an intimate relationship with the uterine wall, essentially like that in the true placental mammals. On the other hand, in *Dasyurus* the allantois is degenerate and the yolk-sack alone makes contact with the uterine wall. Essentially similar conditions are found in the American opossum (*Didelphis*). In the higher placental mammals, on the other hand, only the true placenta is of functional importance in supplying the growing embryo with maternal nutriment. Thus the marsupials specialized in the early and brief internal development of the embryo, which depends for food chiefly upon its own yolk-sack and which completes its development after birth while attached to the teat. The higher or placental mammals gave the young a longer and better uterine development and a more flexible system of nursing, with greater maternal responsibility.

EVOLUTION AND CLASSIFICATION

As the existing monotremes in many respects represent a specialized side-group of the earliest mammals, the marsupials, on the whole, are the most central group of the mammalian class; consequently the problem of the origin of the marsupials largely resolves itself into the problem of the origin of the mammals, which is treated more fully under MAMMALIA. Nevertheless we present here a short review of the palaeontologic data bearing on the possible relationships of the marsupials to the several Mesozoic orders with which they have been thought to be connected.

Origin of the Marsupials.—The cynodont reptiles, whose fossil skeletons have been found in the Permian formations of Russia and the Triassic of South Africa, may not have been in the direct line of mammalian ascent but they were certainly progressing in that direction and some of them, such as the smaller cynodonts of the family Galesauridae were approaching the carnivorous marsupials in the general appearance of the skull and jaws. The two minute fossil jaws from the Upper Triassic of Carolina named *Dromotherium* and *Microconodon,* which were regarded as basic Mammalia by H. F. Osborn are referred by G. G. Simpson, after careful study of the originals, to the group of cynodont reptiles.

The multituberculate or allotherian mammals (*see* MULTITUBERCULATA), which range in time from the Upper Triassic to the Lower Eocene, appear to have been a side branch of the primitive mammalian stock, paralleling the monotremes on the one hand and the diprotodont marsupials on the other but not closely related to either.

The fossil mammals called triconodonts from the Jurassic of England and Wyoming have usually been referred to the marsupials, but according to the recent studies by Simpson the triconodonts formed a special group of their own, with no valid claims to relationship with the marsupials. These were small predatory mammals, the largest about the size of a cat, with jagged cheek teeth, each molar crown comprising three cusps arranged in a longitudinal line. A braincase of *Triconodon* reveals an extremely primitive stage with large olfactory lobes and unexpanded forebrain. On the whole, the triconodonts stand on a lower level of evolution than any true marsupials.

Another Jurassic group, the Trituberculata, includes various small lower jaws, of which the most widely known has received the name *Amphitherium prevostii.* One of these jaws from Oxford was examined by Cuvier, who noted its resemblance to the jaw of the opossums but also noted that it had ten teeth on each side behind the canine, a greater number than that of any carnivorous marsupial. In 1888 H. F. Osborn pointed out that the lower molar teeth of *Amphitherium* consisted of two moieties: in front an elevated triangle of sharp cusps and behind a low heel or talonid; here clearly was a distinct prophecy of the famous "tuberculo-sectorial" lower molars of Eocene mammals. Whatever its precise relationships, the lower jaw of *Amphitherium* could be changed into that of a primitive marsupial by the inturning of the angular process, by the reduction in the number of the cheek teeth from ten to seven; and by the further development of the heel of the lower molars. Even less change would be required to transform it into the jaw of a generalized placental mammal, in which the angular process is not inflected.

The American Opossums.—The oldest known fossil which may be referred without any doubt to the group of marsupials is a fragmentary skull and lower jaw from the Upper Cretaceous of Montana, described by W. D. Matthew in 1916 as *Eodelphis browni;* this was discovered by Barnum Brown in association with the skull of a Cretaceous dinosaur. As Matthew pointed out, the pieces of the skull and the lower jaw match closely the corresponding parts of existing opossums, which thus take their place among the most primitive known mammals. Matthew has also traced the fossil history of the opossum family through several Eocene formations of Wyoming into the genus *Peratherium,* which is found in the Oligocene formations of western North America and France. In South America fossil opossums of the genera *Microbiotherium* and *Proteodidelphys,* date from the Lower Miocene and earlier formations. From these and similar facts Matthew has pointed out that the family of the opossums, like that of many other families of mammals, appears to have originated in North America and then to have spread on the one hand into Europe and on the other into South America. Possibly the common Virginia opossum, together with related genera in Mexico and Central America, may represent a reflux wave of immigrants coming from South America in Pliocene times.

T. H. Huxley, Dollo and R. A. Bensley have adduced much evidence tending to show that the common opossum (*Didelphis virginiana*) embodies nearly all the characters one might reasonably expect to find in the remote common ancestors of all the higher marsupials, since it retains all their primitive characters but has assumed few specializations of its own. This is not equivalent to saying, however, that American opossums are ancestral to the Australian marsupials. It probably means only that the American opossums are the survivors of an ancient and diversified group, which in some earlier geological epoch was spread perhaps as far east as Asia and which gave rise on the one hand to the American marsupials and on the other to the Australian carnivorous marsupials and later groups.

The tree-climbing habits of the opossum are expressed in its muscular prehensile tail and especially in the grasping power of its hands and feet, each with five fully developed toes; the "friction pads" on the sole of the foot also are well developed. The forearm can be freely twisted on the upper arm and the collar-bones (clavicles) are well developed, as in most climbing mammals. In the hind-limbs the great toe is set off widely from the others, the feet are plantigrade and capable of being freely turned inward.

The braincase of a large opossum is relatively small and unexpanded in keeping with its low type of brain. The muzzle is large and in its interior the delicate bones that support the membranes of the sense of smell are well-developed; the bony orbits or sockets for the eyes are rather small, as are the eyes themselves; the inner ear-bones are relatively small and the same is true of the resonating chamber of the middle ear. All these and many similar facts suggest that the opossum is not an intelligent animal, that it pursues its prey chiefly by the sense of smell, and depends for safety upon hiding in the daytime and prowling about at night.

In conformity with its carnivorous-omnivorous habits, the skull of a large opossum recalls those of other carnivorous mammals in its stout cheek arches and in its high median and occipital crest, all for the support of the stout jaw muscles. The dentition also tells plainly that the opossum is primarily a flesh-eating animal, which however has not acquired highly specialized shearing teeth like those of a cat but has retained certain primitive features. The general outline of an upper molar crown of an opossum is that of a scalene triangle with the apex on the inner side, the shorter leg being in front, the longer one behind. From the general surface of this triangle two small, V-shaped cusps project: a very small one in front (the paracone) and a much larger one behind (the metacone). Between any two adjacent upper molars are empty embrasures or openings, each like an inverted V with the tip pointing outward. Into these embrasures fit the elevated V-shaped forepart of the lower molars, surmounted by three blade-like cusps, the apex of this V pointing outward. The inverted V of a lower molar shears past the large V of an upper molar; while the inwardly projecting apex of an upper molar fits into a concave projection constituting the rear half of a lower molar. Thus the upper and lower molars of the opossum present fundamentally the same combination of shearing V's and piercing projections and sockets which is to be found in the most primitive mammals of the Cretaceous and Eocene ages.

In the opossum, as in all primitive marsupials, there are on each side four upper molars and four lower, also three upper premolars and three lower premolars. The upper premolar crowns have a single high tip, equivalent to the highest cusp on the crown of the molars. Thus there are in all seven teeth on each side, above and below, behind the canines. The same number of postcanine teeth is to be found in primitive placental mammals, but in the latter there are four premolars and three molars. The canine teeth, both upper and lower, of the opossum have long-curved, sharp-tipped crowns, well fitted for fighting and killing. The incisor teeth are small and numerous with simple crowns, five on each side in the upper jaw and four in the lower jaw; of these the first upper incisors are somewhat larger and have downwardly directed points, while the first lower incisors are somewhat inclined forward. Here then is the first hint of the nipping or prehensile development of the incisors which becomes pronounced in the diprotodont group of marsupials. Accordingly the dental formula, showing the number of different kinds of teeth in the upper and lower jaws of the common opossum may be written as follows: (incisors $\frac{5}{4}$ canines $\frac{1}{1}$ premolars $\frac{3}{3}$ molars $\frac{4}{4}$) $\times 2 = 50$. From this as a starting-point the dental formulae of all other marsupials appear to have been derived either by reduction and loss of teeth or, in the case of *Myrmecobius,* by the secondary increase in number of the molar teeth. As in all typical marsupials, only the hinder or third premolars of the adult dentition are preceded by deciduous teeth.

The precise arrangement of the lateral and median vaginal canals varies widely in different individuals and species of the opossum family. In some, the lateral canals are completely separate and there is hardly a beginning of the median cul-de-sac; in other species, however, it is very well developed and in still others transitional conditions are found. The attachment of the embryo to the wall of the uterus is by the yolk-sack, there being no true placenta.

Some of the smaller species of opossums have a large number of young at a birth, together with a large number of teats (rarely, as many as 27) and a reduction or loss of the pouch. It is very doubtful, however, whether these are primitive characters; they seem more like retrogressive specializations within the family.

The common opossum (*Didelphis virginiana*) may reach a total length of 37 inches, the head and body being 22 inches long, while at the other extreme, in the shrew-opossum of Brazil (*Monodelphis*) the length of the head and body is less than 3 inches. The murine opossum (*Marmosa*) of Central America and Brazil includes mouse-like insectivorous forms in which the pouch is absent. The water opossum or yapok (*Chironectes*) of Panama and Guiana is the only known marsupial adapted to a partly aquatic life. The toes of the hind feet are webbed and it resembles an otter in habits. The pouch is present.

The Australian Dasyuroids.—Under the name dasyuroids we may include a series of Australian forms ranging from the tiny "pouched mice" to the wolf-like *Thylacinus.* They are frequently referred to collectively as "carnivorous marsupials." The ordinary "pouched mice" of the genus *Phascogale* are extremely active little animals with the blood-thirsty habits of shrews. They live mostly in the bush or forest. They differ profoundly from true mice not only in their internal anatomy but especially in their dentition, which is of the carnivorous-insectivorous type. In his excellent work *The Mammals of South Australia* F. Wood Jones writes: "The Yellow-footed Pouched Mouse is an animal of great interest from a zoological point of view, since in the whole of its anatomy it shows itself to be a remarkably generalized animal. It represents a marsupial base form, its general anatomy being but little modified from a basal mammalian plan, and it stereotypes the simple creature that could be considered ancestral to most of the marsupial radiations." Although too specialized in certain details, such as the reduction of the first toe of the hind foot and the loss of the caecum of the intestine, to be the direct ancestors of the diprotodont or herbivorous marsupials, the pouched mice of the genus *Phascogale* are at least structurally near to the diverging lines leading to the jumping pouched mice, to the dasyures, to the Tasmanian devil and other peculiar forms.

In the fat-tailed pouched mouse (*Sminthopsis crassicaudata*) the hind foot is much elongated and this feature is carried to an extreme in the jerboa pouched mouse (*Antechinomys*), which shows a maximum adaptation to the jumping habit, including a complete loss of the first digit of the hind foot. As in many other desert-living animals, the ears are very large and the bony shells covering the chambers of the middle ears are greatly enlarged. The animal is insectivorous and probably leaps after insects.

One of the most remarkable members of the pouched mouse group is the mulgara or crest-tailed pouched mouse (*Dasycercus cristicauda*) of South Australia. This sturdily-built, short-limbed little animal is a typical desert form, which has multiplied in an astonishing manner during the passage of a mouse plague across cultivated districts and is a fearless predatory animal.

The carnivorous adaptations of the mulgara are carried further in the so-called native cats or dasyures, which are about as large as true cats but have pointed muzzles. The blades on the upper molars are relatively longer and more obliquely directed than in the mulgara and the third upper premolar is now completely eliminated. The skull bears heavy crests and well developed cheek arches for the support of the powerful muscles. The general form of body is like that of a marten. In the spotted-tailed native cat (*Dasyurus maculatus*) the first digit of the hind foot is retained and the foot pads are striated in conformity with its tree-climbing habits; but in the common native cat (*Dasyurus viverrinus*) the first digit of the hind foot is lost and the foot pads are granular. It formerly inhabited treeless rocky country as well as cultivated districts and was a fearless predatory animal.

The Tasmanian devil (*Sarcophilus ursinus*) is a short-bodied burly dasyurid with a broad muzzle, an enormous, broad and massive skull and most powerful jaws. There are strongly developed blades on the upper and lower molar teeth, which resemble those of such extinct placental carnivores as *Oxyaena*. The inner projections of the upper molar crowns are reduced and the planes of the inner surfaces of these blades now point more obliquely backward than those in the more primitive pouched mice.

In the marsupial wolf or tiger (*Thylacinus*) the general habitus is somewhat wolf-like, except that the feet are shorter and the hinder part of the body gradually tapers into the tail. Broad transverse black stripes over the back and tail give the animal its common name of "tiger." The thylacine (*q.v.*) is a wolf-like derivative of the dasyuroid stock, specialized for long-distance running. Its skull is elongate, in contrast with the very broad short skull of *Sarcophilus*. The molar teeth, although adapted for shearing flesh, differ markedly from those of the dasyures and *Sarcophilus*. The upper molars have lost the accessory cusps on the outer side of the crown, the internal spurs of the upper molars are subcircular, the two main external cusps are more or less approximated. In the lower molars the hinder spur or talonid is reduced, while the front part consists of two large blade-like cusps, the metaconid or hinder inner cusp being totally wanting. The nearest resemblances in dentition and skull are found not in any other Australian forms but among the extinct borhyaenids of the Patagonian Miocene. On the other hand, *Thylacinus* agrees closely with the Australian dasyuroids in many important details, so that there seems little doubt of its derivation from an Australian dasyuroid stock. The further significance of these facts will be discussed below. The thylacine formerly inhabited the mainland of Australia, its fossil remains having been found in caves; but during historic times it has lived only in Tasmania. As it was destructive to sheep it has been almost exterminated and survives only in the mountains.

Under the Australian dasyuroid series we include the banded anteater (*Myrmecobius*) or wombat of South and West Australia. This very rare animal is now almost extinct. In general appearance it strongly recalls other small dasyuroids, having a long pointed muzzle and long ears, somewhat like *Antechinomys*, a transversely striped back, recalling *Thylacinus* and certain bandicoots, a bushy tail, like that of the brush-tailed pouched mouse. Moreover it is pouchless and the large foetuses are carried on the nipples, exposed as in *Dasycercus*. The high number of molars (sometimes rising to five in the upper and six in the lower jaws) may be regarded as a secondary increase in number correlated with reduction in size and spreading out of the teeth, in connection with an elongate, cylindrical extensible tongue, and a backwardly prolonged palate. A comparative study of the entire skeleton of *Myrmecobius* leads to the conclusion that it is thoroughly dasyuroid in type. A fossil lower jaw from the basal Eocene of Montana, named *Myrmecoboides montanensis*, helps us to visualize the process by which more normal insectivorous lower molars could readily be modified into the *Myrmecobius* type by suppression of the main outer cusps on the lower molars and of the inner cusps of the upper molars, this producing what I. W. Gidley has well named a "pseudotriconodont" type. The fossil jaw itself, however, is probably not at all related to *Myrmecobius*, since it agrees with the extinct placental insectivores of the family Lepticitidæ in its dental formula and in the family characters of the teeth.

A most highly aberrant dasyuroid is the pouched mole (*Notoryctes*) of South and Western Australia. The general appearance is like that of the African golden mole (*Chrysochloris*). In adaptation to its digging habits the conical head ends in front in a horny shield over the nose and evidently the head must be pushed into the soil. The neck vertebrae are fused to give it a firm support. The hands are provided with two enormous claws on the third and fourth fingers, the first and second fingers bearing much smaller claws which are opposable to the inner surfaces of the large outer claws. The fifth finger is very short and capped with a horny boss. The body is thick and cylindrical and the tail very short and covered with horny rings. The hind feet are short and spreading, with long digging claws. The eyes are degenerate, almost vestigial, and there are no external ears. The upper molar crowns, like those of the Cape golden mole, consist of very narrow V's, probably derived by degeneration from a more normal, less compressed type; in the lower molars the talonids or hinder spurs are lost. A pouch is present and opens backward. A comparative study of the skeleton has shown that the marsupial mole resembles the Cape golden moles, which are true placental mammals, only in its "habitus," while its "heritage" is unmistakably that of other marsupials.

The Australian Bandicoots.—The largest of these animals somewhat resemble rabbits both in appearance and habits, since they have large ears and dig holes in the ground. They are therefore often called "native rabbits." But they are none the less true marsupials.

The hind feet are remarkably like those of kangaroos and have what was originally the fourth toe much elongated; the first toe, if present, is small; all the remaining toes have large pointed claws for scratching and digging. The hind foot also resembles those of kangaroos and other herbivorous marsupials in the fact that the toes corresponding to the second and third of the normal mammalian foot are very slender, much smaller than the fourth toe, and so closely appressed to each other that they appear to be united at their bases. Each, however, is a complete digit with its own claw and separate muscles. These two digits serve as a comb by which the animal removes from its fur biting lice or other unwelcome objects. This peculiar syndactylous specialization of the hind feet is found also throughout the series of diprotodont or herbivorous marsupials of Australia but not in any of the polyprotodont families (American opossums, Australian dasyuroids, etc.).

The bandicoots have front teeth of the carnivorous-insectivorous or polyprotodont type, essentially like those of the American opossums and the dasyuroids, while their molar teeth, although peculiar, show traces of derivation from some form in which the accessory cusps on the outer sides of the molar were strongly developed. The bandicoots, while chiefly insectivorous, frequently have the molar teeth much ground down by wear, which may indicate that their food gets mixed with a certain amount of grit. Apparently in adaptation to this condition, the molar teeth tend to acquire high crowns, like those of many rodents. Bandicoots are pugnacious little animals which leap up in the air and strike each other with their long-clawed hind-feet. In the forms with very long hind-feet this extraordinary leaping ability is probably useful not only in escaping enemies but in capturing insects. All the species are now rapidly becoming rare. The family (Peramelidae) ranges from New Guinea and adjacent islands on the north to Tasmania on the south.

The Australian Diprotodonts.—Under the term Diprotodontia are generally included all the primarily herbivorous marsupials of Australia, in which the median pair of lower incisor teeth are more or less enlarged and inclined forward, so as to oppose one or more pairs of upper incisors, thereby functioning either as nippers or cutters. All known diprotodonts have the syndactylous relations of the second and third toes described above in the bandicoots. The diprotodont division includes a large number of species of highly diversified size and form, from the tiny dormouse phalanger to the almost elephantine extinct *Diprotodon,* and from the most agile pygmy "flying-squirrel" to the powerful and clumsy wombat.

Australians usually call the phalangers "opossums," but they are not closely related to the American animals. This mistake arises from the facts that both animals are pouched mammals, both live in trees, both have pointed muzzles and strongly grasping hands and feet and prehensile tails. But in many other important characters the American opossum and the Australian "opossum" differ widely. The former belongs to the polyprotodont division, having the incisors and canines disposed as in other carnivorous mammals, the latter have diprotodont front teeth, adapted for cutting vegetable fibre, and crested molar teeth adapted for grinding. Very striking is the contrast in the dental formulae of the two animals:

American opossum (*Didelphis*): $(\mathrm{i.}\frac{5}{4}\ \mathrm{c.}\frac{1}{1}\ \mathrm{p.}\frac{3}{3}\ \mathrm{m.}\frac{4}{4}) \times 2 = 50$

Australian "opossum" (*Trichosurus*): $(\mathrm{i.}\frac{3}{2}\ \mathrm{c.}\frac{1}{0}\ \mathrm{p.}\frac{2}{2}\mathrm{m.}\ \frac{4}{4}) \times 2 = 36$ (or less)

The polyprotodont American opossums have no trace of the syndactylous specialization of the hind feet which, as described above, is so characteristic of the Australian "opossum" and there are many striking differences in the skulls and other parts of the anatomy. The Australian phalangers as a group live in close ecologic relations with the eucalyptus trees that dominate the landscape in all but the dryest regions of the interior. Many eat eucalyptus leaves and the "native bear" (*Phascolarctos*) normally lives on nothing else. To overcome the aromatic essence of these leaves and extract nutriment from this highly indigestible material the phalangers have a long intestine and a greatly enlarged caecum. In locomotor habits the phalangers range from the sloth-like native bear, which clings tenaciously to the branches with its large hands and feet, to the highly active flying phalangers, including several quite different genera, which have a skimming membrane on the sides of the body and between the limbs. In one division of the family, including *Pseudochirus* and *Phascolarctos,* the upper molar teeth each bear two sharp V's or crescents. In another subfamily, which includes the Australian "opossum" (*Trichosurus*), the two V's of the upper molars are modified into cross-crests. The last lower premolar of the typical phalangers has a compressed cutting crown, with more or fewer vertical grooves and ridges. In the phalangers, however, these cutting premolars are not as elongate as they are in the smaller kangaroos. These cutting premolars, both in the upper and lower jaws, became greatly enlarged in the extinct "marsupial lion" (*Thylacoleo*), in which the molars were reduced and the front teeth became enlarged and piercing. Sir Richard Owen was of the opinion that *Thylacoleo* was a fierce carnivorous creature but others have demurred from this opinion on various grounds and think the animal sheared some unknown kind of fruit. In widest contrast to the shearing-toothed *Thylacoleo* is the tiny long-snouted phalanger (*Tarsipes*) of West Australia, which is said to live on the honey and insects found in long-tubed flowers, into which it sticks its long muzzle and extensile tongue.

The kangaroos doubtless represent a ground-living group descended from arboreal ancestors; in the most primitive living type, the musk-kangaroo (*Hypsiprymnus*), the hind-foot still bears the stamp of the foot of the tree-living phalanger, in which the fourth digit is much enlarged, the second and third digits are reduced and syndactylous, the first digit is still present, and separate friction pads are retained under the digits. In the more advanced kangaroos the first digit is lost and so are the friction pads. For further evolution of this family *see* KANGAROO.

The wombats (*Vombatus*) are sometimes called "native badgers" on account of their robustness and burrowing habits, but they far excel the true or placental badgers in strength and in ability to dig deep tunnels with great rapidity. Their skulls are rodent-like in so far as they have only a single pair of long curved incisors in the upper jaw as well as in the lower; their molar teeth also have long-curved crowns and widely open roots. Each upper molar crown consists essentially of a pair of V's in tandem and this arrangement appears to be derivable from the double-V molars of the Koala (*Phascolarctos*) with which the wombats are in many ways rather closely related.

Fossil Marsupials of Australia.—During the Pleistocene or glacial epoch when northern Europe and northern North America were repeatedly covered by continental glaciers, Australia remained free of glaciers except in the vicinity of its highest mountains. While the mastodon, the mammoth, the cave-bear and other animals dominated Europe, Australia had her own peculiar mammalian fauna which has left its bones in cave deposits of eastern Australia and in ancient lake basins of the interior. In the cave fauna are the scattered bones of giant kangaroos of many extinct species, of the lion-like *Thylacoleo,* of the marsupial wolf and many others. Around the margins of the lakes, however, lived still stranger beasts, the clumsy diprotodonts and nototheres. In general body form these resembled huge rodents; the name "marsupial rhinoceros" applied to one notothere seems highly inappropriate even if the animal did have a hump on its nasal bones. In general the molar teeth of the diprotodonts each bear two sharp cross-crests, not unlike those of the extinct proboscidean *Dinotherium.* They appear to be an offshoot of the phalanger stock, distantly related to the kangaroos, wombats and native bears. The fossil diprotodont *Wynyardia,* described by Sir Baldwin Spencer from the Tertiary beds of Table Cape, Tasmania, was formerly regarded as of Oligocene age but is now known to be much younger (Pliocene). The skull is thoroughly phalangerid in type.

Fossil Marsupials of South America.—We have already noted that the family of American opossums, appearing late in the Cretaceous in North America, and continuing there well into Oligocene, somehow found its way into South America at least by Lower Miocene and possibly earlier. But along with these purely American fossils there have been found in the Santa Cruz (Lower Miocene) formation of Patagonia the fossil representatives of two families that have a strangely Australian appearance.

The first are unquestionably carnivorous marsupials, the several genera ranging from the size of a large opossum to that of a hyaena. Of these the largest and most famous form, called *Borhyaena,* figured in scientific literature as a kind of link between the extinct creodonts of the Eocene epoch of North America and the existing marsupial wolf of Australia. But in every fundamental feature they are true carnivorous marsupials. W. D. Matthew even holds that the special resemblances between the Patagonian borhyaenids and the Australian carnivorous marsupials are likewise due in part to parallel evolution, the borhyaenids being predatory derivatives of the American opossum stock, the Australian thylacines of the related Australian dasyurid stock, both derived ultimately from Cretaceous opossums of the northern hemisphere. But H. E. Wood has shown that, apart from the rather close resemblances in the borhyaenid dentition to that of the Australian thylacines, there are several curious resemblances in the backbone, pelvis and limbs, which tend to link borhyaenids with thylacines and contrast them both with opossums, so that to attribute this all to parallelism, plus descent from a common didelphid ancestor, seems to be essentially a *petitio principii,* especially as the now rather numerous known opossums from Cretaceous to Recent times show not the slightest tendency to vary in the borhyaenid-thylacine direction.

The second family of South American marsupials which seem to have a distinctly Australian appearance are the caenolestids. These little animals were long known from a few fragmentary fossils (*Epanorthus, Abderites,* etc). In 1895 Oldfield Thomas announced that this supposedly extinct family was actually represented in the living mammalian fauna of Ecuador and Bolivia by a small shrew-like animal, which he called *Caenolestes* and pointed out that it resembled certain of the extinct Patagonian epanorthids in its dentition, also that it resembled in other respects certain of the Australian phalangers, with the important exception that its hind feet were devoid of the syndactyl specialization of the second and third toes. Since that time a number of species of *Caenolestes* have been found in the mountains of the Andean parts of South America and the anatomy of the animal has been thoroughly studied, especially in the recent monograph by W. H. Osgood. From all this it appears that *Caenolestes* exhibits a highly confusing mixture of resemblances with the Australian bandicoots and diprotodonts, but that it contrasts widely with the opossums except in a few details, such as the construction of Jacobson's organ in the interior of the nose; in this it shows strong resemblances both to the opossums and the bandicoots. The general impression left by a careful consideration of the evidence is that, in spite of the somewhat phalanger-like features of its dentition, *Caenolestes* is not a true diprotodont but merely a phalanger-like offshoot of a primitive marsupial stock that was perhaps more nearly allied with the bandicoots than with the American opossums.

How then did the extinct borhyaenids and the extinct and recent caenolestids, both apparently more nearly related to Australian stocks than to the American opossums, ever get into South America? Are they derived from two as yet undiscovered northern ancestral stocks which also gave rise respectively to the Australian dasyuroids and to the Australian bandicoots and diprotodonts, or did they come into Patagonia from the south, after crossing some long-sunken archipelago connecting Patagonia with the once flourishing continent of Antarctica? Matthew has shown that in a great many other cases relict forms of the southern land masses have been derived from northern ancestors and this may eventually prove true in the case of the borhyaenids and caenolestids. Nevertheless, the more direct evidence so far brought forward by recent authors leaves the impression that the American opossums are not closely related either to the borhyaenids or to the caenolestids and that the latter two are more nearly related respectively with the dasyuroid and perameloid stocks of Australia in spite of their wide geographic separation.

Classification of Families.—The famous classification of the marsupials into two suborders, Polyprotodontia and Diprotodontia, based upon the number and arrangement of the front teeth, seems at the present time to be a rather misleading simplification of a complex situation. The "polyprotodont" bandicoots, for example, appear to be more nearly related to the Australian true diprotodonts than to the American polyprotodont opossums, while the functionally "diprotodont" caenolestids appear to be more nearly related to the polyprotodont bandicoots than to the true diprotodonts. No less objectionable is the old grouping into Diadactyla and Syndactyla recently revived by Wood Jones, which is based solely upon the presence or absence of the syndactylous specialization of the second and third toes of the hind foot. However, the bandicoots, which resemble the kangaroos in possessing the syndactylous type of foot, differ profoundly from them in many other respects. From a comparative study of the dentition we may even affirm with B. A. Bensley that both bandicoots and kangaroos, along with all other Australian families, must be derived from primitive Australian polyprotodonts much resembling the pouched mice (*Phascogale*). In short, in the present state of knowledge it seems advisable to abandon the old larger groups and to group the families into the following series of superfamilies:

1. Superfamily Didelphoidea. North America, Cretaceous to Recent; Europe, Oligocene; South America, Oligocene to Recent. Primarily arboreal with strongly grasping hind feet, the great toe (hallux) large and divergent. Second and third digits not syndactylous. Snout pointed. Insectivorous-carnivorous, with unreduced dentition; polyprotodont. Dental formula typically i.$\frac{5}{4}$ c.$\frac{1}{1}$ p.$\frac{3}{3}$ m.$\frac{3}{3}$, seldom reduced. Upper molars triangular, with strongly developed metacones (main posteroexternal cusps) and various developed accessory marginal cusps; internal cusps large. Lower molars primitive, tuberculo-sectorial. Auditory process of alisphenoid small or moderate, not covering tympanic cavity below. Jacobson's organ well developed. Nipples numerous (5–27). Pouch variable, if present opening forward or downward. Paired vaginal canals separate or partly united in a variable median cul-de-sac. Allantoic sack abortive, not forming a placenta.

Family Didelphiidae. North America, Cretaceous to Oligocene, Recent; South America, Oligocene (?), Lower Miocene, Recent.

2. Superfamily Dasyuroidea. Australian Region,-Pliocene to Recent; One family in South America,-Miocene. Terrestrial or slightly arboreal, with narrow or variously elongated hind feet, the hallux more or less reduced. Snout pointed to blunt. Insectivorous to extremely carnivorous dentition, polyprotodont, often with reduced premolars. Upper molars triangular to shearing. Internal cusps often small. Lower molars tuberculo-sectorial to shearing. Auditory process of alisphenoid much inflated. Nipples usually numerous (4–10). Pouch variable, often reduced or absent; if present, marsupial bones sometimes absent; typically opening backward. Median vaginal canal temporarily pierced at parturition. Allantoic sack abortive.

Family Dasyuridae. Australia, Pleistocene and Recent. Pouched mice, native cats, Tasmanian devil, Tasmanian wolf.

Family Borhyaenidae. Patagonia, South America, Lower Miocene.

Family Myrmecobiidae. Australia, Recent. Banded anteater.

Family Notoryctidae. Australia, Recent. Marsupial mole.

3. Superfamily Perameloidea. Australian Region. Terrestrial, with kangaroo-like hind limbs, longer than fore limbs, adapted for scratching, digging and leaping. Hallux reduced, fourth digit much enlarged, second and third syndactylous. Snout very long, projecting, pointed. Dentition insectivorous-omnivorous, polyprotodont. Dental formula: (i.$\frac{5 \text{ or } 4}{3}$ c.$\frac{1}{1}$ p.$\frac{3}{3}$ m.$\frac{4}{4}$)$\times 2=48$ or 46. Incisor teeth with flattened, not pointed, crowns. Upper molars more or less quadrangular, long-crowned, main outer cusps probably representing much enlarged marginal cusps of primitive dasyuroids. Auditory process of alisphenoid inflated. Jacobson's organ well developed. Nipples six to eight. Pouch present, opening downward and somewhat backward. Median vaginal cul-de-sac moderately developed, young at least occasionally delivered *via* lateral vaginal canals. Allantoic placenta well developed.

Family Peramelidae. Australia and New Guinea, Pleistocene, Recent. Bandicoots.

4. Superfamily Caenolestoidea. Andean South America, Miocene to Recent. Terrestrial shrew-like forms with narrow non-syndactylous hind feet with slender hallux. Snout elongate. Insectivorous, functionally more or less diprotodont but with polyprotodont. Dental formula: (i.$\frac{4}{3 \text{ or } 4}$ c.$\frac{1}{1}$ p.$\frac{3}{3}$ m.$\frac{4}{4}$)$\times 2=46$ or 48. First and second upper molars more or less quadrangular, short crowned; lower molars modified tuberculo-sectorial with large talonids. Last lower premolars sometimes compressed, grooved (*Abderites*). Auditory process of alisphenoid moderate. Jacobson's organ very well developed, essentially as in polyprotodonts. Teats four. Pouch absent in adults. Marsupial bones well developed. Median vaginal canal essentially as in Didelphiidae.

Family Caenolestidae. Patagonia, Miocene to Recent.

5. Superfamily Phalangeroidea. Australian region, Pliocene to Recent. Primarily arboreal, secondarily terrestrial and derived

forms; the primitive arboreal type with strongly grasping hind feet, the hallux large and divergent, second and third digits markedly syndactylous. Snout typically rather short and thick. Dentition primarily herbivorous, diprotodont; dental formula reduced, typically $(i.\frac{3}{2}\ c.\frac{1}{0}\ p.\frac{2}{2}\ m.\frac{4}{4})\times 2=36$. Upper and lower molars typically bicrescentic or bilophodont. Last premolars compressed, in primitive forms grooved. Auditory process of alisphenoid usually well inflated, typically bridging petrous bone below and joining paroccipital process. Nipples usually four, rarely two. Pouch well developed, opening forward. Marsupial bones well developed. Median vaginal canal well developed, the young delivered through a temporary pseudo-vaginal opening. Allantois not forming a placenta.

Family Phalangeridae. Australian Region, Pliocene to Recent. Phalangers, native bears.
Family Thylacoleontidae. Australia, Pleistocene.
Family Macropodidae. Australia, Pliocene to Pleistocene. Kangaroos.
Family Diprotodontidae. Australia, Pliocene to Recent.
Family Vombatidae. Australia, Pliocene to Recent. Wombats.

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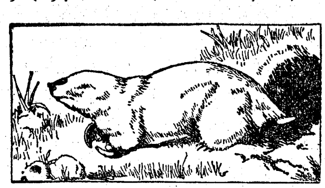
MARSUPIAL MOLE (*Notoryctes typhlops*), a polyprotodont from central South Australia, constituting a family (Notoryctidae). This small burrowing animal is of a pale golden-yellow colour, with long silky hair, a horny shield on the nose, and a stumpy leathery tail. The feet are five-toed, and the third and fourth toes of the front pair are armed with enormous claws for digging. Neither ear conches nor eyes are visible externally. There are but three pairs of incisor teeth in each jaw, and the upper molars are tricuspid. Being a marsupial, it is not a relative of the true moles, but the resemblance of the two forms is due to convergence.



MARSUPIAL MOLE (NOTORYCTES TYPHLOPS), OF SOUTH AUSTRALIA

MARSUPIAL MOUSE, any small member of the family Dasyuridae (*see* Marsupialia); most belong to the genus *Phascogale.* There are over a dozen species, none larger than a rat. Females of several species have pouches, but there are only folds of skin around the mammae in other forms. Marsupial mice are found throughout Australia and on Tasmania, New Guinea and the Aru Islands.

MARSUS, DOMITIUS, Latin poet, friend of Virgil and Tibullus, and contemporary of Horace. He survived Tibullus (d. 19 B.C.), but was no longer alive when Ovid's catalogue of poets (*Ex Ponto,* iv, 16) was written (A.D. 12). He was the author of a collection of epigrams called *Cicuta* ("hemlock") from their bitter sarcasm. According to others the name was derived from a reed-pipe made of the stalks of hemlock; the reading *scutica* ("whip") has also been proposed. He also wrote an epitaph on the death of Tibullus; elegiac poems, an epic poem *Amazonis;* and a prose work on wit (*De urbanitate*).

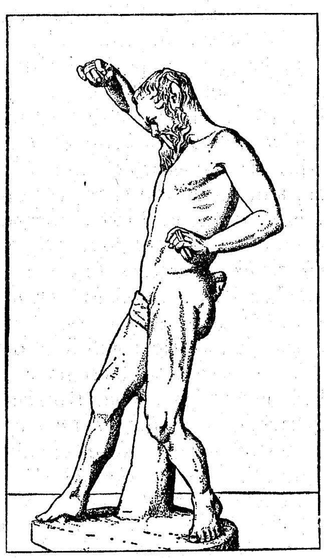
MARSYAS, a daimon or silenus of Anatolian origin, but adopted by Greek legend. According to it Athena had invented the oboe (αὐλός) and threw it away in disgust because it distorted the features. Marsyas found it, and having acquired great skill in playing it, challenged Apollo to a contest with his lyre. Midas, king of Phrygia, who had been appointed judge, declared in favour of Marsyas, and Apollo punished Midas by changing his ears into ass's ears. In another version, the Muses were judges and awarded the victory to Apollo, who tied Marsyas to a tree and flayed him alive. In Rome, a statue of Marsyas, a favourite art-subject (*cf.* Greek Art), stood in the Forum, and this was imitated by Roman colonies and came to be considered a symbol of autonomy.

See Jessen in Roscher's *Lexikon,* art. "Marsyas" (bibl.).

MARTABAN, a town in the Thaton district of Lower Burma, on the right bank of the Salween, opposite Moulmein. It is said to have been founded in A.D. 573, by the first king of Pegu, and was once the capital of a powerful Talaing kingdom; but it is now little more than a village. Martaban is frequently mentioned by European voyagers of the 16th century; and it has given the name of "Martavans" to a class of large vessels of glazed pottery, also known in India as "Pegu jars." It was twice captured by the British, in 1824 and 1852.

MARTELLO TOWER, a kind of tower formerly used in English coast defence. The name is a corruption of Mortella. The Martello tower was introduced in consequence of an incident of the French revolutionary wars. In September 1793 a British squadron of three ships of the line and two frigates was ordered to support the Corsican insurgents. In 1794, an assault was planned upon a tower on Cape Mortella commanding the Gulf of San Fiorenzo. On Feb. 7, 1,400 troops were landed, and the tower was attacked by land and sea on the 8th. The "Fortitude" and "Juno" kept up a cannonade for 2½ hours and then hauled off, the former being on fire and having 62 men killed and wounded. The fire from the batteries on shore produced no impression until a hot shot set fire to the "bass junk with which, to the depth of 5ft., the immensely thick parapet was lined." The garrison of 33 men then surrendered. The armament was found to consist only of two 18-pounders and one 6-pounder. The strong resistance offered by these three guns seems to have led to the conclusion that towers of this description were specially formidable, and Martello towers were built in large numbers, and at heavy expense, along the shores of England, especially on the southern and eastern coasts, which in certain parts are lined with these disused towers at short intervals. They are structures of solid masonry, containing vaulted rooms for the garrison, and providing a platform at the top for two or three guns, which fire over a low masonry parapet. Access is provided by a ladder, communicating with a door about 20ft. above the ground. In some cases a ditch is provided around the base. The defect of the tower was its weakness against vertical fire. The French *tours modèles* were somewhat similar to the Martello.

MARTEN, HENRY (1602–1680), English regicide, was born at Oxford where he entered University College. He first became prominent in 1639 when he refused to contribute to the general loan for the Scottish War, and in 1640 he was returned to parliament as a member for Berkshire. There he spoke in favour of the proposed bill of attainder against Strafford, and used such frank language about the king that Charles demanded his trial for high treason. When rebellion broke out Marten did not take the field, although he was appointed governor of Reading, but in parliament he was very active. In 1643, on account of some remark about extirpating the royal family, he was expelled from parliament, but in the following year was made governor of Aylesbury. Allowed to return to parliament in 1646, Marten again spoke against the king, and attacked the Presbyterians, and, supporting the army against the parliament, signed the agreement of Aug. 1647. He was one of the most prominent of the king's judges and signed the death warrant. In 1649 he was chosen a member of the council of state, but he took no part in public life during the Protectorate. Having resumed



MARSYAS, FROM A COPY OF MYRON'S GROUP, ABOUT 450 B.C., FOUND ON THE ESQUILINE HILL, ROME, NOW IN THE LATERAN MUSEUM, ROME his seat in the Long Parliament in 1659, Marten surrendered himself as a regicide in June 1660. He was imprisoned at Chepstow Castle where he died on Sept. 9, 1680. Although a leading Puritan, Marten was a man of loose morals. He published several pamphlets, and in 1662 *Henry Marten's Familiar Letters to his Lady of Delight,* containing letters to his mistress, Mary Ward.

See J. Forster, *Statesmen of the Commonwealth* (1840); M. Noble, *Lives of the English Regicides* (1798); S. R. Gardiner, *History of the Great Civil War* and *History of the Commonwealth and Protectorate,* and *Dict. Nat. Biog.* for further bibliography.

MARTEN, the name originally applied to the pine marten (*Martes martes*) but now used for all members of this genus of carnivorous mammals (*see* CARNIVORA). Martens are confined to the temperate and subtropical parts of the northern hemisphere, save for one species which extends to Java. They inhabit wooded and rocky localities and climb trees with facility. They are largely carnivorous in diet and have a blood-thirsty disposition. All the species yield valuable fur, but those from the far north are the most esteemed, especially when caught in winter, since the fur is then longer and denser. They are usually captured in "deadfall" traps, in which a log of wood is so arranged as to fall on the victim when it interferes with the bait.

The pine marten is a rich dark brown in colour, reddish-grey beneath, with a yellow breast spot. It varies in length from 2–2½ ft., inclusive of the tail, and is distributed throughout northern Asia and Europe, including the British Isles, where, however, it is very rare. The beech or stone marten (*M. foina*) is lighter in colour and more southern in range. The sable (*M. zibellina*), very like the pine marten, is the most valuable fur-bearer of the group. It inhabits eastern Siberia. The North American marten (*M. americana*) is closely related to the pine marten and sable, which it resembles in habits and appearance. The pekan or fisher (*M. pennanti*) is larger and more stoutly built than its relatives, reaching a length of about 3 feet. The yellow-throated marten (*M. flavigula*) ranges from India and China to Java; it is light brown on the shoulders, becoming blackish on the rump and has an orange chest. The Japanese marten (*M. melampus*) resembles the last species but is golden brown or dark brown above, with blackish feet. (J. E. HL.)

MARTENS, FRÉDÉRIC FROMMHOLD DE (1845–1909), Russian jurist, was born at Pernau in Livonia. In 1868 he entered the Russian ministry of foreign affairs, and in 1872 was professor of public law in the Imperial School of Law and the Imperial Alexander Lyceum. In 1874 he started special juristic work for the Russian government. His book on *The Right of Private Property in War* appeared in 1869, and was followed in 1873 by *The Office of Consul and Consular Jurisdiction in the East.* These were the first of a series of studies which won for their author a world-wide reputation, and raised the character of the Russian school of international jurisprudence. First amongst them must be placed the great *Recueil des traités et conventions conclus par la Russie avec les puissances étrangères* (13 vols., 1874–1902). This collection, published in Russian and French in parallel columns, contains not only the texts of the treaties but valuable introductions dealing with the diplomatic conditions of which the treaties were the outcome. These introductions are based largely on unpublished documents from the Russian archives. Of Martens' original works his *International Law of Civilized Nations* is perhaps the best known. More openly "tendencious" in character are such treatises as *Russia and England in Central Asia* (1879); *Russia's Conflict with China* (1881), *The Egyptian Question* (1882), and *The African Conference of Berlin and the Colonial Policy of Modern States* (1887).

Martens was repeatedly chosen to act in international arbitrations. Among the controversies which he helped to adjust were that between Mexico and the United States—the first case determined by the permanent tribunal of The Hague—and the difference between Great Britain and France in regard to Newfoundland in 1891. He played an important part in the negotiations between his own country and Japan, which led to the peace of Portsmouth (Aug. 1905) and prepared the way for the Russo-Japanese convention. He was employed in laying the foundations for The Hague Conferences. He was one of the Russian Plenipotentiaries at the first conference and president of the fourth committee—that on maritime law—at the second conference. His visits to the chief capitals of Europe in 1907 were an important preliminary in the preparation of the programme. He was judge of the Russian supreme prize court established to determine cases arising during the war with Japan. He died suddenly on June 20, 1909.

See T. E. Holland, in *Journal of the Society of Comparative Legislation* for October 1909, where a list of the writings of Martens appears.

MARTENS, GEORG FRIEDRICH VON (1756–1821), German jurist and diplomatist, was born at Hamburg on Feb. 22, 1756. Educated at the universities of Göttingen, Regensburg and Vienna, he became professor of jurisprudence at Göttingen in 1783 and was ennobled in 1789. In 1814 he was appointed privy cabinet-councillor (*Geheimer Kabinetsrat*) by the king of Hanover, and in 1816 went as representative of the king to the diet of the new German Confederation at Frankfort, where he died on Feb. 21, 1821.

Of his works the most important is the collection of treaties *Recueil des traités,* etc. from 1761 onwards. Of this the first seven vols. were published at Göttingen (1791–1801), followed by four supplementary volumes partly edited by his nephew Karl von Martens. These were followed by *Nouveau recueil,* of treaties subsequent to 1808, in 16 vols. (Göttingen, 1817–42), of which G. F. von Martens edited the first four, the fifth being the work of K. von Martens, the others (6–9) by F. Saalfeld and (10–16) F. Murhard; a *Nouveau Supplément* in 3 vols. was also published by Murhard (Göttingen, 1839–1842). The series has been continued since under other editors.

MARTHA'S VINEYARD, an island of south-eastern Massachusetts, five miles across Vineyard sound from the "heel" of Cape Cod. It comprises about 100sq.m., its greatest length being 19¼m. and its greatest width, from north to south, 9⅜ miles. It figured largely in the whaling industry and merchant trade of former times; now it is chiefly a summer resort, although its many and diverse fisheries continue to be of importance and increasing value. Martha's Vineyard has characteristic insular temperatures. Its topography, of glacial origin, includes picturesque hills, as high as 311ft., strewn with boulders; broad, undulating plains cut by great ponds with many fingerlike coves; deeply indented harbours with contrasting coast lines; and extensive wooded areas. Gay Head, its western peninsula, ends in a stretch of cliffs, 6,000ft. in length and as high as 145ft., of brilliantly coloured sands and clay. Bartholomew Gosnold visited and named Martha's Vineyard in 1602. (It may also have been the Straumey of the Norsemen and the Luisa of Verrazano.) The first settlement was at Great Harbour (Edgartown), sent out by Thomas Mayhew, an English merchant of Watertown, in 1642. The island was controlled by New York until 1692. With the Elizabeth islands it constitutes Dukes county, so named with Kings and Queens, on Long Island, by the New York provincial assembly in 1683.

The six towns of Martha's Vineyard, with population in 1940, are as follows: Tisbury (1,966) is principally the village of Vineyard Haven, called Holmes Hole until 1871. Its fine harbour, of great beauty, made it an historic refuge and port of call for ships. Oak Bluffs (1,584) is the site of camp meetings, held annually, save for a single year, since 1835. Becoming a populous summer town it was incorporated as Cottage City in 1880 and renamed in 1907. Edgartown (1,370) was one of the important whaling centres, serving as the port for Nantucket for many years. It retains much of its atmosphere. West Tisbury (260) was separated from Tisbury in 1892. Chilmark (226) includes the fishing village of Menemsha and the small island of Nomans Land (named after Tequenoman, an Indian). It was founded as Tisbury Manor, with feudal lords, in 1671. Gay Head (127), never relinquished by the Indians, has been an Indian town since 1870. Its men, peculiarly skilled as harpooners, played a noted part in whaling history.

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MARTIAL (MARCUS VALERIUS MARTIALIS) (b. between A.D. 38 and 41, died *c.* A.D. 102), Roman epigrammatist, was born at Bilbilis (Bambola), in Spain (Mart. i. 61. 11 Te, Liciniane, gloriabitur nostra Nec me tacebit Bilbilis). The date of his birth is inferred from his own words in x. 24, where he celebrates his 57th birthday on March 1 (*cf.* x. 92. 10, Martem mearum principem Kalendarum). The poems of Bk. x. belong to the years 95–98.

Life at Rome.—In 64 he came to Rome, where, apart from a brief visit to Cisalpine Gaul (*cf.* iii. 1, iii. 4) in A.D. 88, he made his home for 34 years. Living at first in rather humble circumstances (i. 117, 7 scalis habito tribus sed altis), he gradually made headway and was able to have, in addition to his town house on the Quirinal (x. 58. 10), a small country place at Nomentum (ii. 38, vi. 43, xii. 57) in the Sabine territory. He won the ear of the Court and received from Titus and Domitian the *ius trium liberorum* (ii. 91–92, ix. 97, 5, tribuit quod Caesar uterque ius mihi natorum), a privilege which permitted a person to hold a public office before his 25th year and be exempted from public burdens. Though, strictly, it belonged to the father of three legitimate children, it was frequently conferred on those who had fewer than three children, or even none at all (*cf.* Plin. *Ep.* ii. 13). He also obtained a military tribuneship and the dignities of an *eques Romanus* (iii. 95, 9). In A.D. 98 he finally left Rome to return to his native Bilbilis (xii. 18), where he lived on an estate presented to him by his friend Marcella (xii. 31.7, post septima lustra reverso Hos Marcella lares parvaque regna dedit). Here he wrote and published the last (xii.) book of his Epigrams and soon after died.

Literary Friendships.—At Rome he seemed to have enjoyed the friendship of all the leading literary men of his time. Pliny the Younger (*Ep.* iii. 21) describes his feelings on hearing of the poet's death: "I hear that Valerius Martial has died and I am grieved. He was a man able, acute and keen, who in his writing had wit and pungency and not less of candour. When he was leaving Rome I presented him with his travelling expenses (*viaticum*), a tribute to friendship, a tribute also to the lines he wrote about me." The lines in question are in our texts x. 19, of which Pliny, in his letter, quotes the last ten lines. Quintilian is addressed in ii. 90:

> O chiefest ruler of our wayward youth, Quintilian, glory of the Roman gown, I crave thy pardon if still young nor yet made useless by the years I haste to live True life, which no man hastes enough to live. Howbeit if any is fain to gather wealth Beyond his fathers and to crowd his halls with busts of mighty men, his ancestors, He may defer the day of life, but me the hearth and halls that scorn not sooty smoke Delight, the living spring, the simple grass. Give me my well-fed servant and a wife. No more than needful learnéd, sleep o' nights, And days untroubled by the law's delays.

Lucan is the theme of vii. 21–23, the first and the last of these epigrams being addressed to Polla, Lucan's widow. Juvenal, with whom Martial deprecates comparison (vii.24), is addressed in xii. 18. Silius Italicus is addressed in iv. 14 and mentioned in vi. 64. 10, vii.63.1, xi.48.1, xi.49.3 *seq.*, while i.76, iv.42, iv.49 are addressed to Valerius Flaccus, who is referred to also in i.61.4. There appears to be no reference to Statius either by name or by implication.

Works.—Martial's work consists of: (1) The so-called *Liber Spectaculorum* (33 epigrams), written in connection with the opening of the Colosseum, an amphitheatre in the middle of the city which had been begun by Vespasian (Sueton. *Vesp.* 9) and was finished by Titus (Suet. *Tit.* 7) in A.D. 79. (2) Two books of epigrams (in modern editions Bks. xiii. and xiv.) entitled *Xenia* and *Apophoreta,* two-line inscriptions for presents, published at the Saturnalia of 84. (3) Twelve books of epigrams, of which i. and ii. were published in 86 and iii.-xi. between then and 98. Bk. x. was first published under Domitian, but the revised edition (our present text) belongs to 98. Bk. xii. was written after his final return to Bilbilis. The prose prefaces to Bks. i., ii., viii. (dedication to Domitian), xii. are of considerable interest.

A comparison of Martial with the Greek Anthology suggests three points worthy of notice. (1) By *epigram* the Greeks normally understood a short poem in elegiac couplets, and the overwhelming majority of the epigrams in the Greek Anthology conforms to that definition. We do, indeed, though very rarely, find other metres used, *e.g.,* hendecasyllables, A.P. v. 308, etc., iambic trimeter, A.P. vi. 107, etc., pure hexameters, A.P. v. 109, etc. But in Martial, though the elegiac still constitutes the normal type, other metres occupy a very considerable place. The metres other than elegiac which Martial uses are: (1) hendecasyllables, *e.g.,* x.9.1. Undenis pedibusque syllabisque, (2) pure hexameters, i. 53, etc., (3) iambic trimeter scazon, *e.g.,* vii.26.1, Apollinarem conveni meum, scazon, (4) iambic trimeter alternating with iambic trimeter, *e.g.,* i. 49 Vir Celtiberis non tacende gentibus Nostraeque laus Hispaniae, (5) iambic trimeter scazon alternating with ordinary iambic dimeters, *e.g.,* i.61 Verona docti syllabas amat vatis Marone felix Mantua est, (6) pure iambic trimeters, *e.g.,* vi. 12 Iurat capillos esse quos emit suos. This feature of Martial is probably due, like much else in Martial, to the influence of Catullus, who again was much influenced by the Alexandrines. (2) Whereas the typical epigram of the Greek Anthology does not exceed some eight lines, in Martial 20 to 30 lines is not unusual—iii. 58 extends to 51 lines. Ep. vi. 64 is in pure hexameters and extends to 32 lines. It is followed by a defence in vi. 65. "I know that Tucca says 'you write epigrams in hexameters': Tucca, it is a usual practice and lastly it is legitimate. 'But this is long': that also, Tucca, is usual and legitimate (*solet licetque*). If you approve of shorter epigrams, you should read only distichs. Let's make a bargain—that I be allowed to write long epigrams, you to skip them." (3) The typical epigram in Martial depends for its effect on some witty turn at the end, a "sting" in the tail. This is again a departure from the Greek model, but the development can easily be traced from Alexandrine times. Martial's own point of view may be gathered from vii. 25, where he indicates that epigrams without point and pungency are food only for babes.

Character of His Epigrams.—The subject-matter of the epigrams embraces the whole range of the life of a man about town, and from this point of view their value to the student of Roman life and manners is inestimable. They bear witness alike to the nobler aspects of that life and to the more ignoble. The ugliest feature of Martial's work is the gross indecency—with no plea or palliation of comic effect—which disfigures some—not relatively a large proportion—of his epigrams. It is difficult to imagine the tone of a society which could not merely tolerate but even applaud such language. Martial defends himself on the ground of traditional usage. "I should have apologized," he says (pref. to Bk. i.), "for the lascivious frankness of speech, the language, that is, of my epigrams, had I been setting the example; but it is thus that Catullus writes, thus Marsus, thus Pedo, thus Gaetulicus, thus every author whose work is read to an end. If however any one is so ostentatiously austere that in his presence one can in no page speak Latin, he may content himself with this letter, or even with the title. The Epigrams are written for those who are accustomed to see the Festival of Flora. Let Cato not enter my theatre, or, if he enter, let him look on." Two things may be noted: (1) Martial considered himself in this matter superior to the generality. In x. 9. 2 he describes himself as known "for much wit and that not wanton" (Et multo sale nec tamen protervo), and in xii.43.11 he protests to one who had recited to him eloquent lines on libidinous topics—*Tanti non erat esse te disertum,* Your eloquence was too dearly purchased at such a price. In the dedication to Domitian prefixed to Bk. viii. he writes: "Although men the most austere and of the highest rank have written epigrams affecting a liberty of language appropriate to *mimes,* yet I have not permitted mine to speak so frankly as is usual." (2) Martial protests that licence in speech does not imply licentiousness of life: Lasciva est nobis pagina, vita proba (i.4.8). In any case his candour disarms criticism: Non potes in nugas dicere plura meas Ipse ego quam dixi. . . . Nos haec novimus esse nihil (xiii.2).

Emotional Quality in Poems.—Among the more pleasant features of his poetry are his genuine feeling for the simpler aspects of country life, which reveals itself in many charming pictures (i.49, i.55, iii.58, etc.); the tenderness which shows itself in his sepulchral epigrams, some of which are worthy to stand beside the best Greek examples, such as those on Alcimus (i.88) and Canace (xi.91) or this—one of several—on Erotion, a little slave girl who died in infancy:

Here, ah! too soon, Erotion takes her sleep,
Whom Death's fell scythe ere her sixth year did reap.
O whoso henceforth shall this land possess,
If thou be kind this little grave to dress,
Long may thy tenure be, and through the years
May thy heart know no other place for tears! (x.61).

and finally his affection for his native Bilbilis, to which "after four and thirty harvests" the tired exile returns, having known fame and friends, but also having suffered the disillusion which suggests that sad and sober philosophy of friendship, enunciated long before in Euripides (*Hippol.* 253 *seq.*) and Sophocles (*Aj.* 678 *seq.*): Nulli te facias nimis sodalem, Gaudebis minus et minus dolebis (xii.34.10 *seq.*).

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See also Edwin Post, *Selected Epigrams of Martial* (1908) with introduction and notes; G. Thiele, *Die Poesie unter Domitian,* Hermes 51 (1916); the translation into English verse by Elphinston (London, 1782) is famous for its absurdity, which drew an epigram from Burns.

(A. W. Ma.)

MARTIALIS, QUINTUS GARGILIUS, a Latin writer on horticultural subjects. He has been identified by some with the military commander of the same name, mentioned in a Latin inscription of A.D. 260 (*C. I. L.* viii. 9047) as having lost his life in the colony of Auzia (*Aumale*) in Mauretania Caesariensis. Considerable fragments of his work (probably called *De hortis*), which treated of the cultivation of trees and vegetables, and also of their medicinal properties, have survived, chiefly in the body of and as an appendix to the *Medicina Plinii* (an anonymous 4th century handbook of medical recipes based upon Pliny, *Nat. Hist.* xx.–xxxii.). Extant sections treat of apples, peaches, quinces, almonds and chestnuts. Gargilius also wrote a treatise on the tending of cattle (*De curis boum*), and a biography of the emperor Alexander Severus is attributed by two of the Scriptores historiae Augustae (Aelius Lampridius and Flavius Vopiscus) to a Gargilius Martialis, who may be the same person.

Bibliography.—*Gargilii Martialis . . . fragmenta,* ed. A. Mai (1846); *Plinii secundt quae fertur medicina,* ed. V. Rose (1876); *De curis boum,* ed. E. Lommatzsch (1903) with Vegetius Renatus's *Mulomedicina,* "Gargilius Martialis und die Maurenkriege," C. Cichorius in G. Curtius, *Leipziger Studien.* x. (1887), where the inscription referred to above is fully discussed; *see* also Teuffel-Schwabe, *Hist. of Roman Literature* (Eng. trans.), § 380.

MARTIAL LAW. "Martial Law" is a much misunderstood term, the use of which has given rise to a great deal of speculation.

Definition.—Much of the confusion and doubt about its meaning and the powers exercisable in its name would have been avoided if modern writers had been careful to confine the term to its original meaning as used by Hale and Coke, namely, the law applied to the army and nothing else, the law known as "military law." Modern writers have appropriated the term "martial law" to the assumption of arbitrary powers by the Executive, in time of civil disturbances, over civilians, and have then proceeded to read earlier authorities by the light of its rays. The result is to darken their counsel and beget a gross anachronism. Hale (*History of the Common Law,* pp. 36–42) says of martial laws that "the necessity of good order and discipline *in the army* is that *only* which can give these laws countenance." He accordingly held that it could not apply to civilians in any circumstances.

The term was used in the same sense as Hale uses it in the famous Petition of Right, which forbade martial law in time of peace. The "Petition" did not thereby, either expressly or impliedly, legalize it in time of war. The contemporary debates in the House of Commons show that the men of those days did not contemplate the legality of martial law, as applied to civilians, under any circumstances. In objecting to martial law they were objecting to commissions issued by the king to try civilians as though they were soldiers subject to military law and triable by court-martial. As for soldiers themselves, the contemporary view was that at common law, even they were not, in time of peace, subject to martial law, *i.e.,* to military law, except by statute (a view which now finds countenance in the necessity of the annual Army Act), although in the field, in time of war, they were so subject. Or to put it another way, martial law was pure military law, and as such unknown to the common law, and only came into existence with the outbreak of war and even then was confined to troops.

THE EXERCISE OF MARTIAL LAW

Cockburn, C. J., was unquestionably right in holding (*see* his observations in the *Queen* v. *Nelson,* Finlasson's edition, p. 66) that the Petition of Right condemned the exercise of martial law against the subject "under any circumstances," whether in "war" or in "peace," and even as against soldiers except in the case of armies in time of war. The promoters of the Petition of Right were solely concerned to assert the supremacy of the common law. Even a rebel, they argued, taken with arms in his hands, had a right to be tried by the ordinary common law courts. If he could not be so tried, the law was then altogether suspended. They did not trouble themselves with the question with which modern lawyers are so greatly vexed, namely as to whether there could exist a kind of qualified "state of war" under which the courts might still be sitting, but in circumstances of military indulgence such as would bind them not to interfere. This modern view has helped to give a colour of legality to martial law which would have been incomprehensible to the Stuart generation, denying, as they did, the very existence of the thing except within the determinate limits of military law.

Early Views.—The 17th century view as to the position of the ordinary courts was clear and unequivocal. It was that if the civilian situation was such that the courts were able to sit at all, the judges were free to examine every arbitrary act of the military on its merits. If the civil situation was so "warlike"—the term "war," in connection with martial law, does not mean war in the international sense, but war in the sense of rebellion or civil strife, as in the Statute of Treasons where it is declared to be treason for a subject to "levy war" against the king in his realm—that the courts could not sit, the king's writ did not run, and the sheriffs and ministers of justice could not levy execution, then such facts constituted a state of war (*cf.* Coke, *Institutes I.,* 249 *b*). But the existence of such facts must be proved to the satisfaction of the courts, if and when they were able to sit. The courts could thus, either *at the time or after,* decide whether the military measures taken to suppress the civilian commotion exceeded the necessity of the case, in precisely the same way as the courts always decide how far civilians and police are justified in using force to encounter and suppress force. The mere fact that the military, for the more instant suppression of the disturbances or the rebellion, have "tried" the rebels by court-martial in no way implies that those "trials" are lawful or that any law has been administered. A trial by martial "law" is a purely executive act. It is for this reason that the civil courts have no jurisdiction to review the "judgments" of such bodies by *way of appeal*—the memorandum of their proceedings is not the record of a court of justice (cf. *A. G.* v. *Van Reenen* [1904], A.C. 117). The so-called courts-martial, convened to try civilians under martial law, cannot, as two law officers long ago pointed out (*see* Forsyth, *Cases and Opinions in Constitutional Law,* p. 555), be properly described as courts at all. The way to seek relief from a sentence of such a tribunal is not by writ of prohibition or by appeal, but by an application for a writ of Habeas Corpus (*cf.* Lord Sumner in the recent Irish case *Re Clifford and O'Sullivan* [1921], 2 A.C. 570).

MARTIAL AND COMMON LAW

The truth of the matter is that the term martial law is really an anachronism and legally means nothing at all. Martial law is simply, as Fitzjames Stephen put it, "the assumption by the officers of the Crown of *absolute power* exercised by military force for the suppression of an insurrection and the restoration of order and lawful authority." It should never be resorted to for punishment except in so far as immediate punishment is necessary for suppression of the disturbance. The moment the disturbance is over, the prisoners should be handed over to the civil power. The very fact that it means the assumption of "absolute power" renders it subject to the control of the courts *ab initio*. A mere "proclamation" of martial law by the Crown has, of itself, no legal validity whatsoever. A proclamation is not necessary to justify resort to martial law nor is the resort to martial law justified by it. It is all a question of fact. One must thus carefully distinguish between the prerogative of the Crown to declare war with a foreign country and the alleged prerogative—there is none—to declare the realm internally in a state of war, *i.e.*, a state of rebellion. The former is absolute and binding on the courts (*see* PREROGATIVE) who cannot question it; the latter is not binding on the courts at all and they may, whenever the Crown proclaims a "state of war" within the country, go behind the proclamation and enquire (1) whether, as a question of fact, there is such a state of affairs and (2) whether the acts done by the authorities in putting down such war, if it exists, are justified. There can be no doubt about this, but it is still a matter of some dispute whether, once they are satisfied that a state of war exists, the courts, if sitting, can, during the actual continuance of disturbance, interfere with the action of the military authorities.

In the famous *Marais* case, A.C. (1902) 109, the Privy Council, discarding Coke's doctrine that the fact that the courts were still able to sit did not establish *ipso facto* the absence of the state of war, went on to lay down that the courts should not interfere with the discretion of the military authorities, *e.g.*, by granting a writ of Habeas Corpus, to anyone detained by them, while war was actually raging, but that they might enquire afterwards into the validity of the acts done by the military. To the writer of this article, the distinction seems untenable. It amounts to the paradoxical contention that the common law is, for the time being, neither quick nor dead but merely passive; the "necessity" of the moment is held to be too overwhelming to permit of a contemporaneous enquiry but not so overwhelming as to forbid a retrospective one; "we cannot interfere now"—such appears to be the argument—for, to do so, would be to assume responsibility for and lend countenance to the acts of the military authorities, but we reserve our right to do so afterwards." If this view is to prevail, it would make it possible for the military authorities to contract and expand the geographical area of their martial law jurisdiction at will, with the common law courts merely looking on.

STANDARD CASES

The older doctrine, which received statutory countenance in American cases (cf. *Ex parte Milligan* [1866], 4 Wallace 2, and the dissentient judgment of Mr. Justice Woodbury in *Luther* v. *Borden* [1849], 7 How. 1), was that nothing short of the complete suppression of civil authority and the closing of the courts—in other words, such overwhelming necessity as silences the voice of justice altogether—could establish martial law. The view taken in the *Marais* case seems to proceed on the assumption that the judiciary exists by sufferance of the Executive; it goes very near a repudiation of jurisdiction altogether, and in that respect is perilously like the discredited doctrine of "act of state." It is difficult, if one accepts the doctrine of the *Marais* case, to escape the conclusion in the American case of *Luther* v. *Borden* (although that case be turned on a different point): "If this right [of interference] does not reside in the courts when the conflict is raging, and if the judicial power is, at that time, bound to follow the decision of the political, *it must equally be bound when the contest is over;* it cannot, when peace is restored, punish, as offences and crimes, the acts which it before recognized and was bound to recognize as lawful." In other words, it seems more reasonable to hold that the common law persists throughout the disturbances and that the courts can interfere at any stage. Whether they should do so must depend on the merits of the particular case. They certainly should not interfere if, in the particular situation, their interference is calculated to hamper, delay and embarrass the military authorities in the suppressing of the rebellion, and thereby to prolong it. During the Irish disturbances of 1920–1922, the Irish courts, however, followed and applied the doctrines of the *Marais* case (cf. *Higgins* v. *Willis* [1924], 2 Irish Rep. K.B.D. 386; *R.* v. *Portobello Barracks C.O. Ex parte Erskine Childers* [1923], 1 Irish Rep. 5, and *R.* v. *Strickland* [1921], 2 Irish Rep. 317).

The whole subject of martial law—or rather the extent to which its enforcement is justified—provoked a blaze of excitement in the year 1919, as the result of the action of Gen. Dyer on April 13 of that year in ordering his troops to fire, with decisive results, on a bloodthirsty mob who, for several days, had been terrorizing the peaceful inhabitants of Amritsar in the Punjab province of India. As the result of the agitation of the Indian extremists, a committee of enquiry was appointed, whose constitution and procedure were, in the language of Lord Finlay, "most unseemly." As the result of the committee's report, the India Office, which acted with gross cowardice, removed Gen. Dyer from the army. The whole matter subsequently came under review in a debate in the House of Lords (41 H.L. Deb. 5 s. 222), which, by a large majority, approved the action of Gen. Dyer. Later on in the case of *O'Dwyer* v. *Nair* (unreported) an English jury, after a masterly summing up by Mr. Justice McCardie, vindicated the action of Gen. Dyer, which was one of the points at issue, and awarded heavy damages to Sir Michael O'Dwyer, the lieutenant governor of the Punjab under whose authority Gen. Dyer acted, against the defendant who had written a book describing the action of both these distinguished public servants as an "atrocity." The main point at issue in all this was whether Gen. Dyer used "unnecessary force," and the view was strongly expressed in the House of Lords by Lord Sumner that under modern conditions, with all their possibilities of rapid propaganda and equally rapid communication, a soldier, placed like Gen. Dyer, was entitled to take into account the possibility—and in this case the extreme probability—of a general rising if he did not take stern measures. Public opinion, when not clouded by political considerations, has entirely endorsed this view and it is widely held that the action of Sir Michael O'Dwyer and Gen. Dyer "saved India."

MARTIAL LAW AND THE WORLD WAR

A somewhat paradoxical situation arose with the outbreak of the World War. England was at war with Germany, but there was no "state of war" in England, in other words, no internal disturbance such as would justify resort to martial law. On the other hand, it was obviously necessary that the Executive should be armed with extensive powers to secure the safety and defence of the realm, such as the power, which at common law it did not possess, to suppress the publication of information likely to be of use to the enemy, to secure the safety of communications, and a thousand other things. The difficulty was met by the enactment of the famous Defence of the Realm Acts and the regulations thereunder, the effect of which was, among other things, to introduce a kind of statutory martial law and to abridge the common law rights of the subject in every direction. So far did this departure go that by the Consolidation Act, Nov. 27, 1914, provision was made for trial and punishment by court-martial of any civilian, committing offences against the regulations, "as if he were a person subject to military law"—in other words a soldier—"and had committed the offence on active service." It was further provided that if the offence were committed with the intention of assisting the enemy, "he should be punishable with sentence of death." This tremendous and unprecedented extension of military law to the civil population was severely criticized in the House of Lords, and, four months later, in March 1915, an amending act was passed restoring the right to trial by jury in the case of a British subject, while leaving the alien subject to this military jurisdiction. The mere fact that all this "Dora" legislation was necessary illustrates the strict limitations to which the assumption of despotic power, known as martial law, is subject in English law. The same may be said of the Emergency Powers Act of 1920, giving the Crown power by proclamation, subject always to the positive approval of parliament within 10 days, to take various measures to deal with industrial disturbances threatening the supply of the necessaries of life to the population. (*See* also MILITARY LAW.)

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sults (1914); Morgan, *The Army and the Civil Power* (1918); Forsyth, *Cases and Opinions;* Dicey, *Law of the Constitution;* O'Sullivan, *Military Law and the Supremacy of the Civil Courts; Heddon* v. *Evans* (1919), 35 T. L. K. 642; Clode, *Martial and Military Law;* Holdsworth, *Law Quarterly Review* xviii. 129; Hansard, 41 H.L.Deb. 5 s. 222; Fairman, *Law of Martial Rule* (1930). (J. H. Mo.)

UNITED STATES

In the United States, martial law, as distinguished from military law, is the temporary government and control, under a body of principles or doctrines, by the military authorities, of a Territory or a State in which, by reason of war, or overwhelming public disturbance, the Territory or State is unable to preserve order or enforce its law. (*In re Kemp,* 16 Wis. 309, 368, and *Ex parte Milligan,* 1866, 4 Wallace 2.) Its authority depends upon a state of complete insurrection and terminates when the insurrection ends, or a reasonable time thereafter. (*In re Moyer,* 85 Pac. 192; *Boon* v. *Aetna Insurance Company,* 40 Conn. 575, 584.) Martial law is not provided for in the U.S. Constitution, except by inference, but is rather a means of preserving the Constitution. It is the law of necessity and asserts itself.

Where the civil courts are open and able to exercise their functions, with the aid of the military if necessary, there can be no exercise of martial law. (But see *State Ex Rel. Mays* v. *Brown,* 45 L.R.A., N.S. 996.) When martial law prevails martial-law courts, provost courts, military commissions or other courts of the military commands may punish those guilty of acts which obstruct the military in its enforcement of order. This authority ends with the cessation of hostilities. Martial law may be exercised in time of war only, and within the theatre of war, and where the civil courts are wholly unable to exercise their functions. It found its use in the United States in New Orleans in 1815, in the border States in 1861–65, and during the World War. The use of the military forces to aid the civil power has its justification in law, while martial law finds its justification in necessity.

See Fairman, *Law of Martial Rule* (1930); "Lieber's Justification of Martial Law Theory," *North American Review* (1896); Winthrop, *Military Law and Precedents;* Birkhimer, *Military Government and Martial Law;* W. E. Hall, *International Law.* (F. W. Ha.)

MARTIGNAC, JEAN BAPTISTE SYLVERE GAY, Vicomte de (1778–1832), French statesman, was born at Bordeaux on the 20th of June 1778. In 1798 he acted as secretary to Sieyès; then after serving for a while in the army, he turned to literature, producing several light plays. Under the Empire he practised with success as an advocate at Bordeaux, where in 1818 he became advocate-general of the *cour royale.* In 1819 he was appointed *procureur-général* at Limoges, and in 1821 was returned for Marmande to the Chamber of Deputies, where he supported the policy of Villèle. In 1822 he was appointed councillor of state, in 1823 he accompanied the duc d'Angoulême to Spain as civil commissary; in 1824 he was created a viscount and appointed director-general of registration. In contact with practical politics his ultra-royalist views were gradually modified in the direction of the Doctrinaires, and on the fall of Villèle he was selected by Charles X. to carry out the new policy of compromise. On the 4th of January 1828 he was appointed minister of the interior, and, though not bearing the title of president, became the virtual head of the cabinet. He succeeded in passing the act abolishing the press censorship, and in persuading the king to sign the ordinances of the 16th of June 1828 on the Jesuits and the little seminaries. He was exposed to attack from both the extreme Left and the extreme Right, and when in April 1829 a coalition of these groups defeated him in the chamber, Charles X., who had never believed in the policy he represented, replaced him by the prince de Polignac. His last public appearance was in defence of Polignac in the Chamber of Peers in December 1830. He died April 3, 1832.

Martignac published *Bordeaux au mois de Mars 1815* (1830), and an *Essai historique sur les révolutions d'Espagne et l'intervention française de 1823* (1832). *See* also E. Daudet, *Le Ministère de M. de Martignac* (1875).

MARTIGUES, a port of south-eastern France, department of Bouches-du-Rhône, on the south shore of the lagoon of Berre, and at the eastern extremity of that of Caronte, by which the former is connected with the Mediterranean. Pop. (1936) 6,415. Built in 1232 by Raymond Bérenger, count of Provence, Martigues was made a viscountship by Joanna I., queen of Naples. Henry IV. made it a principality, in favour of a princess of the house of Luxembourg. It afterwards passed into the hands of the duke of Villars. Martigues is 23 m. W.N.W. of Marseilles by rail. It is divided into three quarters by canals. It has a harbour (used by coasting and fishing vessels), marine workshops, and oil and soap manufactures. A dainty, *boutargue,* is prepared from the roes of the grey mullet caught in the salt lagoons and is said to rival Russian caviare, though the flavour is quite different. Owing to its canals and numerous bridges the town has sometimes been called "the Venice of Provence."

MARTIN, ST. (*c.* 316–400), bishop of Tours, was born of heathen parents at Sabaria (Stein am Agger) in Pannonia, about the year 316. When ten years old he became a catechumen, and at 15 he reluctantly entered the army. While stationed at Amiens he divided his cloak with a beggar, and on the following night had the vision of Christ making known to his angels this act of charity to Himself on the part of "Martinus, still a catechumen." Soon afterwards he received baptism, and two years later, having left the army, he joined Hilary of Poitiers, who wished to make him a deacon, but at his own request ordained him to the humbler office of an exorcist. On a visit home he converted his mother, but his zeal against the Arians roused persecution against him, and for some time he lived an ascetic life on the desert island of Gallinaria near Genoa. Between 360 and 370 he was again with Hilary at Poitiers, and founded in the neighbourhood the monasterium locociagense (Licugé). In 371–372 the people of Tours chose him for their bishop. He did much to extirpate idolatry from his diocese and from France, and to extend the monastic system. To obtain privacy for the maintenance of his personal religion, he established the monastery of Marmoutier-les-Tours (Martini monasterium) on the banks of the Loire.

At Trèves, in 385, he entreated that the lives of the Priscillianist heretics should be spared, and he ever afterwards refused to hold ecclesiastical fellowship with those bishops who had sanctioned their execution. He died at Candes in the year 400, and is commemorated by the Roman Church on Nov. 11.

He is the patron of the cities of Mainz and Würzburg. The *Life* by his disciple Sulpicius Severus is practically the only source for his biography, but it is full of legendary matter and chronological errors. Gregory of Tours gives a list of 206 miracles wrought by him after his death; Sidonius Apollinaris composed a metrical biography of him. The Feast of St. Martin (Martinmas) took the place of an old pagan festival, and inherited some of its usages (such as the *Martinsmännchen, Martinsfeuer, Martinshorn* and the like, in various parts of Germany); by this circumstance is probably to be explained the fact that Martin is regarded as the patron of drinking and jovial meetings, as well as of reformed drunkards.

See A. Dupuy, *Geschichte des heiligen Martins* (Schaffhausen, 1855); J. G. Cazenove in *Dict. chr. biog.* iii. 838; C. A. Bernoulli, *Die heiligen der Merowinger* (1900); C. H. von Rhin, *Martin von Tours* (1912).

MARTIN (Martinus), the name of several popes.

Martin I. succeeded Theodore I. in June or July 649. He had previously acted as papal apocrisiarius at Constantinople. Almost his first official act was to summon a synod (the first Lateran) for dealing with the Monothelite heresy. It met in the Lateran church, was attended by one hundred and five bishops (chiefly from Italy, Sicily and Sardinia, a few being from Africa and other quarters), held five sessions or "secretarii" (Oct. 5–31, 649), and in twenty canons condemned the Monothelite heresy, its authors, and the writings by which it had been promulgated. In this condemnation were included, not only the *Ecthesis* or exposition of faith of the patriarch Sergius for which the emperor Heraclius had stood sponsor, but also the Typus of Paul, the successor of Sergius, which had the support of the reigning emperor (Constans II.). Martin published the decrees of his Lateran synod in an encyclical, and Constans replied by enjoining his exarch to seize the pope and send him prisoner to Constantinople. Martin was arrested in the Lateran (June 15, 653), hurried out of Rome, and conveyed first to Naxos and subsequently to Constantinople (Sept. 17, 654). He was ultimately banished to Cherson, where he arrived on March 26, 655, and died on Sept. 16 following. His successor was Eugenius I.

A full account of the events of his pontificate will be found in Hefele's *Conciliengeschichte,* vol. iii. (1877).

MARTIN II. and III., *see* MARINUS I. and II.

MARTIN IV. (Simon Mompitié de Brion), pope from Feb. 22, 1281, to March 28, 1285, should have been named Martin II. He was born about 1210 in Touraine. He became a priest at Rouen and canon of St. Martin's at Tours, and was made chancellor of France by Louis IX. in 1260 and cardinal-priest of Sta. Cecilia by Urban IV. in 1261. As papal legate in France he conducted the negotiations for the assumption of the crown of Sicily by Charles of Anjou, through whose influence he succeeded Nicholas III., after a six-months' struggle between the French and Italian cardinals. The Romans at first declined to receive him, and he was consecrated at Orvieto on March 31, 1281. His excommunication of the emperor Michael Palaeologus (Nov. 1281), who stood in the way of the French projects against Greece, weakened the union with the Eastern Christians, dating from the Lyons Council of 1274. He unduly favoured his own countrymen, and for three years after the Sicilian Vespers (March 31, 1282) he employed all the resources of the papacy on behalf of his patron against Peter of Aragon. He was driven from Rome by a popular uprising and died at Perugia. His successor was Honorius IV.

His registers have been published in the *Bibliothèque des écoles françaises d'Athènes et de Rome* (Paris, 1901).

See A. Potthast, *Regesta pontif. roman.,* vol. 2 (Berlin, 1875); K. J. von Hefele, *Conciliengeschichte,* Bd. 6, 2nd ed.; F. Gregorovius, *Rome in the Middle Ages,* vol. 5, trans. by Mrs. G. W. Hamilton (London, 1900–02); H. H. Milman, *Latin Christianity,* vol. 6 (London, 1899); W. Norden, *Das Papsttum u. Byzanz* (Berlin, 1903); E. Choullier, "Recherches sur la vie du pape Martin IV.," in *Revue de Champagne,* vol. 4 (1878); *Processo istorico dell' insurrezione di Sicilia dell' anno 1282,* ed. by G. di Marzo (Palermo, 1882).

MARTIN V. (Otto Colonna) (1417–1431) was elected at Constance on St. Martin's Day, in a conclave composed of twenty-three cardinals and thirty delegates from the five different "nations" of the council. Having become a cardinal under Innocent VII., he had seceded from Gregory XII. in 1408, and together with the other cardinals at Pisa, had taken part in the election of Alexander V. and afterwards of John XXIII. At Constance, his rôle had been chiefly that of an arbiter; he was a good and gentle man, leading a simple life, free from intrigue. While refraining from making any pronouncement as to the validity of the decrees of the fourth and fifth sessions, which had seemed to proclaim the superiority of the council over the pope, Martin V. nevertheless soon revealed his personal feelings by having the constitution read in consistory which forbade any appeal from the judgment of the sovereign pontiff in matters of faith (May 10, 1418).

Martin V. himself settled a great number of points, which had been raised at the council, and then passed a series of special concordats with Germany, France, Italy, Spain and England. Though this was not the thorough reform of which need was felt, the council itself gave the pope a *satisfecit.* When the council was dissolved Martin V. made it his task to regain Italy. After staying for long periods at Mantua and Florence, where the deposed pope, Baldassare Cossa (John XXIII.), came and made submission to him, Martin V. was enabled to enter Rome (Sept. 30, 1420). He set to work to repair the damage done by the Great Schism, to enter into negotiations, unfortunately unfruitful, with the Greek Church also with a view to a return to unity, to organize the struggle against heresy in Bohemia; to interpose his pacific mediation between France and England, as well as between the parties which were rending France; and, finally, to welcome Bernardino of Siena and Francesca Romana, foundress of the nursing sisterhood of the Oblate di Tor de' Specchi (1425).

Martin V., after an interval of five years, summoned a new council, which was almost immediately transferred from Pavia to Siena, in consequence of an epidemic (1423). It was quickly dissolved. Pending the reunion of the new council which had been summoned at Basel, Martin V. himself endeavoured to effect a reformation in certain points, but he died (Feb. 20, 1431), just as he had designated the young and brilliant Cardinal Giuliano Cesarini to preside in his place over the council of Basel.

See L. Pastor, *Geschichte der Päpste* (1901), i. 205–279; J. Guiraud, *L'État pontifical après le Grand Schisme* (1896); Müntz, *Les Arts à la cour des papes pendant le xv^e^ et le xvi^e^ siècle* (1878); N. Valois, *La Crise religieuse du xv^e^ siècle; le pape et le concile* (1909), vol. i. p. i.–xxix., 1–93.

MARTIN, FRANÇOIS XAVIER (1762–1846), American jurist and author, was born in Marseille, France, on March 17, 1762. An immigrant to North Carolina during the Revolution, he supported himself by teaching French and working as a printer. Meanwhile he studied English and law to such good purpose that he became a member of the general assembly in 1806 and was commissioned a judge of the superior court of the Territory of Mississippi in 1809. The following year he assumed a similar position in Louisiana. In 1813 he became attorney general of the newly established State of Louisiana, in 1815 a judge of the supreme court, and from 1836 to 1846 the presiding judge. His work in publishing in English and French *A General Digest of the Acts of Legislatures of the Late Territory of Orleans and of the State of Louisiana* (1816) and in publishing reports of decisions of the superior and supreme court (20 vol., 1811–30), particularly valuable in view of the tangle of French, Spanish and English laws, won him the title of "father of Louisiana jurisprudence." His *History of Louisiana from the Earliest Period* (2 vol., 1827–29) made him a pioneer in this field also, but his work, though accurate, partakes of some of the dryness of his legal studies and lacks entirely the glow of Gayarré's histories. Martin was also the author of a *History of North Carolina* (2 vol., 1829) and of various other legal books published in, or concerned with, that State. He died in New Orleans on Dec. 10, 1846.

See memoirs by H. A. Bullard in B. F. French, *Historical Collections of Louisiana* (vol. ii., 1850) and by W. W. Howe in the 1882 edition of Martin's *History.*

MARTIN, HENRI (1810–1883), French historian, was born at St. Quentin (Aisne), where his father was a judge. With Paul Lacroix ("le Bibliophile Jacob"), he planned a history of France, to consist of excerpts from the chief chroniclers and historians, with original matter filling up gaps in the continuity. His *Histoire de France,* 15 vols. (1833–36), was the result. This *magnum opus,* rewritten and further elaborated (4th ed., 16 vols. and index, 1861–65) gained for the author in 1856 the first prize of the Academy, and in 1869 the grand biennial prize of 20,000 francs. A popular abridgment in seven volumes was published in 1867. This, together with the continuation, *Histoire de France depuis 1789 jusqu'à nos jours* (6 vols., 1878–83), gives a complete history of France, and supersedes Sismondi's *Histoire des Français.* Martin sat in the *assemblée nationale* as deputy for Aisne in 1871, and was elected life senator in 1878, but he left no mark as a politician. He died in Paris on Dec. 14, 1883.

See Hanotaux, *Henri Martin; sa vie, ses oeuvres, son temps* (2nd ed., 1898).

MARTIN, HOMER DODGE (1836–1897), American artist, was born at Albany (N.Y.) on Oct. 28, 1836. A pupil for a short time of William Hart, his earlier work followed the lines of the Hudson river school. He was elected as associate of the National Academy of Design, New York, in 1868, and a full academician in 1874. During a trip to Europe in 1876 he was captivated by the Barbizon school, and from 1882–86 he lived in France, spending much of the time in Normandy. At Villerville he painted his "Harp of the Winds," now at the Metropolitan Museum of Art, New York. Among his important canvases are "Westchester Hills," "Adirondack Scenery," "The Cinqueboeuf Church," "Sand Dunes," and "A Newport Landscape." Martin is generally spoken of as one of the great trio of American landscape artists, the others being Inness and Wyant, and examples of his work are in most of the important American collections. He died at St. Paul (Minn.) on Feb. 2, 1897.

MARTIN, JOHN (1789–1854), English painter, was born at Haydon Bridge, near Hexham, on July 19, 1789. His first picture, "Sadak in Search of the Waters of Oblivion," was exhibited in the Royal Academy of 1812. His most famous work was "Belshazzar's Feast," exhibited in 1821, and reproduced in many media. Other popular works were "Joshua" (1816), "The Fall of Babylon" (1833), the "Eve of the Deluge" (1841), and a series of other Biblical and imaginative subjects. In 1832–1833 Martin drew and engraved a fine series of designs to Milton, and with Westall he produced a set of Bible illustrations. He died in the Isle of Man on Feb. 17, 1854.

See M. L. Hendered, *John Martin, Painter* (1923).

MARTIN, LUTHER (1748–1826), American lawyer, was born in New Brunswick, N.J., on Feb. 9, 1748. He graduated at the college of New Jersey (now Princeton university) in 1766, and removed to Maryland, teaching at Queenstown in that colony until 1770. He was admitted to the bar in 1771, and became recognized as one of the ablest lawyers in the United States. From 1778 to 1805 and again in 1818–22 he was attorney-general of Maryland. He was one of Maryland's representatives in the constitutional convention of 1787 at Philadelphia, but opposed the constitution and refused to affix his signature. He subsequently allied himself with the Federalists, and was an opponent of Thomas Jefferson, who in 1807 spoke of him as the "Federal Bull-Dog." His ability was shown in his famous defence of Judge Samuel Chase (*q.v.*) in the impeachment trial before the United States Senate in 1804–05, and in his defence of Aaron Burr (*q.v.*) against the charge of treason in 1807. Though he received a large income, he was so improvident that he was frequently in want. Martin died at the home of Aaron Burr in New York on July 10, 1826.

See the biographical sketch by Henry P. Goddard, *Luther Martin, the Federal Bull-Dog* (Baltimore, 1887), No. 24 of the "Peabody Fund Publications," of the Maryland Historical Society.

MARTIN, SIR THEODORE (1816–1909), British man of letters, the son of a solicitor, was born at Edinburgh on Sept. 16, 1816, and educated at the Royal High school and the University. He practised for some time as a solicitor in Edinburgh, but in 1846 went to London, where he joined a firm of parliamentary agents, eventually becoming senior partner. He contributed in Edinburgh to *Fraser's Magazine* and *Tait's Magazine*, under the signature of "Bon Gaultier," and in 1855, with W. E. Aytoun (*q.v.*), he published the famous *Bon Gaultier Ballads*. In 1858 he published, also with Aytoun, a volume of translations of the *Poems and Ballads of Goethe*. In 1861 he married Helena Faucit (*q.v.*). While engaged upon a memoir of Aytoun (1867) Martin was requested by Queen Victoria to undertake the *Life of His Royal Highness the Prince Consort* (5 vols., 1874–76). A knighthood was then conferred upon him. Among his other works may be mentioned *Queen Victoria as I Knew Her* (1908). Sir Theodore Martin died on Aug. 18, 1909.

MARTIN, VIOLET FLORENCE (1862–1915) ("Martin Ross"), was born at Ross House, Co. Galway, from which she took her pen-name, on June 11, 1862, of an old Irish family. From the time of her father's death in 1872, she spent her childhood in Dublin, and was educated privately and at Alexandra college, Dublin. The greater part of her life was spent in Ireland, but she often travelled abroad with her cousin Edith Oenone Somerville, with whom she collaborated. Their books give vivid and sympathetic pictures of Irish life, and their love of hunting (Miss Somerville was for 12 years master of the West Carbery foxhounds) gave rise to the series of books of which *Some Experiences of an Irish R.M.* is perhaps the best known. Their novels include *The Real Charlotte* (1894), their first serious work; *Mount Music* (1919), and *The Enthusiast* (1921). The two latter were published under joint authorship, although after Miss Martin's death, as they were largely her work. Her qualities can best be seen in two volumes of essays, autobiographical in character, *Some Irish Yesterdays* (1906) and *Stray-Aways* (1920). She died at Cork on Dec. 21, 1915.

MARTIN, SIR WILLIAM FANSHAWE (1801–1895), British admiral, son of Admiral of the Fleet Sir Thomas Byam Martin, comptroller of the navy, was born on Dec. 5, 1801. He entered the navy when twelve, and secured rapid promotion, becoming lieutenant in 1820, commander of the "Fly" sloop in 1823, commodore commanding the Channel squadron in 1849–52, rear-admiral in 1853 and for the next four years superintendent of Portsmouth dockyard. He was made vice-admiral in February 1858 and, after a year as a lord of the admiralty, was appointed commander-in-chief in the Mediterranean. He had no war service, and, beyond the Italian disturbance of 1860–61, no opportunity for showing diplomatic ability. He became an admiral in Nov. 1863 and on Dec. 4 succeeded to the baronetcy which had been conferred on his grandfather. His last appointment was the command at Plymouth, 1866–69. In 1878 he was made rear-admiral. He died at Upton Grey, near Winchfield, on March 24, 1895. He is remembered as a reformer of discipline and the originator of a system of steam manoeuvres.

MARTIN, a name applied to the well-known European and American birds, the house martin (*Delichon urbica*), sand martin (*Riparia riparia*) and the purple martin (*Progne subis*). Others occur all over the world, except in New Zealand.

The house martin, like its ally the swallow (*q.v.*) is a migrant, arriving in Europe and western Asia in spring from its winter quarters in South Africa and India. It is a smaller bird than the swallow, lacking the latter's forked tail; the plumage is black above and white beneath. The nest, a half hemisphere of mud and straw, lined with feathers, is built under the eaves of houses; occasionally nests are found on cliffs, which must have been the original site. Two broods are usual.

The sand martin is smaller than the last and has a brownish tinge to the upper parts. It is the earliest of the British Hirundinidae to arrive. The nest is placed at the end of a horizontal burrow in a sandy bank or the face of a quarry. It ranges from Ireland to the Sea of Okhotsk and thence right across North America, where it is called the bank swallow. In winter, it reaches the Transvaal, India and Caiçara in Brazil. The larger purple martin of Canada and the United States normally builds in hollow trees, but readily adapts itself to nesting-boxes, but leaves when house sparrows are abundant. It ranges from southern Mexico to within the Arctic Circle. The rock-martin (*Riparia rupestris*) of Europe builds a bottleshaped nest of mud. All the martins feed on insects, which they capture as they fly. The eggs are usually white. The kingbird (*q.v.*) is known as bee martin.

MARTIN OF TROPPAU or **MARTIN THE POLE** (d. 1278), chronicler, was born at Troppau, and entered the order of St. Dominic at Prague. Afterwards he went to Rome and became papal chaplain under Clement IV. and other popes. In 1278 Pope Nicholas III. appointed him archbishop of Gnesen, but he died at Bologna whilst proceeding to Poland to take up his new duties. Martin wrote some sermons and some commentaries on the canon law; but more important is his *Chronicon pontificum et imperatorum*, a history of the popes and emperors to 1277, which is untrustworthy, but was much used by subsequent chroniclers.

The Latin text is printed, with introduction by L. Weiland, in Band XXII. of the *Monumenta Germaniae historica* (Hanover and Berlin, 1826 *seq.*). *See* G. Waitz, H. Brosien and others in the *Neues Archiv der Gesellschaft für ältere deutsche Geschichtskunde* (Hanover, 1876 *seq.*); W. Wattenbach, *Deutschlands Geschichtsquellen*, Band II. (Berlin, 1894); and A. Molinier, *Les Sources de l'histoire de France*, Tome III. (1903).

MARTINEAU, HARRIET (1802–1876), English writer, was born at Norwich, where her father was a manufacturer, on June 12, 1802. The family was of Huguenot extraction (*see* MARTINEAU, JAMES) and professed Unitarian views. The atmosphere of her home was industrious, intellectual and austere; she herself was clever, but weakly and unhappy; she had no sense of taste or smell, and moreover early grew deaf. At fifteen she was sent on a prolonged visit to her aunt, Mrs. Kentish, who kept a school at Bristol. Here her life became happier. In 1821 she began to write anonymously for the *Monthly Repository*, a Unitarian periodical, and in 1823 she published *Devotional Exercises and Addresses, Prayers and Hymns*.

In 1826 her father died, leaving a bare maintenance to his wife and daughters. Harriet's eldest brother and her lover both died about the same time. Then the Martineaus lost all their money.

Harriet began to write for her living. She met with moderate success only until she found (1831) a publisher for the series of tales known as *Illustrations of Political Economy.* In 1832 she moved to London, where she numbered among her acquaintance Hallam, Milman, Malthus, Monckton Milnes, Sydney Smith, Bulwer, and later Carlyle. In 1834 Harriet Martineau paid a long visit to America. Her open adhesion to the Abolitionist party, then small and very unpopular, gave great offence, which was deepened by the publication, soon after her return, of *Society in America* (1837) and a *Retrospect of Western Travel* (1838). An article in the *Westminster Review,* "The Martyr Age of the United States," introduced English readers to the struggles of the Abolitionists.

In 1839, during a visit to the Continent, Miss Martineau's health broke down. She retired to solitary lodgings in Tynemouth, and remained an invalid until 1844. Besides a novel, *The Hour and the Man* (1840), *Life in the Sickroom* (1844), and the *Playfellow* (1841), she published a series of tales for children containing some of her most popular work: *Settlers at Home, The Peasant and the Prince, Feats on the Fiord,* etc. During this illness she for a second time declined a pension on the civil list, fearing to compromise her political independence. Her letter on the subject was published, and some of her friends raised a small annuity for her soon after. She removed to Ambleside, where she built herself "The Knoll," the house in which the greater part of her after life was spent. In 1845 she published three volumes of *Forest and Game Law Tales.* In 1846 she made a tour with some friends in Egypt, Palestine and Syria, and on her return published *Eastern Life, Present and Past* (1848). This work showed that as humanity passed through one after another of the world's historic religions, the conception of the Deity and of Divine government became at each step more and more abstract and indefinite. The ultimate goal Harriet Martineau believed to be philosophic atheism, but this belief she did not expressly declare.

In 1851 Miss Martineau alienated many of her friends by the publication of *Letters on the Laws of Man's Nature and Development.* She contributed regularly from 1852 to 1866 to the *Daily News.* In the early part of 1855 Miss Martineau found herself suffering from heart disease. She now began to write her autobiography, but her life, which she supposed to be so near its close, was prolonged for twenty years. She died at "The Knoll" on June 27, 1876. She cultivated her tiny farm with success, and her poorer neighbours owed much to her. The verdict which she records on herself in the autobiographical sketch left to be published by the *Daily News* has been endorsed by posterity.

See her *Autobiography, with Memorials by Maria Weston Chapman* (1877); Mrs. Fenwick Miller, *Harriet Martineau* (1884, "Eminent Women Series"); Janet E. H. Courtney, *Free Thinkers of the Nineteenth Century* (1920); Theodora Bosanquet, *Harriet Martineau* (1927); and F. S. Marvin, "Harriet Martineau: Triumph and Tragedy," *Hibbert Jour.,* vol. xxv., pp. 631–640 (1928).

MARTINEAU, JAMES (1805–1900), English philosopher and divine, was born at Norwich, of Huguenot ancestry, on April 21, 1805, the seventh child of Thomas Martineau and Elizabeth Rankin, the sixth, his senior by almost three years, being his sister Harriet (*see* above). James was educated at Norwich Grammar school and at the private academy of Dr. Lant Carpenter at Bristol. On leaving he was apprenticed to a civil engineer at Derby, but in 1822 entered Manchester college, then lodged at York with a view to entering the Unitarian ministry.

On leaving the college in 1827 Martineau taught for a time in his old school at Bristol. From 1828 to 1832 he was junior minister of a Presbyterian church in Dublin, but resigned on a matter of conscience. He was then called to Liverpool, and there for a quarter of a century he exercised extraordinary influence as a preacher. In 1840 he was appointed professor of mental and moral philosophy and political economy in Manchester New college, now removed to Manchester. This position he held for 45 years (until 1885). In 1853 the college removed to London, and four years later Martineau followed. In 1858 he became minister of Little Portland street chapel in London. Martineau received many academic honours. He died in London on Jan. 11, 1900.

Martineau's most characteristic and stimulating works are his sermons, published as *Endeavours after the Christian Life* (1st series, 1843; 2nd series, 1847); *Hours of Thought* (1st series, 1876; 2nd series, 1879); the various hymn-books he issued at Dublin in 1831, at Liverpool in 1840, in London in 1873; and the *Home Prayers* in 1891. Martineau just escaped the active period of the old Unitarian controversy. But its presence is felt in his *The Rationale of Religious Enquiry* (1836), and later in his *Types of Ethical Theory* (1885) and *The Study of Religion* (1888) and, in some measure, in *The Seat of Authority in Religion* (1890).

Martineau's theory of the religious society or church was that of an idealist rather than of a statesman or practical politician. He stood equally remote from the old Voluntary principle, that "the State had nothing to do with religion," and from the sacerdotal position that the clergy stood in an apostolic succession, and either constituted the Church or were the persons into whose hands its guidance had been committed. He hated two things intensely, a sacrosanct priesthood and an enforced uniformity. He may be said to have believed in the sanity and sanctity of the state rather than of the Church. Statesmen he could trust as he would not trust ecclesiastics. And so he even propounded a scheme, which fell still-born, that would have repealed uniformity, taken the church out of the hands of a clerical order, and allowed the coordination of sects or churches under the state. Not that he would have allowed the state to touch doctrine, to determine polity or discipline; but he would have had it to recognize historical achievement, religious character and capacity, and endow out of its ample resources those societies which had vindicated their right to be regarded as making for religion. His ideal may have been academic, but it was the dream of a mind that thought nobly both of religion and of the state.

See *Life and Letters* by J. Drummond and C. B. Upton (2 vols., 1901); J. E. Carpenter, *James Martineau, Theologian and Teacher* (1905); J. Crawford, *Recollections* of James Martineau (1903); A. W. Jackson, *James Martineau, a Biography and a Study* (Boston, 1900); H. Sidgwick, *Lectures on the Ethics of Green, Spencer and Martineau* (1902); and J. Hunt, *Religious Thought in England in the 19th Century.*

MARTINET, a military term (more generally used in a disparaging than in a complimentary sense) implying a strict disciplinarian or drill-master. The term originated in the French army about the middle of Louis XIV.'s reign, and was derived from Jean Martinet, who as lieutenant-colonel of the King's regiment of foot and inspector-general of infantry drilled and trained that arm in the model regular army created by Louis and Louvois between 1660 and 1670. Martinet seems also to have introduced the copper pontoons with which Louis bridged the Rhine in 1672. He was killed, as a *maréchal de camp,* at the siege of Duisburg in the same year, being accidentally shot by his own artillery while leading the infantry assault. His death, and that of the Swiss captain Soury by the same discharge gave rise to a *bon mot,* typical of the polite ingratitude of the age, that Duisburg had only cost the king a martin and a mouse.

The "martin" as a matter of fact shares with Vauban and other professional soldiers of Louis XIV. the glory of having made the French army the first and best regular army in Europe. Great nobles, such as Turenne, Condé and Luxemburg, led this army and inspired it, but their fame has obscured that of the men who made it manageable and efficient. It was about this time that the soldier of fortune, who joined a regiment with his own arms and equipment and had learned his trade by varied experience, began to give place to the soldier regularly enlisted as a recruit in permanent regiments and trained by his own officers. The consequence of this was the introduction of a uniform, or nearly uniform system of drill and training. Thus Martinet was the forerunner of Leopold of Dessau and Frederick William, just as Jean Jacques de Fourilles, the organizer of the cavalry, who was forced into an untimely charge at Seneffe (1674) by a brutal taunt of Condé, and there met his death, was the forerunner of Zieten and Seydlitz. These men, while differing from the creators of the Prussian army in that they contributed nothing to the tactics of their arms, at least made tactics possible by the thorough drilling and organization they imparted to the hardly coherent elements of an army.

MARTINEZ DE CAMPOS, ARSENIO: *see* CAMPOS, ARSENIO MARTÍNEZ DE.

MARTINEZ DE LA ROSA, FRANCISCO DE PAULA (1787–1862), Spanish statesman and dramatist, was born at Granada and educated at the university there. He won popularity with a series of epigrams on local celebrities published under the title of *El Cementerio de momo*. During the struggle against Napoleon he took the patriotic side, was elected deputy, and at Cadiz produced his first play, *Lo que puede un empleo,* a prose comedy in the manner of the younger Moratin. *La Viuda de Padilla* (1814), a tragedy modelled upon Alfieri, was less acceptable to the Spanish public. Meanwhile, the author became more and more engulfed in politics, and in 1814 was banished to Africa, where he remained till 1820, when he was suddenly recalled and appointed prime minister. During the next three years he was the most unpopular man in Spain; denounced as a revolutionist by the Conservatives and as a reactionary by the Liberals, he alienated the sympathies of all parties, and his rhetoric earned for him the contemptuous nick-name of *Rosita la Pastelera.* Exiled in 1823, he took refuge in Paris, where he issued his *Obras literarias* (1827), including his *Arte poética,* in which he exaggerated the literary theories already promulgated by Luzán. Returning to Spain in 1831, he became prime minister on the death of Ferdinand VII, ambassador at Paris in 1839–40, and at Rome in 1842–43. Martinez de la Rosa never rose above mediocrity either as a statesman or as a writer though the production of his *La Conjuración de Venecia* (April 23, 1834), entitled him to be called the pioneer of the romantic drama in Spain. The play is more reminiscent of Casimir Delavigne than of Victor Hugo; but it was unquestionably effective and smoothed the way for the bolder essays of Rivas, Garcia Gutiérrez and Hartzenbusch.

MARTINEZ RUIZ, JOSÉ: *see* AZORÍN.

MARTINEZ SIERRA, GREGORIO (1881–), Spanish novelist and dramatist, was born at Madrid on May 6, 1881. Martínez Sierra writes a slightly alembicated prose in *Sol de la tarde* (1904), *Tú eres la paz* (1907) and other novels. As a dramatist he has won considerable popularity by plays of an almost feminine delicacy, of which *Canción de Cuna* (1911) is the most typical example. His *Reino de Dios* (1915) was translated into English in 1924 and acted in London in 1927 under the title of *The Kingdom of God.*

MARTINI, FERDINANDO (1841–1928), Italian author and statesman. Born at Monsummano in Tuscany on July 30, 1841, he took to journalism at an early age to earn his living, and after a short period as a normal school teacher at Pisa, he joined the staff of the *Fanfulla* of Rome, and afterwards founded the *Fanfulla della Domenica,* to which Carducci, Bonghi, Verga, Panzacchi and other eminent writers contributed. In 1874 he was elected to parliament for Monsummano, and soon made a name for himself as a brilliant and witty speaker. He became minister of education in the first Giolitti cabinet (1892–93), and in 1898 he was appointed on the suggestion of King Umberto first civilian governor of Eritrea, a position which he held for ten years. He reorganized the colony, reduced its budget from 17 to 5 millions, built roads and a railway, and constructed the new capital at Asmara. He accepted the post of minister of the colonies offered him by Salandra (*q.v.*) in 1914, and on the outbreak of World War I he at once became an active interventionist, and resigned with Salandra in 1916. At the elections of 1919 he failed to be re-elected owing to the strong pressure of Nitti. In 1922 he was created a senator on the proposal of Mussolini, but took little part in public life on account of his feeble health. Besides numerous articles, many of which are collected in a volume *Fra un sigaro e l'altro,* which ran through several editions, he wrote short stories and novels (*Chi sa il giuoco non l'insegni, Il bacio dato non è mai perduto, Il peggior passo,* etc.). His *Confessioni e Ricordi,* published in 1922, enjoyed a wide popularity. His writings are not deep or of the highest literary merit, but witty, brilliant and racy, as was his conversation. Among other works may be mentioned *Al teatro* (1908), *Cose africane* (1896), and *Nell 'Africa italiana* (1891).

MARTINI, GIOVANNI BATTISTA (1706–1784), Italian musician, was born at Bologna on April 24, 1706. He was received as a Minorite on Sept. 11, 1722. In 1725 he became chapel-master in the Franciscan church at Bologna, where he opened a school of composition at which several celebrated musicians were trained. He consistently declared his preference for the traditions of the old Roman school of composition. Padre Martini was a zealous collector of musical literature, and possessed an extensive musical library which passed at his death to the Imperial library at Vienna, and the city of Bologna; Burney estimated the collection at 17,000 volumes. He died at Bologna on Aug. 4, 1784. His *Elogio* was published by Pietro della Valle at Bologna in the same year.

Martini's father, Antonio Mario Martini, a violinist, had taught him the elements of music, and he had later learned singing and harpsichord playing from Padre Pradieri and counterpoint from Antonio Riccieri. His education in classics he received from the fathers of the oratory of San Filippo Neri. Most contemporary musicians speak of Martini with admiration, and Mozart's father consulted him with regard to the talents of his son. Abt Vogler, however, makes reservations in his praise, condemning his philosophical principles as too much in sympathy with those of Fox, which had already been expressed by P. Vallotti.

The Liceo of Bologna possesses the mss. of two oratorios; and a requiem, with some other pieces of church music, are now in Vienna. *Litaniae atque antiphonae finales B. V. Mariae* were published at Bologna in 1734, as also twelve *Sonate d'intavolatura;* six *Sonate per l'organo ed il cembalo* in 1747; and *Duetti da camera* in 1763. Martini's most important works are his *Storia della musica* (Bologna, 1757–81) and his *Saggio di contrapunto* (Bologna, 1774–75). His celebrated canons, published in London, about 1800, edited by Pio Cianchettini, show him to have had a strong sense of musical humour.

MARTINI, JOHANN PAUL AEGIDIUS (1741–1816), German musician, sometimes also known as Martini Il Tedesco, was born in Freistadt, Germany, Sept. 1, 1741. When he was only 10 he became organist at the Jesuit seminary at Neustadt and at 17 held the same position at the Franciscan convent at Freiburg. He soon determined to remove to France, however, and first settled at Nancy. There he changed his family name, Schwartzendorf, to Martini, by which he was known thereafter, and entered the service of King Stanislaus I of Poland, then living in France. After the king's death, Martini went to Paris, where he remained for the rest of his life. He published his highly popular opera, "L'Amoureux de quinze ans" in 1771. For a time, he served as conductor of the Théâtre Feydeau, and later became inspector of the Paris conservatory, following which he was made professor of composition there. He was forced to retire in 1802, but when Louis XVIII came to power in 1814 he made Martini superintendent of court music. Martini died in Paris, Feb. 10, 1816. Besides his considerable output of music, both secular and religious, he wrote *Mélopée moderne,* a study of vocal music.

MARTINI, SIMONE (*c.* 1284–1344), Sienese painter, probably a pupil of Duccio, from whom he inherited his love of harmonious colour, to which he added a grace of line and delicacy of interpretation beyond anything to be found in his master's works. The beings he created move in a world of beauty, of grace and restfulness, and seem to embody the knightly ideals of the later middle ages.

The first known fresco of Simone is in the hall of the Palazzo Pubblico in Siena—the "Madonna Enthroned, with the Infant and a number of angels and saints" (1315). In S. Lorenzo Maggiore, of Naples, he painted a life-sized picture of King Robert crowned by his brother, St. Louis of Toulouse (1317). In 1320 he painted for the high altar of the church of S. Caterina in Pisa the Virgin and Child between six saints; above are archangels, apostles and other figures. The compartmented portions of this work are now dispersed, some of them being in the Museum of Pisa, others in the seminary. Towards 1321 he executed for the church of S. Domenico in Orvieto a picture of the bishop of Savona kneeling before the Madonna, attended by saints, now in the museum of the cathedral. In 1328 he produced for the sala del consilio in Siena a striking equestrian portrait of the victorious general, Guidoriccio Fogliani de' Ricci.

Simone had married in 1324 Giovanna, the daughter of Memmo (Guglielmo) di Filippuccio. Her brother, named Lippo Memmi, was also a painter and was frequently associated with Simone in his work; and this is the only reason why Simone has come down to us with the family name Memmi. They painted together, in 1333, the "Annunciation," which is now in the Uffizi gallery. From 1333 to 1339 Simone worked at Assisi, where he decorated the chapel of St. Martin in the Lower church with scenes illustrating the life of the saint. In the arch between this chapel and the nave he painted figures of eight saints. These frescoes are among his finest works. Four small panels, two at Antwerp, one in Berlin, and one in the Louvre, are ascribed to this period. They represent scenes of the Passion, and the artist here displays a taste for tragic, realistic effects. In 1339 he settled at the papal court in Avignon, where he made the acquaintance of Petrarch, and he painted for the poet a portrait of Laura, which gave occasion for two of Petrarch's sonnets in which Simone is eulogized. He is also said to have illuminated for the poet a copy of the commentary of Servius upon Virgil, now preserved in the Ambrosian library of Milan. One of his latest productions (1342) is the picture of "Christ Found by his Parents in the Temple," now in the Liverpool gallery. Simone died in Avignon in July 1344. He was the most important painter of the Sienese school in the 14th century, and his influence in Siena was great; while, outside his native city, important groups of adherents were formed at Naples, Pisa, Orvieto and to some extent in France; and to them was due the propagation of the Sienese style.

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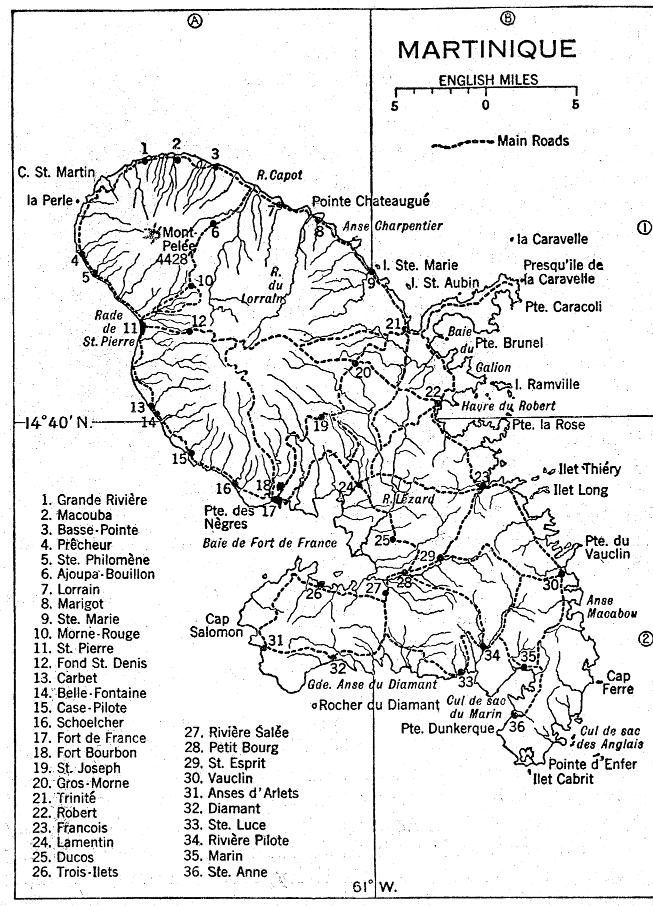
MARTINIQUE, an island of the West Indies, a French colony in the chain of the Lesser Antilles, 25 mi. S. of Dominica and 20 mi. N. of St. Lucia, both British islands, about 14° 40′ N., 61° W. Length 40 mi., greatest width 21 mi.; area 427 sq.mi. A cluster of volcanic mountains in the north, a similar group in the south, and a line of lower heights between them, form the backbone of the island. Its deep ravines and precipitous escarpments are clothed in forest. The massif of Mont Pelé in the north is the culminating point (4,430 ft.); that of Carbet reaches 3,963 ft., the mountains in the S. are much lower.

Of the numerous streams which traverse the strip between the watershed and the sea (the longest radiating from Mount Carbet), about seventy-five are of considerable volume, and in the rainy season often become destructive torrents. On the north-west and north the coast is elevated; on the south a lateral range, branching from the backbone of the island, forms a blunt peninsula bounding the low-shored bay of Fort de France. Another peninsula, Caravelle, projects from the middle part of the east coast, and south of this the coast is low and fretted, with many islets, cays and coral reefs. Plains, most numerous and extensive in the south, make up about one-third of the total area of the island.

Mean annual temperature, 80° F in the coast region, the monthly mean for June being 83°; for January 77°. Annual rainfall, 87 in. August has the heaviest share (11·3 in.), though the rainy season extends from June to October; March, the driest month, has 3·7. The low coastal districts are not very healthy for Europeans in the hotter months, but there are numerous sanatoria in the forest region at an elevation of about 1,500 ft., where the average temperature is some 10° F lower. The north winds which prevail from November to February are comparatively fresh and dry; those from the south (July to Oct.) are damp and warm. From March to June easterly winds prevail.

Population (1936) 246,712. In 1905, shortly after the first eruption of Mont Pelé, the population was only 182,024. The bulk of the population consists of negroes, coloured people of various grades, ranging from the "Saccatra," who has retained hardly any trace of European blood, to the so-called "Sangmêlé," with only a suspicion of negro commixture. The capital of the island is Fort de France, on the bay of the same name, with a fine harbour defended by three forts, and a population of 43,338. Other principal centres of population are, on the west coast Lamentin, on the same bay as the capital, and on the east coast Le François and Le Robert. The colony is administered by a governor and a general council, and returns a senator and two deputies. There are elective municipal councils. The island is



served by French, British, Canadian and American steamship lines, and local communications are carried on by small coasting steamers and by subsidized coaches on excellent roads. In 1925 the total value of the exports (mainly sugar, rum, coffee, cocoa and vanilla) was fr. 154,871,706, France taking by far the greater part. Imports were valued at fr. 132,566,419, of which more than two-thirds by value came from France, the United States of America being the next principal importing country.

Martinique, the name of which may be derived from a native form Madiana or Mantinino, was probably discovered by Columbus on June 15, 1502; although by some authorities its discovery is placed in 1493. It was inhabited by Caribs who had expelled or incorporated an older stock. On June 25, 1635, possession was taken of the island in the name of the French *Compagnie des Îles d'Amérique.* Actual settlement was carried out by Pierre Belain, Sieur d'Esnambuc, captain-general of the island of St. Christopher. In 1637 his nephew Dyel Duparquet became captain-general of the colony, now numbering seven hundred men, and subsequently obtained the seigneurie of the island by purchase from the company under the authority of the king of France. In 1654 three hundred Jews, expelled from Brazil, landed, and by 1658 there were at least five thousand people exclusive of the Caribs, who after much fighting, were exterminated. Purchased by the French government from Duparquet's children for 120,000 livres, Martinique was assigned to the West India Company, but in 1674 became part of the royal domain. The *habitants* (French landholders) at first cultivated cotton and tobacco; but in 1650 sugar planting was begun, and in 1723 the coffee plant was introduced. Slave labour was an early feature (there were 60,000 blacks in the island by 1736), but was abolished in 1860. In 1666 and 1667 the island was attacked by the British, but hostilities were terminated by the treaty of Breda. The Dutch made similar attempts in 1674, and the British again in 1693. Captured by Rodney in 1762, Martinique was next year restored to the French; but after the conquest by the British in 1793 it was retained for eight years; and, seized again in 1809, it was not surrendered till 1814. The island was the birth-place of the Empress Josephine.

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NATIVE WOMAN OF MARTINIQUE

Martinique has suffered from occasional hurricanes, as in 1767, when 1,600 persons perished, and in 1839, 1891, 1903 and 1928. Earthquakes have also been frequent, but the most terrible natural disaster was the eruption of Mont Pelé in 1902, when St. Pierre, formerly the chief commercial centre of the island, was destroyed. Early in the year manifestations of volcanic activity had occurred; on April 25 there was a heavy fall of ashes, and on the 2nd and 3rd of May a heavy eruption destroyed extensive sugar plantations north of St. Pierre, and caused a loss of some 150 lives. A few days later news that the Souffrière in St. Vincent was in eruption reassured the inhabitants of St. Pierre, as it was supposed that this outbreak might relieve the volcano of Pelé. But on May 8 the final calamity came without warning; a mass of fire swept over St. Pierre, destroying the ships in the harbour, among which, only one, the "Roddam" of Scruttons, escaped. A fall of molten lava and ashes followed the flames, accompanied by dense gases which stifled those who had escaped. The total loss of life was estimated at 40,000. Consternation was caused not only in the West Indies, but throughout the world, and at first it was seriously suggested that the island should be evacuated, but no countenance was given to this proposal by France. Relief measures were undertaken and voluntary subscriptions raised. The material losses were estimated at £4,000,000; but, besides St. Pierre, only one-tenth of the island had been devastated, and although during July there was further volcanic activity, causing more destruction, the economic situation recovered more rapidly than was expected.

See *Annuaire de la Martinique* (Fort de France); H. Mouet, *La Martinique* (Paris, 1892); M. J. Guët, *Origines de la Martinique* (Vannes, 1893); G. Landes, *Notice sur la Martinique* (with full bibliography) (Paris, 1900); M. Dumoret, *Au pays du sucre* (Paris, 1902); and on the eruption of 1902, A. Heilprin, *Mont Pelée and the Tragedy of Martinique* (Philadelphia and London, 1903); A. Lacroix, *La Montagne Pelée et ses éruptions* (Paris, 1904); and the report of Drs. J. S. Flett and T. Anderson (November 20, 1902), who investigated the eruptions on behalf of the Royal Society; *cf.* T. Anderson, "Recent Volcanic Eruptions in the West Indies," in *Geographical Journal*, vol. xxi. (1903).

MARTINSBURG, a city of north-eastern West Virginia, U.S.A., the county seat of Berkeley county; 80 m. N.W. of Washington, on federal highway 11, and served by the Baltimore and Ohio and the Pennsylvania railways. The population was 12,515 in 1920 (91% native white) and was 15,063 in 1940 by the federal census. It lies 435 ft. above sea level, at the entrance to the beautiful and historic Shenandoah valley, and is surrounded by apple and peach orchards and farms. There are large deposits of limestone, clay and shale in the vicinity. The county ships 2,161,958 bushels of apples each year, and the city's plants can 1,500,000 gallons and make 3,000,000 gallons of cider vinegar. Martinsburg has the largest apple by-product plant in the U.S.A. and the largest mill making men's hosiery. Other important manufactures are woollen goods, women's garments, cement, amesite, brick and paper boxes. The Baltimore and Ohio has large repair shops here. Martinsburg was laid out by General Adam Stephen and was named after Colonel Thomas Bryan Martin. It was chartered as a city in 1778. During the Civil War it was occupied at different times by several Union and Confederate forces.

MARTINS FERRY, a city of Belmont county, Ohio, U.S.A., on the Ohio river, nearly opposite Wheeling, with which it is connected by a bridge. It is served by the Baltimore and Ohio, the Pennsylvania and the Wheeling and Lake Erie railways. Pop. (1920) 11,634 (82% native white); 14,729 in 1940 by the federal census. The city lies on two plateaus, the lower occupied chiefly by factories, the upper by dwellings. It is an important coal-mining and manufacturing centre.

Tin, sheet iron, stoves and structural steel are leading products. The first settlement (1785) was abandoned on account of trouble with the Indians. In 1795 a town (called Jefferson) was laid out by Absalom Martin, and it was abandoned because it was not made the county seat. In 1835 Ebenezer Martin, son of Absalom, again laid out the town. It was incorporated in 1865 and chartered as a city in 1885.

MARTINSVILLE, a city of central Indiana, U.S.A., 30 mi. S.W. of Indianapolis, on the Big Four and the Pennsylvania railways; the county seat of Morgan county, and a health resort with several hotels and sanatoria utilizing the mineral water from artesian wells. The population was 4,895 in 1920 (99% native white) and 5,009 in 1940 by federal census.

MARTINSVILLE, a city of the first class in southern Virginia, U.S.A., the county seat of Henry county; on federal highways 58 and 220, at an altitude of 980 ft., and is served by the Danville and Western and the Norfolk and Western railways. The population was 7,705 in 1930; and 10,080 in 1940 by the federal census. Martinsville and Henry county, Va., have a total annual pay roll of $10,000,000, the principal industries being furniture factories, cotton and hosiery mills, knitting mills, nylon (Du Pont) plant, and tobacco (leaf and manufactured). The city was founded in 1830 and incorporated in 1873.

MARTINUZZI, GEORGE [GYÖRGY UTIEŠENOVIĆ] (1482–1551), Hungarian statesman, known in Hungarian history as FRATER GYÖRGY or simply THE FRATER, was born at Kamičic, Croatia, the son of Gregory Utiešenović, a Croatian gentleman. His mother was a Martinuzzi, a Venetian patrician family. From his eighth to his twentieth year he was attached to the court of John Corvinus; subsequently he saw something of warfare under John Zapolya but, tiring of a military life, he entered the Paulician Order in his twenty-eighth year. His historical career began when his old patron Zapolya, now king of Hungary, forced to fly before his successful rival Ferdinand, afterwards the emperor Ferdinand I., sent him on a diplomatic mission to Hungary. It was due to his tact and ability that John recovered Buda (1529), and henceforth Frater György became his treasurer and chief counsellor.

In 1534 Martinuzzi became bishop of Nagyvarád (Grosswardein); in 1538 he concluded with Austria the peace of Grosswardein, which left Zapolya with the royal title and most of Hungary. On Zapolya's death (1540) Martinuzzi acted as guardian and regent for his infant son John Sigismund, for whom on Dec. 29, 1541 he concluded the Treaty of Gyula with the Sultan, which left an enlarged Transylvania as an independent principality under Turkish suzerainty. For a time Martinuzzi kept Transylvania neutral and on friendly terms with both Austria and the Porte. In 1550, however, the Queen-Mother Isabella, who hated him, contrived against him with the hospodars of Moldavia and Wallachia and the Turks. Martinuzzi defeated all his enemies and concluded a composition confirmed by the diet of Kalozsvár (1551) whereby Isabella renounced her rights over Transylvania, in her son's name, to Ferdinand of Austria.

The Frater retained the governorship of Transylvania, and was subsequently consecrated Cardinal and archbishop of Esztergom. Thus Hungary was once more reunited, but the inability of Ferdinand to defend it against the Turks, as promised, forced the Frater to resume payment of tribute to the Porte in December 1551. Ferdinand, however, suspecting the cardinal's loyalty, had him assassinated at Alvinczy (Dec. 17, 1551). Ferdinand took the responsibility of the murder on himself. He sent to Julius III. an accusation of treason against the Frater in eighty-seven articles, and after long hesitation, and hearing one hundred and sixteen witnesses, the pope exonerated Ferdinand of blame.

See A. Bechet, *Histoire du ministère du cardinal Martinusius* (Paris

1715); O. M. Utiešenović, *Lebensgeschichte des Cardinals Georg Utiešenović* (Vienna, 1881); *Codex epistolaris Fratris Georgii 1535–1551*, ed. A. Károlyi (Budapest, 1881); also M. Jókai's historical romance, *Brother George* (Hung.) (Budapest, 1893).

MARTIUS, CARL FRIEDRICH PHILIPP VON (1794–1868), German botanist and traveller, was born on April 17, 1794, at Erlangen, where he graduated M.D. in 1814. He afterwards devoted himself to botanical study, and in 1817 was sent to Brazil by the king of Bavaria. In 1820 he was appointed conservator of the botanic garden at Munich, and in 1826 professor of botany in the university; he held both offices until 1864.

His chief publications include: *Nova Genera et Species Plantarum Brasiliensium* (1823–32, 3 vols.), *Icones selectae Plantarum Cryptogamicarum Brasiliensium* (1827), *Historia Palmarum* (3 vols., 1823–50), and an account of his travels in Brazil (3 vols., 1823–31). In 1840 he began the *Flora Brasiliensis,* with the assistance of other botanists. He died at Munich on Dec. 13, 1868.

MARTOS, CRISTINO (1830–1893), Spanish politician, was born at Granada on Sept. 13, 1830. As a student, he narrowly escaped being expelled from Madrid university for his share in demonstrations against the government of Queen Isabella. He joined O'Donnell and Espartero in 1854, turned against O'Donnell to assist the Democrats and Progressists in the unsuccessful movements of 1866, and, driven to go abroad, returned to take his seat in the Cortes (1869). Throughout the revolutionary period he represented the advanced Radical tendencies of the men who wanted to give Spain a democratic monarchy. After the abdication of Armadeus, Martos played a prominent part in the proclamation of the Federal republic. In May 1874, he returned to the bar. He sat in several parliaments under Alphonso XII. and the queen-regent Christina. Failing to form a rival party against Sagasta, he sank into political insignificance, despite his great talent as an orator and debater, and died in Madrid on Jan. 16, 1893.

MARTOS, a town of Spain, in the province of Jaén, 16 mi. W.S.W. of Jaén, by the Jaén-Lucena railway. Pop. (1940), 17,-206 (mun., 27,127). Martos is on an outlying western peak of the Jabalcuz mountains. It possibly stands on or near the site of the *Tucci* of Ptolemy, which was fortified and renamed *Colonia Augusta Gemella* by the Romans. It was taken from the Moors in 1225 by Ferdinand III and given to the knights of Calatrava. The brothers Carvajal were executed here in 1312 by order of Ferdinand IV. In the neighbourhood are sulphurous springs with bathing establishments.

MARTYN, HENRY (1781–1812), English missionary to India, was born on Feb. 18, 1781, at Truro, Cornwall. He was educated at Truro grammar school and St. John's college, Cambridge, and was senior wrangler and first Smith's prizeman in 1801. In 1802 he became a fellow of his college. He had intended to go to the bar, but the stories of the missionaries William Carey and David Brainerd decided him to seek a missionary career. He obtained a chaplaincy under the East India Company and left for India on July 5, 1805. He translated the whole of the New Testament into Hindi, and into Persian twice, and the Psalms into Persian, the Gospels into Judaeo-Persic, and the Prayer-book into Hindustani. Ordered by the doctors to take a sea voyage, he went to Persia to correct his Persian New Testament, whence he wished to go to Arabia, and there compose an Arabic version. He set out from Bombay in January 1811 for Bushire, bearing letters from Sir John Malcolm. After an exhausting journey from the coast he reached Shiraz, and was soon plunged into discussion with the disputants of all classes. Having made an unsuccessful journey to Tabriz to present the shah with his translation of the New Testament, he fell ill with fever, and had to seek a change of climate. On Sept. 12, 1812, he started with two Armenian servants, crossed the Araxes, rode from Tabriz to Erivan, from Erivan to Kars, from Kars to Erzerum, from Erzerum to Chiflik, urged on from place to place by a thoughtless Tatar guide, and, though the plague was raging at Tokat (near Eski-Shehr in Asia Minor), he was compelled by prostration to stop there. On Oct. 6, he died.

See his *Journals and Letters* (1837) ed. Samuel Wilberforce. *See* also *Lives* by John Sargent (1819; new ed. 1885), and G. Smith (1892).

MARTYN, JOHN (1699–1768), English botanist, was born in London on Sept. 12, 1699. Originally intended for a business career, he abandoned it in favour of scientific studies. He was one of the founders (with J. J. Dillen and others) and the secretary of a botanical society which met for a few years in the Rainbow Coffee-house, Watling Street; he also started the *Grub Street Journal*, a weekly satirical review, which lasted from 1730 to 1737. He held a professorship of botany at Cambridge, 1732–62, and at the same time practised as a physician at Chelsea, where he died Jan. 29, 1768. His reputation chiefly rests upon *Historia plantarum rariorum* (1728; 3rd ed., 1797; Eng. ed., 1728–32), and his translation, with valuable agricultural and botanical notes, of the *Eclogues* (1749) and *Georgics* (1741) of Virgil.

See memoir by Thomas Martyn reprinted in *Memoirs of John Martyn and Thomas Martyn*, by G. C. Gorham (1830), and *Dict. Nat Biog.* for a complete list of his works.

MARTYR, a word meaning literally "witness" (Gr. μάρτυρ or μάρτυς), and often used in that sense in the New Testament, *e.g.,* Matt. xviii. 16; Mark xiv. 63. During the conflict between Paganism and Christianity when many Christians "testified" to the truth of their convictions by sacrificing their lives, the word assumed its modern technical sense. The beginnings of this use are to be seen in such passages as Acts xxii. 20; Rev. ii. 13. During the first three centuries the fortitude of these "witnesses" won the admiration of their brethren. The zeal of Ignatius (*c.* 115), who begs the Roman Church to do nothing to avert from him the martyr's death, was natural enough in a spiritual knight-errant, but with others in later days, especially in Phrygia and North Africa, the passion became artificial. Fanatics sought death by insulting the magistrates or by breaking idols, and in their enthusiasm for martyrdom became self-centred and forgetful of their normal duty. None the less it is true that these men and women endured torments, often unthinkable in their cruelty, and death rather than abandon their faith. The same phenomena have been witnessed, not only in the conflicts within the Church that marked the 13th to the 16th centuries, but in the different mission fields, and particularly in Madagascar and China.

See A. J. Mason, *The Historic Martyrs of the Primitive Church* (1905); H. B. Workman, *Persecution in the Early Church* (1906); Paul Allard, *Ten Lectures on the Martyrs* (1907); Foxe's *Book of Martyrs;* Mary I. Bryson, *Cross and Crown* (1904).

MARTYROLOGY, a catalogue or list of *martyrs* or, more exactly, of *saints,* arranged in the order of their anniversaries. This is the now accepted meaning in the Latin Church. In the Eastern Church the nearest equivalent to the martyrology is the Greek Synaxarium. As regards form, we should distinguish between simple martyrologies, which consist merely of an enumeration of names, and historical martyrologies, which also include stories or biographical details. As regards documents, the most important distinction is between local and general martyrologies. The former give a list of the festivals of some particular Church; the latter are the result of a combination of several local martyrologies. The most important ancient martyrology preserved to the present day is in the form (mainly) of an enumeration of names, and was falsely attributed to St. Jerome. In its present form it goes back to the end of the 6th century. It is the result of the combination of a general martyrology of the Eastern Churches, a local martyrology of the Church of Rome, some general martyrologies of Italy and Africa, and a series of local martyrologies of Gaul. The task of critics is to distinguish between its various constituent elements. Unfortunately, this document has reached us in a lamentable condition. Of the best known historical martyrologies the most famous is that of Usuard (*c.* 875), on which the Roman martyrology was based. The first edition of the Roman martyrology appeared at Rome in 1583. The third edition, which appeared in 1584, was approved by Gregory XIII., who imposed this martyrology upon the whole Church.

Bibliography.—*See* C. de Smedt, *Introductio generalis ad historiam ecclesiasticam* (Gandavi, 1876), pp. 127–156; H. Matagne and V. de Buck in De Backer, *Bibliothèque des écrivains de la Compagnie de Jésus,* 2nd ed., vol. iii. pp. 369–387; De Rossi-Duchesne, *Les Sources du martyrologe hiéronymien* (Rome, 1885); H. Achelis, *Die Martyrologien, ihre Geschichte und ihr Wert* (Berlin, 1900); H. Delehaye, "Le

Témoignage des martyrologes," in *Analecta bollandiana,* xxvi. 78–99 (1907); H. Quentin, *Les Martyrologes historiques du moyen âge* (Paris, 1908).

MARUTS, the storm-gods of Hindu mythology, prominent in the *Rig-Veda* which makes them sons of Rūdra, but associates them with Indra, the goddesses Indrānī and Saraswati, and more closely, with Rodasi, their beauteous bride. Yet they are sometimes hostile to Indra and rend Vritra, the "drought," in pieces. In the epic era they appear to be the Māruta, the winds, sons of the benevolent earth-goddess, Aditi.

See E. W. Hopkins, *Epic Mythology* (Strasbourg, 1915).

MARVELL, ANDREW (1621–1678), English poet and satirist, son of Andrew Marvell and his wife Anne Pease, was born at the rectory house, Winestead, in the Holderness division of Yorkshire, March 31, 1621. In 1624 his father exchanged the living of Winestead for the mastership of Hull grammar school. He also became lecturer at Holy Trinity church and master of the Charterhouse in the same town. Thomas Fuller (*Worthies of England,* ed. 1811, i. 165) describes him as "a most excellent preacher." The younger Marvell was educated at Hull grammar school and at Trinity college, Cambridge. He contributed two poems to the *Musa cantabrigiensis* in 1637, and in the following year he received a scholarship at Trinity college, and took his B.A. degree in 1639. His father was drowned in 1640 while crossing the Humber in company with the daughter of a Mrs. Skinner, almost certainly connected with the Cyriack Skinner to whom two of Milton's sonnets are addressed. Marvell travelled for four years on the Continent, visiting Holland, France, Italy and Spain. In Rome he met Richard Flecknoe, whom he satirized in the amusing verses on "Flecknoe, an English priest at Rome."

Although Marvell ranks as a great Puritan poet his sympathies were at first with Charles I., and in the lines on "Tom May's Death" he found no words too strong to express his scorn for the historian of the Long Parliament. He himself was no partisan, but had a passion for law and order. He acquiesced, accordingly, in the strong rule of Cromwell, but in his famous "Horatian Ode upon Cromwell's Return from Ireland" (1650) he inserts a well-known tribute to the courage and dignity of Charles I. In 1650 he became tutor to Lord Fairfax's daughter Mary, afterwards duchess of Buckingham. During his life with the Fairfaxes at Nunappleton, Yorkshire, he wrote the poems "Upon the Hill and Grove at Billborow" and "On Appleton House." Doubtless the other poems on country life, and his exquisite "garden poetry" may be referred to this period.

Marvell was acquainted with Milton, probably through their common friends, the Skinners, and in Feb. 1653 Milton recommended him as assistant to himself in his duties as foreign secretary. The appointment was, however, given at the time to Philip Meadows, and Marvell became tutor to Cromwell's ward, William Dutton, at Eton, in the house of John Oxenbridge, then a fellow of the college, but formerly a minister in the Bermudas. No doubt the well-known verses, "Bermudas," were inspired by intercourse with the Oxenbridges. He was employed by Milton in 1654 to convey to Bradshaw a copy of the *Defensio secunda.* When the secretaryship again fell vacant in 1657 Marvell was appointed, and retained the appointment until the accession of Charles II. During this period he wrote many political poems all of them displaying admiration for Cromwell.

Marvell's connection with Hull had been strengthened by the marriages of his sisters with persons of local importance, and in Jan. 1659 he was elected to represent the borough in parliament. He was re-elected in 1660, again in 1661, and continued to represent the town until his death. According to Milton's nephew, Edward Phillips, the poet owed his safety at the Restoration largely to the efforts of Marvell, who "made a considerable party for him" in the House of Commons. From 1663 to 1665 he acted as secretary to Charles Howard, 1st earl of Carlisle, on his difficult and unsuccessful embassy to Muscovy, Sweden, and Denmark; and this is the only official post he filled during the reign of Charles. With the exception of this absence, and of short visits to Holland on private business, Marvell was constant in his parliamentary attendance to the day of his death. He looked after the special interests of the port of Hull. He was a member of the corporation of Trinity House, both in London and Hull, and became a younger warden of the London Trinity House. His correspondence with his constituents, from 1660 to 1678, some 400 letters in all, first printed by Dr. Grosart (*Complete Works,* vol. ii.) forms a useful source of information.

When in 1667 the Dutch fleet sailed up the Thames, Marvell expressed his wrath at the gross mismanagement of public affairs in the broadside, "Last Instructions to a Painter." He had no scruples in the choice of the weapons he employed in his warfare against the corruption of the court, which he paints even blacker than do contemporary memoir writers; and his satire often descends to the level of the lampoon. The most inexcusable of his scandalous verses are perhaps those on the duchess of York. In the same year he attacked Lord Clarendon, evidently hoping that with the removal of the "betrayer of England and Flanders" matters would improve. But in 1672 when he wrote his "Poem on the Statue in the Stocks-Market" he had no illusions left about Charles, whom he describes as too often "purchased and sold," though he concludes with "Yet we'd rather have him than his bigoted brother." "An Historical Poem," "Advice to a Painter," and "Britannia and Raleigh" urge the same advice. These and other equally bold satires were probably handed round in ms., or secretly printed, and it was not until after the Revolution that they were collected with those of other writers in *Poems on Affairs of State* (3 pts., 1689; 4 pts., 1703–07). Marvell's controversial prose writings are wittier than his verse satires, and are free from the scurrility which defaces the "Last Instructions to a Painter." A short and brilliant example of his irony is "His Majesty's Most Gracious Speech to both Houses of Parliament" (printed in *Grosart,* ii. 431 seq.), in which Charles is made to take the house into the friendliest confidence on his domestic affairs.

Marvell was among the masters of Jonathan Swift, who, in the "Apology" prefixed to the *Tale of a Tub,* wrote that his answer to Samuel Parker could be still read with pleasure, although the pamphlets that provoked it were long since forgotten.

His *Mr. Smirke, or the Divine in Mode . . .* (1676) was a defence of Herbert Croft, bishop of Hereford. *An Account of the Growth of Popery and Arbitrary Government in England, more particularly from the Long Prorogation of Parliament . . .* (1677) was written in the same outspoken tone as the verse satires, and brought against the court the indictment of nursing designs to establish absolute monarchy and the Roman Catholic religion at the same time. A reward was offered for the author, and it is said that Marvell was in danger of assassination. He died on Aug. 16, 1678, in consequence of an overdose of an opiate taken during an attack of ague. He was buried in the church of St. Giles-in-the-Fields, London. Joint administration of his estate was granted to one of his creditors, and to his widow, Mary Marvell.

Marvell had friends among the republican thinkers of the times. Aubrey says that he was intimate with James Harrington, the author of *Oceana,* and he was probably a member of the "Rota" club. He kept his political virtue unspotted. There is a story that his old schoolfellow, Danby, was sent by the king to offer the incorruptible poet a place at court and a gift of £1,000, which Marvell refused with the words: "I live here to serve my constituents: the ministry may seek men for their purpose; I am not one."

Among Marvell's works is also a *Defence of John Howe on God's Prescience . . .* (1678), and among the spurious works fathered on him are: *A Seasonable Argument . . . for a new Parliament* (1677), *A Seasonable Question and a Useful Answer . . .* (1676), *A Letter from a Parliament Man . . .* (1675), and a translation of *Suetonius* (1672). Marvell's satires were no doubt first printed as broadsides, but few are extant in that form. Earlier editions of his works were superseded by Dr. A. B. Grosart's laborious work, *The Complete Works in Verse and Prose of Andrew Marvell, M.P.* (4 vols., 1872–75) in the "Fuller Worthies Library," and by the Oxford edition of the *Poems and Letters,* edited (1927) by H. M. Margoliouth. *See* also the admirable edition of the *Poems and Satires of Andrew Marvell . . .* (2 vols., 1892) in the "Muses' Library," where a full bibliography of his works and of the commentaries on them is provided; *The Poems and some Satires of Andrew Marvell* (ed. Edward Wright, 1904); *Andrew Marvell* (1905), by Augustine Birrell in the "English Men of Letters" series; and W. H. Bagguley, *Andrew Marvell, 1621–1675 Tercentenary Tributes* (1922).

MARX, KARL HEINRICH (1818–1883), German socialist and philosopher, and head of the International Working Men's Association (*see* INTERNATIONAL) was born on May 5, 1818, in Treves (Rhenish Prussia). His father, a Jewish lawyer, in 1824 went over to Christianity, and he and his whole family were baptized as Protestants.

The son went to the high grammar school at Treves, and from 1835 to the universities of Bonn and Berlin. He studied first law, then history and philosophy, and in 1841 received the degree of doctor of philosophy. In Berlin he had close intimacy with the brothers Bruno and Edgar Bauer and their Hegelian circle, the so-called "Freien."

Beginnings.—His Radical views made a university career out of the question, and he joined the staff of the *Rheinische Zeitung*, which expounded the ideas of the most advanced section of the Rhenish Radical *bourgeoisie*. In Oct. 1842 he became one of the editors of this paper, which, however, was suppressed in the beginning of 1843. In the summer of this year Marx married Jenny von Westphalen, the daughter of a high government official. Through her mother Jenny von Westphalen was a lineal descendant of the earl of Argyle, who was beheaded under James II. She was a most faithful companion to Marx during all the vicissitudes of his career and died on Dec. 2, 1881; he outliving her only 15 months.

Already in the *Rheinische Zeitung* there appeared some socialist doctrine couched in a somewhat philosophical strain. Marx, though not accepting these views, refused to criticize them until he had studied the question thoroughly. For this purpose he went in the autumn of 1843 to Paris, where the socialist movement was then at its intellectual zenith, and where he, together with Arnold Ruge, the well-known literary leader of Radical Hegelianism, was to edit a review, the *Deutsch-französische Jahrbücher,* of which, however, only one number appeared. It contained two articles by Marx—a criticism of Bruno Bauer's treatment of the Jewish question, and an introduction to a criticism of Hegel's philosophy of the law. The first contended that the social emancipation of the Jews could only be achieved together with the emancipation of society from Judaism, *i.e.* commercialism. The second declared that in Germany no partial political emancipation was possible; there was now only one class from which a real and reckless fight against authority was to be expected—namely, the proletariat. But the proletariat could not emancipate itself except by breaking all the chains, by dissolving the whole constituted society, by recreating man as a member of the human society in the place of established states and classes. "Then the day of German resurrection will be announced by the crowing of the Gallican cock."

Both articles thus relegated the solution of the questions then prominent in Germany to the advent of socialism, and so far resembled in principle other socialist publications of the time. But the way of reasoning was different, and the final words of the last quoted sentence pointed to a political revolution, to begin in France as soon as the industrial evolution had created a sufficiently strong proletariat. In contradistinction to most of the socialists of the day, Marx laid stress upon the political struggle as the lever of social emancipation. In some letters which formed part of a correspondence between Marx, Ruge, Ludwig Feuerbach, and Mikhail Bakunin, published as an introduction to the review, this opposition of Marx to socialistic "dogmatism" was enunciated in a still more pronounced form: "Nothing prevents us," he said, "from combining our criticism with the criticism of politics, from participating in politics, and consequently in real struggles. We will not, then, oppose the world like doctrinarians with a new principle: here is truth, kneel down here! We expose new principles to the world out of the principles of the world itself. We don't tell it: 'Give up your struggles, they are rubbish, we will show you the true war-cry.' We explain to it only the real object for which it struggles, and consciousness is a thing it *must* acquire even if it objects to it."

In Paris Marx met Friedrich Engels (1820–1895) (*q.v.*), from whom the *Deutsch-französische Jahrbücher* had two articles—a powerfully written outline of a criticism of political economy, and a letter on Carlyle's *Past and Present.* The first result of the collaboration of Marx and Engels was the book *Die heilige Familie oder Kritik der kritischen Kritik, gegen Bruno Bauer und Konsorten,* a scathing exposition of the perverseness of the high-sounding speculative radicalism of Bauer and the other Berlin "Freie." By aid of an analysis which, though not free from exaggeration and a certain diffuseness, bears testimony to the great learning of Marx and the vigorous discerning faculty of both the authors, it is shown that the supposed superior criticism—the "critical criticism" of the Bauer school, based upon the doctrine of a "self-conscious" idea, represented by or incarnated in the critic—was in fact inferior to the older Hegelian idealism. The socialist and working-class movement in Great Britain, France and Germany are defended against the superior criticism of the "holy" Bauer family.

In Paris, where Marx had very intimate intercourse with Heinrich Heine, who always speaks of him with the greatest respect, and some of whose poems were suggested by him, he contributed to a Radical magazine, the *Vorwärts*; but at the request of the Prussian government, nearly the whole staff got orders to leave France. Marx now went to Brussels, where he shortly afterwards was joined by Engels. In Brussels he published his second great work, *La Misère de la philosophie,* a sharp rejoinder to the *Philosophie de la misère ou contradictions économiques* of P. J. Proudhon. In this he deals with Proudhon, whom in the former work he had defended against the Bauers, not less severely than with the latter. It is shown that in many points Proudhon is inferior to both the middle-class economists and the socialists, that his somewhat noisily proclaimed discoveries in regard to political economy were made long before by English socialists, and that his main remedies, the "constitution of the labour-value" and the establishment of exchange bazaars, were but a repetition of what English socialists had already worked out much more thoroughly and more consistently. In justice to Proudhon, it must be added that it is more often his mode of speaking than the thought underlying the attacked sentences that is hit by Marx's criticism. In Brussels Marx and Engels also wrote a number of essays in which they criticized the German literary representatives of that kind of socialism and philosophic radicalism which was mainly influenced by the writings of Ludwig Feuerbach, and deduced its theorems or postulates from speculations on the "nature of man." They mockingly nicknamed this kind of socialism "German or True Socialism," and ridiculed the idea that by disregarding historical and class distinctions a conception of society and socialism superior to that of the English and French workers and theorists could be obtained. Some of these essays were published at the time, two or three by one of the attacked writers in his own magazine; one, a criticism of Feuerbach himself, was in a modified form published by Engels in 1885, but others have remained in manuscript. They were at first intended for publication in two volumes as a criticism of post-Hegelian German philosophy, but the revolution of 1848 postponed for a time all interest in theoretical discussions.

In Brussels Marx and Engels came into still closer contact with the socialist working-class movement. They founded a German workers' society, acquired a local German weekly, the *Brüsseller deutsche Zeitung,* and finally joined a communistic society of German workers, the "League of the Just," a secret society which had its main branches in London, Paris, Brussels and several Swiss towns. For this league, which till then had adhered to the rough-and-ready communism of the German workman Wilhelm Weitling, but which now called itself "League of the Communists" and became an educational and propagandist body, Marx and Engels at the end of 1847 wrote their famous pamphlet, *Manifest der Kommunisten.* It was a concise exposition of the history of the working-class movement in modern society according to their views, to which was added a critical survey of the existing socialist and communist literature, and an explanation of the attitude of the Communists towards the advanced opposition parties in the different countries.

Cologne and London.—Scarcely was the manifesto printed when, in Feb. 1848, the Revolution broke out in France, and "the crowing of the Gallican cock" gave the signal for an upheaval in

Germany such as Marx had prophesied. After a short stay in France, Marx and Engels went to Cologne in May 1848, and there with some friends they founded the *Neue rheinische Zeitung,* with the sub-title "An Organ of Democracy," a political daily paper on a large scale, of which Marx was the chief editor. They took a frankly revolutionary attitude, and directed their criticism to a great extent against the middle-class democratic parties, who, by evading all decisive issues, delayed the achievement of the upheaval. When in November 1848 the king of Prussia dissolved the National Assembly, Marx and his friends advocated the non-payment of taxes and the organization of armed resistance. Then the state of siege was declared in Cologne, the *Neue rheinische Zeitung* was suspended, and Marx was put on trial for high treason. He was unanimously acquitted by a middle-class jury, but in May 1849 he was expelled from Prussian territory. He went to Paris, but was soon given the option of either leaving France or settling at a small provincial place. He preferred the former, and went to England. He settled in London, and remained there for the rest of his life.

At first he tried to reorganize the Communist League; but soon a conflict broke out in its ranks, and after some of its members had been tried in Germany and condemned for high treason, Marx, who had done everything to save the accused, dissolved the Communist League altogether. Nor was a literary enterprise, a review, also called the *Neue rheinische Zeitung,* more successful; only six numbers of it were issued. It contained, however, some very remarkable contributions; and a series of articles on the career of the French Revolution of 1848, which first appeared there, was in 1895 published by Engels in book form under the title of *Die Klassenkämpfe in Frankreich von 1848* "by Karl Marx." Carlyle's *Latter Day Pamphlets,* published at that time, met with a very vehement criticism in the *Neue rheinische Zeitung.* The endeavours of Ernest Jones and others to revive the Chartist movement were heartily supported by Marx, who contributed to several of the Chartist journals of the period, mostly, if not wholly, without getting or asking payment.

He lived at this time in great financial straits, occupying a few small rooms in Dean street, Soho, and all his children then born died very young. At length he was invited to write letters for the *New York Tribune,* whose staff consisted of advanced democrats and socialists of the Fourierist school. For these letters he was paid at the rate of a guinea each. Part of them, dealing with the Eastern Question and the Crimean War, were republished in 1897 (London, Sonnenschein). Some were even at the time reprinted in pamphlet form. The co-operation of Marx, who was determinedly anti-Russian, since Russia was the leading reactionary power in Europe, was obtained by David Urquhart and his followers. A number of Marx's articles were issued as pamphlets by the Urquhartite committees, and Marx wrote a series of articles on the diplomatic history of the 18th century for the Urquhartite *Free Press* (Sheffield and London, 1856–1857).

When in 1859 the Franco-Austrian War about Italy broke out, Marx denounced it as a Franco-Russian intrigue, directed against Germany on the one hand and the revolutionary movement in France on the other. He opposed those democrats who supported a war which in their eyes aimed at the independence of the Italian nation and promised to weaken Austria, whose superiority in Germany was the hindrance to German unity. Violent derogatory remarks directed against him by the well-known nationalist Karl Vogt gave occasion to a not less violent rejoinder, *Herr Vogt,* a book full of interesting material for the student of modern history. Marx's contention, that Vogt acted as an agent of the Bonapartist clique, seems to have been well founded, whilst it must be an open question how far Vogt acted from dishonourable motives. The discussions raised by the war also resulted in a great estrangement between Marx and Ferdinand Lassalle. Lassalle had taken a similar view of the war to that advocated by Vogt, and fought tooth and nail for it in letters to Marx.

In the same year, 1859, Marx published as a first result of his renewed economic studies the book *Zur Kritik der politischen Ökonomie.* It was the first part of a much larger work planned to cover the whole ground of political economy. But Marx found that the arrangement of his materials did not fully answer his purpose, and that many details had still to be worked out. He consequently altered the whole plan and sat down to rewrite the book, of which in 1867 he published the first volume under the title *Das Kapital.*

The International.—In the meantime, in 1864, the International Working Men's Association was founded in London, and Marx became in fact though not in name, the head of its general council. All its addresses and proclamations were penned by him and explained in lectures to the members of the council. The first years of the International went smoothly enough. Marx was then at his best. He displayed in the International a political sagacity and toleration which compare most favourably with the spirit of some of the publications of the Communist League. He was more its teacher than an agitator, and his expositions of such subjects as education, trade unions, the working day, and co-operation were highly instructive. He did not hurry on extreme resolutions, but put his proposals in such a form that they could be adopted by even the more backward sections, and yet contained no concessions to reactionary tendencies.

But this condition of things was not permitted to go on. The anarchist agitation of Bakunin, the Franco-German War, and the Paris Commune created a state of things before which the International succumbed. Passions and prejudices ran so high that it proved impossible to maintain any sort of centralized federation. At the congress of The Hague, Sept. 1872, the general council was removed from London to New York. But this was only a makeshift, and in July 1876 the remains of the old International were formally dissolved at a conference held in Philadelphia. That its spirit had not passed away was shown by subsequent international congresses, and by the growth and character of socialist labour parties in different countries. They have mostly founded their programmes on the basis of its principles, but are not always in their details quite in accordance with Marx's views. Thus the programme which the German socialist party accepted at its congress in 1875 was very severely criticized by Marx. This criticism, reprinted in 1891 in the review *Die neue Zeit,* is of great importance for the analysis of Marx's conception of socialism.

The dissolution of the International gave Marx opportunity of returning to his scientific work. He did not, however, succeed in publishing further volumes of *Das Kapital.* In order to make it —and especially the part dealing with property in land—as complete as possible, he took up, as Engels tells us, a number of new studies, but repeated illness interrupted his researches, and on March 14, 1883, he passed quietly away. He lies buried in Highgate cemetery.

Of his six children only three girls grew up: Jenny, who married Charles Longuet; Laura, who married Paul Lafargue; and Eleanor, who lived for many years an unhappy life with Edward Aveling. (E. Bn.)

Marxist Theory.—The starting point of Marx's theory of Socialism is his doctrine of the class struggle. This provides the clue to the two doctrines chiefly associated with his name—the materialist conception of history and the theory of surplus value. The former of these, though it underlies all his thinking, is nowhere systematically expounded in his books. The latter is the main theme of his chief work, *Das Kapital.*

Marx's materialist conception of history has been often misunderstood. It is far from being merely the doctrine that economic forces are predominant in the direction of social affairs, though this is involved in it. Still less is it the doctrine that individual men act only from material motives, and this is not even involved in it at all. Marx's theory must be confounded neither with the views of writers like Buckle on the effect of physical environment on the course of history, nor with the utilitarian doctrines of Bentham and his followers. In essence, Marx contended that there exist, in any society, certain material "forces of production" and a certain knowledge of their use in man's service. These form the "conditions of production," and for their employment there is required an arrangement of the powers of society, implying a certain relationship among the members, and the establishment and maintenance of appropriate social institutions. If, for example, at a particular stage of development the "forces of production" are to be fully exploited, certain forms of private property must be recognized and secured, and certain members of society endowed with authority both over the material means of production and over the other members, who must accept the subordinate rôle assigned to them by the dictates of economic circumstance. This recognition and this authority imply and require a power able to enforce them; and this power is found in the State, which takes its special form from the character of the economic institutions it exists in order to uphold. Political and social institutions are thus dependent upon and derive their special forms from the underlying economic circumstances of the society in which they exist. Political power is a derivative power, depending for its validity and survival on its correspondence with the needs forced on men by the conditions of production.

These underlying conditions are, however, flexible because of changes both in the forces of production at men's command and in the knowledge of their use. It follows that the superstructure —the arrangement of social classes and the political institutions by which the existing order is maintained—must also change as the conditions of production are modified. But institutions, once established, are highly resistant to modification. The class-structure of society and its political and social institutions therefore tend to lag behind the movement of economic change, until the accumulated disharmony forces drastic readjustment by the method of revolution. Then the entire superstructure is brought crashing down, and a new arrangement of classes and a new set of institutions in harmony with the new economic order arise.

Hegelianism.—The mechanism by which this process is carried into effect is the class-struggle. At this point Marx brings to his aid the Hegelian dialectic in which he had been trained. For Hegel, the history of the world is real only as a history of ideas. Each idea, as it is affirmed as truth, brings with it the idea that is its negation. The ideas do battle, and out of their conflict a new and higher idea arises, to be fought and conquered in its turn. For this battle of ideas Marx substitutes a battle of economic forces, waged by means of the social classes which are the product of these forces. One set of economic forces raises a particular class to power, and this class makes a State in its own image, for the enforcement of its decrees upon the society as a whole. But no class can rule without bringing an antagonistic class into play.

Thus, modern capitalism cannot develop its powers without calling into being a proletariat—a working class depending solely on its wages for the means of life. This proletariat, moreover, must be gathered together in factory and mine, and organized into a co-operative force labouring to produce wealth for the capitalist. Thus concentrated and organized, it becomes a power, and develops a will of its own, contrary to the will of its capitalist masters. In time, it develops far enough to be able to dispense with these masters, and organize the changing and ever expanding forces of production in a new way. It turns upon its masters, and in the fulness of time overthrows them, and sets up a new social and political superstructure corresponding to the new needs of the productive forces. This conception of the method of social and political change underlies the fierce invective of the *Communist Manifesto* of 1847, and indeed all Marx's writings on the practical strategy of socialism and revolution. It has also been the theoretical driving force behind the Communism of modern Russia, and finds dogmatic expression in the writings of Nikolai Lenin.

Marx's only general account of the Materialist Conception of History is found in a few pages of the Preface and Introduction to his *Critique of Political Economy,* the germ of his larger work, *Capital.* But the *Communist Manifesto* is mainly an application of it, while the historical chapters of the first volume of *Capital* (13–15 and 26–32) are in essence an attempt to work out its bearing on the origin and growth of the capitalist system. The pamphlet *Historic Materialism,* by Marx's close collaborator and editor, Friedrich Engels, states the doctrine in a more systematic, if cruder form.

Surplus Value.—The doctrine of surplus value, which is the main theme of *Capital,* is best understood in close relation to Marx's doctrine of historical development and the class struggle. According to the latter, the capitalist class is the exploiter and the labouring class the exploited which will in due time overthrow its rulers. The extraction of surplus value from the workers is the means by which this exploitation is accomplished. In seeking to prove that this exploitation exists, Marx takes his text from the classical economists of his own day, and especially from Ricardo and his less subtle populariser, M'Culloch. According to the classical doctrine, the value of commodities depends on the amount of labour involved in their production, and incorporated in them as finished products. Socialist writers before Marx, such as William Thompson and Thomas Hodgskin, had used this Ricardian doctrine as the basis for an assertion of the workers' "right to the whole produce of labour," and had treated the reward of the capitalists (rent, interest and profits) as sheer extortion, filched from the workers by means of the capitalists' social power.

Marx refines upon this view, and seeks to show that the extortion is made possible because, whereas all commodities sell at their value (apart from temporary market deviations) there is one peculiarity about the worker's only commodity, his labour-power, that marks it off from all others. For this commodity alone has the power, in producing other commodities, to produce a value greater than it possesses itself. The value of the commodity, labour-power, is determined, like that of all other commodities, by the quantity of labour required for its production, or in other words, by the amount of labour required to enable the labourer to subsist and reproduce his kind. But the labourer produces by a day's work more than enough for his subsistence and the subsistence of his family. The capitalist, after paying him a subsistence wage, is able to keep for himself the rest of the labourer's product. This residue, the fund from which rent, interest and profits are drawn, Marx calls "surplus value." Suppose, he says, the labourer works 12 hours a day, and only 6 hours are needed for his subsistence. The capitalist can then filch in the form of surplus value the product of 6 hours' labour. The rate of surplus value is 100% of the labourer's wage, and 50% of the total product.

This doctrine is elaborately worked out in the massive volumes of *Capital.* Marx admits, of course, that all kinds of labour are not of equal value. The skilled workman produces more value than the unskilled, and he also receives higher wages. How are these differences measured? By the differing costs of producing and maintaining the supply of skilled and unskilled workers. The training of the skilled worker is a cost of producing him, and the maintenance of the supply of skilled labour involves additional costs. The "labour" whose amount is the measure and determinant of the value of commodities is not the actual labour time of the workers, irrespective of their skill and quality, but an "abstract, undifferentiated human labour" of which skilled labour is to be regarded as a multiple. One hour's labour of a skilled man may count as two or more hours of this "simple labour"; but the difference is not arbitrary. It is measured by the relative costs of producing the different types of labour.

Equally, not all labour, but only useful labour, is productive of value. Useless labour produces no value at all; and even useful labour produces value only in so far as it is of average, or ordinary, efficiency. A slow worker, who takes two hours to do what an ordinary, or average, worker would do in an hour, produces in two hours only one hour's value. This is Marx's conception of "socially necessary labour."

The Social Right.—While asserting that the worker is exploited by the extraction of surplus value, Marx throws overboard completely the notion that each worker ought to receive the full value of his own product. Modern production, he points out, is essentially a social and co-operative process, in which it is impossible to say what, or how much, any single individual has produced. The "right to the whole produce" thus becomes, not a right of any worker to his own product, but a social right of all the workers to the whole product of their combined and co-operative labour. The entire economic system is essentially one: it is no more possible to draw a line between factory and factory, or industry and industry, than between individual workers.

If then, Marx claims the entire product for the whole body of producers, and treats all surplus value as filched from them by extortion, what allowance does he make for the labour of organising and managing production, and of distributing the products? He is ready to allow that the brain-worker engaged in production is a producer of value equally with the manual worker. But he denies that the processes of distribution, the merchanting and trading processes of industry, are productive of value. This is not to say that they are unnecessary. They are necessary expenses of production, and cause deductions from the amount of surplus value left for division as rent, interest and profits to the exploiters. The workers engaged in distribution have clearly to be paid as well as the directly productive workers. The capitalist also may be doing useful work; but in addition to his own share in the social product he is filching the workers' surplus value.

This surplus value is divided into rent, interest and profits. In discussing the principles on which this division takes place Marx makes few original contributions to economic theory, following in the main the orthodoxy of his own day. But in discussing the allocation of profits (*Capital,* Vol. III.) he incidentally modifies in a vital fashion the impression created by his treatment of the question of value in Volume I. Profits in different employments, he points out, are equalized by the competition of capitalists one with another. If the profits in one employment are high, fresh competitors enter the field, and lower prices until profits fall to the average level.

Capital and Value.—How does this doctrine square with Marx's general theory, borrowed from the orthodox economists, that value depends on the amount of labour incorporated in a commodity, and surplus value on the capitalists' success in prolonging the duration or intensity of labour beyond what is needed in order to provide the labourers' subsistence? According to Marx, surplus value is produced only by labour. Capital itself, spent on machines or materials, can transfer its value to the finished product, but can create in the process no additional value. Thus, if two capitalists have each £1,000, and one spends £700 on machines and materials and £300 on labour, and the other £500 on each, the one has only £300, and the other £500, of capital in a form capable of yielding surplus value. Marx calls this "variable capital," and all capital expended in any way except on the purchase of labour he calls "constant capital"—a distinction fundamentally different from the customary division of capital into "fixed" and "circulating," which Marx also employs. The capitalist with the larger variable capital will, on the face of it, secure a proportionately larger "surplus value." But he will not, according to Marx, secure a larger profit; for the averaging process mentioned above, operating through the prices of the commodities produced by the two capitalists, will bring their profits to a common level.

What follows? It has been tacitly assumed, throughout Volume I., that, apart from temporary marked deviations due to supply and demand, all commodities tend to sell at their value. But it now appears that they do not. They sell at prices which will yield to each capitalist the appropriate profit, and owing to the differing "compositions" of the various capitals employed, as between "constant" and "variable" capital, these prices cannot coincide with the values determined by the amount of abstract labour incorporated in each commodity. Marx's "value," unlike that of the orthodox economists, thus turns out to have no necessary relation to the price of any particular commodity, but to be a property intrinsic to the commodity and wholly distinct from its market price. On this showing, much of the criticism directed against Marx's theory of value is irrelevant; for it has been largely based on the assumption that "value" is equivalent to "normal price." And Marx himself appears to assume this in the first volume.

Marx's explanation would probably have been that, throughout *Capital,* he is dealing, not with the actual phenomena of any particular capitalist society, but with the abstract and unqualified working of a pure capitalist system treated as a unified whole. In this rarified atmosphere, all labourers are one huge exploited class, all capitalists one exploiting class, all values one unified social value. The divergence between particular values and prices does not arise, because the totals of all values and all prices, in which alone the abstract working of the system can be seen, necessarily coincide. The values of particular commodities can no more be separately determined than the contribution of any individual labourer to their production. It is only in the total system that the working of the social process can be clearly seen. This point is of vital importance to the understanding of the highly abstract method followed throughout the first two volumes of *Capital.* The third, put together by Engels after Marx's death from scattered notes, is not wholly in the same vein. It often comes far nearer to a discussion of concrete phenomena.

Subsidiary Doctrines.—There are, of course, many subsidiary doctrines in *Capital,* and some of them are of great importance (*e.g.,* the theory of commercial crises) for the understanding of Marx's place in the history of economic thought. But it has seemed better, in this article, to concentrate upon a careful exposition of his fundamental doctrines than to attempt to cover a wider field. Something must, however, be said in conclusion of his contribution to the problem of Socialist strategy, since round this point centre the most lively controversies among modern Marxists.

We have seen that Marx represents the State as a part of the political superstructure whose form is, in the long run, governed by the character of the productive forces. Its function is to uphold the dominant productive system, and the social relationships which are essential for its working. It is "an executive committee for managing the affairs of the governing class as a whole." Accordingly, when a new governing class is brought to power by a revolution in the productive forces, it becomes necessary for the new class to re-make the State in its own image. It cannot simply take over the State from its old masters, and use it for its own ends; for it will not be adapted for those ends. It must smash the old State, and make a new one for itself. It is on this part of Marx's doctrine that the modern Communists base their policy, quoting in support of their views Marx's famous discussion of the Paris Commune of 1871, first issued as a manifesto of the International Working Men's Association, and now known as *The Civil War in France.* On the other hand, the Social Democrats of Germany, and indeed most European Socialist Parties, profess to be Marxist, and yet work for the constitutional conquest of political power by peaceful capture of the existing State machine. They mean to modify the machine, but not to smash it or build up a new State on a purely proletarian foundation.

The doctrine of the "dictatorship of the proletariat," emphasized by the modern Communists, is based directly on Marx's theory of the State. The dictatorship is the means by which the proletariat makes, and exerts the authority of, a new State of its own. But this stage is conceived as purely transitional. The dictatorial proletarian State is a necessary instrument for the crushing of counter-revolution and the firm establishment of the new order. But, when once this is accomplished, the need for it disappears. There is no longer a proletariat to dictate; for exploitation has been abolished, and all classes are merged in one. The apocalyptic vision of the closing chapter of Volume I. of *Capital* has come true. The State, in Lenin's phrase, "withers away": the problem of government is replaced by that of social administration in a classless society in which all economic antagonisms have been resolved. Thus Marxian socialism, like all socialism, ends in the proclamation of a Utopia. But this Utopia is not, for Marx, the end; it is the opening of a new chapter in the record of mankind. At this point, with the final disappearance of class distinctions and the exploitation of man by man, "pre-history ends, and history begins."

No attempt has been made in this article to criticise or evaluate the Marxian doctrine as a whole. It has been confined to an attempt to state clearly the main outlines of the Marxian system, in so far as this is possible in face of the incompleteness of Marx's published work. In the note below, mention has been made of books both favourable and unfavourable to the Marxian standpoint. (G. D. H. C.)

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WRITINGS.—An exhaustive bibliography of Marx and Engels' writings is given in vol. 1 of *Archiv* (in Russian and German) published by the Marx-Engels Institute, Moscow, which has also begun the issue of a collected edition of their writings in 42 vols.

MARX, WILHELM (1863–), German politician, was born at Cologne Jan. 15, 1863. He entered the political branch of the Civil Service and became a judge. In 1899 he was elected to the Prussian Diet and in 1910 entered the German Reichstag, where he soon became prominent among the leaders of the Centre. He was elected president of the Centre party in 1921, and on Nov. 30, 1923 succeeded Stresemann as chancellor of the Reich. In Aug. 1924 he took part in the Conference of London which determined the acceptance of the Dawes Plan. (*See* GERMANY.) In the autumn of 1924 Marx dissolved the Reichstag in the hope of getting a government majority, and after the elections retired from the post of chancellor. In Feb. 1925 he became Prussian Minister-President for a short period. After the death of Ebert he stood as candidate for the post of president of the Reich, but was defeated by Hindenburg. In Jan. 1926 he became Minister for Justice and Occupied Territories in the second Luther Cabinet and later in the same year succeeded Luther as Chancellor. He remained Chancellor through the reshuffle on the entry of the German National Party representatives into the cabinet, but resigned on June 13, 1928, partly owing to ill health.

MARY, the mother of Jesus. At the time when the gospel history begins, she had her home in Galilee, at the village of Nazareth.

Of her parentage nothing is recorded in any extant historical document of the 1st century, for the genealogy in Luke iii. (*cf.* i. 27) is manifestly that of Joseph.

In early life she became the wife of Joseph (*q.v.*) and the mother of Jesus Christ; that she afterwards had other children is inferred by some from Matt. i. 25.

The few incidents mentioned in Scripture about her show that she followed our Lord to the very close of His earthly career with unfailing motherliness, but the "Magnificat" assigned to her in Luke i. is the only passage which would distinctly imply on her part a high prophetic appreciation of His divine mission. It is however doubtful whether Luke really intended to assign this hymn to Mary or to Elizabeth (*cf.* especially *Niceta of Remesiana* by A. E. Burn, Cambridge, 1905; Harnack's "Das Magnificat der Elizabeth" in the *Sitzungsberichte* of the Berlin Academy for 1900, and Burkitt's "Who spoke the Magnificat?" in the *Journal of Theological Studies,* Jan. 1906). The original text of Luke probably mentioned no name in introducing the Magnificat; scribes supplied the ambiguity by inserting, some Mary, others Elizabeth. It is doubtful which represents the intention of the writer: there is perhaps more to be said for the view that he meant to assign the Magnificat to Elizabeth. The Fourth Gospel records that Mary was present at the Crucifixion, where she was commended by Jesus to the care of the Apostle John (John xix. 26 f.), Joseph having apparently died before this time. Mary is mentioned in Acts i. 14 as having been among those who continued in prayer along with the apostles at Jerusalem during the interval between the Ascension and Pentecost. There is no mention in the New Testament of the time or place of her death.

The subsequent growth of ecclesiastical tradition, legend and belief regarding Mary will be traced most conveniently under the separate heads of (1) her perpetual virginity, (2) her absolute sinlessness, (3) her peculiar relation to the Godhead, which specially fits her for successful intercession on behalf of mankind.

(1) Her Perpetual Virginity.—This doctrine was, to say the least, of no importance in the eyes of the evangelists, and so far as extant writings go there is no evidence of its having been anywhere taught within the pale of the Catholic Church of the first three centuries. On the contrary, to Tertullian the fact of Mary's marriage after the birth of Christ is a useful argument for the reality of the Incarnation against gnostic notions, and Origen relies upon the references to the Lord's brethren as disproving the Docetism with which he had to contend. The ἀειπαρθενία, though very ancient, is in reality a doctrinc of non-Catholic origin, and first occurs in a work proscribed by the earliest papal *Index librorum prohibitorum* (attributed to Gelasius) as heretical—the so-called *Protevangelium Jacobi,* written, it is generally admitted, within the 2nd century. According to this very early romance, which seems to have formed the basis of the later *Liber de infantia Mariae et Christi salvatoris* and *Evangelium de nativitate Mariae,* the name of Mary's father was Joachim (in the *Liber de infantia* a shepherd of the tribe of Judah, living in Jerusalem); he had long been married to Anna her mother, whose continual childlessness had become a cause of much humiliation and sorrow to them both. The birth of a daughter was at last angelically predicted to each parent separately. From her third to her twelfth year "Mary was in the Temple of the Lord as a dove that is nurtured; and she received food from the hand of an angel." When she became of nubile age a guardian was sought for her by the priests among the widowers of Israel "lest she should defile the sanctuary of the Lord"; and Joseph, an elderly man with a family, was indicated for this charge by a miraculous token. Some time afterwards the annunciation took place; when the Virgin's pregnancy was discovered, Joseph and she were brought before the high priest, and, though asserting their innocence in all sincerity, were acquitted only after they had been tried with "the water of the ordeal of the Lord" (Num. v. 11ff.). Numerous details regarding the birth at Bethlehem are then given. To Jerome the perpetual virginity not only of Mary but even of Joseph appeared of so much consequence that while a young man he wrote (387) the long and vehement tract *Against Helvidius,* in which he was the first to broach the theory (which has since gained wide currency) that the brethren of our Lord were children neither of Mary by her husband nor of Joseph by a former marriage, but of another Mary, sister to the Virgin and wife of Clopas or Alphaeus. At last the epithet of ἀεὶ παρθένος was authoritatively applied to the Virgin by the council of Chalcedon in 451, and the doctrine implied has ever since been an undisputed point of orthodoxy both in the Eastern and in the Roman Churches, some even seeking to hold the Anglican Church committed to it on account of the general declaration (in the *Homilies*) of concurrence in the decisions of the first four general councils.

(2) Her Absolute Sinlessness.—While much of the apocryphal literature of the early sects in which she is repeatedly spoken of as "undefiled before God" would seem to encourage some such doctrine as this, many passages from the acknowledged fathers of the Church could be cited to show that it was originally quite unknown to Catholicism. Even Augustine repeatedly asserts that she was born in original sin (*De gen. ad lit.* x. 18); and the *locus classicus* regarding her possible immunity from actual transgression, on which the subsequent doctrine of Lombardus and his commentators was based, is simply an extremely guarded passage (*De nat. et grat.* ch. 36), in which, while contradicting the assertion of Pelagius that many had lived free from sin, he wishes exception to be made in favour of "the holy Virgin Mary, of whom out of honour to the Lord I wish no question to be made where sins are treated of—for how do we know what mode of grace wholly to conquer sin may have been bestowed upon her who was found meet to conceive and bear Him of whom it is certain that He had no sin." A writer so late as Anselm (*Cur deus homo,* ii. 16), declares that "the Virgin herself whence He (Christ) was assumed was conceived in iniquity, and in sin did her mother conceive her, and with original sin was she born, because she too sinned in Adam in whom all sinned," and the same view was expressed by Damiani. For the growth of the modern Roman doctrine of the immaculate conception from the time in the 12th century, when the canons of Lyons sought to institute a festival in honour of her "holy conception," and were remonstrated with by Bernard, *see* IMMACULATE CONCEPTION. The epithets applied to her in the Greek Church are such as ἀμόλυντος, πάναγνος, ἁγία, παναγία; but in the East generally no clear distinction is drawn between immunity from actual sin and original sinlessness.

(3) Her Peculiar Relation to the Godhead, which Specially Fits Her for Successful Intercession on Behalf of Mankind.—It seems probable that the epithet θεοτόκος ("Mother of God") was first applied to Mary by theologians of Alexandria towards the close of the 3rd century; but it does not occur in any genuine extant writing of that period, unless we are to assign an early date to the apocryphal *Transitus Mariae,* in which the word is of frequent occurrence. In the 4th century it is met with frequently, being used by Eusebius, Athanasius, Didymus, and Gregory of Nazianzus,—the latter declaring that the man who believes not Mary to have been θεοτόκος has no part in God (*Orat.* li. p. 738). If its use was first recommended by a desire to bring into prominence the divinity of the Incarnate Word, there can be no doubt that latterly the expression came to be valued as directly honourable to Mary herself and as corresponding to the greatly increased esteem in which she personally was held throughout the Catholic world, so that when Nestorius and others began to dispute its propriety, in the following century, their temerity was resented, not as an attack upon the established orthodox doctrine of the Nicene creed, but as threatening a more vulnerable and more tender part of the popular faith. It is sufficient in illustration of the drift of theological opinion to refer to the first sermon of Proclus, preached on a certain festival of the Virgin at Constantinople about the year 430, or to that of Cyril of Alexandria delivered in the church of the Virgin Mary at the opening of the council of Ephesus in 431. In the former the orator speaks of "the holy Virgin and Mother of God" as "the spotless treasure-house of virginity, the spiritual paradise of the second Adam; the workshop in which two natures were welded together . . . the one bridge between God and men"; in the latter she is saluted as the "mother and virgin," "through whom (δι' ἧς) the Trinity is glorified and worshipped, the Cross of the Saviour exalted and honoured, through whom Heaven triumphs, the angels are made glad, devils driven forth, the tempter overcome, and the fallen creature raised up even to heaven." The response which such language found in the popular heart was sufficiently shown by the shouts of joy with which the Ephesian mob heard of the deposition of Nestorius, escorting his judges with torches and incense to their homes, and celebrating the occasion by a general illumination. The causes which in the preceding century had led to this exaltation of the Mother of God in the esteem of the Catholic world are not far to seek. On the one hand the solution of the Arian controversy, however correct it may have been theoretically, undoubtedly had the practical effect of relegating the God-man redeemer for ordinary minds into a far away region of "remote and awful Godhead," so that the need for a mediator to deal with the very Mediator could not fail to be felt. Perhaps it ought to be added that the comparative colourlessness with which the character of Mary is presented, not only in the canonical gospels but even in the most copious of the apocrypha, left greater scope for the untrammelled exercise of devout imagination than was possible in the case of Christ, in the circumstances of whose humiliation and in whose recorded utterances there were many things which the religious consciousness found difficulty in understanding or in adapting to itself. At all events, from the time of the council of Ephesus, to exhibit figures of the Virgin and Child became the approved expression of orthodoxy, and the relationship of motherhood in which Mary had been formally declared to stand to God was instinctively felt to give the fullest and freest sanction of the Church to that invocation of her aid which had previously been resorted to only hesitatingly and occasionally. Previous to the council of Ephesus, indeed, the practice had obtained complete recognition, so far as we know, in those circles only in which one or other of the numerous redactions of the *Transitus Mariae* passed current. There we read of Mary's prayer to Christ: "Do Thou bestow Thine aid upon every man calling upon, or praying to, or naming the name of Thine handmaid"; to which His answer is, "Every soul that calls upon Thy name shall not be ashamed, but shall find mercy and support and confidence both in the world that now is and in that which is to come in the presence of My Father in the heavens." But Gregory of Nazianzus also, in his panegyric upon Justina, mentions with incidental approval that in her hour of peril she "implored Mary the Virgin to come to the aid of a virgin in her danger." Of the growth of the Marian cultus, alike in the East and in the West, after the decision at Ephesus it would be impossible to trace the history, however slightly, within the limits of the present article. Justinian in one of his laws bespeaks her advocacy for the empire, and he inscribes the high altar in the new church of St. Sophia with her name. Narses looks to her for directions on the field of battle. The emperor Heraclius bears her image on his banner. John of Damascus speaks of her as the sovereign lady to whom the whole creation has been made subject by her son. Popular devotion gradually developed the entire system of doctrine and practice which Protestant controversialists are accustomed to call by the name of Mariolatry. With reference to this much-disputed phrase it is always to be kept in mind that the directly authoritative documents, alike of the Greek and of the Roman Church, distinguish formally between *latria* and *dulia,* and declare that the "worship" to be paid to the Mother of God must never exceed that superlative degree of *dulia* which is vaguely described as *hyperdulia.* But it does not seem unfair to hold the Roman Church responsible for the natural interpretations and just inferences which may be drawn even from apparently exaggerated expressions in such works as the well-known *Glories of Mary* and others frequently quoted in controversial literature. There is a good *résumé* of Catholic developments of the cultus of Mary in Pusey's *Eirenicon.*

MARY, known as MARY MAGDALENE, a woman mentioned in the Gospels, first in Luke viii. 2, as one of a company who "healed of evil spirits and infirmities . . . ministered unto them (Jesus and the apostles) of their substance." It is said that seven demons were cast out of her. Mary came from Magdala (el-Mejdel, 3m. N.W. from Tiberias: in Matt. xv. 39 the right reading is not Magdala but Magadan). She went with Jesus on the last journey to Jerusalem, witnessed the Crucifixion, followed to the burial, and returned to prepare spices. John xx. gives an account of her finding the tomb empty and of her interview with the risen Jesus. Mary of Magdala has been confounded (1) with the unnamed fallen woman who in Simon's house anointed Christ's feet (Luke vii. 37); (2) with Mary of Bethany, sister of Lazarus and Martha.

MARY I., queen of England (1516–1558), unpleasantly remembered as "the Bloody Mary" on account of the religious persecutions which prevailed during her reign, was the daughter of Henry VIII. and Catherine of Aragon, born in the earlier years of their married life, when as yet no cloud had darkened the prospect of Henry's reign. Her birth occurred at Greenwich, on Monday, Feb. 18, 1516, and she was baptized on the following Wednesday, Cardinal Wolsey standing as her godfather. She seems to have been a precocious child, and is reported in July 1520, when scarcely four and a half years old, as entertaining some visitors by a performance on the virginals. When she was little over nine she was addressed in a complimentary Latin oration by commissioners sent over from Flanders on commercial matters, and replied to them in the same language "with as much assurance and facility as if she had been twelve years old" (Gayangos, iii. pt. 1, 82). Her father was proud of her achievements. About the same time that she replied to the commissioners in

Latin he was arranging that she should learn Spanish, Italian and French. A great part, however, of the credit of her early education was undoubtedly due to her mother, who not only consulted the Spanish scholar Vives upon the subject, but was herself Mary's first teacher in Latin.

When Mary was two years old she was proposed in marriage to the dauphin, son of Francis I. Three years afterwards the French alliance was broken off, and in 1522 she was affianced to her cousin the young emperor Charles V. by the Treaty of Windsor. Not many years passed away before Charles released himself from this engagement and made a more convenient match. In 1526 a rearrangement was made of the royal household, and it was thought right to give Mary an establishment of her own along with a council on the borders of Wales, for the better government of the Marches. For some years she accordingly kept her court at Ludlow, while new arrangements were made for the disposal of her hand. She was now proposed as a wife, not for the dauphin as before, but for his father Francis I., who had just been redeemed from captivity at Madrid, and who was only too glad of an alliance with England to mitigate the severe conditions imposed on him by the emperor. Wolsey, however, on this occasion, only made use of the princess as a bait to enhance the terms of the compact, and left Francis free in the end to marry the emperor's sister.

It was during this negotiation, as Henry afterwards pretended, that the question was first raised whether his own marriage with Catherine was a lawful one. But this story is proved to be untrue by the strongest evidence, for we have pretty full contemporary records of the whole negotiation. On the contrary, it is clear that Henry, who had already conceived the project of a divorce, kept the matter a dead secret, and was particularly anxious that the French ambassadors should not know it, while he used his daughter's hand as a bait for a new alliance. The alliance itself, however, was actually concluded by a treaty dated Westminster, April 30, 1527, in which it was provided, as regards the Princess Mary, that she should be married either to Francis himself or to his second son Henry duke of Orleans.

During the next nine years the life of Mary, as well as that of her mother, was rendered miserable by the conduct of Henry VIII. in seeking a divorce. During most of that period mother and daughter seem to have been kept apart. Possibly Queen Catherine had the harder trial; but Mary's was scarcely less severe. Removed from court and treated as a bastard, she was, on the birth of Anne Boleyn's daughter, required to give up the dignity of princess and acknowledge the illegitimacy of her own birth. On her refusal her household was broken up, and she was sent to Hatfield to act as lady-in-waiting to her own infant half-sister. Nor was even this the worst of her trials; her very life was in danger from the hatred of Anne Boleyn. Her health, moreover, was indifferent, and even when she was seriously ill, although Henry sent his own physician, Dr. Buttes, to attend her, he declined to let her mother visit her. At her mother's death, in January 1536, she was forbidden to take a last farewell of her.

But in May following another change occurred. Anne Boleyn, the cause of her miseries, fell under the king's displeasure and was put to death. Mary was then urged to make a humble submission to her father as the means of recovering his favour, and after a good deal of correspondence with the king's secretary, Cromwell, she actually did so. The terms exacted of her were bitter in the extreme, but there was no chance of making life tolerable otherwise, if indeed she was permitted to live at all; and the friendless girl, absolutely at the mercy of her father who could brook no contradiction, at length subscribed an act of submission, acknowledging the king as "Supreme Head of the Church of England under Christ," repudiating the pope's authority, and confessing that the marriage between her father and mother "was by God's law and man's law incestuous and unlawful." Henry was now reconciled to her, and gave her a household in some degree suitable to her rank. During the rest of the reign we hear little about her except in connection with a number of new marriage projects taken up and abandoned. Her privy purse expenses for nearly the whole of this period have been published, and show that Hatfield, Beaulieu or Newhall in Essex, Richmond and Hunsdon were among her principal places of residence. Although she was still treated as of illegitimate birth, it was believed that the king, having obtained from parliament the extraordinary power to dispose of the crown by will, would restore her to her place in the succession, and three years before his death she was so restored by statute, but still under conditions to be regulated by her father's will.

Under the reign of her brother, Edward VI. she was again subjected to severe trials, which at one time made her seriously meditate escaping abroad. Edward himself indeed seems to have been personally kind to her, but the religious revolution in his reign assumed proportions such as it had not done before, and Mary, who had done sufficient violence to her own convictions in submitting to a despotic father, was not disposed to yield an equally tame obedience to authority exercised by a factious council in the name of a younger brother not yet come to years of discretion. Besides, the cause of the pope was naturally her own. In spite of the declaration formerly wrung from herself, no one regarded her as a bastard, and the full recognition of her rights depended on the recognition of the pope as head of the Church. Hence, when Edward's parliament passed an Act of Uniformity enjoining services in English and communion in both kinds, she insisted on having Mass in her own private chapel under the old form. When ordered to desist, she appealed for protection to the emperor Charles V., who, being her cousin, intervened for some time not ineffectually, threatening war with England if her religious liberty was interfered with.

But Edward's court was composed of factions of which the most violent eventually carried the day. Lord Seymour, the admiral, was attainted of treason and beheaded in 1549. His brother, the Protector Somerset, met with the same fate in 1552. Dudley, duke of Northumberland, then became paramount in the privy council, and easily obtained the sanction of the young king to those schemes for altering the succession which led immediately after his death to the usurpation of Lady Jane Grey. Dudley had, in fact, overawed the rest of the privy council, and when the event occurred he took such energetic measures to give effect to the scheme that Lady Jane was actually recognized as queen for some days, and Mary had to fly from Hunsdon into Norfolk. But the country was devoted to her cause, as indeed her right in law was unquestionable, and before many days she was royally received in London, and took up her abode within the Tower.

Her first acts at the beginning of her reign displayed a character very different from that which she still holds in popular estimation. Her clemency towards those who had taken up arms against her was remarkable. She released from prison Lady Jane's father, Suffolk, and had difficulty even in signing the warrant for the execution of Northumberland. Lady Jane herself she fully meant to spare, and did spare till after Wyatt's formidable insurrection. Her conduct, indeed, was in every respect conciliatory and pacific, and so far as they depended of her personal character the prospects of the new reign might have appeared altogether favourable. But her position was one of peculiar difficulty, and the policy on which she determined was far from judicious. Inexperienced in the art of governing, she had no trusty councillor but Gardiner; but she was naturally led to rely even more on the advice of her cousin, the emperor, who had been her mother's friend in adversity, and had done such material service to herself in the preceding reign. Following the emperor's guidance she determined almost from the first to make his son Philip her husband, though she was eleven years his senior. She was also strongly desirous of restoring the old religion and wiping out the stigma of illegitimacy upon her birth.

Restoration of the old religion might deprive the new owners of abbey lands of their comfortable acquisitions; and it was only with an express reservation of their interests that the thing was actually accomplished. A declaration of her own legitimacy necessarily cast a slur on that of her sister Elizabeth, and cut her off from the succession. But the marriage promised to throw England into the arms of Spain and place the resources of the kingdom at the command of the emperor's son. The Commons sent her a deputation to entreat that she would not marry a foreigner, and when her resolution was known insurrections broke out in different parts of the country. Suffolk, whose first rebellion had been pardoned, proclaimed Lady Jane Grey again in Leicestershire, while Wyatt raised the county of Kent and, though denied access by London Bridge, led his men round by Kingston to the very gates of London before he was repulsed. In the midst of the danger Mary showed great intrepidity, and the rebellion was presently quelled; after which she married Philip, restored the old religion, and induced Cardinal Pole to absolve the kingdom from its past disobedience to the Holy See.

It was a more than questionable policy thus to ally England with Spain—a power then actually at war with France. By the treaty, indeed, England was to remain neutral; but the force of events, in the end, compelled her to take part in the quarrel. Meanwhile the country was full of faction, and seditious pamphlets of Protestant origin inflamed the people with hatred against the Spaniards. Philip's Spanish followers met with ill-usage everywhere, and violent outbreaks occurred. A year after his marriage Philip went over to Brussels to receive from his father the government of the Low Countries and afterwards the kingdom of Spain. To Mary's distress, his absence was prolonged for a year and a half, and when he returned in March 1557 it was only to commit England to the war; after which he went back to Brussels in July, to return no more to England.

Hostilities with France were inevitable, because France had encouraged disaffection among Mary's subjects, even during the brief truce of Vaucelles. Conspiracies had been hatched by English refugees in Paris, and an attempt to seize Scarborough had been made with the aid of vessels from the Seine. But perhaps the strangest thing about the situation was that the pope took part with France against Spain. It was this war with France that occasioned the final calamity of the loss of Calais.

The persecution of the Protestants, which has cast so much infamy upon her reign, was not due, as commonly supposed, to inhumanity on her part. When the kingdom was reconciled to Rome and absolved by Cardinal Pole, it followed, almost as a matter of necessity, that the old heresy laws should be revived, as they were then by Act of Parliament. Serious doubts were felt as to the result even from the first; but the law having been once passed could not be relaxed.

No doubt there were milder men among the heretics, but as a class their stern fanaticism and ill-will to the old religion made them dangerous, even to the public peace. Rogers, the first of the martyrs, was burnt on Feb. 4, 1555. Hooper, bishop of Gloucester, had been condemned six days before, and suffered the same fate upon the 9th. From this time the persecution went on uninterrupted for three years and three quarters, numbering among its victims Ridley, Latimer and Cranmer. It came to an end at last on the death of Mary. Nearly three hundred victims are known to have perished at the stake; and their fate created a revulsion against Rome that nothing else was likely to have effected.

Mary was of weak constitution and subject to frequent illnesses, both before and after her accession. One special infirmity caused her to believe a few months after her marriage that she was with child, and thanksgiving services were ordered throughout the diocese of London in November 1554. The same delusion recurred in March 1558, when though she did not make her expectation public, she drew up a will in anticipation of the dangers of childbirth, constituting her husband regent during the minority of her prospective heir. To this she added a codicil on Oct. 28 following, when the illness that was to be her last had set in, showing that she had ceased to have much expectation of maternity, and earnestly entreating her "next heir and successor by the laws" (whom she did not name) to allow execution of the instrument. She died on Nov. 17, 1558.

Her name deserved better treatment than it has generally met with; for she was far from cruel. Her kindness to the poor is undoubted, and the severe execution of her laws seemed only a necessity. Even in this matter, moreover, she was alive to the injustice with which the law was usually strained in behalf of the prerogative; and in appointing Sir Richard Morgan chief justice of the Common Pleas she charged him "not to sit in judgment otherwise for her highness than for her subjects," and to avoid the old error of refusing to admit witnesses against the Crown (Holinshed III. 1112). Her conduct as queen was governed by the best possible intentions; and it is evident that her very zeal for goodness caused most of the trouble she brought upon herself. Her subjects were entirely released, even by papal authority, from any obligation to restore the confiscated lands of the Church. But she herself made it an object, at her own expense, to restore several of the monasteries; and courtiers who did not like to follow her example, encouraged the fanatics to spread an alarm that it would even yet be made compulsory. So the worldly minded joined hands with godly heretics in stirring up enmity against her.

See Sir F. Madden, Introduction to *The Privy Purse Expenses of the Princess Mary* (1831); A. Strickland, *Lives of the Queens of England* (1840–48); Tybler, *History of Edward VI. and Queen Mary;* R. W. Dixon, *History of the Church of England* (6 vols., 1877–1902); A. Zimmermann, *Maria die Katholische* (1890); Stone, *History of Mary I., Queen of England* (1901); M. Hume, *Two English Queens and Philip* (1908); also J. Lingard, *History of England to 1688* (1819–30, new ed., 1915); J. A. Froude, *History of England* (12 vols., 1869); *Calendar of Papers of the Reign of Henry VIII.* (ed. Brewer and Gairdner 1862–72). (J. Gai.)

MARY II. (1662–1694), queen of England, wife of king William III., elder daughter of James, duke of York, afterwards King James II., by his first wife, Anne, daughter of Edward Hyde, 1st earl of Clarendon, was born in London on April 30, 1662. She was educated as a Protestant, and as it was probable that she would succeed to the English throne after the deaths of her uncle, Charles II., and her father, the choice of a husband for her was an important political event. About 1672 the name of William, prince of Orange, was mentioned in this connection; and after some hesitation on both sides caused by the condition of European politics, the betrothal of William and Mary took place in October 1677, and was quickly followed by their marriage in London on Nov. 4. Mary's married life in Holland does not appear to have been a happy one. She soon became very popular among the Dutch, but she remained childless. Her troubles were not diminished after her father became king of England in 1685. James had treated his daughter very shabbily in money matters; and it was increasingly difficult for her to remain loyal to both father and husband when they were so divergent in character and policy. Mary shared heartily in the events which immediately preceded William's expedition to England in 1688. After the success of the undertaking she arrived in London in February 1689; and by her faithful adherence to her promise made a satisfactory settlement of the English crown possible.

William and Mary were together proclaimed king and queen of England, and afterwards of Scotland, and were crowned on April 11, 1689. During the king's absence from England the queen, assisted by a committee of the privy council, was entrusted with the duties of government, duties which she performed faithfully, but which she gladly laid down on William's return. In these times of danger, however, she acted when necessary with courage and promptitude, as when in 1690 she directed the arrest of her uncle Henry Hyde, 2nd earl of Clarendon; but she was constantly anxious for William's safety, and unable to trust many of her advisers. She was distressed by a quarrel with her sister Anne in 1692 following the dismissal of Marlborough, and this event somewhat diminished her popularity, which had hitherto been one of the mainstays of the throne. Weak in body and troubled in mind, the queen died at Kensington Palace from small-pox on Dec. 28, 1694, and was buried in Westminster Abbey.

Mary was a woman of a remarkably modest and retiring disposition, whose outstanding virtue was perhaps her unswerving loyalty to William. Burnet has passed a remarkable panegyric upon her character. She was extremely pious and charitable; her blameless private life was in marked contrast with her surroundings, both in England and Holland; without bigotry she was greatly attached to the Protestant faith and to the Church of England. Greenwich Hospital for Seamen was founded in her honour.

For the political events of Mary's life *see* William III. For her private life *see* Sir John Dalrymple, *Memoirs of Great Britain and*

Ireland (London, 1790); Countess Bentinck, *Lettres et mémoires de Marie, reine d'Angleterre* (The Hague, 1880); *Memoires and Letters of Mary Queen of England* (ed. by R. Doebner, Leipzig, 1886); F. J. L. Krämer, *Maria II. Stuart* (Utrecht, 1890); Agnes Strickland, *Lives of the Queens of England,* vols. x. and xi. (London, 1847); G. Burnet, *History of my own Time* (Oxford, 1833); O. Klopp, *Der Fall des Hauses Stuart* (Vienna, 1875–88). *Letters of two Queens Mary II. and Anne,* ed. Holden (1925).

MARY (1867–), Queen Consort of George V, daughter of the Duke of Teck and Mary Adelaide, daughter of Adolphus, duke of Cambridge, seventh son of George III., was born at Kensington Palace May 26, 1867, and was baptised as Victoria Mary Augusta Louise Olga Pauline Claudine Agnes. She was affianced in 1891 to Albert Edward, Duke of Clarence, eldest son of Edward VII., who died Jan. 14, 1892. On July 3, 1893, she married George, Duke of York, and when he succeeded to the throne, on the death of Edward VII., was crowned with him in Westminster Abbey June 22, 1911. Both as Princess of Wales and as queen she took a prominent part in public life, showing special and well-informed interest in all that concerned the welfare of women and children. This was particularly notable at the outset of the World War, when the organization of relief, as well as the promotion of the women's part in public service, claimed and received her constant attention. By the universal testimony of those who came into direct contact with her through those anxious years, no one showed a more practical appreciation of the problems to be solved than the queen. In the first month of the war she inaugurated (Aug. 20) the "Queen's Work for Women Fund" to provide employment for as many as possible of the women thrown out of work by the outbreak of war. Over 70 special relief workrooms were opened, through which about 9,000 women passed before Feb. 1915; after that date, the need became less as the women were gradually absorbed into munition making and other industries. On Aug. 10, 1914, the queen also inaugurated "Queen Mary's Needlework Guild" for the purpose of "organizing a collection of garments for those who will suffer on account of the War." On March 11, 1921, the queen showed her sympathy with the higher education of women by visiting the women's colleges at Oxford and responding generously to their appeal for funds. The interest shown by the queen in the hospitals and the nursing profession was signalized when she opened the new College of Nursing (the gift of Lord and Lady Cowdray) in London on May 31, 1926. On June 23, 1936, Queen Mary was created Dame Grand Cross of the Victorian Order, being the first woman admitted into the Order. (*See* GEORGE V; EDWARD VIII.)

MARY (1496–1533), queen of France, daughter of Henry VII. of England and Elizabeth of York. The treaty of Calais (Dec. 21, 1507) arranged for her marriage with Charles of Austria (Charles V.) when the prince reached the age of 14, and the wedding was celebrated by proxy in 1508. The contract was renewed (1513) by Henry VIII., but the emperor Maximilian I. was now in treaty for a marriage with Renée of France (with Brittany as a dowry) for his son, and evinced an intention to withdraw from the contract. He was forestalled by Wolsey, who arranged, by the peace of 1514, the marriage of Mary with Louis XII. of France. The marriage was celebrated at Abbeville on Oct. 9. The bridegroom was a broken man of fifty-two; the bride a beautiful, well-educated and charming girl of eighteen, whose heart was already engaged to Charles Brandon, duke of Suffolk, her future husband. The political marriage was, however, no long one.

Mary was crowned queen of France on Nov. 5, 1514; on Jan. 1 following King Louis died. Mary had only been induced to consent to the marriage with Louis by the promise that, on his death, she should be allowed to marry the man of her choice. But the dukes of Lorraine and Savoy were mentioned as possible suitors, and meanwhile the new king, Francis I., was making advances to her. Suffolk himself was at the head of the embassy which came from England to congratulate the new king, and he used the opportunity to win the hand of the queen. Mary feared opposition, and, in spite of Suffolk's promise to the king to delay any action until after his return, she persuaded him to marry her secretly before he left Paris. Suffolk was ultimately pardoned through Wolsey's intercession, on payment of a heavy fine and the surrender of all the queen's jewels and plate. The marriage was solemnized at Greenwich on May 13, 1515. Mary died on June 24, 1533. By the duke of Suffolk she had three children: Henry, born on March 11, 1516, created earl of Lincoln (1525), who died young; Frances, born on July 16, 1517, the wife of Henry Grey, marquess of Northampton, and mother of Lady Jane Grey (*q.v.*); and Eleanor.

See *Lettres de Louis XII. et du cardinal Georges d'Amboise* (Brussels, 1712); *Letters and Papers of Henry VIII.* (Cal. State Pap.); M. A. E. Green, *Lives of the Princesses of England* (vol. v., 1849–55); Life by James Gairdner in *Dict. Nat. Biog.*

MARY (QUEEN OF SCOTS)[1] (1542–1587), daughter of King James V. and his wife Mary of Lorraine, was born at Linlithgow in Dec. 1542, a few days before the death of her father. In July 1543 a treaty for the betrothal of the infant to Edward, heir of Henry VIII. of England, was made by the regent Arran, but Henry's obvious ambition to annex the crown of Scotland at once to that of England aroused instantly the general suspicion and indignation of Scottish patriotism. The marriage treaty was denounced by the Scots at the end of the same year, Henry retaliated by invasions of Scotland, and the Scots renewed their ancient alliance with France. In 1548 the queen of five years old was betrothed to the dauphin Francis, and set sail for France, where she arrived on Aug. 15. For the next ten years, the child was under the care of her mother's relatives, the Guises. In April 1558 she was married to the dauphin, and in November of the same year Elizabeth became queen of England. In the eyes of Roman Catholic Europe, Elizabeth's birth was illegitimate, and Mary was *de jure* queen of England. Henry II. of France ordered his son and daughter-in-law to challenge Elizabeth's claim by assuming the royal arms of England. Civil strife broke out in Scotland between John Knox and the queen-dowager—between the self-styled "congregation of the Lord" and the adherents of the regent—and Elizabeth retaliated by helping the insurgent Protestants against the queen-dowager and her French troops. The war ended with the death of Mary of Lorraine in June 1560. Francis and Mary, who had become king and queen of France, had no efficient representative in Scotland, and the Protestant leaders were in control of the situation. On Aug. 25 Protestantism was proclaimed and Catholicism suppressed in Scotland by a parliament which was assembled without the assent of the absent queen.

On Dec. 5 Francis II. died; in Aug. 1561 his widow left France for Scotland. The queen arrived in safety at Leith. On Aug. 21 she first met the only man able to withstand her; and their first passage of arms left, as he has recorded, upon the mind of John Knox an ineffaceable impression of her "proud mind, crafty wit and indurate heart against God and His truth." And yet her acts of concession and conciliation were such as no fanatic on the opposite side could have approved. She assented, not only to the undisturbed maintenance of the new creed, but even to a scheme for the endowment of the Protestant ministry out of the confiscated lands of the Church. Her half-brother, Lord James Stuart, shared the duties of her chief counsellor with William Maitland of Lethington, the keenest and most liberal thinker in the country. By the influence of Lord James, in spite of the earnest opposition of Knox, permission was obtained for her to hear mass celebrated in her private chapel—a licence to which, said the reformer, he would have preferred the invasion of ten thousand Frenchmen.

[1]In a letter dated April 4, 1882, referring to the publication of his drama *Mary Stuart,* Swinburne wrote to Edmund Clarence Stedman: "*Mary Stuart* has procured me two satisfactions which I prefer infinitely to six columns of adulation in *The Times* and any profit thence resulting. (1) A letter from Sir Henry Taylor . . . (2) An application from the editor of the *Encyclopædia Britannica*—who might, I suppose, as in Macaulay's time, almost command the services of the most eminent scholars and historians of the country—to me, a mere poet, proposing that I should contribute to that great repository of erudition the biography of Mary Queen of Scots. I doubt if the like compliment was ever paid before to one of our 'idle trade.'" The present article is based on the biography consequently written by the poet for the 9th edition, after revision by Prof. R. S. Rait.

Through all the first troubles of her reign the young queen steered her skilful and dauntless way with the tact of a woman and the courage of a man. An insurrection in the north, headed by the earl of Huntly, gave Lord James, whom she created earl of Murray, the opportunity of destroying the influence of the most powerful Catholic nobleman in Scotland (1562).

The question of the queen's second marriage was, meanwhile, occupying the attention of both English and Scottish statesmen. The chief aim of the diplomacy of Mary and Maitland of Lethington was a recognition by Elizabeth of the Scottish queen's claim to succeed her, in default of heirs of Elizabeth's own body. A marriage between Mary and a Habsburg prince was rendered impossible by Elizabeth's threat that, if Mary married a foreign prince, she would be debarred from the English succession. Elizabeth proposed as a suitor to the queen of Scots her own favourite, Lord Robert Dudley, the widower if not the murderer of Amy Robsart; but she permitted Mary's cousin, Henry, Lord Darnley, to make a visit to Scotland. Darnley's mother, the countess of Lennox, was the daughter of Margaret Tudor, widow of James IV., by her second husband, the earl of Angus, and therefore the next heir to the English throne after Mary herself. She had been born and brought up in England, and had married the earl of Lennox, an exiled Scottish traitor of Mary's minority. Elizabeth knew that a marriage which would unite the two claims to the succession was a probable result of Darnley's visit, but she protested against the marriage. Mary, who had already married her kinsman, in secret, at Stirling Castle, with Catholic rites celebrated in the apartment of David Rizzio, her secretary for correspondence with France, assured the English ambassador, in reply to the protest of his mistress, that the marriage would not take place for three months, when a dispensation from the pope would allow the cousins to be publicly united without offence to the Church. On July 29, 1565, they were accordingly remarried at Holyrood. Protestant feeling was aroused, and Murray raised a rebellion. He entered Edinburgh with his forces, but failed to hold the town against the guns of the castle, and fell back upon Dumfries before the advance of the royal army, which was joined by James Hepburn, earl of Bothwell, on his return from a three years' outlawed exile in France. Another new adherent was the son of the late earl of Huntly, to whom the forfeited honours of his house were restored a few months before the marriage of his sister to Bothwell. In Oct. 1565 the queen marched an army of 18,000 men against the malcontents; their forces dispersed in face of superior numbers, and Murray, on seeking shelter in England, was received with contumely by Elizabeth, whose half-hearted help had failed to support his enterprise, and whose intercession for his return found at first no favour with the queen of Scots. But the conduct of the besotted boy on whom, at their marriage, she had bestowed the title of king, began at once to justify the enterprise and to play into the hands of all his enemies alike. His father set him on to demand the crown matrimonial, which would at least have assured to him the rank and station of independent royalty for life. Rizzio, hitherto his friend and advocate, induced the queen to reply by a reasonable refusal to this hazardous and audacious request. Darnley who professed to be jealous of Rizzio's intimacy with his wife, at once threw himself into the arms of the party opposed to the policy of the queen and her secretary, and the destruction of Rizzio was planned.

On March 9 the palace of Holyrood was invested by a troop under the command of Morton, while Rizzio was dragged by force out of the queen's presence and slain without trial in the heat of the moment. A parliament which had been summoned for the attainder of Murray and his fellow-conspirators was discharged by proclamation issued in the name of Darnley as king; and in the evening of the next day the banished lords returned to Edinburgh. On the day following they were graciously received by the queen, who undertook to sign a bond for their security, but delayed the subscription till next morning under plea of sickness. During the night she escaped with Darnley, whom she had already seduced from the party of his accomplices, and arrived at Dunbar on the third morning after the slaughter of her favourite. From thence they returned to Edinburgh on March 28 guarded by 2,000 horsemen under the command of Bothwell, who had escaped from Holyrood on the night of the murder, to raise a force on the queen's behalf with his usual soldierly promptitude. The slayers of Rizzio fled to England, and were outlawed; Darnley was permitted to protest his innocence and denounce his accomplices.

A reconciliation between husband and wife followed the birth of their son, James, on June 19, 1566, but it was only temporary. Darnley refused to be present at the baptism of the prince in October, and soon afterwards, while suffering from a serious illness, he went to stay with his father in Glasgow. He had earned his doom at all hands alike, and if his wife and Bothwell were by this time plotting against him, his death was not to be the result of a mere domestic conspiracy, for Bothwell had other accomplices than the queen. On Jan. 22, 1567, Mary visited her husband at Glasgow and proposed to remove him to Craigmillar Castle, where he would have the benefit of medicinal baths; but instead of this resort he was conveyed, on the last day of the month, to the lonely and squalid shelter of the residence known as Kirk-of-Field. On the evening of Sunday, Feb. 9, Mary took her last leave of the miserable boy who had so often and so mortally outraged her as consort and as queen. That night the whole city was shaken out of sleep by an explosion of gunpowder which shattered to fragments the building in which he should have slept and perished; and the next morning the bodies of Darnley and a page were found strangled in a garden adjoining it, whither they had apparently escaped over a wall, to be despatched by the hands of Bothwell's confederates.

Three months and six days after the murder of her husband Mary became the wife of her husband's murderer. On Feb. 11 she had written to the bishop of Glasgow, her ambassador in France, announcing her providential escape from a design upon her own as well as her husband's life. A reward of £2,000 was offered by proclamation for discovery of the murderer. Bothwell and others, his satellites or the queen's, were instantly placarded by name as the criminals. Gracefully and respectfully, with statesmanlike, yet feminine dexterity, the demands of Darnley's father for justice on the murderers of his son were accepted and eluded by his daughter-in-law. On March 28 the Privy Council, in which Bothwell himself sat, appointed April 12 as the day of his trial. Bothwell was acquitted in default of witnesses against him, and his wealth and power were enlarged by gift of the parliament which met on the 14th and rose on April 19—a date made notable by the subsequent supper at Ainslie's tavern, where Bothwell obtained the signatures of its leading members to a document affirming his innocence, and pledging the subscribers to promote the marriage by which they recommended the queen to reward his services and benefit the country. On the second day following Mary went to visit her child at Stirling, where his guardian, the earl of Mar, refused to admit more than two women in her train. It was well known in Edinburgh that Bothwell had a body of men ready to intercept her on the way back, and carry her to Dunbar—not, as was naturally inferred, without good assurance of her consent. On April 24, as she approached Edinburgh, Bothwell accordingly met her at the head of 800 spearmen, assured her (as she afterwards averred) that she was in the utmost peril, and escorted her, together with Huntly, Lethington and Melville, who were then in attendance, to Dunbar Castle. On May 3 Lady Jane Gordon, who had become countess of Bothwell on Feb. 22 of the year preceding, obtained a separation on the ground of her husband's infidelities. Mary and Bothwell returned to Edinburgh with every prepared appearance of a peaceful triumph. Lest her captivity should have been held to invalidate the late legal proceedings in her name, proclamation was made of forgiveness accorded by the queen to her captor in consideration of his past and future services. Bothwell, as a conscientious Protestant, refused to marry his mistress according to the rites of her Church, and she, the chosen champion of its cause, agreed to be married to him by a Protestant.

On May 12 Bothwell was created duke of Orkney and Shetland and the marriage was solemnized three days later. The confederate lords almost immediately took up arms and seized the town and the castle of Edinburgh. Proclamations were issued in which the crime of Bothwell was denounced, and the disgrace of the country, the thraldom of the queen and the mortal peril of her infant son, were set forth as reasons for summoning all the lieges of the chief cities of Scotland to rise in arms on three hours' notice and join the forces assembled against the one common enemy. On June 15, one month from their marriage day, the queen and Bothwell, at the head of a force of fairly equal numbers, but visibly inferior discipline, met the army of the confederates at Carberry hill, some 6m. from Edinburgh. Du Croc, the French ambassador, obtained permission, through the influence of Maitland, to convey to the queen the terms proposed by their leaders—that she and Bothwell should part, or that he should meet in single combat a champion chosen from among them. At last it was agreed that the queen should yield herself prisoner, and Bothwell be allowed to retire in safety to Dunbar, with the few followers who remained to him.

In the evening she was taken to Holyrood, and thence to the port of Leith, where she embarked under guard, with her attendants, for the island castle of Lochleven. On the 20th a silver casket containing letters and French verses, miscalled sonnets, in the handwriting of the queen, was taken from the person of a servant who had been sent by Bothwell to bring it from Edinburgh to Dunbar. (*See* CASKET LETTERS.) Three days after this discovery Lord Lindsay, Lord Ruthven and Sir Robert Melville were despatched to Lochleven, there to obtain the queen's signature to an act of abdication in favour of her son, and another appointing Murray regent during his minority. She submitted, and a commission of regency was established. After an imprisonment of 11 months, in the course of which Elizabeth intervened on her behalf, and sent Mary a letter and a ring in token of her protection, a young member of the household at Lochleven, Willie Douglas, aged 18, succeeded on May 2 in assisting her to escape by a postern gate to the lake-side, and thence in a boat to the mainland, where George Douglas, Lord Seton and others were awaiting her. Thence they rode to Seton's castle of Niddry, and next day to Hamilton Palace, round which an army of 6,000 men was soon assembled. The queen's forces made for the castle of Dumbarton, marching 2m. south of Glasgow, by the village of Langside. Here Murray, with 4,500 men, met and defeated his sister's army on May 13. Mary fled 60m. from the field of her last battle before she halted at Sanquhar, and for three days of flight, according to her own account, had to sleep on the hard ground, live on oatmeal and sour milk, and fare at night like the owls, in hunger, cold and fear. On the third day from the rout of Langside she crossed the Solway and landed at Workington in Cumberland, May 16, 1568. On the 20th Lord Scrope and Sir Francis Knollys were sent from court to carry messages and letters of comfort from Elizabeth to Mary at Carlisle. Her fateful choice of England instead of France was determined by her thirst for victory. She believed that Elizabeth's horror of rebellion would lead the English queen to assist her to regain her crown, and she knew no such help could be expected from France, embroiled in the wars of religion. On July 15, after various delays interposed by her reluctance to leave the neighbourhood of the border, where on her arrival she had received the welcome and the homage of the leading Catholic houses of Northumberland and Cumberland, she was removed to Bolton Castle in north Yorkshire. During her residence here a conference was held at York between her own and Elizabeth's commissioners and those appointed to represent her son as a king of Scots. These latter, of whom Murray himself was the chief, privately laid before the English commissioners the contents of the famous casket. On Oct. 24 the place of the conference was shifted from York to London, where the enquiry was to be held before Queen Elizabeth in council. Mary was already aware that the chief of the English commissioners, the duke of Norfolk, was secretly an aspirant to the peril of her hand; and on Oct. 21 she gave the first sign of assent to the suggestion of a divorce from Bothwell. On Oct. 26 the charge of complicity in the murder of Darnley was distinctly brought forward against her, in spite of Norfolk's reluctance and Murray's previous hesitation. On Jan. 10, 1569, the judgment given at the conference acquitted Murray and his adherents of rebellion, while affirming that nothing had been proved against Mary—a verdict accepted by Murray as equivalent to a practical recognition of his office as regent for the infant king. This position he was not long to hold; and the fierce exultation of Mary at the news of his murder gave reason to fear, if her liberty of correspondence and intrigue were not restrained, the likelihood of a similar fate for Elizabeth. On Jan. 26, 1569 she had been removed from Bolton Castle to Tutbury in Staffordshire, where proposals were conveyed to her, at the instigation of Leicester, for a marriage with the duke of Norfolk, to which she gave a graciously conditional assent; but the discovery of these proposals consigned Norfolk to the Tower, and on the outbreak of an insurrection in the north Mary, by Lord Hunsdon's advice, was again removed to Coventry, when a body of her intending deliverers was within a day's ride of Tutbury. In October Cecil had an interview with Mary at Chatsworth, when the conditions of her possible restoration to the throne in compliance with French demands were debated at length. The queen of Scots, with dauntless dignity, refused to yield the castles of Edinburgh and Dumbarton into English keeping, or to deliver up her fugitive English partisans then in Scotland; upon other points they came to terms, and the articles were signed Oct. 16. On the same day Mary wrote to Elizabeth, requesting the favour of an interview which might reassure her against the suggestion that this treaty was a mere pretence. On Nov. 28 she was removed to Sheffield Castle, where she remained for the next 14 years in charge of the earl of Shrewsbury. The detection of a plot, in which Norfolk was implicated, for the invasion of England by Spain on behalf of Mary, who was then to take him as the fourth and most contemptible of her husbands, made necessary the reduction of her household and the stricter confinement of her person. On May 28, 1572, a demand from both houses of parliament for her execution as well as Norfolk's was rejected by Elizabeth, who, however, entered into negotiations with successive Scottish regents for Mary's delivery into their hands and her immediate execution.

In 1581 Mary accepted the advice of Catherine de' Medici and Henry III. that she should allow her son's title to reign as king of Scotland conjointly with herself when released and restored to a share of the throne. This plan was but part of a scheme including the invasion of England by her kinsman, the duke of Guise, who was to land in the north and raise a Scottish army to place the released prisoner of Sheffield beside her son on the throne of Elizabeth. After the overthrow of the Scottish accomplices in this notable project, Mary poured forth upon Elizabeth a torrent of pathetic and eloquent reproach for the many wrongs she had suffered at the hands of her hostess, and pledged her honour to the assurance that she now aspired to no kingdom but that of heaven. In the spring of 1583 she retained enough of this saintly resignation to ask for nothing but liberty, without a share in the government of Scotland; but Lord Burghley not unreasonably preferred, if feasible, to reconcile the alliance of her son with the detention of his mother. In the autumn of 1584 she was removed to Wingfield Manor under charge of Sir Ralph Sadler and John Somers, who accompanied her also on her next removal to Tutbury in Jan. 1585. On Christmas Eve, 1585, she was removed from the hateful shelter of Tutbury to the castle of Chartley in the same county. Her correspondence in cipher from thence with her English agents abroad, intercepted by Walsingham and deciphered by his secretary, gave eager encouragement to the design for a Spanish invasion of England under the prince of Parma. In 1585 Anthony Babington was induced to undertake the deliverance of the queen of Scots by the murder of the queen of England. In the conduct and detection of her correspondence with Babington, traitor was played off against traitor, and spies were utilized against assassins, with as little scruple as could be required or expected in the diplomacy of the time. In August the conspirators were netted, and Mary was arrested at the gate of Tixall park. At Tixall Mary was detained till her papers at Chartley had undergone thorough research. Her secretaries were examined in London, and one of them gave evidence that she had first heard of the conspiracy by letter from Babington, of whose design against the life of Elizabeth she thought it best to take no notice in her reply, though she did not hold herself bound to reveal it. On Sept. 25 she was removed to the castle of Fotheringay in Northamptonshire. On Oct. 6 she was desired to answer the charges brought against her before certain of the chief English nobles.

On Oct. 14 and 15, 1586, the trial was held in the hall of Fotheringay Castle. Mary conducted the whole of her own defence with courage incomparable and unsurpassable ability, insisting on the production of proof in her own handwriting as to her complicity with the project of the assassins, who had expiated their crime on the 20th and 21st of the month preceding. Elizabeth determined to adjourn the judgment and transfer the place of it to the star-chamber. Here, on Oct. 25, the commissioners again met; and one of them alone, Lord Zouch, dissented from the verdict by which Mary was found guilty of having, since June 1 preceding, compassed and imagined divers matters tending to the destruction of Elizabeth. This verdict was conveyed to her, about three weeks later, by Lord Buckhurst and Robert Beale. She wrote to Elizabeth and the duke of Guise two letters of almost matchless eloquence and pathos, admirable especially for their loyal and grateful remembrance of all her faithful servants.

Elizabeth was uncertain how James VI., then 20 years of age, might take the execution of his mother. When Elizabeth discovered that James was much more interested in the succession to the English throne than in his mother's life, and that, if he was assured that her trial and condemnation would not prejudice his claim to the succession, he would (in his own words) "digest" his resentment, she rejected the intercessions made by France and Scotland, and on Feb. 1, 1587, she signed the death-warrant. On Feb. 7 the earls of Shrewsbury and Kent arrived at Fotheringay with the commission of the council for execution of the sentence. Mary received the announcement with majestic tranquillity, expressing in dignified terms her readiness to die, her consciousness that she was a martyr for her religion, and her total ignorance of any conspiracy against the life of Elizabeth. At eight next morning she entered the hall of execution, having taken leave of the weeping envoy from Scotland, to whom she gave a brief message for her son; took her seat on the scaffold, listened with an air of even cheerful unconcern to the reading of her sentence, solemnly declared her innocence of the charge conveyed in it and her consolation in the prospect of ultimate justice, rejected the professional services of Richard Fletcher, dean of Peterborough, lifted up her voice in Latin against his in English prayer, and when he and his fellow-worshippers had fallen duly silent prayed aloud for the prosperity of her own Church, for Elizabeth, for her son, and for all her enemies; then, with no less courage than had marked every hour and every action of her life, received the stroke of death from the wavering hand of the headsman.

Five months after Mary's death her body was buried at Peterborough, whence in 1612 it was removed to King Henry VII.'s chapel in Westminster Abbey. It still lies there in a sumptuous tomb erected by her son, James VI.

Mary Stuart was in many respects the creature of her age, of her creed, and of her station; but the noblest and most noteworthy qualities of her nature were independent of rank, opinion or time. Even the detractors who defend her conduct on the plea that she was a dastard and a dupe are compelled in the same breath to retract this implied reproach, and to admit, with illogical acclamation and incongruous applause, that the world never saw more splendid courage at the service of more brilliant intelligence, that a braver if not "a rarer spirit never did steer humanity." A kinder or more faithful friend, a deadlier or more dangerous enemy, it would be impossible to dread or to desire. Passion alone could shake the double fortress of her impregnable heart and ever-active brain. The passion of love, after very sufficient experience, she apparently and naturally outlived; the passion of hatred and revenge was as inextinguishable in her inmost nature as the emotion of loyalty and gratitude. Of repentance it would seem that she knew as little as of fear, having been trained from her infancy in a religion where the decalogue was supplanted by the creed. Adept as she was in the most exquisite delicacy of dissimulation, the most salient note of her original disposition was daring rather than subtlety. Beside or behind the voluptuous or intellectual attractions of beauty and culture, she had about her the fresher charm of a fearless and frank simplicity, a genuine and enduring pleasure in small and harmless things no less than in such as were neither. In 1562 she amused herself for some days by living "with her little troop" in the house of a burgess of St. Andrews "like a burgess's wife," assuring the English ambassador that he should not find the queen there,—"nor I know not myself where she is become." From Sheffield lodge, 12 years later, she applied to the archbishop of Glasgow and the cardinal of Guise for some pretty little dogs, to be sent her in baskets very warmly packed,—"for besides reading and working, I take pleasure only in all the little animals that I can get." For her own freedom of will and of way, of passion and of action, she cared much; for her creed she cared something; for her country she cared less than nothing. She would have flung Scotland with England into the hell fire of Spanish Catholicism rather than forgo the faintest chance of personal revenge. Elizabeth, so shamefully her inferior in personal loyalty, fidelity and gratitude, was as clearly her superior on the one all-important point of patriotism. (A. C. S.; R. S. R.)

Bibliography.—The biography of Mary Stuart being virtually the history of Scotland during the period covered by her life, with which the history of England at the same period is also largely concerned, the chief events in which she figured are related in all the general *Histories* of both countries. The most important original authorities are the voluminous *State Papers* of the period, with other ms. documents preserved at the British Museum, the Cambridge University Library, Hatfield and elsewhere. *See* especially the *Reports* of the Hist. MSS. Commission; *Calendar of State Papers relating to Scotland and Mary Queen of Scots* (Scottish Record Publ., 1898); *Calendar of Letters and State Papers relating to English Affairs, principally in the Archives at Simancas* (vols. i.-iv., 1892–1899); and the *Calendars of State Papers: Domestic Series, Edw. VI.–James I.; Foreign Series, Elizabeth; Venice Series.*

The most important unofficial contemporary works are the *Histories* of John Knox, Bishop John Lesley, George Buchanan, and Robert Lindsay of Pitscottie; the *Diurnal of Remarkable Occurrents from the death of James IV. till 1575* (Bannatyne club, 1833); Robert Birrell's "Diary," in Sir. J. G. Dalzell's *Fragments of Scottish History* (Edinburgh, 1798), etc. Much of Mary's own correspondence will be found in Prince A. Labanoff's *Lettres inédites, 1558–87* (1839), and *Lettres, instructions, et mémoires de Marie Stuart* (7 vols., London, 1844), selections from which have been translated into English by W. Turnbull in *Letters of Mary Queen of Scots* (1845), and by Agnes Strickland in *Letters of Mary Queen of Scots and Documents connected with her Personal History* (3 vols., 1842). Recently the following three publications have added to our knowledge of original sources: Conyers Read: *Bardon Papers* (published by the Royal Historical Society in its Camden Society Series); J. Pollen, *The Babington Conspiracy* (Scottish History Society); and M. Wood, *Balcarres Papers* (Scottish History Society).

Among recent works may be mentioned F. A. MacCunn, *Mary Stuart* (1905); Andrew Lang, *The Mystery of Mary Stuart* (1900); R. S. Rait and A. T. Cameron, *King James's Secret; Negotiations relating to the Execution of Mary, Queen of Scots* (1927).

MARY (1457–1482), duchess of Burgundy, only child of Charles the Bold, duke of Burgundy, and his wife Isabella of Bourbon, was born on Feb. 13, 1457. As heiress of the rich Burgundian domains her hand was eagerly sought by a number of princes. When her father fell upon the field of Nancy, on Jan. 5, 1477, Louis XI. of France took possession of the duchy of Burgundy as a fief lapsed to the French crown, and also of Franche Comté, Picardy and Artois. He was anxious that Mary should marry the Dauphin Charles and thus secure the inheritance of the Netherlands for his descendants. Mary declined the French alliance, and married the archduke Maximilian of Austria, afterwards the emperor Maximilian I., at Ghent on Aug. 18, 1477. She died, of a fall from her horse, on March 27, 1482. Three children had been the issue of her marriage, and her elder son, Philip, succeeded to her dominions under the guardianship of his father.

END OF VOLUME FOURTEEN

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